Admiralty Inlet Pilot Tidal Project
Final Technical Report

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Any findings, opinions, and conclusions or recommendations expressed in this report are those of the author(s) and do not necessarily reflect the views of the Department of Energy.

Executive Summary

Tidal energy represents potential for the generation of renewable, emission free, environmentally benign, and cost effective energy from tidal flows. A successful tidal energy demonstration project in Puget Sound, Washington would potentially enable significant commercial development resulting in important benefits for the northwest region and the nation. Public Utility District No. 1 of Snohomish County (the District) began studying the Admiralty Inlet Pilot Tidal Project (Project) in 2006. This Project promoted the goals set forth by the United States Department of Energy's (DOE) Wind and Hydropower Technologies Program for advancing the commercial viability, cost-competitiveness, and market acceptance of marine hydrokinetic systems.

The Project purpose was to license, permit and install a grid connected deep-water tidal array to be used as a platform to gather operational and environmental data. The data could then be used to better inform the viability of commercial tidal energy generation from technical, economic, social, and environmental standpoints. This data would serve as a critical step towards the responsible advancement of commercial scale tidal energy in the United States and around the world. Not only would this information impact future tidal energy development, it could also aid in the advancement of other alternative energy developments including wave and offshore wind.

Regulatory requirements necessitated extensive collaboration with local, state, and federal agencies on the Project and resulted in issuance of all required permits and authorizations. Outreach to other stakeholders and interested parties increased public awareness and comfort with the relatively new technology being proposed for the Project, an otherwise unexplored alternative energy source in the region.

Design considerations associated with the Project included but were not limited to the transmission cable, cable laying procedures, power conversion, and grid interconnection in addition to a robust environmental monitoring program developed in coordination with scientists and engineers at the University of Washington, NOAA Fisheries, and other resource agencies. All of the designs developed for the Project under this award can be adapted and applied to future marine hydrokinetic projects, potentially lowering costs, increasing efficiency and creating job opportunities in a growing field.

In late 2014, the District discontinued the Project activities due to escalating costs, and subsequently terminated the DOE award in early 2015. Consequently, remaining tasks including final engineering design, deployment, operation, and monitoring will not be completed. This report discusses the results and accomplishments achieved under the award.

The original scope of this award included the following five tasks:

Task-1 Regulatory Compliance, Systems Engineering Design and Vendor Selection;
Task-2 Final Design, Equipment Procurement and Cable Lay/Power Control Building Construction;
Task-3 Go/No-Go Decision in coordination with DOE;
Task-4 Turbine Deployment and Electrical Connection;
Task-5 Project Operation, Evaluation and Removal.

The District collaborated extensively with project stakeholders to complete Task 1 and its subtasks. The remaining tasks had not been reviewed under NEPA at the time of award termination, and had not commenced. Completion of Task 1 above brought the project through

all necessary requirements to begin procuring equipment and executing construction agreements in support of deployment of the turbines in Admiralty Inlet.

Table of Contents

1. Introduction 7
1.1 Project Goals and Objectives 7
1.2 Tasks Planned 8
2. Results and Accomplishments 9
2.1 Task 1 – Project Design, Planning, and Vendor Selection 9
2.2 Partnerships 12
2.3 Accomplishments 13
3. Products, Reports, and Permits 14
3.1 FERC Environmental Assessment and Pilot License 14
3.2 ROV Survey Report 15
3.3 Proof of Concept Report 15
3.4 Grid Interconnection Facilities Impact Study 15
3.5 Permits and Authorizations 16
4. Project Challenges 17
4.1 Opposition 17
4.2 License and Permitting Timeline 18
4.3 Response to Challenges 18
4.3 Recommendations 19
5. Conclusion 19
6. References 20

List of Figures

Figure 1 – Map of Puget Sound 8

List of Tables

Table 1 – List of vendors 10
Table 2 – Summary of Reports and Products Prepared 14
Table 3 – Permits and Authorizations 17

Appendices

Appendix A - Public Works Bid Documents: Plans and Specifications
Includes:
Geotechnical Report – Landau Associates, 2013
Geophysical Investigation – Golder Associates, 2011
ROV Cable Route Survey – NUC, 2012
FERC Environmental Assessment, 2013
Turbine Supply and Maintenance Agreement
State and Local Permits
Owner Controlled Insurance Program
Appendix B – FERC License Order, March 20, 2014
Appendix C – Proof of Concept Report – Applied Motion Systems and OpenHydro, 2014
Appendix D – Puget Sound Energy Interconnection Facilities Study, 2013

List of Acronyms or Abbreviations

CZMA – Coastal Zone Management Act
District – Public Utility District No. 1 of Snohomish County
DOE – United States Department of Energy
FERC – Federal Energy Regulatory Commission
HIRA – Hazard Identification and Risk Assessment
MARC – Marine Aquatic Resource Committee

MHK – Marine Hydrokinetic
NEPA – National Environmental Policy Act
NNMREC – Northwest National Marine Renewable Energy Center
NOAA – National Oceanic and Atmospheric Administration
PCCE – Power Control and Conditioning Equipment
PCLC – Pacific Crossing Landing Corporation
PNNL – Pacific Northwest National Laboratory
POC – Proof of Concept
ROV – Remotely Operated Vehicle
SEPA – State Environmental Policy Act (Washington State)
SNL – Sandia National Laboratory
TRL – Technical Readiness Level

1. Introduction

1.1 Project Goals and Objectives

The objective of the Puget Sound Tidal Energy Demonstration Project (the Project) was to deploy, operate, monitor and evaluate two 6-meter diameter Open-Center turbines developed and manufactured by OpenHydro Group, Ltd. The Project would generate up to 300 kilowatts of electrical energy during periods of peak tidal currents and provide an attenuated average energy output of approximately 30-40 kilowatts to the local electrical grid. While the Project would have been a grid-connected array, its primary purpose was to gather data to better inform the viability of commercial tidal energy from technical, economic, social, and environmental standpoints. Such data from a pilot project is critical to the advancement of commercial scale tidal energy in the United States.

The Project plan would temporarily place the two turbines in a high-current area approximately 58 meters deep and 1 kilometer offshore of Admiralty Head, Washington (Figure 1). Power would be transferred to the electrical grid via subsea trunk cables (transmission cables) to Whidbey Island. The cable connection between the turbines and shore would utilize a conduit installed via Horizontal Directional Drilling (HDD) to avoid disturbing the nearshore area. The turbines would fit on a gravity-based foundation and would not require anchor placements or pilings for installation. Both the turbines and their foundations were specifically designed to be removable for scheduled routine maintenance or repair using live-boat operations to minimize the potential for anchoring to damage a communication cable in the project area.

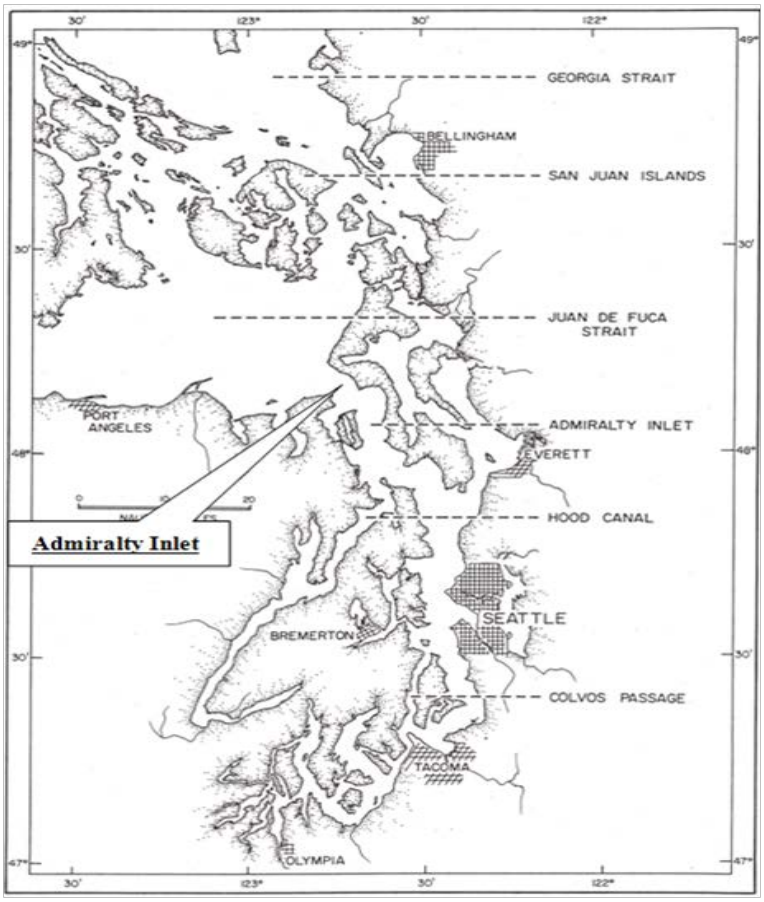

Figure 1 – Map of Puget Sound

1.2 Tasks Planned

The Project scope of work included five tasks described below. At the time of termination, Task 1 was completed, and the remaining tasks were on hold, pending NEPA review. Results are discussed in section 2.

Task 1: Project Design, Planning and Vendor Selection

The objective of Task 1 was to complete all permit and regulatory activities, including obtaining the FERC license, and other applicable authorizations from federal, state, and local agencies. Task 1 also included completion of construction planning activities and selection of the public works contractor to oversee Project construction. Completion of Task 1 would bring the Project engineering designs to near-final stage, in preparation of final plans being submitted to the contractor. This task was complete at the time of award termination.

Task 2: Final Design, Equipment Procurement, Assembly, and Construction

Task 2 was intended to finalize system engineering design and procure, fabricate, ship and assemble all materials, complete equipment construction and site preparation activities, including construction of the power control building on shore.

Task 3: Go/No-Go Decision

Task 3 would allow for DOE to complete an evaluation of the project to obtain approval to move into budget period 2 and final deployment activities encompassed in the remaining tasks.

Task 4: Sea Trialing, Deployment, Subsea Connection, Testing
This task would include deployment and commissioning of the tidal array. In addition to successful deployment in Admiralty Inlet, the objectives of Task 4 were to begin all environmental testing necessary to qualify the system at Technology Readiness Level (TRL) 8 and demonstrate readiness for the first phase of a commercial plant build out. Sea trialing would include towing turbine and foundation assembly near the deployment site using the installer barge. This task would also include all electrical connections to the power control equipment and local electric grid.

Task 5: Operation, Evaluation, and Removal
The final task included operation of the fully functioning system and performing all required monitoring and evaluation activities, both for system operation purposes and regulatory compliance purposes. This information was to be provided to the DOE, regulatory agencies, and other stakeholders on a regular basis throughout Project operation.

2. Results and Accomplishments

2.1 Task 1 – Project Design, Planning, and Vendor Selection

Task 1 incorporated extensive partnerships with Project vendors for legal/regulatory services, engineering design and proof-of-concept testing, as well as preparation of contracts and bid documents. The District core team included three engineers, one regulatory analyst, three attorneys, plus numerous support and administrative staff from several departments across the District. Outside vendors included the following:

Vendor Name	Project Roles	Dates of work
OpenHydro, Ltd.	Turbine developer, engineering design	2012-2014
Sound and Sea Technology	Marine operations engineering and design	2012-2014
Harmsen and Associates	Land survey, preparation of permit supplemental documents	2012-2014
Center Marine	Marine operations consulting	2012-2014
Lawhead Architects	Power control building - planning and design, permit assistance	2012-2013
Aronson	Security design for power control building	2013
HDR	Consulting – biological studies and information requests	2013
CapRock Geology	Benthic habitat analysis from ROV survey info	2012
Island County	Permitting agency	2012-2014
Golden Cup	Food service for agency meetings	2012-2014
Jessie Valentine	Property owner – lease payment	2012
Sound Publishing	Newspaper public notice	2013
Daily Herald	Newspaper public notice	2013
Frix Technologies	FERC aperture image creation	2014
Golder Associates	Geophysical consulting, study preparation	2013
Northwest Underwater Construction	Marine design, engineering, ROV survey	2013
AMEC	Cultural resources consultation	2012
Perkins Coie	Outside counsel – contracts, bid documents, compliance with grant terms & conditions	2013-2014

VanNess Feldman	Outside counsel – FERC license assistance, license and permitting application review, appeal response and filings	2012-2014
Puget Sound Energy	Grid interconnection and studies	2012-2014
State of Washington	Permitting agency	2012
Wind Simplicity	Testing for power control and conversion equipment	2013

Table 1 – List of vendors

2.1.1 Regulatory Tracking

Subtask 1.1, regulatory tracking, was defined as "working with regulatory agencies and stakeholders to track final permit progress and regulatory authorizations." A substantial portion of the Task 1 effort involved working with and building strong relationships with regulatory agencies and various other stakeholders. All permit applications were submitted prior to initiating this award. Work under subtask 1.1 included addressing remaining agency concerns and providing additional information as requested. These efforts resulted in all required permits and authorizations being issued (Table 2). Due to Project opposition (discussed in section 4.1), significant District and vendor resources were dedicated to addressing lengthy regulatory appeal processes and drafting responses to oppositional filings. Agencies ultimately ruled in favor of the Project moving forward by denying appeals at the local, state, and federal levels, and issuing the associated permits and authorizations. The FERC docket contains all filings relating to the Project by all parties and is available by searching project no. P-12690 in the FERC e-library.

After FERC issued the Project pilot license in March, 2014, the District began license compliance activities. This included creating a compliance schedule, submitting initial compliance documents and reports, and convening an adaptive management group called the Marine Aquatic Resource Committee (MARC). The MARC was comprised of agencies and tribes with jurisdiction over or interest in the Project area. MARC members included representatives from the following:

- Snohomish PUD
- NOAA National Marine Fisheries Service
- U.S. Fish and Wildlife Service
- Washington Department of Fish and Wildlife
- Washington Department of Ecology
- Washington Department of Natural Resources
- Tulalip Tribes
- Suquamish Tribe
- Swinomish Indian Tribal Community
- Sauk-Suiattle Tribe

The objective of the MARC was to consult on monitoring plans and any revisions to those plans over the course of Project operations. Two MARC meetings were held during spring and summer, 2014 as the District initiated license compliance and proposed revisions to two monitoring plans and one license article.

The following required documents were prepared and filed with FERC under initial license compliance activities:

- License Article 202: Production of FERC Exhibits F and G, including aperture images.

- License Article 401: The District consulted with the Washington Department of Ecology to prepare a Spill Prevention and Contingency Plan. This plan outlined any potential material spills that could occur during Project installation, operation, and removal, and appropriate response measures. No hazardous materials would be used for the Project, and risk of spills to land or water would be minimal.
- License Article 411: The District developed a Hazard Identification and Risk Assessment (HIRA) document that expanded on all potential hazards (navigation, marine operations, interaction with subsea cable, etc.) that could arise during Project installation, operation, or removal. FERC required consultation on the HIRA with the US Coast Guard, the Army Corps of Engineers, and the Pacific Crossing Landing Corporation (PCLC, owners of a major subsea telecommunications cable running from the United States to Japan through Admiralty Inlet). At the time of Project termination, the District had completed the draft HIRA and required consultation, but had not filed the final HIRA document with FERC.
- License Article 413: District staff worked with the National Park Service, Washington State Parks, Ebey's Landing Historical Reserve (Whidbey Island), and the Island County Marine Resources Committee to develop an Interpretation and Education Plan. This document outlined plans for installing interpretive signage at a location overlooking Admiralty Inlet to educate the public about the Project.
- License Article 417: The District consulted with Washington State Ferries to prepare a Ferry Services Operation Plan that outlined how Project installation and operations would coincide with the regularly scheduled Coupeville to Port-Townsend ferry running near the proposed turbine site, and avoid unnecessary interruptions to ferry operations.

2.1.2 Systems Engineering Design

Subtask 1.2, Systems Engineering Design, included "Design and integration for all planning components (e.g. power conditioning, grid connection, monitoring infrastructure, supervisory control and data acquisition) to a near-final stage."

Systems engineering occurred over a period of many months and the results are demonstrated in the Public Works Bidding and Turbine Supply Maintenance Agreements, which are attached as appendices to this report. This iterative process started with early stage conceptual plans for creating energy from tidal currents using an Open-Centre turbine designed by OpenHydro, Ltd., together with the transmission cables and power control and conditioning equipment necessary for connection to a utility grid. These plans were continually refined until the documents were considered nearly final in late 2014. The Project design was consistently under pressure for change as inputs from the following were received at various stages:

- Environmental monitoring objectives and design;
- Stakeholder and regulatory permit conditions;
- Deployment limitations and operational parameters around the proposed turbines;
- Challenges associated with performing marine operations in a busy, deep-water tidal resource; and
- The District's objective to efficiently operate a system and provide relevant data, meaningful to the future of a growing industry.

The District and its partners developed and proved the concepts necessary to complete the documents which were ultimately used to obtain pricing. In order to achieve final design, the District would have been required to sign construction agreements and incorporate specific details associated with the Contractor's resources proposed.

2.1.3 Contractor Selection

Subtask 1.3 was defined as "Preparation of bid documents, competitive bidding and bid evaluation and award of key construction contractors (e.g. horizontal directional drilling, on-shore civil works, turbine/foundation deployment, subsea cable installation, grid interconnection)."
The District worked with engineering firms and outside counsel to develop detailed specifications and contract documents, respectively, for the public works contract proposed for the Project installation. This public works contractor would have overseen all aspects of the construction and installation of the Project, both marine and terrestrial. Various subcontractors would have been hired to manage specific areas of technical expertise required for the work. The bid documents were completed and advertised in January, 2014. Due to permitting delays and requests for rehearing of the FERC license, the bid opening was postponed until October 1, 2014. The District received three responsive bids, identified an apparent low bidder within the District's engineer's estimate acceptable range, and began reviewing the bids for consistency with the plans and specifications. However, with the suspension of Project activities, the District opted to allow the bids to expire on November 30, 2014.

In addition to the contract document development, the District recognized the need to minimize costs associated with contractor risk on the Project, and avoid contractors inflating their bids due to this risk. The District developed an owner-controlled insurance program (OCIP) to allow risk to be managed by a company that would insure both the District and the contractor. The OCIP development process was overseen by District legal and risk management staff as well as outside legal counsel and underwriters. While onerous, this process would be a significant cost reduction measure over the course of the Project.

2.1.4 Construction Management Plan

Subtask 1.4 was "Development of a construction management plan."
Construction management plans were integrated into the contract documents prepared for turbine supply and the general construction as described above.

2.2 Partnerships

Early in the Project planning stages, the District developed a partnership with the Northwest National Marine Renewable Energy Center (NNMREC) at the University of Washington (UW), involving faculty, staff, and students from the Department of Mechanical Engineering and Applied Physics Laboratory. NNMREC researchers have developed instrumentation and methodologies for monitoring various elements of the marine environment and how these elements would interact with marine hydrokinetic devices. While NNMREC activities were not funded under the subject award of this report, their findings have been instrumental in the overall progress of the Project, including influencing engineering design and helping develop environmental monitoring plans conditioned in the FERC license. Their work continues under other federally funded awards. NNMREC has and plans to continue to build off the platform of the Admiralty Project has provided. Research being conducted at NNMREC is expected to provide innovative techniques for environmental monitoring and instrumentation applicable to future marine hydrokinetic projects around the world.

In 2008, the District executed a detailed technology evaluation process to select a turbine manufacturer for the Project. Criteria included performance, reliability, and environmental impact of the device, and experience and qualifications of the company. After careful consideration of submissions, the District selected OpenHydro, Ltd, an Irish company, to provide engineering design, manufacturing and installation of the tidal turbines. OpenHydro's proprietary device is the Open-Centre turbine, designed to allow water to flow through the

center of the device, turning the turbine rotor while the generator stator is stationary around the outside, fully enclosing the turbine blade tips. The Open-Centre turbines are also designed to rotate in both directions, to use water-lubricated bearings (no oil or petroleum based fluids), and to sit on gravity-based foundations that require no pile driving or pinning to the sea floor. The District was confident in the assessment of OpenHydro's technical readiness and ability to supply turbines in accordance with anticipated permit and license conditions.

The environmentally-friendly turbine design was a large factor in the selection of OpenHydro as a Project partner. The District relied heavily on these design features and incorporated them into the Project planning, permitting and licensing.

2.3 Accomplishments

While the Project will not be moving forward, significant accomplishments were made in the advancement of tidal energy technology that can provide insight to projects around the world, serving as both a case study and a baseline information source for other marine hydrokinetic project proponents in the future. Specific accomplishments include:

- The District and Project partners developed a buildable, "shovel-ready" design for the first grid-connected deep-water tidal device array installation, including an installation/recovery plan that managed risk between the District, public works contractor, and turbine supplier while maintaining acceptable warranty terms.
- Developed bid plans and specifications for large public works contractor selection.
- Developed a process for creating an owner-controlled insurance program to cover project construction and operations.
- Increased level of confidence with agency stakeholders and public in marine hydrokinetic (MHK) technology through numerous outreach efforts, effectively introducing the technology to many who had never seen it before.
- Obtained all required permits and authorizations required to build and deploy the Admiralty project, including a pilot license from the FERC.
- Successfully addressed numerous environmental concerns regarding terrestrial and marine effects and species interactions with the devices, discussed in a detailed Environmental Assessment document produced by FERC.
- Overcame several regulatory issues including appeals at the local, state, and federal levels.
- Implemented strong partnerships with university level researchers developing environmental monitoring methodology and instrumentation for MHK installations. Using the Admiralty project as a platform, these R&D teams are continuing to develop technology and systems that can be utilized by other projects around the world.

3. Products, Reports, and Permits

Products prepared for the Project under this award are outlined in the following table, and discussed in the sections below. Permits and authorizations are listed in Table 3.

Report Name	Prepared By	Date	Status
ROV Survey Report	Sound and Sea Technology/Northwest Underwater Construction	September, 2012	Final
Habitat Characterization/ROV Review Report	CapRock Geology	October, 2012	Final
System Impact Study	Puget Sound Energy	February, 2013	Final
Interconnection Facilities Study	Puget Sound Energy	May, 2013	Final
Final Environmental Assessment	FERC	August, 2013	Final
Pilot Project License	FERC	March, 2014	Final
Hazard Identification and Risk Assessment	District	June, 2014	Draft, consultation complete
Interpretation and Education Plan	District	September, 2014	Final
Spill Prevention and Containment Plan	District	September, 2014	Final
Turbine Supply and Maintenance Agreement	District	November 5, 2013	Final
PWC Bid Specifications	District	January, 2014	Final
Proof of Concept Report	AMS/OpenHydro	October, 2014	Final

Table 2 – Summary of Reports and Products Prepared

3.1 FERC Environmental Assessment and Pilot License

In August 2013, the FERC issued a Final Environmental Assessment (EA) for the Project, based on extensive environmental information provided by the District, Project consultants, and collaboration with Agency stakeholders. The EA evaluated the proposed actions associated with the Project and whether significant adverse environmental effects would result. Categories of evaluation included Geologic/Soil Resources, Marine Resources, Threatened and Endangered Species, Terrestrial Resources, Recreation, Land and Ocean Use, Navigation, Aesthetic Resources and Cultural Resources. In addition, FERC evaluated the Project for economic benefits and cost.

In some instances, FERC recommended alternatives or additional environmental measures to the proposed actions for the Project, and in others agreed with the actions as proposed. Most of these recommendations were then incorporated into the Pilot Project License. FERC concluded that approval of the action would not significantly affect the quality of the human

environment, and an environmental impact was not required. FERC subsequently issued a Finding of No Significant Impact (FONSI) document for the Project. Approximately seven months later in March, 2014, the FERC issued their Order Issuing Pilot Project License.

After the Pilot License issuance, the District began license compliance activities including preparation of a schedule and applicable filings. Documents prepared for FERC license compliance are discussed in section 2.1.1 above.

3.2 ROV Survey Report

In July, 2012, the Northwest Underwater Constructors (NUC) conducted an additional remotely operated vehicle (ROV) survey to review the seafloor conditions in the area of the updated turbine locations and revised cable route (the first survey was in 2010 and did not include the cable route). NUC set-up and launched the ROV system during live boat operations on the M/V Salvager to conduct a general bottom survey and document visually observed conditions of the proposed turbine site using a DVD-recordable underwater video system for subsequent viewing. The survey crew noted several boulders larger than 1 meter diameter. Very little bottom sediment was observed.

Seafloor conditions were consistent with previous reviews during the 2010 ROV inspection and the instrumentation deployments conducted by University of Washington researchers. Within Admiralty Bay, the sea floor sediment of the eastern (shallow) half of the cable route appeared to be predominantly coral- and algae-covered pebbles and cobblestones. Visibility in the inner Admiralty Bay section was hampered by abundant presence of organic debris in the water. The easternmost end of the cable route, in water depths from about 17 to 25 meters, was heavily vegetated by short, feathery algae (NUC/SST, 2012).

As part of the 2012 ROV survey review, CapRock Geology (Dr. Gary Greene) studied the footage from the ROV camera to provide an overview of the substrate conditions and the benthic habitat in the area. Visible substrate in the turbine area was determined to be mostly well-rounded cobbles and pebbles in the 10-15cm diameter range, with minimal fine sediment due to high water velocity. The ecosystem appeared to be composed of very robust encrusting organisms (sea stars, urchins) that can survive in a high current energy physical environment and a coarse-grain substrate (Greene, 2012).

The work conducted for the 2012 ROV survey was a continuation of work conducted under award DE-FG36-08GO18169 (2008-2012), but was only partly funded under that award.

3.3 Proof of Concept Report

Applied Motion Systems, Inc., a subcontractor to OpenHydro, developed a proof of concept (POC) testing strategy to determine the feasibility of the Power Conditioning and Control Equipment (PCCE) responsible for generator control, battery based energy storage, and power delivery from the turbines to the grid. The District planned to utilize a battery storage arrangement that would allow power from the turbines to be converted to usable power without the need for extensive upgrades to the electrical grid in the area. The POC report concludes with recommendations for power control equipment and configuration that would best integrate with the OpenHydro turbine power output and existing electrical grid at the shore landing site. Additional discussion and results can be found in the POC Report, included as an appendix.

3.4 Grid Interconnection Facilities Impact Study

The District worked with Puget Sound Energy (PSE), provider of electricity service for Whidbey Island, to apply for grid interconnection of the electricity produced by the Project. PSE and the

District prepared a System Impact Study and a Facilities Study to determine how the Project would impact the PSE utility system in the area, and whether PSE would need to upgrade existing electrical facilities to accommodate the additional electrical load from the Project.

3.5 Permits and Authorizations

Agency	Permit/Authorization/License	Status
Federal Energy Regulatory Commission (FERC)	National Environmental Policy Act Environmental Assessment	Final EA issued 8/9/13
	Pilot License for Hydrokinetic Projects	License issued 3/20/14 Rehearing review: complete, decision denying rehearing issued 12/5/2014
Department of Energy	National Environmental Policy Act (NEPA) Environmental Assessment	Anticipated after license rehearing decision from FERC
National Marine Fisheries Service (NMFS)	Endangered Species Act Consultation and Biological Opinion (BiOp)	BiOp Issued 12/3/13
	Marine Mammals Protection Act Consultation Magnuson-Stevens Fishery Conservation and Management Act	Underway with FERC license
US Fish and Wildlife Service (US Department of the Interior)	Federal Power Act Section 18 (fishways) Consultation Federal Power Act Section 10(j)	Underway with FERC license
US Army Corps of Engineers	Clean Water Act Section 404 Clean Water Act Section 10	Letter stating no Corps permit required, 6/14/12
Washington Department of Fish & Wildlife (WDFW)	Hydraulic Project Approval (HPA)	Final HPA issued 1/13/14
Washington Department of Ecology	Clean Water Act Section 401 Water Quality Certification	Issued 12/3/13
	Coastal Zone Management Act (CZMA) Concurrence	CZMA waived 1/30/14
Washington Department of Natural Resources (DNR)	Aquatic Resources Use Authorization (Aquatic Lands Lease)	99% Draft Issued October 2014

Washington State Department of Archaeology and Historic Preservation (DAHP)	National Historic Preservation Act Section 106 Concurrence	Complete, no adverse effect concurrence issued 2/28/2012
Washington Department of Transportation	Highway Access Permit	Complete, issued 7/30/12
Island County	Shoreline Conditional Use Permit	Issued 12/6/13 Appeal hearing March 2014 Final issued 3/25/14
	Building Permit	Issued 8/25/14
	Flood Development Permit	Issued 8/25/14
	Ebey's Historical Reserve Certificate of Appropriateness	Complete, issued 4/26/12
PUD No.1 of Snohomish County	State Environmental Policy Act Environmental Review	Complete, issued 8/27/13; DNS issued 11/14/13

Table 3 – Permits and Authorizations

4. Project Challenges

4.1 Opposition

Opposition to the Project by telecommunications company PCLC required significant dedication of resources over the course of three years. Their main concern was that the proximity of the tidal turbines may pose a risk to a fiber optic cable that provides telecommunication services across the Pacific Ocean. PCLC attempted to prohibit or delay issuance of the FERC license and other Project permits by submitting numerous comments to FERC and other agencies and stakeholders. The District worked extensively to respond to the concerns and maintained the position that the Project would not pose a material risk to the fiber optic cable. When Project permits and the FERC pilot license were issued, this opposition resulted in multiple appeals at the local and state levels, and a rehearing request to FERC for the pilot license, all of which required District resources in the form of legal filings, extensive information gathering and document preparation. The District continued to maintain the position that the Project would not damage or cause additional risk to the cable. After reviewing all submitted information, FERC and agencies agreed, and the appeals and rehearing were denied during 2014, eliminating those impediments for the Project to move forward.

Other opposition included environmental concerns such as potential turbine interaction with marine species and habitat, scouring of the seabed around the turbine foundations, loss of recreation or fishing areas (such as Usual and Accustomed tribal fishing areas), and potential interaction with shipping patterns in the Admiralty Inlet shipping channel. The District prepared numerous studies and monitoring plans (conditioned in the FERC license) to address these potential concerns under this and previous DOE awards. Because the Project will not be installed, the resulting data from these potential interactions cannot be monitored and studied. However, information gathered and preparatory work done for this Project will set an informative

baseline for future project proponents and regulatory agencies to address similar concerns proactively.

4.2 License and Permitting Timeline

The District submitted the final license application (FLA) to FERC on February 29, 2012. The evaluation process for a hydrokinetic pilot license was expected to take approximately six months. In March, 2012, the FERC issued an additional information request (AIR), to which the District responded in April, 2012. A second AIR was issued in July, 2012, and the FERC scheduled a technical conference for August, 2012. The technical conference focused on the Project's proximity to the telecommunications cable PC-1 north, owned and operated by PCLC (discussed above in section 4.1). The FERC issued a draft Environmental Assessment in January, 2013, which prompted numerous public and agency comments requiring responses. The final EA was issued in August, 2013, allowing the final required authorizations for the FERC license (local, state, and federal) to be completed and leading to the license order in March, 2014, a full two years after the District submitted the FLA.

4.3 Response to Challenges

Throughout the Project, the District was dedicated to addressing challenges directly and transparently. Some of the key challenges were addressed through the following:

- Establishing relationships with agencies and other stakeholders early, including regular stakeholder meetings early on in the planning stages. Maintaining a contact person at each agency and the District allowed for open communications on information requests and concerns.
- Early selection of the turbine technology provider (OpenHydro), allowing the District to carry the technology through all environmental research, studies, and license/permit applications.
- Utilizing internal staff (i.e. legal) as possible to draft official responses or manage outside vendors, allowing project management staff to move forward on timeline tasks.
- Developing an owner-controlled insurance program (OCIP): although this process added time and expense upfront, the benefits of reduced contractor and other vendor costs would have far reaching benefits throughout the Project.
- Addressing environmental challenges through partnership with a top research university (NNMREC) and national laboratories (Pacific Northwest National Laboratory [PNNL] and Sandia National Laboratory [SNL]). This allowed the District to utilize experts in the MHK field to provide baseline data about the Project location and innovative strategies for environmental monitoring.
- In addition to environmental monitoring data, the DOEs support of the project through PNNL and SNL employed top experts in marine mammal research to alleviate concerns from NOAA National Marine Fisheries Service (NMFS) regarding interactions between these species (specifically southern resident killer whales) and the turbines. The laboratories partnered to develop a strike analysis using OpenHydro turbines as models. The analysis concluded that minimal injury to the species would result from a potential strike or collision.
- Developing environmental monitoring and mitigation plans accepted by all resource agencies that adhered to three mutually-agreed principles: that the topics included in the plans represented a significant environmental concern, that the plans were likely to produce information about interactions (rather than findings of "no impact"), and that the plan methodologies were sufficiently robust to allow results to be published in the peer reviewed literature. This development process was time consuming, but resulted in plans

with a high probability of "moving the regulatory needle" if the project had moved forward.

- Developing operation plans for navigational safety and hazard identification (HIRA) that identified and provided contingencies for potential risks to human safety and property such as subsea cables, in consultation with applicable resource agencies and stakeholders. These plans were conditioned through the FERC license to be followed prior to and throughout Project operations.

4.3 Recommendations

In addition to the above strategies for dealing with challenges, the District would recommend the formation of a federal working group representing the MHK industry to prevent unnecessary exclusion zones from being established in US waters, impeding the testing and development of MHK projects.

5. Conclusion

The Admiralty Inlet Pilot Tidal Project is the result of eight years of research, studies, agency and public outreach, innovative engineering design, and partnership collaboration. The District's objectives in initiating the Project were to provide data to inform the viability of commercial scale tidal energy generation from technical, economic, social, and environmental standpoints. Although construction of the Project will not be completed, numerous achievements were made throughout the course of the Project that have moved the industry closer to achieving these objectives. Data from the Project provides an informative baseline to future project proponents who hope to reach commercial viability in the MHK field. The District appreciated the opportunity to work with the DOE and all Project partners in making these achievements possible.

6. References

Applied Motion Systems, 2014. Proof of Concept Report, ENG-14-01 for OpenHydro, SnoPUD, Admiralty Inlet Proof of Concept. October 16, 2014.

Copping, A.E., T.J. Carlson, J.L. Elster, R. Jepsen, K. Metzinger, M.E. Jones, M. Watkins, B.E. Watson, 2012. Assessment of Strike of Adult Killer Whales by an OpenHydro Tidal Turbine Blade. Prepared for Department of Energy by Pacific Northwest National Laboratory and Sandia National Laboratory. Rev. 1, September, 2012.

FERC, 2013. Final Environmental Assessment for Hydropower License. Admiralty Inlet Pilot Tidal Project – FERC project NO. 12690-005 (DOE/EA-1949). August, 2013.

FERC, 2014. Order Issuing Pilot Project License (Minor Project). March 20, 2014.

Golder Associates, 2011. Geophysical Investigation for Admiralty Inlet Turbine Project. September 6, 2011.

Greene, Gary G., 2012. Habitat Characterization, ROV Review Report, October 2012.

Landau Associates, 2013. Geotechnical Report, Admiralty Inlet Pilot Tidal Project. February 13, 2013.

Northwest Underwater Construction (NUC), Sound and Sea Technology, 2012. Tidal Energy Project, ROV Inspection Report. July 25, 2012.

Puget Sound Energy, 2013. System Impact Study Interconnection Request for a Small Generating Facility. Puget Sound Energy, Inc. Customer Renewable Energy Programs Department, Total Energy System Planning Department, System Protection Department. February 14, 2013.

Puget Sound Energy, 2013. Interconnection Facilities Study for SnoPUD Tidal Project. Puget Sound Energy Programs Total Energy Planning Department. May, 2013.

Appendix A

Public Works Contract Bid Documents

SNOHOMISH COUNTY PUD
PUBLIC UTILITY DISTRICT NO. 1

Request for Proposal No. 1479

PWC – Admiralty Inlet Pilot Tidal Project

NOTICE TO BIDDERS

NOTICE IS HEREBY GIVEN that the Board of Commissioners of Public Utility District No. 1 of Snohomish County ("DISTRICT") will receive and open sealed bids from bidders for the following work:

Request for Bid No. 1479
PWC – ADMIRALTY INLET PILOT TIDAL PROJECT

at the DISTRICT office of Contracts/Purchasing, 1802 – 75th Street S.W., Everett, Washington, on Wednesday, the 5th day of February, 2014, at 2:00 p.m. (Local Time). Address bids to P.O. Box 1107, Everett, Washington 98206-1107. The bid opening is public and all bids will be read aloud. Each bid **shall** be accompanied by bid security in the amount of 5 percent (5%) of the base bid subtotal (the sum of the Schedule-1 bid and Schedule-2 bid), excluding state and local sales tax on the total base bid.

The DISTRICT intends to install two tidal turbines on the sea floor in Admiralty Inlet to generate electricity and gather data to inform the technical, economic, and environmental viability of tidal energy generation ("Project"). The work associated with this portion of the Project ("Work") includes the procurement of marine cables and terminations, marine cable installation, including on shore connections utilizing horizontal directional drilling (HDD), subsea cable connections to the two turbines, site preparation, construction of a 720 square foot control building, and integration with other suppliers as required to complete an operational tidal energy project. The bid also anticipates work that may be required to recover and redeploy the turbines to accomplish repairs. The Project site is in and adjacent to the Admiralty Inlet, near the city of Coupeville in Island County, Washington.

There will be two opportunities to attend a **mandatory** prebid meeting: Thursday, January 16, 2014 at 8:00 am, or Tuesday, January 21, 2014 at 9:00 am. Both meetings will be held in the Auditorium at the DISTRICT's Electric Building, 2320 California Street, Everett, Washington. **Bidders must attend at least one of the two mandatory prebid meetings in order to submit a bid for the Project.**

For additional information pertaining to this Request for Proposal, please visit www.snopud.com, select "Bids" and select "RFP No. 1479." If interested in receiving a packet please complete the Bidder's Request Form. This Notice to Bidders, the Planholders List, Addenda, Bid Responses, Award Recommendation, and Bid Protest Procedures are available for viewing on the District's website, in read only format. The electronic file is provided as a courtesy to the Prospective Bidders by the District.

The District encourages minority and women's business enterprises to request these contract documents and to bid on this work.

PUBLIC UTILITY DISTRICT NO. 1
OF SNOHOMISH COUNTY

BOARD OF COMMISSIONERS
by STEVE KLEIN
GENERAL MANAGER

DATE: December 30, 2013
PUBLISHED: January 2, 2014

LEGAL28801418.2

INDEX TO ARTICLES

PWC – ADMIRALTY INLET PILOT TIDAL PROJECT

SECTION A

INSTRUCTIONS TO BIDDERS

- 1.1 Invitation to Bid
- 1.2 Receipt of Bids
- 1.3 Bid Opening
- 1.4 Bid Award
- 1.5 Site of the Work
- 1.6 Naming of Subcontractors
- 1.7 Bids
- 1.8 Examination of Conditions
- 1.9 Bid Security
- 1.10 DISTRICT'S Right to Reject Bids
- 1.11 Bid Evaluation
- 1.12 Performance Security
- 1.13 Corrections, Interpretations and Addenda
- 1.14 Mandatory Bidder Responsibility Requirements
- 1.15 Other Requirements and Supplemental Bidder Responsibility Requirements
- 1.16 Environmental Provisions

SECTION B

GENERAL CONDITIONS

- 1.0 The Contract
  - 1.1 General
  - 1.2 Intent
- 2.0 Contract Documents
  - 2.1 Definitions
    - 2.1.1 The Contract Documents
    - 2.1.2 DISTRICT
    - 2.1.3 CONTRACTOR
    - 2.1.4 Work
    - 2.1.5 Subcontractor
    - 2.1.6 Project
    - 2.1.7 Drawings
    - 2.1.8 Specifications
  - 2.2 Ownership of Contract Documents
- 3.0 Administration of the Contract
  - 3.1 Administration by the DISTRICT
  - 3.2 Review of Contract Documents, Field Conditions, Subsurface Conditions, and Questions about Drawings and Specifications
  - 3.3 DISTRICT'S Right to Stop and/or to Carry Out the Work
  - 3.4 Surveys and Approvals
- 4.0 CONTRACTOR Responsibilities
  - 4.1 Duty to Perform the Work
  - 4.2 Customer Relations, Project Management and Supervision
  - 4.3 Labor and Materials
    - 4.3.1 DISTRICT-Furnished Equipment Installed by CONTACTOR (OFCI)
    - 4.3.2 Materials and Equipment Furnished and Installed by CONTRACTOR
    - 4.3.3 Payment of Prevailing Wages
    - 4.3.4 Workers and Discipline
    - 4.3.5 Sanitation
  - 4.4 Franchises, Licenses and Bonds
  - 4.5 Laws and Regulations
  - 4.6 Omissions and Discrepancies

INDEX TO ARTICLES

PWC – ADMIRALTY INLET PILOT TIDAL PROJECT

SECTION B

GENERAL CONDITIONS (continued)

4.0 CONTRACTOR Responsibilities (continued)
- 4.7 Utilities or Obstructions
- 4.8 CONTRACTOR'S Warranty
- 4.9 Clean-up
- 4.10 Use of Site
- 4.11 Cutting and Patching
- 4.12 Schedule
- 4.13 Submittals, Shop Drawings, Product Data, and Samples
- 4.14 Apprenticeship
- 4.15 Royalties, Patents, and Copyrights
- 4.16 Obligations Under Federal Law

5.0 Subcontracts
- 5.1 Award of Subcontracts
- 5.2 Substitution of Subcontractors
- 5.3 No Contractual Agreement Between Third Parties and DISTRICT
- 5.4 CONTRACTOR Responsibility
- 5.5 Subcontractor Work
- 5.6 Contingent Assignment of Subcontractors

6.0 Separate Contracts
- 6.1 Cooperation with Separate Contractors
- 6.2 Duty to Correct and Reimburse

7.0 Claims and Dispute Resolution
- 7.1 General
- 7.2 Notice and Claims
- 7.3 Dispute Resolution
- 7.4 Miscellaneous

8.0 Time
- 8.1 Notice to Proceed
- 8.2 Time for Completion
- 8.3 Progress
- 8.4 Delays and Extension of Time

9.0 Payment and Completion
- 9.1 Contract Price
- 9.2 Schedule of Values
- 9.3 Application of Payment
- 9.4 Payment
- 9.5 Payment by the CONTRACTOR to Subcontractors
- 9.6 Disputed Amounts
- 9.7 Retainage
- 9.8 Failure to Make Payment
- 9.9 Substantial Completion
- 9.10 Final Completion, Final Acceptance and Final Payment
- 9.11 Waiver of Claims
- 9.12 Liens

INDEX TO ARTICLES

PWC – ADMIRALTY INLET PILOT TIDAL PROJECT

SECTION B

GENERAL CONDITIONS (continued)

10.0 Protection of Persons and Property
- 10.1 Safety Precautions and Programs
- 10.2 Safety and Protection
- 10.3 Restoring Improvements

11.0 Indemnity and Damages Waiver
- 11.1 Indemnity
- 11.2 Waiver of Consequential Damages

12.0 Insurance and Bonds
- 12.1 Insurance
- 12.2 CONTRACTOR'S Responsibility Not Limited by Insurance
- 12.3 Corrections to Project
- 12.4 Certification and Cancellation of Insurance
- 12.5 Payment, Performance, and Maintenance Bonds

13.0 Changes in the Work
- 13.1 Options to Change the Work
- 13.2 Pricing Components
  - 13.2.1 Direct Labor Costs
  - 13.2.2 Direct Material Costs
  - 13.2.3 Construction Equipment Usage Costs
  - 13.2.4 Subcontractor Costs
  - 13.2.5 Fee
  - 13.2.6 Cost of Change in Insurance or Bond Premium
- 13.3 Reservation of Rights

14.0 Uncovering and Correcting Work
- 14.1 Inspection and Tests
- 14.2 Defects and Remedies

15.0 Termination and Suspension
- 15.1 DISTRICT'S Right to Terminate
  - 15.1.1 DISTRICT'S Right to Terminate CONTRACTOR for Cause
  - 15.1.2 DISTRICT'S Right to Terminate CONTRACT for Convenience
- 15.2 CONTRACTOR'S Right to Terminate Contract
- 15.3 Removal of Equipment
- 15.4 Suspension of the Work

16.0 Miscellaneous
- 16.1 Governing Law
- 16.2 Nonwaiver
- 16.3 Labor Peace
- 16.4 Assignment
- 16.5 Interest
- 16.6 Time Limit on Claims
- 16.7 Record Keeping
- 16.8 Statutes

INDEX TO ARTICLES

PWC – ADMIRALTY INLET PILOT TIDAL PROJECT

SECTION C

SPECIAL CONDITIONS

1.0 Access
2.0 Coordination and Cooperation Requirements with Separate Contractor
3.0 Confidential Information/Intellectual Property
4.0 Vessel and Marine Requirements
5.0 Land Used for the Work
6.0 Federal Requirements
7.0 Davis-Bacon Act Wages Required
8.0 Insurance

SECTION D

EXHIBITS

A Bid Bond
B Performance and Payment Bonds
C Department of Labor and Industries
Affidavit of Wages Paid on Public Works Contract
D Prevailing Wages
D1 State of Washington Prevailing Wages
D2 Davis-Bacon Wages
E Agreement
F Affidavit
G CONTRACTOR'S Release
H OCIP Project Insurance Manual
I Maintenance Bond

SPECIFICATION

APPENDICES

BID FORM

DRAWINGS

SECTION A
INSTRUCTIONS TO BIDDERS

1.1 INVITATION TO BID

Bids are hereby invited from bidders for the Work identified in the Notice to Bidders. Such Work includes the Work required by the plans and specifications for the Project, which are attached and also on file at the DISTRICT's Contracts/Purchasing Office, located at 1802 - 75th Street S.W., Everett, Washington 98203-6264.

1.2 RECEIPT OF BIDS

a. Time

Bids must be received by the DISTRICT at the location below not later than Wednesday, February 5th, 2014, at 2:00 p.m., local time.

b. Place

Regular US Mail		**Hand Delivery (Fed Ex or UPS)**
Snohomish County PUD		Snohomish County PUD
Contracts & Purchasing	OR	Contracts & Purchasing
P.O. Box 1107		1802 75th Street SW
Everett, WA 98206-1107		Everett, WA 98203-6264

NOTE: Bids will not be accepted at any other DISTRICT location.

1.3 BID OPENING

Bids will be opened on the date and at the hour stated above in the DISTRICT'S Operations Center bid room, located in the Administrative Building at:

1802 - 75th Street S.W., Everett, WA 98203

1.4 BID AWARD

The DISTRICT intends but is not bound to award a Contract based on the Notice to Bidders on or about Monday, March 17, 2014, which is subject to change at the sole discretion of the DISTRICT. The DISTRICT intends but is not required to post its award recommendation on the DISTRICT's website before the award date. It is the bidder's responsibility to obtain this information from the DISTRICT, which usually will be available at www.snopud.com under the "Bids" tab. Bid protest procedures and timelines associated with a protest are also available on the website.

1.5 SITE OF THE WORK

The Project site and work location is in and adjacent to the Admiralty Inlet near the city of Coupeville, in Island County, Washington. See Contract Documents.

1.6 NAMING OF SUBCONTRACTORS

Each bidder **must** fully comply with all Washington state requirements that apply to contracts estimated to cost in excess of $1,000,000.00, which include the identification of certain proposed Subcontractors on the bid form per RCW 39.30.060.

1.7 BIDS

Bids are to be submitted using only the bid form included with the Bidding Documents. Place bid and required bid security in an opaque, sealed envelope. **Please use the return label on the outside of the bid package when submitting a bid.**

REQUEST FOR BID NO. 1479
BID OPENING: WEDNESDAY, February, 5, 2014, 2:00 P.M. LOCAL TIME
TITLE OF WORK: PWC – ADMIRALTY INLET PILOT TIDAL PROJECT

a. An original bid must be submitted in the required format. Each bid shall include and be based upon all Addenda issued during the bidding period.

b. The DISTRICT reserves the right to waive non-material errors or irregularities in any bid. Non-material errors or irregularities waived by the DISTRICT may be corrected prior to the execution of any Contract. If the sum of the bid items does not equal the total amount bid, the correct sum of the bid items may be deemed the total amount bid.

c. No bid may be withdrawn after the time set for bid opening, unless the award of the Contract is delayed for a period exceeding sixty (60) days.

1.8 EXAMINATION OF CONDITIONS

Bidders shall satisfy themselves as to the conditions of the Work by personal examination of the plans, specifications and site of the proposed Work, and by other examination and investigation regarding the nature of the Project and difficulties that may be encountered.

Submission of a bid shall constitute affirmation by the bidder that the bidder has competed the following:

a. Carefully examined the Contract Documents;

b. Visited and examined the site of the Work; and

c. Included in the bid and each of the bid items a sum sufficient to cover all items required by the Contract Documents and all conditions, matters, and contingencies that could affect the Work or the cost or challenges of performance.

The failure or omission of any bidder to receive or examine any site condition, form, instrument, addendum, or other documents shall in no way relieve such bidder from any obligation with respect to its bid or the Contract. The DISTRICT shall not be responsible for claims or damages caused by conditions, matters, and contingencies that could reasonably have been determined from inspection of the Project site and examination of the Contract Documents.

The DISTRICT shall not be responsible for claims or damages caused by conditions, matters, and contingencies that could reasonably have been determined from inspection of the Project site and examination of the Contract Documents.

1.9 BID SECURITY

Each bid shall be accompanied by a bid security in a sum not less than five percent (5%) of the base bid subtotal (the sum of Schedule-1 and Schedule-2 bid items), excluding state and local sales tax. Such security shall be in the form of a certified or cashier's check payable to the Public Utility District No. 1 of Snohomish County, or a bid bond (see Exhibit A) issued by a corporate surety licensed and authorized to do business in the State of Washington. The security shall be and remain the property of the DISTRICT as liquidated damages but not a penalty in the event that the successful bidder should fail or refuse to enter into a contract in accordance with its bid or furnish the required performance security and insurance within ten (10) days of award. Unless otherwise agreed, the bid bond shall be obtained from and maintained with companies rated A- or better by Best's Key Rating Guide.

It is understood by the bidder that any failure of the bidder to contract will cause substantial injury to the DISTRICT, which injury is not easily reduced to monetary terms, and it is therefore agreed that, in the event bidder fails to contract, the entire bid security will be retained by the DISTRICT.

1.10 DISTRICT'S RIGHT TO REJECT BIDS

The Board of Commissioners reserves the right to reject any and all bids and to accept the bid or bids which, in its sole and absolute judgment, will best serve the interests of the DISTRICT under the circumstances.

Each bid shall be deemed a firm offer continuing for at least sixty (60) days from the date of the bid opening.

1.11 BID EVALUATION

A Contract will not be awarded until the DISTRICT is satisfied that the successful bidder has met the mandatory bidder responsibility requirements of paragraph 1.14 and the supplemental bidder responsibility criteria of paragraph 1.15, is reasonably familiar with the class of work and has the necessary capital, tools, capabilities and experience required. Completion of the Work within the time stated is essential. Past performance of the bidder, including past failure of the bidder to complete other work on time, reasonable doubt as to whether the bidder would complete the work on time, or prior commitments of the bidder, may all justify rejection of a bid.

All relevant factors, whether or not specifically provided for in the Contract Documents, may be considered by the DISTRICT in determining the award of Contract.

1.12 PERFORMANCE SECURITY

Prior to the signing of the Contract, and within ten (10) days after the bidder is notified that it is the successful bidder, the bidder shall furnish the DISTRICT with performance security in the amount of 100% of the total Contract Price, which shall cover the full, faithful performance of the Contract and the payment of all obligations arising thereunder. Security shall consist of a performance bond in the form attached as "Exhibit B," issued by a corporate surety licensed to do business in the State of Washington, or other DISTRICT-approved performance security. Unless otherwise agreed, the performance bond shall be obtained from and maintained with companies rated A- or better by Best's Key Rating Guide.

Upon Substantial Completion of the Schedule-1 Work, the successful Bidder shall provide a maintenance bond for potential Schedule-2 Work in the form attached as "Exhibit I," issued by a corporate surety licensed to do business in the State of Washington, or other DISTRICT-approved performance security. Unless otherwise agreed, the performance bond shall be obtained from and maintained with companies rated A- or better by Best's Key Rating Guide. Receipt of the maintenance bond acceptable to the DISTRICT is a requirement of the DISTRICT’s release of the performance bond provided for Schedule-1 Work.

1.13 CORRECTIONS, INTERPRETATIONS AND ADDENDA

Any omissions, discrepancies or clarification needed to the Contract Documents shall be identified to the DISTRICT in writing. The DISTRICT may issue written Addenda to clarify questions that arise. All interpretations or explanations of the Contract Documents shall be in writing in the form of Addenda and no oral statements shall in any way modify the Contract Documents whether made before or after the letting of the Contract.

1.14 MANDATORY BIDDER RESPONSIBILITY REQUIREMENTS

In submitting a bid for this work, a bidder must meet the following criteria in order to be considered a responsible bidder qualified to be awarded a public works project:

a. At the time of bid submittal, be a registered contractor in the State of Washington with a certificate of registration in compliance with RCW 18.27;

b. Have a current state unified business identifier number;

c. If applicable, have industrial insurance coverage for the bidder's employees working in Washington as required by RCW 51; an employment security department number as required by RCW 50; and a state excise tax registration number as required by RCW 82;

d. Not be disqualified from bidding on any public works contract under RCW 39.06.010 or RCW 39.12.065(3); and

e. If bidding on a public works project subject to the apprenticeship utilization requirements in RCW 39.04.320, not have been found out of compliance by the Washington state apprenticeship and training council for working apprentices out of ratio, without appropriate supervision, or outside their approved work processes as outlined in their standards of apprenticeship under chapter 49.04 RCW for the one-year period immediately preceding the date of the bid solicitation.

RCW 39.06.020 requires the general contractor to verify responsibility criteria for each first tier Subcontractor, and Subcontractors must verify responsibility criteria for each of its lower-tier Subcontractors. Verification includes that the above responsibility criteria and, if applicable, possession of an electrical contractor license (if required by RCW 19.28) or an elevator contractor license (if required by RCW 70.87).

1.15 OTHER REQUIREMENTS AND SUPPLEMENTAL BIDDER RESPONSIBILITY REQUIREMENTS

By submitting a bid, the bidder represents that it has the necessary experience and expertise to perform the Work. In addition, the bidder must satisfy the following supplemental criteria to be considered a responsible bidder. If the bidder objects to any of the supplemental criteria, it must provide written notice to the DISTRICT of its objection at least ten (10) days before the date of bid opening.

a. The bidder must demonstrate that it has the ability, capacity, and skill to perform the Contract safely and competently, including providing evidence if requested of an acceptable safety and loss history;

b. The bidder must have the character, integrity, reputation, judgment, experience, and efficiency required by the DISTRICT.

c. The bidder must demonstrate that it has the ability to perform the Contract within the time specified.

d. The bidder must demonstrate previous and existing compliance with laws relating to the Contract.

e. The bidder must demonstrate its ability, over the past five (5) years, to have successfully performed and completed public works projects of a similar size, scope and scale to the Project. In evaluating the "success" of such projects, the DISTRICT may check owner references for prior projects and evaluate the owner's assessment of the bidder performance, including but not limited to the following areas:

1. Quality of project and quality control;
2. Management of safety and safety record;
3. Timeliness of performance;
4. Use of skilled personnel;
5. Management of subcontractors;
6. Availability of and use of appropriate equipment;
7. Compliance with contract documents; and
8. Management of schedule, submittals process, change orders, and close-out.

f. The bidder shall not currently be debarred or suspended by the Federal government.

g. The bidder must demonstrate that its proposed Project Manager has a minimum of five (5) years of successful experience in project management of marine projects and public works projects of a similar scope and complexity to the Project.

h. The bidder must demonstrate that its proposed Superintendent has a minimum of seven (7) years of successful supervision of marine projects and public works projects of a similar scope and complexity to the Project.

i. The bidder must not currently be a party to a formal dispute resolution process with the DISTRICT—i.e., a pending mediation, arbitration or litigation—and must not have lawsuits with judgments entered against the bidder within five (5) years of the bid submittal deadline that suggest a pattern of failing to meet the terms of contracts, unless there are extenuating circumstances that are deemed acceptable in the sole discretion of the DISTRICT.

j. The bidder must not have had any public works contract terminated for cause or terminated for default by a government agency during the five (5) year period immediately preceding the bid submittal deadline for this Project, unless there are extenuating circumstances that are deemed acceptable in the sole discretion of the DISTRICT.

1.16 ENVIRONMENTAL PROVISIONS

As required by law, the DISTRICT has compiled provisions that deal with the prevention of environmental pollution and the preservation of public natural resources. These authorities are included in a volume entitled "Environmental Provisions" that is on file with the Board of Commissioners, and which, if applicable to this work, is incorporated into these Contract Documents by this reference. This compilation is not exhaustive, but is intended to be an aid to the CONTRACTOR; it shall be the duty of the CONTRACTOR to become familiar and comply with all applicable environmental laws.

SECTION B
GENERAL CONDITIONS

1.0 THE CONTRACT

1.1 GENERAL

The Contract Documents form the Contract for Construction. The Contract represents the entire and integrated agreement between the DISTRICT and the CONTRACTOR and supersedes all prior negotiations, representations or agreements, either written or oral. The Contract may be amended or modified only as set forth in the Contract Documents.

1.2 INTENT

The intent of the Contract Documents is to include all items necessary for the proper execution and completion of the Work by the CONTRACTOR. The Contract Documents are complementary, and what is required by one shall be as binding as if required by all. Performance by the CONTRACTOR shall be required only to the extent consistent with the Contract Documents and reasonably inferable from them as being necessary to produce the indicated results.

2.0 CONTRACT DOCUMENTS

2.1 DEFINITIONS

Unless otherwise stated in the Contract Documents, words not defined that have well-known technical or construction industry meanings are used in the Contract Documents in accordance with such recognized meanings. The terms listed below are defined and interpreted as follows:

2.1.1 "The Contract Documents" are complementary and enumerated in the Agreement between the DISTRICT and CONTRACTOR ("Agreement"). In the event of a conflict or discrepancy among or in the Contract Documents, interpretation shall be governed by the following priority, with an Addendum or a revision to a Contract Document having precedence over the original document, and with later Addenda having precedence over earlier:

i. Any amendments or Contract modifications.
ii. The Agreement;
iii. General Conditions and any Special or Other Conditions specific to the Project; and
iv. Specifications, material and system schedules, Drawings and attachments.

If there is any inconsistency between the Drawings, product schedules, or Specifications, or any attachments, the CONTRACTOR shall make an inquiry to the DISTRICT to determine how to proceed. Unless otherwise ordered in writing by the DISTRICT, the CONTRACTOR shall provide the better quality of, and the greater quantity of, any work or materials at no change in the Contract Price or Contract Time. In the event that Work is shown on Drawings but not contained in Specifications or product schedules or contained in Specifications or product schedules but not shown on the Drawings, the Work shown or contained shall be provided at no change in the Contract Price or Contract Time, according to Specifications or Drawings to be issued by the DISTRICT consistent with and reasonably inferable from the Work shown.

2.1.2 "DISTRICT" means Public Utility District No. 1 of Snohomish County. The DISTRICT will designate in writing a representative who shall act on behalf of the DISTRICT with respect to matters requiring the DISTRICT's approval or authorization. The "DISTRICT" does not include DISTRICT employees or consultants that may contact the CONTRACTOR or be present at the Project site. A CHANGE IN THE CONTRACT PRICE OR CONTRACT TIME OR A WAIVER OF ANY PROVISION OF THE CONTRACT DOCUMENTS CAN ONLY BE MADE IN WRITING BY THE DISTRICT's BOARD OF COMMISSIONERS. No other person is authorized to change the Contract Price, Contract Time or to grant such waivers on behalf of the DISTRICT. No officer,

agent, representative, or employee of the DISTRICT shall be personally responsible for any liability arising under this Contract.

2.1.3 "CONTRACTOR" means the person, partnership, firm or corporation contracting to do the Work under these Contract Documents. The CONTRACTOR shall be licensed, bonded, and insured in the jurisdiction where the Project is located. The term CONTRACTOR shall also include the CONTRACTOR's authorized representative.

2.1.4 "Work" means the construction and services required by the Contract Documents, whether completed or partially completed, and includes all labor, tools, equipment, materials, services and incidentals necessary to complete the obligations of the CONTRACTOR under the Contract Documents. The Work may constitute only a part of the Project, and may interface and need to be coordinated with the work of others.

2.1.5 "Subcontractor" means any person, partnership, firm or corporation that contracts directly with the CONTRACTOR to perform any Work under the Contract Documents. "Subcontractor of any tier" includes Subcontractors as well as any person, partnership, firm or corporation that contracts with a Subcontractor or a lower-tier Subcontractor to perform any of the Work.

2.1.6 "Project" is identified in the Agreement and is the total construction to be performed by or through the DISTRICT, of which the Work performed under the Contract Documents is a part. The Project includes construction by others engaged by the DISTRICT.

2.1.7 "Drawings" are the graphic and pictorial portions of the Contract Documents showing the design, location and dimensions of the Work, including plans, elevations, sections, details, schedules and diagrams. Computed dimensions shall take precedence over scaled dimensions and large scale Drawings shall take precedence over small scale Drawings.

2.1.8 "Specifications" are those portions of the Contract Documents that specify the written requirements for materials, equipment, systems, standards and workmanship for the Work and for performance of related services. The organization of the Specifications into divisions, sections and articles, and the arrangement of Drawings, shall not control the CONTRACTOR in dividing the Work among Subcontractors or in establishing the extent of Work to be performed by any trade, nor shall it remove the obligation to complete all of the Work when coordination between the Specifications and Drawings is required.

2.2 OWNERSHIP OF CONTRACT DOCUMENTS

All Drawings, Specifications, and other Contract Documents, including copies thereof, prepared or furnished by the DISTRICT are the DISTRICT's property. They shall not be used by the CONTRACTOR or Subcontractors of any tier on other work and, with the exception of the signed Contract set, shall be returned to the DISTRICT upon request.

3.0 ADMINISTRATION OF THE CONTRACT

3.1 ADMINISTRATION BY THE DISTRICT

3.1.1 The DISTRICT will provide administration of the Contract. All communications with the DISTRICT or its consultants related to the Contract shall be through the DISTRICT's Representative. The DISTRICT shall have the authority but not the obligation to reject work, materials and equipment that does not conform to the Contract Documents, and to decide questions concerning the Contract Documents that arise during execution of the Work. None of the DISTRICT's consultants is an agent of the DISTRICT, and none is authorized to agree on behalf of the DISTRICT to changes in the Contract Price or Contract Time, nor to waive provisions of the Contract Documents, nor to direct the CONTRACTOR to take actions that change the Contract Price or Contract Time, nor to accept notice of Claims or Claims on behalf of the DISTRICT.

3.1.2 The DISTRICT and its representatives shall at all times have access to the Work in progress, and the CONTRACTOR shall provide proper facilities for such access and for inspection.

3.1.3 The DISTRICT shall furnish information or services required of the DISTRICT with reasonable promptness. The DISTRICT may make suggestions of means and methods, techniques, sequences or procedures, but the CONTRACTOR alone has responsibility for and shall control its means methods, techniques, sequences and procedures. The CONTRACTOR is also solely responsible for safety precautions and programs. The DISTRICT shall not be responsible for safety precautions or programs in connection with the Work, and shall not be responsible for the CONTRACTOR's failure to carry out the Work in accordance with the Contract Documents. The DISTRICT has authority to reject Work that does not conform to the Contract Documents, but the failure to so reject or the presence of the DISTRICT at the site shall not be construed as assurance that the Work is acceptable or being completed in compliance with the Contract Documents.

3.2 REVIEW OF CONTRACT DOCUMENTS, FIELD CONDITIONS, SUBSURFACE CONDITIONS, AND QUESTIONS ABOUT DRAWINGS AND SPECIFICATIONS

3.2.1 Execution of the Contract by the CONTRACTOR is a representation that the CONTRACTOR has visited the site(s), become generally familiar with local conditions under which the Work is to be performed, and correlated personal observations with the requirements of the Contract Documents. By executing the Contract, the CONTRACTOR represents and acknowledges that the Contract Price is reasonable compensation for the Work, that the Contract Time is adequate, and that it has carefully examined the Contract Documents and the Project site, including any existing structures, and that it has satisfied itself as to the nature, location, character, quality and quantity of the Work, the physical labor, materials, equipment, goods, products, supplies, work, services and other items to be furnished and all other requirements of the Contract Documents, as well as the surface conditions and other foreseeable matters that may be encountered at the Project site or affect performance of the Work or the cost or difficulty thereof, including but not limited to those conditions and matters affecting: transportation, access, local regulations, handling and storage of materials, equipment and other items; availability and quality of labor and utilities; availability and condition of roads; normal climatic conditions and seasons; physical conditions at the Project site and the surrounding locality; topography and ground surface conditions; and equipment and facilities needed preliminary to and at all times during the performance of the Work. The failure of the CONTRACTOR fully to acquaint itself with any such condition or matter shall not in any way relieve the CONTRACTOR from the responsibility for performing the Work in accordance with the Contract Documents, within the Contract Time, and for the Contract Price.

3.2.2 Because the Contract Documents are complementary, the CONTRACTOR shall, before starting each portion of the Work, carefully study and compare the various Drawings, Specifications, and other Contract Documents relative to that portion of the Work, as well as the information furnished by the DISTRICT, shall take field measurements of and verify any existing conditions, including all general reference points and existing conditions, related to that portion of the Work, and shall observe any conditions at the site affecting it and shall carefully compare such field measurements and conditions and other information known to the CONTRACTOR with the Contract Documents before commencing such activities. These obligations are for the purpose of facilitating coordination and construction by the CONTRACTOR and are not for the purpose of discovering errors, omissions, or inconsistencies in the Contract Documents; however, the CONTRACTOR shall promptly report to the DISTRICT any errors, inconsistencies or omissions discovered by or made known to the CONTRACTOR as a request for information in such form as the DISTRICT may require. The CONTRACTOR's review is made in the CONTRACTOR's capacity as a contractor and not as a licensed design professional, unless otherwise specifically provided in the Contract Documents.

3.2.3 The DISTRICT has undertaken a limited investigation of the subsurface conditions at the Project site for design purposes only. The results of these investigations are available for the convenience of CONTRACTOR, but they are not Contract Documents. There is no guarantee, express or implied, that the conditions indicated are representative of those existing throughout the site or that unforeseen developments may not occur. The CONTRACTOR is solely responsible for interpreting the information and extrapolating beyond the testing location, including each individual boring, test pit or other location.

3.2.4 If the CONTRACTOR encounters conditions at the site that are (1) subsurface or otherwise concealed physical conditions that differ materially from those indicated in the Contract Documents or any soils reports made available by the DISTRICT to the CONTRACTOR or (2) unknown physical conditions of an unusual nature that differ materially from those ordinarily found to exist and generally recognized as inherent in construction activities of the character provided for in the Contract Documents, the CONTRACTOR shall promptly provide written notice to the DISTRICT before conditions are disturbed and in no event later than seven (7) days after first observance of the conditions. For avoidance of doubt, the CONTRACTOR is instructed to assume that subsurface conditions will include fine grained silt with varying amounts of clay and fine sand, drop stones up to and including boulders several feet in diameter, and wood in size up to potential logs. The DISTRICT will promptly investigate such conditions and, if the DISTRICT determines that they differ materially and cause an increase or decrease in the CONTRACTOR's cost of, or time required for, performance of any part of the Work, will establish a change in the Contract Price or Contract Time, or both, consistent with the requirements of the Contract Documents. If the CONTRACTOR disputes the DISTRICT's determination, the CONTRACTOR may proceed as provided in Article 7.0. No increase to the Contract Price or the Contract Time shall be allowed if the CONTRACTOR knew or reasonably should have known of the concealed conditions prior to executing the Contract.

3.2.5 The CONTRACTOR shall submit requests for information following the procedure and using the form set forth in the Contract Documents. The CONTRACTOR shall minimize requests for information by thoroughly studying the Contract Documents and reviewing all requests from its Subcontractors. The CONTRACTOR shall prioritize time-sensitive requests. The CONTRACTOR shall allow adequate time in its planning and scheduling for a response from the DISTRICT to a request for information.

3.3 DISTRICT'S RIGHT TO STOP AND/OR TO CARRY OUT THE WORK

3.3.1 If the CONTRACTOR fails to correct Work that is not in accordance with the requirements of the Contract Documents, or repeatedly or materially fails to carry out or improperly performs the Work, the DISTRICT may issue a written order signed by the DISTRICT's Representative to stop the Work, or any portion thereof, until the cause for the order has been eliminated. The DISTRICT's right to stop the Work shall not impose a duty on the DISTRICT to exercise this right for the benefit of the CONTRACTOR or any third party.

3.3.2 If the CONTRACTOR fails to perform the Work properly, fails to perform any provision of this Contract, fails to maintain the Construction Schedule, or if the performance of the Work is such that the DISTRICT reasonably concludes that the Work will not be completed in the specified manner or within the Contract Time, then the DISTRICT may, after three (3) days' written notice to the CONTRACTOR and without prejudice to any other remedy the DISTRICT may have, itself perform or have performed any or all of the Work under the Contract and may deduct the cost thereof from any payment then or later due the CONTRACTOR.

3.4 SURVEYS AND APPROVALS

The DISTRICT shall furnish surveys describing physical characteristics, legal limitations and utility locations for the Project site, and a legal description of the site.

4.0 CONTRACTOR RESPONSIBILITIES

4.1 DUTY TO PERFORM THE WORK

4.1.1 The CONTRACTOR shall perform the entire Work required by the Contract in accordance with the Contract Documents.

4.1.2 The CONTRACTOR shall perform such detailed examination, inspection and quality surveillance of the Work as will ensure that the Work is progressing and is being completed in strict accordance with the Contract Documents. The CONTRACTOR shall plan and lay out all Work in advance of operations so as to coordinate all Work without delay or revision. The CONTRACTOR shall be responsible for inspection of portions of the Work already performed to determine that such portions are in proper condition to receive subsequent Work. Under no conditions shall a portion of Work proceed prior to preparatory work having been satisfactorily completed. The CONTRACTOR shall ensure that the responsible Subcontractor has carefully examined all preparatory work and has notified the CONTRACTOR (who shall notify the DISTRICT in writing) of any defects or imperfections in preparatory work that will, in any way, affect completion of the Work.

4.1.3 After the Contract has been executed, the DISTRICT may consider a written request for the substitution of material or products in place of those specified in the Contract Documents only under the circumstances described and following the procedures set forth in the Contract Documents. The CONTRACTOR may make substitutions only with the written consent of the DISTRICT. By requesting a substitution, the CONTRACTOR represents that it has personally investigated the proposed material or product and determined that it is equal or better in all respects to that specified (or if not equal or better, the CONTRACTOR shall identify such deficiencies), that the same or better warranty will be provided for the substitution, that complete cost data, including all direct and indirect costs of any kind, has been presented, that it waives any known or unknown Claim for an increase in the Contract Price or Contract Time related to the substitution, that it has coordinated with affected Subcontractors, that the substitution will not impact other parts of the Work, and that it will coordinate the installation of the substitute if accepted and make all associated changes in the Work. The DISTRICT will not be responsible for the performance of the substituted product.

4.2 CUSTOMER RELATIONS, PROJECT MANAGEMENT AND SUPERVISION

4.2.1 The CONTRACTOR shall supervise and direct the Work, using the CONTRACTOR's best skill and attention. The CONTRACTOR shall be and operate as an independent contractor in the performance of the Work and shall have complete control over and responsibility for all personnel and Subcontractors performing the Work. The CONTRACTOR shall be responsible to the DISTRICT for acts and omissions of the CONTRACTOR's principals, employees, Subcontractors of any tier and their agents and employees, and other persons or entities directly or indirectly performing portions of the Work for, or on behalf of, the CONTRACTOR.

4.2.2 The CONTRACTOR is not authorized to enter into any agreements or undertakings for or on behalf of the DISTRICT and is not an agent or employee of the DISTRICT. The CONTRACTOR will cooperate with the DISTRICT and others to create an environment of harmony, cooperation, and mutual respect and focus on the success of the Project.

4.2.3 The CONTRACTOR's personnel and equipment shall at all times present a neat appearance. All Work, contacts with third parties, and any complaints shall be handled by the CONTRACTOR with due regard for the DISTRICT's relations with the public. The CONTRACTOR agrees that complaints of any nature received from property owners, public authorities, or other sources shall receive immediate attention. All complaints and

any action taken by the CONTRACTOR in connection with such complaints shall be immediately reported to the DISTRICT.

4.2.4 The CONTRACTOR shall, during the progress of the Contract, employ and assign a competent project manager and superintendent and necessary assistants to the Project. The CONTRACTOR's superintendent shall not be employed on any other project during the course of the Work.

4.2.5 The CONTRACTOR shall inform the DISTRICT in writing of the name, authority, business address and telephone number of project management personnel. Neither the project manager nor superintendent shall be changed without the written consent of the DISTRICT, unless the project manager or superintendent ceases to be employed by the CONTRACTOR. In such case, the CONTRACTOR shall notify the DISTRICT and propose a new project manager or superintendent acceptable to the DISTRICT. The CONTRACTOR shall, if requested to do so by the DISTRICT, remove any project manager, superintendent or other assistant whom the DISTRICT believes to be incompetent, dishonest, careless, negligent, uncooperative or unsatisfactory. Failure to comply with such request shall be sufficient grounds for termination of the Contract for cause.

4.2.6 The superintendent shall be present or be duly represented at the Project site at all times during the progress of the Contract, and shall have authority to make binding and enforceable decisions in the name of the CONTRACTOR. All requirements, instructions and other communications given to the superintendent by the DISTRICT shall be binding as if given to the CONTRACTOR, and shall be confirmed in writing upon CONTRACTOR’s request.

4.3 LABOR AND MATERIALS

4.3.1 DISTRICT-Furnished Equipment Installed by CONTRACTOR (OFCI) (See Specifications, Section 01010, Paragraph 1.05 and other Contract Documents)

The CONTRACTOR shall receive and inspect any DISTRICT-Furnished Equipment, including but not limited to items furnished on behalf of the DISTRICT by others. These items shall be deemed acceptable to the CONTRACTOR if not promptly rejected in writing. The CONTRACTOR shall be entitled to damages for any defects in DISTRICT-Furnished Equipment only to the extent these damages are recovered by the DISTRICT against the supplier. If, at any time, the CONTRACTOR discovers any defect in material or equipment furnished by the DISTRICT, the CONTRACTOR shall immediately notify the DISTRICT in writing and shall cease to use such defective items.

Upon receipt of DISTRICT-Furnished Equipment, the CONTRACTOR shall bear the risk of loss for such items until Final Acceptance of the Work by the DISTRICT, and the CONTRACTOR shall repair or replace at its own expense any material or equipment that is lost or damaged prior to Final Acceptance.

4.3.2 Materials and Equipment Furnished and Installed by CONTRACTOR

Unless otherwise specifically provided in the Contract Documents, the CONTRACTOR shall provide and pay for all labor, tools, equipment, materials, electricity, power, water, other utilities, transportation and other facilities necessary for the execution and completion of the Work.

All material shall conform to the manufacturer's standards and shall be installed in strict accordance with the manufacturer's instructions, specifications and directions. The CONTRACTOR shall, if required in writing by the DISTRICT, furnish satisfactory evidence regarding the kind and quality of any materials identifying thereon the source, and warranting their quality and compliance with the Contract Documents.

4.3.3 Payment of Prevailing Wages

The CONTRACTOR shall pay (and shall ensure that all Subcontractors of any tier pay) all prevailing wages and Davis-Bacon Act wages applicable to the Project. The Special Conditions or other Contract Documents may specify additional or supplementary requirements.

Pursuant to RCW 39.12, "Prevailing Wages on Public Works," no worker, laborer, or mechanic employed in the performance of any part of the Work shall be paid less than the "prevailing rate of wage" (in effect as of the date that bids are due) as determined by the Industrial Statistician of the Department of Labor and Industries. The schedule of the prevailing wage rates for the locality or localities where this Contract will be performed is attached to the executed Contract as Exhibit D and made a part of the Contract Documents by reference as though fully set forth herein; if not attached, then the applicable prevailing wages under RCW 39.12 are determined as of the bid date for the county in which the Project is located and are available at the DISTRICT's office, at http://www.lni.wa.gov/ TradesLicensing/%0bPrevWage/WageRates/default.aspg, and will be mailed upon request. The CONTRACTOR shall keep a paper copy at the Project site. The CONTRACTOR shall provide its Subcontractors with a schedule of the applicable prevailing wage rates. Questions relating to prevailing wage data should be addressed to the Industrial Statistician upon request.

Mailing Address:	Department of Labor and Industries Prevailing Wage Office PO Box 44540 Olympia, WA 98504
Telephone:	(360) 902-5335
Facsimile:	(360) 902-5300

The information in Exhibit D is offered for the convenience of the CONTRACTOR. The DISTRICT does not represent that the information is accurate or complete. To the extent that there is any discrepancy between the attached or provided schedule of prevailing wage rates and the published rates applicable under WAC 296-127-011, or if no schedule is attached, the applicable published rates shall apply with no increase in the Contract Price. It is the CONTRACTOR's responsibility to ensure that the correct prevailing wage rates are paid.

Prior to any payment being made on behalf of the DISTRICT under this Contract, the CONTRACTOR and each Subcontractor of any tier shall file a Statement of Intent to Pay Prevailing Wages with the Department of Labor and Industries and submit a copy to the DISTRICT certified by the Director of Labor and Industries. Each statement shall be filed in accordance with the requirements of the Department of Labor and Industries. No progress payment shall be due until the DISTRICT receives these statements.

The CONTRACTOR shall also post in a location readily visible to workers at the Project site:

a. A copy of the Statement of Intent to Pay Prevailing Wages approved by the Industrial Statistician of the Department of Labor and Industries; and

b. The address and telephone number of the Industrial Statistician of the Department of Labor and Industries where a complaint or inquiry concerning prevailing wages may be made.

Pursuant to RCW 39.12.060, in case any dispute arises as to what the prevailing wages are for work of a similar nature, and such dispute cannot be adjusted by the parties in interest, including labor and management representatives, the matter shall be referred for

arbitration to the Director of the Department of Labor and Industries, and his or her decision shall be final and conclusive and binding on all parties involved in the dispute.

The CONTRACTOR shall defend, indemnify and hold the DISTRICT harmless, including attorneys' fees, from any violation or alleged violation by the CONTRACTOR or any Subcontractor of any tier of RCW 39.12 ("Prevailing Wages on Public Works") or Chapter 51 RCW ("Industrial Insurance"), including but not limited to RCW 51.12.050.

4.3.4 Workers and Discipline

The CONTRACTOR shall at all times enforce strict discipline and good order among its employees, and shall not employ any unfit person or anyone not skilled in the work to which they are assigned. The CONTRACTOR shall replace any employees or agents whom the DISTRICT considers objectionable.

4.3.5 Sanitation

The CONTRACTOR shall provide and maintain necessary sanitation conveniences for the use of workers at the site, properly secluded from public observation.

4.4 FRANCHISES, LICENSES AND BONDS

Permission under franchises, licenses and bonds of a temporary nature necessary for the prosecution of the Work, as well as inspection fees in connection with them, shall be secured and paid by the CONTRACTOR.

4.5 LAWS AND REGULATIONS

The CONTRACTOR shall comply with and give notices required by all applicable Federal, State, County and City laws, ordinances and regulations, as well as amendments bearing on the conduct of the Work, and shall promptly report to the DISTRICT any nonconformity discovered by or made known to the CONTRACTOR. If the CONTRACTOR performs any work contrary to such laws, ordinances, rules or regulations, the CONTRACTOR shall bear all related costs. The CONTRACTOR shall be solely responsible for insuring that all Work under this Contract is carried out in a safe manner and in accordance with the Washington Industrial Safety and Health Act (WISHA) and other applicable safety laws, rules, and regulations.

4.6 OMISSIONS AND DISCREPANCIES

Minor items of work or material omitted from the Drawings or Specifications, but which are inferable from the information presented and normally provided by accepted good practice, shall be provided and/or performed by the CONTRACTOR as part of the Contract Price. If the CONTRACTOR observes that the Contract Documents, including Drawings and Specifications, or physical conditions of the site are at variance, are in error, or omit any necessary detail, the CONTRACTOR shall promptly notify the DISTRICT, in writing, and any necessary changes shall be adjusted as provided in the Contract for changes in the Work. Any Work done after such observation, until authorized, shall be at the CONTRACTOR's risk.

4.7 UTILITIES OR OBSTRUCTIONS

The CONTRACTOR should assume that the locations of any underground or hidden utilities, underground tanks, plumbing or electrical runs indicated in surveys or the Contract Documents are shown in approximate locations, and shall verify all utility locations. The accuracy of any such information is not guaranteed by the DISTRICT. The CONTRACTOR shall protect all existing utilities, structures, and plants. The CONTRACTOR shall bear the risk of loss if any of the Work directly or indirectly damages or interrupts any utilities or utility service, or causes or contributes to damages of any nature, and shall repair the same at no extra cost to the DISTRICT.

4.8 CONTRACTOR'S WARRANTY

4.8.1 The CONTRACTOR warrants that materials and equipment furnished under this Contract will be of good quality and new, unless otherwise required or explicitly permitted by the Contract Documents. The CONTRACTOR further warrants that the Work will be performed in a skillful and workmanlike manner and will conform to the requirements of

the Contract Documents. Moreover, the CONTRACTOR warrants that the Work will be free from defects for a period of one year from the date of Final Acceptance of the Project. The CONTRACTOR is not relieved of its general warranty obligations by the specification of a particular product or procedure in the Contract Documents. Warranties in the Contract Documents shall survive completion, acceptance and final payment.

4.8.2 The CONTRACTOR shall collect, assign, and deliver to the DISTRICT any written warranties provided by others or required by the Contract Documents. These warranties shall extend to the DISTRICT all rights, claims, benefits and interests that the CONTRACTOR may have under express or implied warranties or guarantees against a Subcontractor of any tier, supplier or manufacturer for defective or non-conforming Work.

4.9 CLEAN-UP

The CONTRACTOR shall keep the Project site reasonably clear during the progress of the Work and shall not encumber the site with any equipment or materials. The CONTRACTOR shall comply with all clean-up requirements set forth in the Contract Documents and, prior to completion, leave the Project site in a neat, orderly, and workmanlike condition. If the CONTRACTOR fails, in the reasonable opinion of the DISTRICT, to appropriately clean up the Project site at any time, the DISTRICT may do so and the costs thereof shall be charged to the CONTRACTOR.

4.10 USE OF SITE

The CONTRACTOR shall confine operations at the Project site to areas permitted by applicable laws, statutes, ordinances, permits, codes, rules and regulations, and lawful orders of public authorities and the Contract Documents.

4.11 CUTTING AND PATCHING

The CONTRACTOR shall be responsible for cutting, fitting or patching required to complete the Work or to make its parts fit together properly. All areas requiring cutting, fitting and patching shall be restored to their prior condition, unless otherwise required by the Contract Documents.

Existing structures and facilities, including but not limited to buildings, landscaping, utilities, topography, streets, curbs, and walks, that are damaged or removed due to excavations or other construction operations of the CONTRACTOR, shall be patched, repaired or replaced by the CONTRACTOR to the satisfaction of the DISTRICT, the owner of such structures and facilities, and governmental authorities having jurisdiction. If the governmental authorities require that the repairing and patching be done with their own labor and/or materials, the CONTRACTOR shall abide by such requirements and shall pay for such Work at no additional cost to the DISTRICT.

4.12 SCHEDULE

4.12.1 The CONTRACTOR shall, promptly after being awarded the Contract and as a condition to receipt of its first progress payment, prepare and submit for the DISTRICT's information and acceptance three (3) paper color copies and one native electronic copy of a critical path method construction schedule for the Work (the "Construction Schedule"), which shall be consistent with the requirements of the Contract Documents. The CONTRACTOR shall also prepare, submit, and keep current a submittal schedule that shall be coordinated with the Construction Schedule.

4.12.2 The CONTRACTOR shall submit an updated Construction Schedule each month with its payment application. The Construction Schedule shall not exceed time limits current under the Contract Documents, shall be revised monthly, shall address the entire duration of the Project, and shall provide for expeditious and practicable execution of the Work. The CONTRACTOR shall allocate a separate line item in the schedule of values for scheduling of at least one percent (1%) of the Contract Price, which shall cover both the initial Construction Schedule and all monthly updates. The CONTRACTOR shall request payment for this line item with each payment application, based upon the value of completed Work. For any month that the CONTRACTOR fails to submit a satisfactory

Construction Schedule or an accurate update identifying accurately the current status of the Work, the CONTRACTOR shall not be entitled to any payment for scheduling for that month, and the percentage of the scheduling line item represented by that month's percentage of completion of the Work shall, at the DISTRICT's option, be permanently deducted from the Contract Price by Change Order.

4.12.3 The CONTRACTOR shall perform the Work in accordance with the most recently submitted Construction Schedule and shall promptly notify the DISTRICT of any substantial deviations, including deviations that affect the critical path. The CONTRACTOR shall promptly notify the DISTRICT in writing of any proposed changes in the Construction Schedule or the Contract Time. The CONTRACTOR shall notify the DISTRICT in accordance with Article 7.0 of any event that could delay performance of any item of the Work, stating the cause of the delay, the expected duration of the delay, the anticipated effect of the delay on the Construction Schedule and the action being taken to address the delay. The CONTRACTOR shall comply with the contractual dispute resolution procedures with regard to any delays that it believes are the responsibility of the DISTRICT.

4.12.3 If any update of the Construction Schedule sets forth a date for Substantial Completion for the Work or any milestone of the Work beyond the dates established in the Contract Documents, the CONTRACTOR shall submit to the DISTRICT for review and approval a narrative description of the means that the CONTRACTOR proposes to use to expedite the Work to ensure timely completion of the various milestones of the Work and the Work as a whole. The CONTRACTOR shall have sole responsibility for all means and methods in performing the Work. Regardless of the cause of any delay, the CONTRACTOR shall exercise reasonable efforts to bring the Project back into compliance with the Construction Schedule and to achieve completion of all milestones and overall Substantial Completion of the Work within the Contract Time.

4.13 SUBMITTALS, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES

4.13.1 Shop Drawings, Product Data, Samples and other submittals are not Contract Documents. Their purpose is for the CONTRACTOR to demonstrate how the CONTRACTOR proposes to conform to the information provided and the design concept expressed in the Contract Documents for those portions of the Work for which the Contract Documents require submittals. Review and acceptance of submittals by the DISTRICT shall not constitute an approval of the CONTRACTOR's means and methods (which shall be solely the CONTRACTOR's responsibility) or a waiver or modification of any requirement of the Contract Documents.

4.13.2 The Work shall be in accordance with accepted submittals except that the CONTRACTOR shall not be relieved of responsibility for deviations from the requirements of the Contract by the review, acceptance, or approval of Shop Drawings, Product Data, Samples or similar submittals. The CONTRACTOR shall perform no portion of the Work for which the Contract Documents require submittals until the required submittals have been reviewed and no exceptions taken.

4.13.3 The CONTRACTOR shall track the status of submittals. The CONTRACTOR shall provide submittals to the DISTRICT in accordance with a submittal schedule acceptable to the DISTRICT and in such sequence and frequency as to cause no delay in the Work. At the time of submission, the CONTRACTOR shall inform the DISTRICT in writing if there is any deviation in the Shop Drawings, Product Data, Samples, or other submittals from the requirements of the Contract Documents. Each Shop Drawing or Product Data submittal shall bear a cross reference note referring to a page or detail number on the Drawings and/or Specifications in order to facilitate the review and prompt return of the submittal to the CONTRACTOR. Shop Drawings for interrelated Work shall be submitted at the same time. The CONTRACTOR shall stamp and initial its approval on all submittals prior to submitting them to the DISTRICT indicating that the CONTRACTOR

has satisfied its responsibilities under the Contract Documents for review of the submittals. The CONTRACTOR shall not be relieved of responsibility for errors or omissions in Shop Drawings, Product Data, Samples or similar submittals by the approval, review or acceptance thereof by the DISTRICT.

4.14 APPRENTICESHIP

4.14.1 To the extent required by RCW 39.04.320, the CONTRACTOR shall achieve any apprentice participation required by law. Apprentice hours shall be performed by participants in training programs approved by the Washington State Apprenticeship Council.

4.14.2 "Labor hours" means the total hours of workers receiving an hourly wage who are directly employed on the site of the Project. "Labor hours" includes hours performed by workers employed by the CONTRACTOR and all Subcontractors working on the Work. "Labor hours" does not include hours worked by foremen, superintendents, owners, and workers who are not subject to prevailing wage requirements of RCW 39.12.

4.14.3 During the term of this Contract, the DISTRICT may adjust the apprentice labor hour requirement upon its finding or determination that includes:

(1) A demonstration of lack of availability of apprentices in the geographic area of the Project;
(2) A disproportionately high ratio of material costs to labor hours that does not make feasible the required minimum levels of apprentice participation;
(3) Demonstration by participating contractors of a good faith effort to comply with the requirements of RCW 39.04.300, 39.04.310 and 39.04.320;
(4) Small contractors or subcontractors (e.g., small or emerging businesses) would be forced to displace regularly employed members of their workforce;
(5) The reasonable and necessary requirements of the Contract render apprentice utilization infeasible at the required level (e.g., the number of skilled workers required and/or limitations on the time available to perform the Work preclude utilization of apprentices); or
(6) Other criteria the DISTRICT deems appropriate, which are subject to review by the office of the Governor.

4.14.4 The CONTRACTOR shall report apprentice participation to the DISTRICT at least quarterly on forms acceptable to the DISTRICT. In addition, copies of quarterly certified payroll records may be requested to document the goal. The reports will include:

(1) The name of the Project;
(2) The dollar value of the Work;
(3) The date of the CONTRACTOR's Notice to Proceed;
(4) The name of each apprentice and apprentice registration number;
(5) The number of apprentices and labor hours worked by them, categorized by trade or craft;
(6) The number of journey level workers and labor hours worked by them, categorized by trade or craft; and
(7) The number, type, and rationale for the exceptions granted.

4.15 ROYALTIES, PATENTS, AND COPYRIGHTS

The CONTRACTOR shall pay all royalties and license fees unless the Contract Documents explicitly indicate that such costs and fees are the responsibility of others. The CONTRACTOR shall defend suits or claims for infringement of copyrights and patent rights and shall hold the DISTRICT and any designer (A/E) harmless from loss on account thereof, but shall not be responsible for such defense or loss when a particular design, process or product of a particular manufacturer or manufacturers is required by the Contract Documents, or where the copyright violations are contained in Drawings, Specifications or other documents prepared by the DISTRICT or any A/E. However, if the CONTRACTOR has reason to believe that a required

design, process or product is an infringement of a copyright or a patent, the CONTRACTOR shall be responsible for such loss unless such information is promptly furnished to any A/E.

4.16 OBLIGATIONS UNDER FEDERAL LAW

The CONTRACTOR shall not presently be debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participating in the Contract or the Project by any Federal department or agency. If requested, the CONTRACTOR shall complete a certification form regarding debarment, suspension, ineligibility, and voluntary exclusion. Any such form completed by the CONTRACTOR shall be incorporated into the Contract by reference. The CONTRACTOR shall immediately provide written notice to the DISTRICT if at any time the CONTRACTOR learns that it has become debarred, suspended, proposed for debarment, declared ineligible or is voluntarily excluded from participating in the Contract or the Project by any Federal department or agency; or if at any time the CONTRACTOR learns that its certification was or has become erroneous.

The CONTRACTOR shall not award any subcontract to a party that is debarred, suspended or otherwise excluded from or ineligible for participation (as more fully described above) in any federal assistance programs, except with the express written consent of the DISTRICT. In addition, the Special Conditions, Specifications or Contract Documents may include requirements that the CONTRACTOR comply with provisions of the Federal Acquisition Regulations or other Federal laws or regulations, which provisions are incorporated by reference into the Contract. The CONTRACTOR hereby agrees to include all such provisions in any subcontracts entered into relating to the Project.

5.0 SUBCONTRACTS

5.1 AWARD OF SUBCONTRACTS

5.1.1 Unless otherwise stated in the Contract Documents or the Bidding Documents, the CONTRACTOR, as soon as practicable after award of the Contract, shall furnish the DISTRICT the names of all persons or entities (including those who are to furnish materials or equipment fabricated to a special design) proposed for each portion of the Work, consistent with the listing requirements of the bid, as well as the proprietary names and the suppliers of the principal items or systems of materials and equipment proposed for the Work. No progress payment will become due until after this information has been furnished. The DISTRICT may respond promptly to the CONTRACTOR in writing stating (1) whether or not the DISTRICT, after due investigation, has reasonable objection to any such proposed person or entity or (2) that the DISTRICT requires additional time for review. If the DISTRICT makes a reasonable objection, the CONTRACTOR shall replace the Subcontractor with no increase to the Contract Price or Contract Time. Such a replacement shall not relieve the CONTRACTOR of its responsibility for the performance of the Work and compliance with all of the requirements of the Contract within the Contract Price and Contract Time.

5.1.2 "Reasonable objection" as used in this Section 5.1 includes but is not limited to: a (1) proposed Subcontractor of any tier differing from the entity listed with the bid, (2) lack of "responsibility" of the proposed Subcontractor, as defined by Washington law and the Contract or Bidding Documents, or lack of qualification or responsibility of the proposed Subcontractor based on the Contract or Bidding Documents, or (3) material failure of the Subcontractor to perform satisfactorily (such as causing a material delay or submitting a claim that the DISTRICT considers inappropriate) on one or more projects for the DISTRICT within five (5) years of the bid date.

5.2 SUBSTITUTION OF SUBCONTRACTORS

The CONTRACTOR shall not substitute a Subcontractor, person, or organization that has been accepted by the DISTRICT, unless such substitution has been approved in writing by the DISTRICT.

5.3 NO CONTRACTUAL AGREEMENT BETWEEN THIRD PARTIES AND DISTRICT

The Contract Documents shall not be construed to create a contractual relationship of any kind (1) between the DISTRICT and a Subcontractor of any tier (although the DISTRICT does not waive any third-party beneficiary rights it may otherwise have as to Subcontractors of any tier), (2) between the CONTRACTOR and any DISTRICT employee or consultant, or (3) between any persons or entities other than the DISTRICT and CONTRACTOR.

5.4 CONTRACTOR RESPONSIBILITY

The CONTRACTOR shall be responsible to the DISTRICT for the acts and omissions of its Subcontractors of any tier. The CONTRACTOR shall require each Subcontractor to agree in writing, to the extent of the Work to be performed by the Subcontractor, to be bound to the CONTRACTOR by the Contract Documents, and to assume toward the CONTRACTOR all the obligations and responsibilities, including the responsibility for safety relating to the Subcontractor's work, that the CONTRACTOR, by the Contract Documents, assumes toward the DISTRICT. Each subcontract shall preserve and protect the rights of the DISTRICT so that subcontracting will not prejudice these rights, and shall allow to the Subcontractor, unless specifically provided in the subcontract, the benefit of all rights, remedies and redress against the CONTRACTOR that the CONTRACTOR, by the Contract Documents, has against the DISTRICT. Where appropriate, the CONTRACTOR shall require each Subcontractor to enter into similar agreements with lower-tier Subcontractors. Upon request, the CONTRACTOR shall provide to the DISTRICT copies of written agreements between the CONTRACTOR and any Subcontractor.

5.5 SUBCONTRACTOR WORK

The CONTRACTOR shall schedule, supervise and coordinate the operations of all Subcontractors of any tier. No subcontracting of any of the Work shall relieve the CONTRACTOR from its responsibility for the complete performance of the Work in accordance with the Contract Documents or from its responsibility for the performance of all obligations of the Contract Documents, including scheduling and coordination. The CONTRACTOR will be solely responsible for any scope gaps in its contracts with Subcontractors, including gaps that result from Subcontractor exclusions.

5.6 CONTINGENT ASSIGNMENT OF SUBCONTRACTS

The CONTRACTOR assigns each subcontract to the DISTRICT, provided that the assignment is (1) effective only after termination of the Contract by the DISTRICT and only for those subcontracts that the DISTRICT accepts by notifying the Subcontractor and the CONTRACTOR in writing; and (2) subject to the prior rights of a surety, if any, obligated under any bond relating to the Contract. When the DISTRICT accepts the assignment of a subcontract, the DISTRICT assumes the CONTRACTOR's rights and obligations under the subcontract, but only for events and payment obligations that arise from events after the date of the assignment.

6.0 SEPARATE CONTRACTS

6.1 COOPERATION WITH SEPARATE CONTRACTORS

6.1.1 The DISTRICT intends to let contracts to other contractors and suppliers (each defined in these General Conditions as a "Separate Contractor") in connection with the Project and to perform work with its own forces. The CONTRACTOR shall coordinate, help to schedule, and cooperate with any Separate Contractor, as well as any DISTRICT forces. The CONTRACTOR shall afford the DISTRICT and Separate Contractors reasonable opportunity for the introduction and storage of their materials and the execution of their work.

6.1.2 A portion of the CONTRACTOR's Work will depend on the work of Separate Contractors. The CONTRACTOR shall inspect and promptly report to the DISTRICT, in writing, any defects in such prior work which render it unsuitable for the CONTRACTOR to proceed. Failure of the CONTRACTOR to so inspect and report defects in writing shall constitute an acceptance of such prior work by CONTRACTOR.

6.1.3 To insure proper execution of the CONTRACTOR's Work, the CONTRACTOR shall measure work already in place and shall report at once to the DISTRICT in writing any discrepancy between the executed work and the Drawings or other Contract Documents.

6.2 DUTY TO CORRECT AND REIMBURSE

6.2.1 Should the CONTRACTOR or any of its Subcontractors of any tier cause damage of any kind, including but not limited to delay, to any Separate Contractor or its subcontractors, the CONTRACTOR shall, upon due notice, promptly use its best efforts to settle or otherwise resolve the dispute with such Separate Contractor or subcontractor. The CONTRACTOR shall also promptly remedy damage caused by the CONTRACTOR to completed or partially completed construction.

6.2.2 The CONTRACTOR shall reimburse and indemnify the DISTRICT for costs the DISTRICT incurs or that are payable to a Separate Contractor because of the CONTRACTOR's delays, improperly timed activities, defective construction, or otherwise attributable to CONTRACTOR. The DISTRICT shall be responsible to the CONTRACTOR for costs the CONTRACTOR incurs because of a Separate Contractor's delays, damage to the Work or defective construction of the Separate Contractor, but only to the extent the DISTRICT recovers from such Separate Contractor. If a Separate Contractor sues or initiates any proceeding against the DISTRICT on account of any damages or delays alleged to have been caused by the CONTRACTOR, the DISTRICT shall notify the CONTRACTOR. The CONTRACTOR shall defend all such proceedings at its own expense, and shall defend, indemnify, and hold the DISTRICT harmless from any damages awarded on such claims, including all attorneys' fees and other costs and expenses incurred by the DISTRICT.

7.0 CLAIMS AND DISPUTE RESOLUTION

7.1 GENERAL

In an effort to reduce the incidence and costs to all parties of extended disputes, all Claims, direct or indirect, arising out of, or relating to, the Contract Documents or the breach thereof, except those which have been waived under the terms of the Contract Documents, shall be decided exclusively by the following alternative dispute resolution procedure unless the parties mutually agree in writing otherwise. To the extent that the DISTRICT and CONTRACTOR agree to a partnering process to help resolve disputes, that process shall be in addition to, and not in place of, the mandatory dispute resolution procedures set forth below. Pending final resolution of a Claim, including the dispute resolution process set forth below, the CONTRACTOR shall proceed diligently with performance of the Contract and maintain the Construction Schedule, and the DISTRICT shall continue to make payments of undisputed amounts in accordance with the Contract Documents.

7.2 NOTICE AND CLAIMS

7.2.1 A Claim is a demand or assertion by one of the parties seeking, as a matter of right, adjustment or interpretation of the Contract terms, payment of money, extension of time or other relief with respect to the terms of the Contract Documents. The term "Claim" also includes other disputes and matters in question between the DISTRICT and CONTRACTOR arising out of or relating to the Contract Documents. The responsibility to substantiate Claims shall rest with the party making the Claim. Claims must be initiated in writing and include the information and substantiation required by the Contract Documents.

7.2.2 Except for Claims requiring notice before proceeding with the affected Work, the CONTRACTOR shall submit a written notice of a Claim to the DISTRICT within seven (7) days of the occurrence of the event giving rise to the Claim and shall include a clear description of the event leading to or causing the Claim.

7.2.3 The CONTRACTOR shall submit a written Claim as provided herein within thirty (30) days of submitting the notice. Claims shall include a clear description of the Claim and any proposed change in the Contract Price (showing all components and calculations) and/or Contract Time (showing cause and analysis of the resultant delay in the critical path) and shall provide all data supporting the Claim, including without limitation a complete explanation as to why the relief sought is not within the scope of the Contract Documents. The CONTRACTOR may delay submitting data by an additional fourteen (14) days if it notifies the DISTRICT that substantial data must be assembled. Failure to properly and timely submit a notice or Claim shall waive the Claim. A Claim shall be deemed to include all changes, direct and indirect, in cost and in time to which the CONTRACTOR (including Subcontractors of any tier) is entitled and may not contain reservations of rights without the DISTRICT's written approval; any unapproved reservations of rights shall be of no effect. Any claim of a Subcontractor of any tier may be brought only through, and after review by, the CONTRACTOR. For the purpose of calculating time periods, an "event giving rise to a Claim," among other things, is not a request for information but rather is a response that the CONTRACTOR believes would change the Contract Price and/or Contract Time.

7.2.4 Any notice of a Claim of the CONTRACTOR against the DISTRICT and any Claim of the CONTRACTOR, whether under the Contract or otherwise, must be made pursuant to and in strict accordance with the applicable provisions of the Contract. No act, omission, or knowledge, actual or constructive, of the DISTRICT shall in any way be deemed to be a waiver of the requirement for timely written notice and a timely written Claim unless the DISTRICT and the CONTRACTOR sign an explicit, unequivocal written waiver approved by the DISTRICT's Board of Commissioners. The fact that the DISTRICT and the CONTRACTOR may consider, discuss, or negotiate a Claim that has or may have been defective or untimely under the Contract shall not waive any provision of the Contract Documents unless the DISTRICT and CONTRACTOR sign an explicit, unequivocal waiver approved by the DISTRICT's Board of Commissioners. The CONTRACTOR expressly acknowledges and agrees that the CONTRACTOR's failure to timely submit required notices and/or timely submit Claims has a substantial impact upon and prejudices the DISTRICT, including but not limited to preventing the DISTRICT from fully investigating or verifying the Claim, mitigating damages, choosing alternative options, adjusting the budget, deleting or modifying the impacted Work, and/or monitoring time, cost and quantities. For these and other reasons, the CONTRACTOR and DISTRICT agree that the DISTRICT is prejudiced by the CONTRACTOR's failure to timely submit notices and/or Claims, and the DISTRICT shall not be required to establish actual prejudice to enforce the notice or Claim provisions of the Contract.

7.3 DISPUTE RESOLUTION

7.3.1 Following the DISTRICT's receipt of the written Claim, the parties shall in good faith attempt to resolve the Claim at the site level. At any time, the DISTRICT may require that an officer of the CONTRACTOR and the DISTRICT's designee (all with authority to settle) meet, confer, and attempt to resolve a Claim. If the Claim is not resolved during such meeting, the Claim shall be subject to mediation in accordance with Section 7.3.2. This requirement cannot be waived except by an explicit written waiver signed by the DISTRICT and the CONTRACTOR.

7.3.2 Claims not resolved through negotiation shall be subject to mandatory mediation. Unless the parties agree otherwise, a request for mediation shall be filed in writing with the other party to the Contract, and the parties shall promptly attempt to mutually agree upon a mediator. If the parties have not reached agreement on a mediator within thirty (30) days of the request, either party may file the request with the American Arbitration Association (AAA) or such other alternative dispute resolution service to which the parties mutually agree, with a copy to the other party, and the mediation shall be administered by the AAA (or other agreed service) in accordance with its Construction Industry Mediation Procedures currently in effect. Mediation will proceed in advance of binding dispute

resolution proceedings, which shall be stayed pending mediation, unless stayed for a longer period by agreement of the parties or court order. The parties to the mediation shall share the mediator's fee and any filing fees equally. The mediation shall be held in Seattle, Washington, unless another location is mutually agreed upon. Agreements reached in mediation shall be enforceable as settlement agreements in any court having jurisdiction thereof. An officer of the CONTRACTOR and the DISTRICT's General Manager or designee must attend the mediation session with authority to settle the Claim. To the extent there are other parties in interest, such as Subcontractors or a Separate Contractor, their representatives, also with authority to settle the Claim, shall also attend the mediation session.

7.3.3 All Claims arising out of or in connection with this Contract or the Project that are not resolved through mediation shall be exclusively and finally resolved by litigation; provided, however, that if the DISTRICT at any time and in its sole discretion concludes that one or more Separate Contractors are necessary or beneficial as parties for the full and final resolution of a claim, dispute or controversy, then Claims arising out of or in connection with this Contract or the Project that are not resolved through mediation shall be exclusively and finally resolved by arbitration that includes such Separate Contractor(s) as parties under the latest rules of the AAA then in effect, unless all such parties mutually agree otherwise in writing.

If the DISTRICT so selects arbitration as the forum for binding dispute resolution, the following procedure shall apply. The locale of any arbitration shall be Seattle, Washington. The CONTRACTOR may bring no arbitration on Claims unless such Claims have been properly raised and considered in the procedures of this Article 7.0, including good faith participation in mediation.

i. A demand for arbitration shall be made in writing, delivered to the other party, and filed with the person or entity administering the arbitration. Unless the parties mutually agree otherwise, the AAA shall administer any arbitration.

ii. The CONTRACTOR shall have the burden to demonstrate in any arbitration that it has complied with the requirements of this Article, including all time limits set forth in the Contract Documents. A demand for arbitration shall be made no earlier than the date written notification is received from one of the parties (or the mediator) stating that the mediation has not been successful, and in no event shall it be made after the date when the institution of legal or equitable proceedings based on the Claim would be barred by the Contract or the applicable statute of limitations or repose. This requirement cannot be waived except by an explicit written waiver signed by the DISTRICT and the CONTRACTOR.

iii. The Parties shall have the right to production of documents, electronically stored information, and tangible things, or entering onto land, for inspection and other purposes as provided in Rule 34 of the Federal Rules of Civil Procedure. In addition, the parties shall have the full right to discovery provided for in Rules 26 through 36 of the Federal Rules of Civil Procedure without arbitrator approval. Any dispute concerning discovery will be resolved by the arbitrator(s).

iv. A party may file, and the arbitrator(s) shall consider and rule on, pre-trial motions. The arbitrator(s) shall hear and determine any preliminary issue of law asserted by any party to be dispositive of any claim or defense, in whole or in part, in the manner that a court would hear and dispose of a motion to dismiss or for summary judgment, pursuant to such terms and procedures as the arbitrator(s) deem appropriate.

v. It is the intent of the parties that, barring extraordinary circumstances, any arbitration shall be concluded within one (1) year of the date the arbitrator(s) are named, and, unless the parties otherwise agree, the total time of the arbitration hearing (exclusive of

any preliminary hearing time) shall not exceed twenty (20) hearing days, or one hundred sixty (160) hours, whichever is less, with the time to be equitably divided between the parties by order of the arbitrator(s). The parties may, upon mutual agreement, extend or modify these time limits. The arbitrator(s) shall issue their final award or ruling within a time period not to exceed thirty (30) days after closure of the hearings and evidence.

vi. The parties and the arbitrator(s) shall treat all aspects of the arbitration and other related proceedings, including, but not limited to, discovery, testimony, evidence, the record of the proceedings, briefs, and the decision or award, as strictly confidential and not subject to disclosure to any third party or entity, other than to the parties, the arbitrator(s) and the AAA or other administering agency, or as disclosure is otherwise required by law, including RCW 42.56. The hearings shall be conducted privately, in a private setting, with no persons permitted to participate or be present except the parties, their designated counsel and representatives, the arbitrator(s), witnesses, a reporter of the proceedings (if requested and paid for by a party) and a representative of the AAA or other administering agency.

vii. Prior to the commencement of the hearing, either party may request, and the arbitrator(s) shall issue, a written decision that includes a reasoned statement of decision or opinion stating or setting forth the essential facts and legal bases supporting the disposition. In the event a panel is used, the arbitrators' decision shall be signed by at least a majority of the arbitrators.

viii. The parties expressly intend, agree and acknowledge that the parties knowingly, unequivocally and absolutely waive, and the arbitrators are not empowered to grant, any and all right to bring any demand, claim or action against the other for exemplary, consequential, treble or punitive damages in any forum and under any theory of recovery.

ix. Within fifteen (15) days of receipt of the written decision, either party will have the right to file with the arbitrator(s) and serve on the other party a written motion to reconsider. The arbitrator(s) may request the nonmoving or responding party to file a written response within ten (10) days after receipt of that request. The arbitrator(s) thereupon will reconsider the issues raised by the motion and response (if any) and either confirm or alter their decision, which will then be final, binding and conclusive upon the parties. The costs of such motion for reconsideration and written opinion of the arbitrator(s), including attorneys' fees, shall be awarded against the moving party if its motion does not substantially prevail.

x. The decision and any award rendered by the arbitration panel shall then be final, and judgment may be entered in any court having jurisdiction thereof. Except for the bases set forth in Section 7.04A of the Revised Code of Washington (the Uniform Arbitration Act), the parties hereby waive any right to appeal the arbitration decision, which shall be conclusive and binding on the parties.

xi. The cost of the arbitrator(s) shall initially be borne equally by the parties, subject to the arbitrator(s)' discretion to award and/or apportion reimbursement of such fees as part of the "costs" included in any prevailing party determination. Neither the CONTRACTOR nor a Subcontractor of any tier, whether claiming under a bond or lien statute or otherwise, shall be entitled to attorneys' fees directly or indirectly from the DISTRICT (but may recover attorneys' fees from the bond or statutory retainage fund itself to the extent allowable under law).

xii. The DISTRICT may join the CONTRACTOR as a party to any litigation or arbitration involving the alleged negligence, fault, responsibility, or breach of contract of the CONTRACTOR or Subcontractors of any tier. The foregoing arbitration provision and any other agreements to arbitrate with any additional persons or entities duly consented

to by the parties to this Contract shall be specifically enforceable in accordance with applicable law in any court having jurisdiction.

7.4 MISCELLANEOUS

7.4.1 At any time, the DISTRICT may, but is not obligated to, notify the surety of a claim involving the CONTRACTOR or of any performance concerns. If the claim or concern relates a potential CONTRACTOR's default, the DISTRICT may, but is not obligated to, notify the surety and request the surety's assistance in resolving the controversy.

7.4.2 If a Claim relates to or is the subject of a mechanic's lien, the party asserting such Claim may proceed in accordance with applicable law to comply with the lien notice or filing deadlines prior to resolution of the Claim by mediation or by arbitration.

7.4.3 The CONTRACTOR shall not make any negligent or fraudulent misrepresentations, concealments, errors, omissions, or inducements to the DISTRICT in the formation or performance of the Contract. If the CONTRACTOR or a Subcontractor of any tier submits a false or frivolous Claim to the DISTRICT, which for purposes of this Section is defined as a Claim based in whole or in part upon a materially incorrect fact, statement, representation, assertion, or record, the DISTRICT shall be entitled to collect from the CONTRACTOR by offset or otherwise (without prejudice to any right or remedy of the DISTRICT) any and all costs and expenses, including investigation and consultant costs, incurred by the DISTRICT in investigating, responding to, and defending against such false or frivolous Claim.

8.0 TIME

8.1 NOTICE TO PROCEED

A Notice to Proceed will be issued by the DISTRICT after execution of the Agreement and will normally be issued after the CONTRACTOR has complied with the bond, insurance, and other requirements set forth in the Contract Documents. The CONTRACTOR shall begin Work in accordance with the Notice to Proceed and shall complete all of the Work within the Contract Time.

8.2 TIME FOR COMPLETION

Unless otherwise provided, the Contract Time is the period of time, including authorized adjustments, specified in the Contract Documents for Substantial Completion of the entire Work. The CONTRACTOR’s sequence and method of operations, application of effort, and work force shall at all times be such as to insure the orderly, expeditious, and timely completion of the Work, including all interim milestones by the dates specified in the Contract Documents.

8.3 PROGRESS

8.3.1 The CONTRACTOR shall proceed expeditiously with adequate forces and shall achieve completion of any and all interim milestones in accordance with the Contract Documents, Substantial Completion of the entire Work within the Contract Time, and Final Completion within sixty (60) days thereafter unless otherwise specified in the Contract Documents. Time limits stated in the Contract Documents are of the essence of the Contract. By executing the Agreement, the CONTRACTOR confirms that the Contract Time is a reasonable period for performing the Work.

8.3.2 THE TIMELY COMPLETION OF THIS PROJECT IS ESSENTIAL TO THE DISTRICT. The CONTRACTOR shall furnish sufficient forces, construction plant and equipment, and shall work such hours, including night shifts, overtime operations and weekend and holiday work as may be necessary to insure the production of the Work in accordance with the Contract Documents, the date of Substantial Completion and the approved Construction Schedule. If the CONTRACTOR fails substantially to perform in a timely manner in accordance with the Contract Documents and, through the fault of the CONTRACTOR or Subcontractor(s) of any tier fails to meet the Construction Schedule, the CONTRACTOR shall take such steps as may be necessary to immediately improve

its progress by increasing the number of workers, shifts, overtime operations or days of work or other means and methods, all without additional cost to the DISTRICT. Provisions in the Contract for liquidated damages shall not relieve or release the CONTRACTOR from liability for any and all damages suffered by the DISTRICT due to other breaches of the Contract or suffered by Separate Contractors.

8.3.3 In determining the Contract Price, the CONTRACTOR has considered and confirmed as sufficient the time for completion specified in the Contract Documents and has also taken into consideration:

.1 Delay and Work interruption caused by requirements of the Drawings, Specifications and other Contract Documents, particularly as applied to the site and conditions under which the Work will be performed;

.2 Delay and potential Work interruptions caused by such factors as normal weather conditions, subsurface conditions and obstructions, labor disputes, holidays, and transportation time; and

.3 Delay and potential Work interruption caused by third parties, such as any Separate Contractors employed by DISTRICT.

No additional compensation will be granted or extension of time allowed because of such delays or interruptions unless caused by the DISTRICT.

8.3.4 It is the CONTRACTOR's option, but not its right, to attempt to complete the Project earlier than the date(s) specified in the Contract Documents. Thus, any Claim based upon delay shall be evaluated based upon the completion date(s) specified in the Contract Documents, not an earlier projected completion date that the CONTRACTOR may propose.

8.4 DELAYS AND EXTENSION OF TIME

8.4.1 If the CONTRACTOR is delayed at any time in the commencement or progress of the Work (1) by an act or neglect of the DISTRICT, or of an employee of consultant of the DISTRICT, or of a Separate Contractor employed by the DISTRICT; (2) by changes ordered in the Work, to the extent reflected in approved Change Orders providing for specific extensions of the Contract Time; (3) by unanticipated, abnormal weather; (4) by unexpected industry-wide labor disputes, fire or unusual delay in deliveries not caused by the CONTRACTOR or a Subcontractor, or unanticipated governmental delays (including unanticipated permit delays not caused by the CONTRACTOR); (5) by delay authorized by the DISTRICT pending mediation and arbitration; or (6) by other causes that the DISTRICT determines may justify excusable delay, then the Contract Time shall be extended by Change Order for such reasonable time, limited to the change in the actual critical path of the Project directly caused thereby, as the DISTRICT may determine. In no event, however, shall the CONTRACTOR be entitled to any extension of time absent proof of (1) delay to an activity on the critical path of the Project, so as to actually delay the Project completion beyond the date of Substantial Completion, or (2) delay transforming an activity to the critical path, so as to actually delay the Project completion beyond the date of Substantial Completion.

8.4.2 This Section 8.4 does not preclude recovery of damages for delay by either party under other provisions of the Contract Documents.

.1 If the delay was not caused by the DISTRICT, the CONTRACTOR, a Subcontractor of any tier, or anyone acting on behalf of any of them, the CONTRACTOR is entitled only to an increase in the Contract Time in accordance with the Contract Documents but not an increase in the Contract Price. If the delay was caused by the CONTRACTOR, a Subcontractor of any tier, or anyone acting on behalf of any of them, the CONTRACTOR is not entitled to an increase

in the Contract Time or in the Contract Price. The CONTRACTOR shall be entitled to a change in the Contract Price only if the delay was caused by the DISTRICT or someone acting on behalf of the DISTRICT. The CONTRACTOR shall not recover damages, an equitable adjustment or an increase in the Contract Price or Contract Time from the DISTRICT where the CONTRACTOR could have reasonably avoided the delay by the exercise of due diligence. The CONTRACTOR shall be able to recover an increase in the Contract Price, provided it is consistent with the terms of the Contract Documents, only if the delay affected the critical path, was unreasonable and was caused by the DISTRICT or anyone acting on its behalf under the Contract Documents. The DISTRICT is not obligated directly or indirectly for damages, an equitable adjustment, or an increase in the Contract Price for any delay suffered by a Subcontractor of any tier that does not increase the Contract Time.

.2 In the event the CONTRACTOR (including any Subcontractors of any tier) is held to be entitled to damages from the DISTRICT for delay beyond the amount permitted in Section 13.2, the total combined damages to the CONTRACTOR and any Subcontractors of any tier for each day of delay shall be limited to $2,500 per calendar day. By submitting a bid on the Work and executing the Contract, the CONTRACTOR represents that it would be difficult if not impossible to determine the amount of any delay damages due it, that it has taken this provision for liquidated damages into consideration in the Contract Price, and that these liquidated damages are a reasonable estimate of its loss. No damages will be allowed for any time prior to seven (7) days before receipt of written notice of the Claim of the delay pursuant to the Contract Documents.

.3 The CONTRACTOR shall not in any event be entitled to damages arising out of actual or alleged loss of efficiency; morale, fatigue, attitude, or labor rhythm; constructive acceleration; home office overhead; expectant underrun; trade stacking; reassignment of workers; rescheduling of Work, concurrent operations; dilution of supervision; learning curve; beneficial or joint occupancy; logistics; ripple; season change; extended or increased overhead or general conditions; profit upon damages for delay; impact damages including cumulative impacts; or similar damages. Any effect that such alleged costs may have upon the CONTRACTOR or its Subcontractors of any tier is fully compensated through the percentage Fee on Change Orders paid through Section 13.2 and any liquidated damages paid hereunder.

.4 The CONTRACTOR shall not be entitled to any adjustment in the Contract Time or the Contract Price, or to any additional payment of any sort, by reason of the loss or the use of any float time, including time not on the critical path or time between the CONTRACTOR's anticipated completion date and the end of the Contract Time, whether or not the float time is described as such on the Construction Schedule.

8.4.3 If adverse weather conditions are the basis for a Claim for additional time, the Claim shall be documented by data substantiating that weather conditions were abnormal for the period of time, could not have been reasonably anticipated and had an adverse effect on the scheduled construction, and that the Work was on schedule (or not behind schedule through the fault of the CONTRACTOR) at the time the adverse weather conditions occurred. Neither the Contract Time nor the Contract Price will be adjusted for normal inclement weather. The CONTRACTOR shall be entitled to a change in the Contract Time only (but not a change in the Contract Price) if the CONTRACTOR can substantiate to the reasonable satisfaction of the DISTRICT that there was materially greater than normal inclement weather considering the full term of the Contract Time and using a ten (10) year average of accumulated record mean values from climatological data compiled by the U.S. Department of Commerce National Oceanic and Atmospheric Administration for the locale closest to the Project, and that the alleged abnormal inclement weather actually extended the critical path of the Work. The change in the Contract Time shall be provisional until Substantial Completion has been achieved, at which time the change in

the Contract Time shall be calculated as the total net accumulated number of calendar days lost due to inclement weather from commencement of the Work until Substantial Completion, which exceeds the total net accumulated number to be expected for the same period from the aforesaid data.

9.0 PAYMENT AND COMPLETION

9.1 CONTRACT PRICE

The Contract Price is stated in the Agreement and, including authorized adjustments, is the total amount payable by the DISTRICT to the CONTRACTOR for performance of the Work under the Contract Documents.

9.2 SCHEDULE OF VALUES

At least ten (10) business days before the first payment application, the CONTRACTOR shall submit to the DISTRICT a schedule of values allocating the entire Contract Price to the various portions of the Work and prepared in such form and supported by such data to substantiate its accuracy as the DISTRICT may require. This schedule, unless objected to by the DISTRICT, shall be used as a basis for reviewing the CONTRACTOR's applications for payment.

.1 Mobilization shall be a maximum five percent (5%) of the Contract Price, and shall be paid only if supported by an itemized breakdown of costs acceptable to the DISTRICT.

.2 The schedule of values shall allocate at least two percent (2%) of the Contract Price to commissioning, as defined in the Contract Documents (Specifications, Section 01735), which the CONTRACTOR shall allocate to those Subcontractors participating in commissioning.

.3 Payment on line items for the expenses of the CONTRACTOR's bond and/or builder's risk insurance will be made only upon receipt of paid invoice from the surety and/or insurance carrier.

.4 The schedule of values shall also allocate at least three percent (3%) of the Contract Price as a separate line item for that portion of the Work between Substantial Completion and Final Completion, which shall be allocated as follows: at least two percent (2%) shall be allocated to Work that occurs after Substantial Completion and at least one percent (1%) shall be allocated for the CONTRACTOR's provision of approved as-built drawings and operations and maintenance data as defined in the Contract Documents and completion of all other requirements for Final Completion and final payment. The line item shall be entitled "Final Documentation and Punch List Completion" and will be earned and paid as a part of the final payment. This percentage is not retainage but rather a recognition that the CONTRACTOR and its Subcontractors will expend significant costs in advancing the Work from Substantial Completion to Final Completion and that this amount is not earned until Final Completion of the Work is accomplished. The DISTRICT may, at its sole discretion, release portions of this amount progressively as items are completed and upon reasonable terms.

9.3 APPLICATIONS FOR PAYMENT

9.3.1 Progress payments will be made monthly for Work duly certified, approved, and performed during the calendar month preceding the application. These amounts are paid in trust to the CONTRACTOR for distribution to Subcontractors to the extent and in accordance with the approved payment application.

9.3.2 During the last week of each month, the CONTRACTOR shall submit a report on the current progress of the Work, an updated Construction Schedule, and a draft, itemized payment application for Work performed during that calendar month on a form supplied or approved by the DISTRICT. This shall not constitute a payment request. The CONTRACTOR and DISTRICT shall meet within the next seven (7) days and confer regarding the current progress of the Work and the amount of payment to which the CONTRACTOR is entitled. The DISTRICT may request the CONTRACTOR to provide data substantiating the CONTRACTOR's right to payment, such as copies of requisitions from Subcontractors of any tier, lien releases, and certified payroll records (if requested by the DISTRICT), and reflecting retainage as provided elsewhere in the Contract

Documents. The CONTRACTOR shall not be entitled to make a payment request, nor is any payment due the CONTRACTOR, until such data is furnished.

9.3.3 After the CONTRACTOR and DISTRICT have met and conferred regarding the updated draft application, and the CONTRACTOR has furnished all progress information and data requested, and after the CONTRACTOR has provided the DISTRICT with current meeting minutes, daily reports (if requested), as-built drawings, and an updated Construction Schedule, the CONTRACTOR may submit four (4) identical copies of its payment request no later than the fifth (5th) day of the following month in the agreed-upon amount, in the form of a notarized, itemized payment application for Work properly performed during the prior calendar month on a form furnished or approved by the DISTRICT. The CONTRACTOR shall also submit a lien release on a form furnished or approved by the DISTRICT from each Subcontractor for whose Work the DISTRICT paid the CONTRACTOR for the prior month. The Application shall also state that prevailing wages have been paid in accordance Washington law and the Contract Documents and that all payments due Subcontractors of any tier from the DISTRICT's payment the prior month have been made. The submission of this application constitutes a certification that the Work is current on the Construction Schedule, unless otherwise noted on the application. If required by the DISTRICT, the CONTRACTOR shall submit proof of payment to Subcontractors for prior months, such as lien releases or cancelled checks. A payment request shall not be valid unless it complies with the requirements of the Contract Documents.

9.3.4 The CONTRACTOR warrants that title to all Work covered by a payment application will pass to the DISTRICT no later than the time of payment, but the CONTRACTOR shall remain responsible for all Work through Final Completion. The CONTRACTOR further warrants that upon submittal of a payment application all Work for which payments have been received from the DISTRICT shall, to the best of the CONTRACTOR's knowledge, information and belief, be free and clear of liens, claims, security interests or encumbrances in favor of the CONTRACTOR, Subcontractors, material suppliers, or other persons or entities making a claim by reason of having provided labor, materials and equipment relating to the Work.

9.3.5 Unless otherwise provided in the Contract Documents, payments shall be made on account of Project-specific materials and equipment delivered and suitably stored at the site for subsequent incorporation in the Work. If approved in writing and in advance by the DISTRICT, payment may similarly be made for materials and equipment suitably stored off the site at a location agreed upon in writing. Payment for materials and equipment stored on or off the site shall be conditioned upon compliance by the CONTRACTOR with procedures satisfactory to the DISTRICT to establish the DISTRICT's title to such materials and equipment or otherwise protect the DISTRICT's interest, and shall include the costs of applicable insurance, storage and transportation to the site for such materials and equipment stored off the site.

9.4 PAYMENT

9.4.1 After a complete payment application has been received and approved by the DISTRICT, and after payment has been authorized by the DISTRICT's Board of Commissioners, payment will be made within thirty (30) days. Any payments made by, or through, or following receipt of payment from third parties will be made in accordance with the third party's policies and procedures. The DISTRICT shall also be entitled to withhold payment to the extent provided by the Contract Documents.

9.4.2 The DISTRICT may withhold payment in whole or in part, to the extent reasonably necessary to protect the DISTRICT from loss for which the CONTRACTOR is responsible, including loss resulting from acts and omissions such as:

.1 defective Work not remedied;

.2 third party claims (except where an insurer has unconditionally accepted coverage) filed or reasonable evidence indicating probable filing of such claims unless security acceptable to the DISTRICT is provided by the CONTRACTOR;
.3 failure of the CONTRACTOR to make payments properly to Subcontractors or for labor, materials or equipment;
.4 reasonable evidence that the Work cannot be completed for the unpaid balance of the Contract Price;
.5 damage to the DISTRICT or a Separate Contractor (except where an insurer has unconditionally accepted coverage);
.6 reasonable evidence that the Work will not be completed within the Contract Time, and that the unpaid balance would not be adequate to cover damages for the anticipated delay;
.7 unsatisfactory prosecution of the Work by the CONTRACTOR, including but not limited to failure to carry out the Work in accordance with the Contract Documents;
.8 delay by the CONTRACTOR and/or its Subcontractor(s) of any tier, or failure to comply with the Construction Schedule requirements;
.9 failure to submit affidavits pertaining to wages paid as required by statute;
.10 failure to submit a properly updated Construction Schedule;
.11 failure to comply with a requirement of the Contract Documents in which the DISTRICT has reserved the right to withhold payment;
.12 liquidated damages;
.13 failure to properly maintain as-builts;
.14 failure to properly submit daily construction records; or
.15 failure to properly submit certified payrolls following the DISTRICT's request.

9.4.3 Pursuant to RCW 39.12, "Prevailing Wages on Public Works," the CONTRACTOR will not receive any payment until the CONTRACTOR and all Subcontractors of any tier for whom payment is sought have submitted state-approved "Statements of Intent to Pay Prevailing Wage" to the DISTRICT. Each statement must have the approval of the Industrial Statistician of the Department of Labor and Industries before it is submitted to the DISTRICT. The statement must include the CONTRACTOR's registration number, the number of workers in each trade classification, and the applicable wage rate for each trade listed. The CONTRACTOR agrees to provide each Subcontractor of any tier with a schedule of applicable prevailing wage rates. The CONTRACTOR and the respective Subcontractors of any tier shall pay all fees required by the Department of Labor and Industries, including fees for the approval of the "Statement of Intent to Pay Prevailing Wages." Approved copies of the "Statement of Intent to Pay Prevailing Wages" must be posted where workers can easily read them.

9.5 PAYMENT BY THE CONTRACTOR TO SUBCONTRACTORS

No payment request shall include amounts the CONTRACTOR does not intend to pay to a Subcontractor because of a dispute or other reason. If, after making a request for payment but before paying a Subcontractor for its performance covered by the payment request, the CONTRACTOR discovers that part or all of the payment otherwise due to the Subcontractor is subject to withholding from the Subcontractor under the subcontract (such as for unsatisfactory performance or non-payment of lower-tier Subcontractors), the CONTRACTOR may withhold the amount as allowed under the subcontract, but it shall give the Subcontractor and the DISTRICT written notice of the remedial actions that must be taken as soon as practicable after determining the cause for the withholding but before the due date for the Subcontractor payment, and pay the Subcontractor within eight (8) working days after the Subcontractor satisfactorily completes the remedial action identified in the notice.

9.6 DISPUTED AMOUNTS

9.6.1 If the CONTRACTOR believes it is entitled to payment for Work performed during the prior calendar month in addition to the agreed-upon amount, the CONTRACTOR may, also by the fifth (5th) day of the month, submit to the DISTRICT along with the approved

payment request, a separate written payment request specifying the exact additional amount due, the category in the schedule of values in which the payment is due, the specific Work for which the additional amount is due, and why the additional payment is due. Furthermore, for the submittal to be considered, the CONTRACTOR and all Subcontractors shall file with the DISTRICT by the same date certified copies of all payroll records pursuant to WAC 296-127-320 relating to the additional amount claimed to be due.

9.6.2 The DISTRICT shall have the right to take possession of and use any completed or partially completed portions of the Work at any time. Such possession and use shall not be deemed Substantial Completion or an acceptance of any Work not completed in accordance with the Contract Documents.

9.7 RETAINAGE

9.7.1 In accordance with RCW 60.28, a sum equal to five percent (5%) of each approved payment application shall be retained. Prior to submitting its first payment request, the CONTRACTOR shall exercise, in writing, one of the options listed below:

.1 Retained percentages will be retained in a fund by the DISTRICT and not subject to release until sixty (60) days following the Final Acceptance of the Work as completed; or

.2 Deposited by the DISTRICT in an interest-bearing account in a bank, mutual savings bank or savings and loan association and not subject to release until sixty (60) days following Final Acceptance of the Work as completed; or

.3 Placed in escrow with a bank or trust company and not subject to release until sixty (60) days following the Final Acceptance of the Work as completed.

.4 If the CONTRACTOR provides a bond in place of retainage, it shall be in accordance with RCW 60.28 and in an amount equal to 5% of the Contract Price plus Change Orders. The minimum requirements for the bond are that it must be on a form acceptable to the DISTRICT and signed by a surety registered by the Washington State Insurance Commissioner and on the currently authorized insurance list published by the Washington State Insurance Commissioner; additional requirements as established by the DISTRICT may be applied.

9.7.2 The CONTRACTOR or a Subcontractor may withhold payment of not more than five percent (5%) as retainage from the monies earned by any Subcontractor or lower-tier Subcontractor, provided that the CONTRACTOR pays interest to the Subcontractor at the same interest rate it receives from its reserved funds. If requested by the DISTRICT, the CONTRACTOR shall specify the amount of retainage and interest due a Subcontractor.

9.7.3 The retainage will be held and applied by the DISTRICT as a trust fund in a manner required by RCW 60.28. Release of the retainage will be processed in the ordinary course of business upon the expiration of sixty (60) days following Final Acceptance of the Work by the DISTRICT provided that no notice of lien shall have been given as provided in RCW 60.28, that no claims have been brought to the attention of the DISTRICT and that the DISTRICT has no claims under this Contract; and provided further that release of retention has been duly authorized by the State. The following items must also be obtained prior to release of retainage: pursuant to RCW 60.28, a certificate from the Department of Revenue; pursuant to RCW 50.24, a certificate from the Department of Employment Security; and appropriate information from the Department of Labor and Industries.

9.8 FAILURE TO MAKE PAYMENT

If the DISTRICT does not pay undisputed amounts due and owing to the CONTRACTOR, within fifteen (15) days of the date established in the Contract Documents, then the CONTRACTOR may, upon fifteen (15) additional days' written notice to the DISTRICT, during which the DISTRICT can cure, stop the Work until payment of the amount owing has been received. The

Contract Time shall be extended appropriately, and the Contract Price shall be increased by the amount of the CONTRACTOR's reasonable costs of shut-down, delay and start-up.

9.9 SUBSTANTIAL COMPLETION

9.9.1 Substantial Completion is the stage in the progress of the Work, or portion or phase thereof designated and approved by the DISTRICT, when the Work or designated portion is sufficiently complete in accordance with the Contract Documents so that the DISTRICT can fully utilize the Work, or the designated portion, for its intended use. The fact that all connections may be complete or the DISTRICT may utilize the Work or a designated portion does not necessarily indicate that the Work is acceptable in whole or in part. All Work other than incidental corrective or punch list Work be completed, including but not limited to the following:

.1 Obtain applicable occupancy/completion permits, assuring the DISTRICT's full access and use of completed Work.

.2 Submit a punch list of items to be completed or corrected and written request for inspection.

.3 Complete start-up, testing, and provide instruction and training sessions on all major equipment and systems, except training that must occur after commissioning.

.4 Discontinue or change over and remove unnecessary temporary facilities and services from the Project site.

.5 Advise the DISTRICT on coordination of shifting insurance coverages, including proof of extended coverages as required.

9.9.2 The Work is not Substantially Complete unless the DISTRICT reasonably judges that the Work can achieve Final Completion within sixty (60) days (or such other period of time as is specified in the Contract Documents); all designated systems and parts are connected and usable; all equipment and systems are ready for commissioning; training sessions (except those that must occur after commissioning) have occurred; O & M manuals have been submitted for review; and all required occupancy/completion permits and similar approvals or certificates by governing authorities and franchised services have been issued.

9.9.3 When the CONTRACTOR considers that the Work, or a portion thereof which the DISTRICT agrees to accept separately, has achieved Substantial Completion, the CONTRACTOR shall prepare and submit to the DISTRICT a comprehensive list of items to be completed or corrected prior to final payment. The CONTRACTOR shall proceed promptly to complete and correct items on the list and shall contemporaneously clean-up any dust or debris created through punch list work activities. Failure to include an item on such list does not alter the responsibility of the CONTRACTOR to complete all Work in accordance with the Contract Documents.

9.9.4 Upon notification from the CONTRACTOR, the DISTRICT will make an inspection to determine whether the Work or designated portion thereof has achieved Substantial Completion. Other inspections may be made to determine whether interim milestones are complete. If the inspection(s) discloses any item, whether or not included on the CONTRACTOR's list, which is not sufficiently complete in accordance with the Contract Documents so that the DISTRICT can utilize the Work or designated portion thereof for its intended use, the CONTRACTOR shall, before issuance of the Certificate of Substantial Completion, complete or correct such item. In such case, the CONTRACTOR shall then submit a request for another inspection by the DISTRICT to determine Substantial Completion. If the DISTRICT determines that the Work or designated portion has not achieved Substantial Completion, the CONTRACTOR shall expeditiously complete the Work or designated portion, and again request a review. The CONTRACTOR shall pay the costs associated with any further re-reviews, including inspection and consultant fees.

9.9.5 When the Work or designated portion thereof has achieved Substantial Completion, the DISTRICT will prepare a certificate of Substantial Completion which shall establish the date of Substantial Completion and shall fix the time within which the CONTRACTOR shall finish all remaining Work. Warranties required by the Contract Documents shall commence on the date of Substantial Completion of the Work or designated portion thereof unless otherwise provided in the Contract Documents. The CONTRACTOR shall attach and submit with the executed certificate of Substantial Completion a written list of each outstanding and unresolved Claim; any Claim not so submitted and identified, other than retainage and the undisputed balance of the Contract Price, shall be deemed waived and abandoned.

9.10 FINAL COMPLETION, FINAL ACCEPTANCE AND FINAL PAYMENT

9.10.1 The CONTRACTOR shall cause any punch list items to be completed within sixty (60) days of Substantial Completion. If, after Substantial Completion, the DISTRICT considers that the punch list items are unlikely to be completed within sixty (60) days of Substantial Completion (or such other period of time as is specified in the Contract Documents), the DISTRICT may, upon seven (7) days' written notice to the CONTRACTOR, take over and perform some or all of the punch list items. Moreover, and without limiting any other available remedy, the DISTRICT may take over and complete any portion of the Work at any time more than sixty (60) days following Substantial Completion if Final Completion has not been achieved. If the DISTRICT elects to take over and perform any portion of the Work, the DISTRICT may deduct the actual cost of performing the Work (including direct and indirect costs), and including any design costs, plus 15% to account for the DISTRICT's transaction costs from the Contract Price.

9.10.2 Upon receipt of written notice from the CONTRACTOR that all punch list items are completed, the DISTRICT will perform a final inspection. If the DISTRICT determines that some or all of the punch list items have not been addressed, the CONTRACTOR shall be responsible to the DISTRICT for all costs, including re-inspection fees, for any subsequent reviews to determine completion of the punch list. When the DISTRICT determines that all punch list items have been addressed, that the Work is acceptable under the Contract Documents and that the Contract has fully been performed, the DISTRICT will promptly notify the CONTRACTOR. If the DISTRICT determines that some or all of the punch list items are not complete, the CONTRACTOR shall be responsible to the DISTRICT for all costs, including re-review fees, for any subsequent reviews to determine completion of the punch list.

9.10.3 The CONTRACTOR is liable, in addition to any liquidated damages, for, and the DISTRICT may deduct from any amounts due the CONTRACTOR, all consultant fees incurred by the DISTRICT for services performed more than sixty (60) days after Substantial Completion of all the Work (or such other period of time as is specified in the Contract Documents), whether or not those services would have been performed prior to that date had Final Completion been achieved in a timely manner.

9.10.4 The CONTRACTOR may submit a final payment application after Final Completion is achieved. Final Completion will be attained after the CONTRACTOR has accomplished the following:

.1 Complete all requirements for Substantial Completion.

.2 Complete all remaining punch list items and remaining Work, and obtain approval of the DISTRICT that all Work is complete.

.3 Obtain permanent occupancy/completion permits (if only a temporary occupancy/completion permit was issued previously).

.4 Submit any final Change Orders and a final payment application.

.5 Submit final as-built documents, any final property survey, and operation and maintenance manuals required by the Contract Documents.

.6 Deliver tools, spare parts, extra stock of material and similar physical items to the DISTRICT as required by the Contract Documents.

.7 If applicable, complete final cleaning after punch list Work (in addition to the final cleaning that was required to obtain Substantial Completion).

.8 Submit executed warranties.

.9 Discontinue or change over and remove temporary facilities and services from the Project site.

.10 Advise the DISTRICT on coordination of shifting insurance coverages, including proof of extended coverages as required.

.11 Completion and documentation of commissioning.

9.10.5 Neither final payment nor any retained percentage shall become due until after the DISTRICT has formally accepted the Project ("Final Acceptance"). The DISTRICT is not obligated to agree to Final Acceptance if the CONTRACTOR has not submitted the following to the DISTRICT upon request:

.1 an affidavit that all payrolls, bills for materials and equipment, and other indebtedness connected with the Work for which the DISTRICT or the DISTRICT's property might be responsible or encumbered (less amounts withheld by DISTRICT) have been paid or otherwise satisfied, except for any claims that are specifically identified on the affidavit (Affidavit of Payment of Debts and Claims, AIA form G706 or equivalent—see Exhibit F),

.2 a certificate evidencing that insurance required by the Contract Documents to remain in force after final payment is currently in effect and will not be canceled or allowed to expire until at least thirty (30) days' prior written notice has been given to the DISTRICT,

.3 a written statement that the CONTRACTOR knows of no substantial reason that the insurance will not be renewable to cover the period required by the Contract Documents,

.4 consent of surety, if any, to final payment (AIA form G707 or equivalent),

.5 other data establishing payment or satisfaction of or protection against obligations, such as receipts, releases and waivers of liens, claims, security interests or encumbrances arising out of the Contract, to the extent and in such form as may be designated by the DISTRICT (CONTRACTOR's Affidavit of Release of Liens, AIA form G706A or equivalent—see Exhibit G). If a Subcontractor refuses to furnish a release or waiver required by the DISTRICT, the CONTRACTOR may furnish a bond satisfactory to the DISTRICT to indemnify the DISTRICT against such lien. If such lien remains unsatisfied after payments are made, the CONTRACTOR shall refund to the DISTRICT all money that the DISTRICT may be compelled to pay in discharging such lien, including all costs and reasonable attorneys' fees,

9.10.6 Pursuant to RCW 60.28, "Lien for Labor, Materials, Taxes on Public Works," completion of the Contract Work shall occur upon Final Acceptance.

9.11 WAIVER OF CLAIMS

9.11.1 Acceptance of final payment by the CONTRACTOR, a Subcontractor of any tier or a material supplier shall constitute a waiver of claims except those previously made in writing and identified as unsettled in the CONTRACTOR's final payment application.

9.11.2 The execution of a Change Order shall constitute a waiver of Claims by the CONTRACTOR arising out of the Work to be performed or deleted pursuant to the Change Order, except as specifically described in the Change Order. Reservations of rights will be deemed waived and are void unless the reserved rights are specifically described in detail to the satisfaction of the DISTRICT and are initialed by the DISTRICT. If the CONTRACTOR adds a reservation of rights that has not been initialed by the DISTRICT to any Change Order, Engineering Change Directive, Change Directive, Change Order Proposal, payment application or any other document, all amounts therein

shall be considered disputed and not due or payable unless and until costs are re-negotiated or the reservation is withdrawn or changed in a manner satisfactory to and in all cases initialed by the DISTRICT. If the DISTRICT makes payment for a Change Order or a payment application that contains a reservation of rights not initialed by the DISTRICT to indicate agreement with the reservation, and if the CONTRACTOR negotiates the check for such payment, then the reservation of rights shall be deemed waived, withdrawn, and of no effect.

9.12 LIENS

9.12.1 The CONTRACTOR shall promptly pay (and secure the discharge of any liens asserted by) all persons properly furnishing labor, equipment, materials or other items in connection with the performance of the Work (including, but not limited to, any Subcontractors of any tier). The CONTRACTOR shall furnish to the DISTRICT such releases of liens and claims and other documents monthly with its payment application.

9.12.2 If a Subcontractor of any tier refuses to furnish a release or waiver required by the DISTRICT, the DISTRICT may (a) retain in the fund, account, or escrow funds in such amount as to defray the cost of foreclosing the liens of such claims and to pay attorneys' fees, the total of which shall be no less than 150% of the claimed amount, or (b) accept a bond from the CONTRACTOR, satisfactory to the DISTRICT, to indemnify the DISTRICT against such lien. If any such lien remains unsatisfied after all payments from the retainage are made, the CONTRACTOR shall refund to the DISTRICT all moneys that the DISTRICT may be compelled to pay in discharging such lien, including all costs and reasonable attorneys' fees.

9.12.3 Neither the final payment, nor any portion of the retained percentage, shall become due until the CONTRACTOR, if so requested, delivers to the DISTRICT a complete release of all liens arising out of the Contract, as well as an affidavit stating that to the best of the CONTRACTOR’s knowledge, such release includes all labor and materials for which a lien could be filed. The CONTRACTOR may, if any Subcontractor refuses to furnish such a release, furnish a bond satisfactory to the DISTRICT to indemnify and hold harmless the DISTRICT against any lien.

9.12.4 The CONTRACTOR shall defend, indemnify, and hold harmless the DISTRICT from any liens, including all expenses, consultant costs and attorneys' fees, except to the extent a lien has been filed because of the failure of the DISTRICT to make a contractually required payment.

10.0 PROTECTION OF PERSONS AND PROPERTY

10.1 SAFETY PRECAUTIONS AND PROGRAMS

10.1.1 The CONTRACTOR shall be solely responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the performance of the Contract, regardless of the site of the Work. The CONTRACTOR shall maintain all Work sites and perform the Work in a manner that meets federal, state and local statutory and common-law requirements for the provision of a safe place to work, including OSHA and the Washington Industrial Safety and Health Act (WISHA). Without limiting the foregoing and CONTRACTOR’s other safety obligations, CONTRACTOR shall comply with all applicable provisions of Chapter 296-56 WAC and Chapter 296-45 WAC (including WAC 296-45-52525). These requirements shall apply continuously and not be limited to working hours. Any review by the DISTRICT or others of the CONTRACTOR’s performance, and any participation in the Work, shall not be construed to include a review of the adequacy of the CONTRACTOR's safety measures in, on or near any site of the Work. The CONTRACTOR shall be solely and completely responsible for conditions of any Project site, including safety of all persons and property, during performance of the Work.

10.1.2 No action or inaction of the DISTRICT or any third party relating to safety or property protection or a violation thereof will: (1) relieve the CONTRACTOR of sole and complete responsibility for the violation and the correction thereof, or of sole liability for the consequences of said violation; (2) impose any obligation upon the DISTRICT or a third party to inspect or review the CONTRACTOR's safety program or precautions or to enforce the CONTRACTOR's compliance with the requirements of the Contract Documents; (3) impose any continuing obligation upon the DISTRICT or a third party to ensure the CONTRACTOR performs the Work safely or to provide such notice to any person or entity; (4) affect the CONTRACTOR's sole and complete responsibility for performing the Work safely or the CONTRACTOR's responsibility for the safety and welfare of its employees and Subcontractors of any tier; or (5) affect the CONTRACTOR's responsibility for the protection of property, workers, and the general public.

10.2 SAFETY AND PROTECTION

10.2.1 The Project site may be occupied by others during performance of the Work. The safety of site occupants and site security are of paramount importance to the DISTRICT. The CONTRACTOR shall exercise control over all construction operations to ensure the safety of all site occupants.

10.2.2 The CONTRACTOR shall continuously maintain adequate protection of the Work from damages, and shall also protect DISTRICT property and any adjacent property from injury or loss arising in connection with this Contract. The CONTRACTOR shall take reasonable precautions for safety of, and shall provide reasonable protection to prevent damage, injury or loss to (1) employees on or involved in the Work and other persons who may be affected thereby; (2) the Work and materials and equipment to be incorporated therein, whether in storage on or off the site, under care, custody or control of the CONTRACTOR or the CONTRACTOR’s Subcontractors of any tier; and (3) other property at the site or adjacent thereto, such as walks, pavements, roadways, structures and utilities. The CONTRACTOR shall repair any such injury or loss. The CONTRACTOR shall provide and maintain all facilities and precautions for the protection of workers, including any required by the DISTRICT, any other public authority, or any local conditions. If applicable, all Work shall be conducted in such a manner as to interfere as little as possible with the normal procedure of traffic.

10.2.3 At all times until the entire Contract is completed and the Work is accepted by the DISTRICT, the CONTRACTOR shall be responsible for and shall protect from damage, weather, deterioration, theft, vandalism and malicious mischief, and shall promptly remedy and bear the risk of any loss (including any deductible amounts) or destruction of, or injury or damage to, all materials, equipment, tools, and other items incorporated or to be incorporated or consumed in the Work, and all Work in process and completed Work or designated portion.

10.3 RESTORING IMPROVEMENTS

Whenever it is necessary in the course of the Work to remove or disturb culverts, driveways, roadways, pipelines, or other existing improvements, the CONTRACTOR shall restore such improvements to a condition equal to that existing prior to removal or disturbance.

11.0 INDEMNITY AND DAMAGES WAIVER

11.1 INDEMNITY

11.1.1 To the fullest extent permitted by law and subject to the following conditions including the subsections below, the CONTRACTOR shall defend, indemnify and hold harmless the DISTRICT, its Commissioners, officers, employees, consultants, Separate Contractors and others engaged by the DISTRICT, and the agents and employees, successors and assigns of any of them (collectively, the "Indemnified Parties") from and against claims, damages, losses (including loss of use) and expenses, direct and indirect or consequential, including but not limited to costs, design professional and consultant fees,

and attorneys' fees incurred on such claims and in proving the right to indemnification, arising out of or resulting from the acts or omissions of the CONTRACTOR, a Subcontractor, of any tier, their agents and anyone directly or indirectly employed by any of them or anyone for whose acts they may be liable ("Indemnitor"). Such obligation shall not be construed to negate, abridge, or reduce other rights or obligations of indemnity which would otherwise exist as to a party or person described in this Section.

11.1.2 The CONTRACTOR will fully defend and indemnify the Indemnified Parties for the sole negligence or willful misconduct of the Indemnitor. Where claims, damages, losses, or expenses arise from the concurrent negligence of (1) the DISTRICT and (2) the Indemnitor, the CONTRACTOR's obligations to indemnify and defend the Indemnified Parties under this Section shall be effective only to the extent of the Indemnitors' negligence.

11.1.3 The CONTRACTOR agrees to being added by the DISTRICT as a party to any arbitration or litigation with third parties in which the DISTRICT alleges indemnification or contribution from the CONTRACTOR, any of its Subcontractors of any tier, anyone directly or indirectly employed by any of them, or anyone for whose acts any of them may be liable. The CONTRACTOR agrees that all of its Subcontractors of any tier will, in their subcontracts, similarly stipulate; in the event any does not, the CONTRACTOR shall be liable in place of such Subcontractor(s) of any tier. To the extent that any portion of this Section 11.1 is stricken by a court or arbitrator for any reason, all remaining provisions shall retain their vitality and effect. The obligations of the CONTRACTOR under this Section shall not be construed to negate, abridge, or otherwise reduce any other right or obligations of indemnity which would otherwise exist as to any party or person described in this Section. To the extent the wording of this Section would reduce or eliminate an available insurance coverage, this Section shall be considered modified to the extent that such insurance coverage is not affected. This Section shall survive completion, acceptance, final payment and termination of the Contract.

11.1.4 In claims against any person or entity indemnified under this Section 11.1 by an employee of the CONTRACTOR, a Subcontractor of any tier, anyone directly or indirectly employed by them or anyone for whose acts they may be liable, the indemnification obligation under this Section shall not be limited by a limitation on amount or type of damages, compensation or benefits payable by or for the CONTRACTOR or a Subcontractor of any tier under workers' compensation acts, disability benefit acts or other employee benefit acts. After mutual negotiation of the parties, the CONTRACTOR waives immunity as to the Indemnified Parties under Title 51 RCW, "Industrial Insurance." IF THE CONTRACTOR DOES NOT AGREE WITH THIS WAIVER, IT MUST PROVIDE A WRITTEN NOTICE TO THE DISTRICT AT LEAST TEN (10) DAYS PRIOR TO THE DATE FOR THE RECEIPT OF BIDS, OR THE CONTRACTOR WILL BE DEEMED TO HAVE NEGOTIATED AND WAIVED THIS IMMUNITY.

11.2 WAIVER OF CONSEQUENTIAL DAMAGES

11.2.1 The CONTRACTOR and DISTRICT waive Claims against each other for consequential damages arising out of or relating to this Contract, whether based in contract, tort (including negligence and strict liability) or otherwise, for any loss of profits or revenues, loss of use, economic loss, loss of profit or any other consequential loss or damage whatsoever and howsoever arising, whether or not such loss or damage could have been reasonably anticipated by a Party. This mutual waiver includes without limitation: (1) damages incurred by the DISTRICT for rental expenses, income, profit, financing, business and reputation, and for loss of management or employee productivity or of the services of such persons; and (2) damages incurred by the CONTRACTOR for principal and home office overhead and expenses including without limitation the compensation of personnel stationed there, for losses of financing, business and reputation, for losses on other projects, for loss of profit, and for interest or financing costs. This mutual waiver is

applicable, without limitation, to all consequential damages due to either party's termination.

11.2.2 Nothing contained in this Section, however, shall be deemed to preclude an award of liquidated damages, when applicable, in accordance with the requirements of the Contract Documents or to preclude damages specified in the Agreement or the CONTRACTOR's obligation to indemnify the DISTRICT for direct, indirect or consequential damages alleged by a third party.

12.0 INSURANCE AND BONDS

12.1 INSURANCE

The CONTRACTOR and all Subcontractors of any tier shall secure and maintain the insurance required by the Contract Documents as set forth in the Special Conditions.

12.2 CONTRACTOR'S RESPONSIBILITY NOT LIMITED BY INSURANCE

Nothing contained in these insurance requirements, including the Special Conditions, is to be construed as limiting the extent of the CONTRACTOR's responsibility for payment of damages resulting from its operations under this Contract.

12.3 CORRECTIONS TO PROJECT

In the event the CONTRACTOR is required to make corrections to the Work under this Contract after the Work has been inspected and accepted, the CONTRACTOR shall obtain, at the CONTRACTOR's own expense and prior to commencement of any corrective work, full insurance coverage as specified herein and in the Special Conditions.

12.4 CERTIFICATION AND CANCELLATION OF INSURANCE

The CONTRACTOR shall not cause any insurance policy to be canceled or permit any policy to lapse. All insurance policies shall include a provision to the effect that the insurance policy shall not be subject to cancellation, lapse, or to reduction in the required limits of liability or amount of insurance until notice has been provided to the DISTRICT by the insuring company stating the date that such cancellation, lapse or reduction shall be effective which date shall not be less than thirty (30) days after the mailing of such notice.

Prior to performing any services and before any Notice to Proceed from the DISTRICT will be issued, the CONTRACTOR shall file with the DISTRICT Certificates of Insurance rated A/VII or better by A.M. Best Company certifying to the coverage of all insurance required herein. All Certificates of Insurance shall be authenticated by the proper Agent of the Insured and shall certify the name of those insured, the type and amount of the insurance, the location and operations to which the insurance applies, the expiration date, and that the Insuring Company will give notice to the DISTRICT at least thirty (30) days prior to the effective date of any cancellation, lapse or reduction in limits.

12.5 PAYMENT, PERFORMANCE, AND MAINTENANCE BONDS

As a part of the Contract Price, the CONTRACTOR shall secure and furnish bonds from a surety company acceptable to the DISTRICT, admitted and licensed in the State of Washington, possessing an A.M. Best rating of "A minus" or better and a financial rating of no less than "VIII," covering the faithful performance of the Contract (Exhibit "B") and payment of obligations arising under the Contract Documents, each in the full amount of the Contract Price, pursuant to RCW 39.08, "Contractor's Bond." Within ten (10) days after the DISTRICT's issuance of a notice of intent to award the Contract, the CONTRACTOR shall deliver evidence of its bondability to the DISTRICT. Within ten (10) days after its execution of the Contract, the CONTRACTOR shall deliver two (2) copies of the bonds to the DISTRICT. THE DISTRICT MAY DECLINE TO ENTER INTO THE CONTRACT IF THE REQUESTED EVIDENCE OF BONDABILITY IS NOT RECEIVED. THE CONTRACTOR SHALL NOT PROCEED WITH THE WORK AND SHALL NOT BE ENTITLED TO ANY PROGRESS PAYMENT UNTIL SUCH BONDS ARE RECEIVED. The CONTRACTOR shall be responsible for any delay in the Contract Time because of failure to submit acceptable bonds.

Upon Substantial Completion of the Schedule-1 Work, the CONTRACTOR shall provide a maintenance bond for potential Schedule-2 Work in a form reasonably acceptable to the DISTRICT. Receipt of a maintenance bond acceptable to the DISTRICT is a requirement for the DISTRICT's release of the performance bond that was provided for Schedule-1 Work.

If the DISTRICT is damaged by the failure of the CONTRACTOR to maintain any of the bonds or insurance required by the Contract Documents or to so notify the DISTRICT, then the CONTRACTOR shall bear all costs attributable thereto. The DISTRICT may withhold payment pending receipt of all certificates of insurance and bonds. Failure to withhold payment shall not constitute a waiver.

13.0 CHANGES IN THE WORK

13.1 OPTIONS TO CHANGE THE WORK. Changes in the Work may be accomplished after execution of the Contract, and without invalidating the Contract, solely by (1) Change Order (including Change Order Proposals accepted in writing by the DISTRICT or an Engineering Change Directive (ECD) accepted by CONTRACTOR), (2) an ECD issued by the DISTRICT, (3) or Order for a Minor Change in the Work, subject to the limitations stated in the Contract Documents. The CONTRACTOR shall proceed promptly to perform the change, unless otherwise provided in the Change Order, ECD, or Order for a Minor Change in the Work.

13.1.1 A Change Order is a written instrument signed by the DISTRICT and CONTRACTOR stating their agreement upon the change in the Work and the adjustment, if any, in the Contract Price and Contract Time.

13.1.2 An ECD is a written instrument issued by the DISTRICT to transmit new or revised Drawings, issue additions or modifications to the Contract or furnish any other direction that the DISTRICT believes should be documented. ECDs are effective immediately. The DISTRICT's use of an ECD does not constitute the DISTRICT's agreement that the directive constitutes a change in the Work, the Contract Price, or Contract Time. If the CONTRACTOR believes that an ECD affects the Contract Price or Contract Time, the CONTRACTOR must submit a Change Order Proposal for review and response within seven (7) days. If the CONTRACTOR disagrees with the DISTRICT's response to the Change Order Proposal, the CONTRACTOR must submit a notice and Claim pursuant to the Contract Documents. If the CONTRACTOR fails to respond within seven (7) days, or fails to timely notice and Claim pursuant to the Contract Documents, the CONTRACTOR shall be deemed to have accepted the ECD at no change in the Contract Price and Contract Time.

13.1.3 An Order for a Minor Change in the Work (sometimes called a Design Clarification, Field Authorization, Field Directive, or Supplemental Instruction) is a written order from the DISTRICT directing a change that does not involve an adjustment to the Contract Price or extension of the Contract Time and that is not inconsistent with the intent of the Contract Documents. If the CONTRACTOR believes that an Order for a Minor Change in the Work affects the Contract Price or Contract Time, the CONTRACTOR must submit a notice and Claim pursuant to the Contract Documents.

13.1.4 Before effectuating a change in the Work, the DISTRICT may issue a Proposal Request that the CONTRACTOR provide a Change Order Proposal proposing a change in the Contract Price or Contract Time, if any, arising from the proposed change in the Work. The CONTRACTOR shall submit its responsive Change Order Proposal as soon as possible and within seven (7) days, and shall in good faith specify the components and amounts by which the Contract Price and/or Contract Time are proposed to change. Labor, materials and equipment shall be limited to and itemized in the manner described in Section 13.2 for the CONTRACTOR and major Subcontractors. If the CONTRACTOR fails to respond within seven (7) days, the DISTRICT may withhold some or all of a progress payment otherwise due until the tardy Proposal is received.

13.1.5 If the DISTRICT explicitly accepts a Change Order Proposal in writing, the DISTRICT and CONTRACTOR will be immediately bound to the terms of the Proposal, the change will be included promptly in a future Change Order, and the change in the Work described in the Proposal shall commence expeditiously. The DISTRICT may reject the Proposal, in which case the DISTRICT may either not effectuate the change in the Work or may order the change through an ECD or an Order for a Minor Change in the Work.

13.1.6 Upon receipt of an ECD, the CONTRACTOR shall promptly proceed with the change in the Work involved. As soon as possible, and within seven (7) days of receipt, the CONTRACTOR shall advise the DISTRICT in writing of the CONTRACTOR's agreement or disagreement with the proposed adjustment or the method of adjustment, if any, of the Contract Price or Contract Time provided in the ECD. The CONTRACTOR's Change Order Proposal shall reasonably specify the reasons for its disagreement and the adjustment it proposes. Without such timely written notice, the CONTRACTOR shall conclusively be deemed to have accepted the DISTRICT's adjustment. The CONTRACTOR's disagreement shall not relieve the CONTRACTOR of its obligation to comply promptly with any written notice issued by the DISTRICT.

13.1.7 An ECD signed by the CONTRACTOR indicates the CONTRACTOR's agreement with the DISTRICT's proposal, including any adjustment in the Contract Price and Contract Time and the method for determining them. This agreement shall be effective immediately and shall promptly be incorporated into a future Change Order. If the CONTRACTOR does not respond promptly or disagrees with the method for adjustment in the Contract Price, or if the cost is to be determined, the CONTRACTOR shall provide a not-to-exceed price for the ECD within seven (7) days of receipt, and the CONTRACTOR shall keep and present, itemized in the categories of Section 13.2 and in such form as the DISTRICT may prescribe, an itemized accounting together with appropriate supporting data. Failure to provide data within twenty-one (21) days of the DISTRICT's request shall constitute waiver of any Claim for changes in the Contract Time or Contract Price. Unless otherwise agreed in writing by the DISTRICT, the cost shall not exceed the lower of the prevailing cost for the work in the locality of the Project or the cost of the work in the current edition of R.S. Means Company, Inc., Building Construction Cost Data as adjusted to local costs and conditions.

13.1.8 Pending final determination of the total cost of an ECD, and provided that the Work to be performed under the ECD is complete and any reservations of rights have been signed by the DISTRICT, the CONTRACTOR may request payment for amounts not in dispute in payment application accompanied by a Change Order indicating the parties' agreement with part of such costs.

13.2 PRICING COMPONENTS

The total cost of any Change in the Work, or of any other increase or decrease in the Contract Price, including a Claim, shall be limited to the following components:

13.2.1 Direct labor costs: These are the actual labor costs determined by the number of additional craft hours and the hourly costs necessary to perform the change in the Work. The hourly cost shall be based upon the following:

.1 Basic wages and fringe benefits: The hourly wage (without markup or labor burden) and fringe benefits paid by the CONTRACTOR as established by the Washington Department of Labor and Industries or contributed to labor trust funds as itemized fringe benefits, whichever is applicable, not to exceed that specified in the applicable "Intent to Pay Prevailing Wage" for the laborers, apprentices, journeymen, and foremen performing and/or directly supervising the Change in the Work at the site. The premium portion of overtime wages is not included unless pre-approved in writing by the DISTRICT. Costs paid or incurred by the CONTRACTOR for vacations, per diem, subsistence, housing, travel,

bonuses, stock options, or discretionary payments to employees are not separately reimbursable. The CONTRACTOR shall provide to the DISTRICT copies of payroll records, including certified payroll statements for itself and Subcontractors of any tier, upon the DISTRICT's request.

.2 Workers' insurances: Direct contributions to the State of Washington as industrial insurance; medical aid; and supplemental pension by class and rates established by the Washington Department of Labor and Industries.

.3 Federal insurances: Direct contributions required by the Federal Insurance Compensation Act (FICA); Federal Unemployment Tax Act (FUTA); and State Unemployment Compensation Act (SUCA).

13.2.2 Direct material costs: This is an itemization, including material invoice, of the quantity and cost of additional materials reasonable and necessary to perform the change in the Work. The unit cost shall be based upon the net cost after all discounts or rebates, freight costs, express charges, or special delivery costs, when applicable. No lump sum costs will be allowed except when approved in advance by the DISTRICT. Discounts and rebates based on prompt payment need not be included, however, if the CONTRACTOR offered but the DISTRICT declined the opportunity to take advantage of such discount or rebate.

13.2.3 Construction equipment usage costs: This is an itemization of the actual length of time that construction equipment necessary and appropriate for the Work is used solely on the change at the site times the applicable rental cost as established by the lower of the local prevailing rate published in The Rental Rate Blue Book by Data Quest, San Jose, California, as modified by the AGC/WSDOT agreement, or the actual rate paid to an unrelated third party as evidenced by rental receipts. If more than one rate is applicable, the lowest available rate will be utilized. Rates and quantities of equipment rented that exceed the local fair market rental costs shall be subject to the DISTRICT's prior written approval. Total rental charges for equipment or tools shall not exceed 75% of the fair market purchase value of the equipment or the tool. Actual, reasonable mobilization costs are permitted if the equipment is brought to any Project site solely for the change in the Work. Mobilization and standby costs shall not be charged for equipment already present at the site.

The rates in effect at the time of the performance of the changed Work are the maximum rates allowable for equipment of modern design and in good working condition, which includes full compensation for furnishing all fuel, oil, lubrication, repairs, maintenance, and insurance. No gas surcharges shall be charged. Equipment not of modern design and/or not in good working condition will have lower rates. Hourly, weekly, and/or monthly rates, as appropriate, will be applied to yield the lowest total cost. The rate for equipment necessarily standing by for future use (and standing by for no longer than one (1) week) on the changed Work shall be 50% of the rate established above. If equipment is required for which a rental rate is not established by The Rental Rate Blue Book, an agreed rental rate shall be established for the equipment. The rate and use must be approved by the DISTRICT prior to performing the Work.

13.2.4 Subcontractor costs: These are payments the CONTRACTOR makes to Subcontractors for changed Work performed by such Subcontractors. The Subcontractors' cost of changed Work shall be determined in the same manner as prescribed in this Section and, among other things, shall not include consultant costs, attorneys' fees, or Claim preparation expenses.

13.2.5 Fee: This is the maximum amount for all combined overhead, profit and other costs, including all office, home office and site overhead (including facilities, purchasing, clerical, project manager, project engineer, other engineers, project foreman, estimator, superintendent and their vehicles and clerical assistants), taxes (except for state and local sales tax), employee per diem, subsistence and travel costs, warranty, safety costs,

printing and copying, layout and control, quality control/assurance, purchasing, small or hand tool (a tool that costs $500 or less and is normally furnished by the performing contractor) or expendable charges, preparation of as-built drawings, impact on unchanged Work, Change Order and Claim preparation, and delay and impact costs of any kind (cumulative, ripple, or otherwise), added to the total cost to the DISTRICT of any Change Order, ECD, Claim or any other claim of any kind on this Project. No Fee shall be due, however, for direct settlements of Subcontractor claims by the DISTRICT after Substantial Completion. The Fee shall be limited in all cases to the following schedule:

.1 The total summed Fee of the CONTRACTOR and all Subcontractors of any tier shall not exceed twenty-five percent (25%) of the direct costs of the Change in the Work as specified in Sections 13.2.1 through 13.2.4. If the Fee would otherwise exceed twenty-five percent (25%), the CONTRACTOR shall reduce the Fee percentage for the CONTRACTOR and all Subcontractors except for the Subcontractor supplying material or performing Work with its own forces.

.2 The CONTRACTOR shall receive fifteen percent (15%) of the direct costs of the Change in the Work as specified in Sections 13.2.1 through 13.2.4 properly performed by the CONTRACTOR's own forces, subject to the limitation set forth above.

.3 The CONTRACTOR shall receive eight percent (8%) of the amount owed (less fee) directly to a Subcontractor or supplier for materials supplied or for Work properly performed by that Subcontractor or supplier, subject to the limitation set forth above.

.4 Each Subcontractor of any tier shall receive twelve percent (12%) of the direct costs of the Change in the Work performed by its own forces, subject to the limitation set forth above.

.5 Each Subcontractor of any tier shall receive eight percent (8%) of the amount (less fee) it properly incurs for materials supplied or Work properly performed by its suppliers or Subcontractors, subject to the limitation set forth above.

.6 The CONTRACTOR and its Subcontractors of any tier shall receive no more than five percent (5%) of any amounts owed to any lower-tier Subcontractor which is within the lines of contractual responsibility but not in privity of contract with such CONTRACTOR or Subcontractors, for Work performed by that lower-tier Subcontractor.

If a change in the Work involves both additive and deductive items, the appropriate Fee allowed will be added to the net difference of the items. If the net difference is negative, no Fee will be added to the negative figure as a further deduction. The parties acknowledge that the fees listed in this Section 13.2.5 are substantially greater than the fees and overhead normally included in determining the Contract Price bid; that these higher percentages are a sufficient amount to compensate the CONTRACTOR for all effects and impacts of Changes in the Work; and that the resultant overcompensation of the CONTRACTOR for some Changes compensates the CONTRACTOR for any Changes for which the CONTRACTOR believes the percentage is otherwise insufficient.

13.2.6 Cost of change in insurance or bond premium. This is defined as:

.1 CONTRACTOR’s liability insurance: The actual cost (expressed as a percentage submitted with the certificate of insurance provided under the Contract Documents, and subject to audit) of any changes in the CONTRACTOR's liability insurance arising directly from the changed Work; and

.2 Public works bond: The actual cost (expressed as a percentage submitted with evidence of bondability under the Contract Documents, and subject to audit) of the change in the CONTRACTOR's premium for the CONTRACTOR's statutorily required performance and payment bond arising directly from the changed Work.

Upon request, the CONTRACTOR shall provide the DISTRICT with supporting documentation from its insurer or surety of any associated cost incurred. The cost of the insurance or bond premium shall not exceed 2.0% of the cost of the changed Work.

13.3 RESERVATION OF RIGHTS. If the CONTRACTOR adds a reservation of rights that has not been initialed by the DISTRICT to any Change Order, ECD, Change Order Proposal, payment application or any other document, all amounts and all work therein shall be considered disputed and not due or payable unless and until costs are re-negotiated or the reservation is withdrawn or changed in a manner satisfactory to and, in all cases, initialed by the DISTRICT. If the DISTRICT makes payment for a Change Order or a payment application that contains a reservation of rights not initialed by the DISTRICT to indicate agreement with the reservation, and if the CONTRACTOR negotiates the check for such payment, then the reservation of rights shall be deemed waived, withdrawn and of no effect.

14.0 UNCOVERING AND CORRECTING WORK

14.1 INSPECTION AND TESTS

14.1.1 The CONTRACTOR shall make reasonable tests of the Work at the CONTRACTOR's expense as required by the Contract Documents and upon request by the DISTRICT.

14.1.2 If the Specifications, the DISTRICT's instructions, laws, ordinances, regulations, or any public authority requires any Work to be specifically tested or approved, the CONTRACTOR shall give the DISTRICT timely notice of its readiness for testing or inspection, and if the testing or inspection is to be done by another authority, CONTRACTOR shall apprise the DISTRICT of the date fixed for such testing or inspection. If any Work should be covered up without approval or consent of the DISTRICT, it must, if required by the DISTRICT, be uncovered at the CONTRACTOR's expense.

14.1.3 After approval, a reexamination of Work may be ordered by the DISTRICT and, if so ordered, must be uncovered by the CONTRACTOR. If such Work is found to be in accordance with the Contract Documents, the DISTRICT shall pay the cost of reexamination and replacement. If such Work is found to be not in accordance with the Contract Documents, the CONTRACTOR shall pay the cost, unless CONTRACTOR shows that the defect in the Work was caused by a Separate Contractor or third party not under the CONTRACTOR's control.

14.2 DEFECTS AND REMEDIES

14.2.1 If the Work or any part thereof is determined by the DISTRICT to not conform with the Contract Documents, the CONTRACTOR shall promptly rebuild or otherwise remedy such Work so that it is in full compliance with the Contract.

14.2.2 The CONTRACTOR shall be responsible for correcting all defects in the Work appearing within one year after Final Acceptance of the Contract by the DISTRICT or any longer period set forth in the Contract Documents. The CONTRACTOR shall work to remedy such defects within seven (7) days of receipt of notice from the DISTRICT, and shall complete such work within a reasonable time as determined by the DISTRICT. In the event that the CONTRACTOR does not accomplish corrections within the time specified, the Work may be corrected by the DISTRICT, and the cost of such corrections shall be paid by the CONTRACTOR. In emergencies where damage may result from delay or where loss of service may result, such corrections may be made by the DISTRICT, in which case the cost shall be borne by the CONTRACTOR.

14.2.3 The CONTRACTOR shall be responsible for any expenses incurred by the DISTRICT resulting from defects in the Work, including but not limited to actual damages, cost of materials and labor expended by DISTRICT in making emergency repairs, and costs of engineering, inspection and supervision by the DISTRICT.

15.0 TERMINATION AND SUSPENSION

15.1 DISTRICT'S RIGHT TO TERMINATE

15.1.1 DISTRICT'S RIGHT TO TERMINATE CONTRACTOR FOR CAUSE. In the event the CONTRACTOR should be adjudged bankrupt, make a general assignment for the benefit of creditors, if a receiver should be appointed on account of the CONTRACTOR's insolvency, or if the CONTRACTOR should, in the opinion of the DISTRICT, persistently or materially refuse or fail to supply enough properly skilled workmen or materials for proper completion of the Contract, fail to make prompt payment to Subcontractors or suppliers for material or labor, persistently or materially disregards laws, ordinances, or the instructions of the DISTRICT, or otherwise be guilty of a material violation of any provision of the Contract, then the DISTRICT may, without prejudice to any other right or remedy, terminate the CONTRACTOR after giving the CONTRACTOR seven (7) days' written notice. In such event, the DISTRICT may take possession of the site, all materials and equipment thereon, and utilize such materials and equipment to finish the Work by whatever method the DISTRICT may deem expedient. In addition, the DISTRICT may exercise any rights, claims or demands which the CONTRACTOR may have against third persons in connection with this Contract, and for such purpose the CONTRACTOR does hereby assign, transfer and set over unto the DISTRICT all such rights, claims and demands. In such case, the CONTRACTOR shall not be entitled to receive any further payment until the Work is finished. If the unpaid balance of the Contract Price exceeds the expense of finishing the Work, including compensation for additional managerial and administrative services, such excesses shall be paid to the CONTRACTOR. If such expense exceeds such unpaid balance, the CONTRACTOR shall pay the difference to the DISTRICT. If, after the CONTRACTOR has been terminated pursuant to this Section 15.1.1, it is determined that none of the circumstances set forth in Section 15.1.1 exists, then such termination shall be considered a termination for convenience pursuant to Section 15.1.2.

15.1.2 DISTRICT'S RIGHT TO TERMINATE CONTRACT FOR CONVENIENCE. The DISTRICT may, at any time, terminate (without prejudice to any right or remedy of the DISTRICT) the whole or any portion of the Contract for the DISTRICT's convenience and without cause. In case of such termination for the DISTRICT's convenience, the CONTRACTOR shall be entitled to receive payment consistent with the Contract Documents for Work properly executed, and costs necessarily incurred by reason of such termination (such as the cost of settling and paying claims arising out of the termination of Work under subcontracts or orders), along with one percent (1%) of the Contract Price not yet earned. The total sum to be paid to the CONTRACTOR under this Section shall not exceed the Contract Price as reduced by the amount of payments otherwise made.

15.2 CONTRACTOR'S RIGHT TO TERMINATE CONTRACT

If the Work should be stopped under an order of any court or other public authority for a period of six (6) consecutive months through no act or fault of the CONTRACTOR, or of anyone employed by CONTRACTOR, or if payments due under this Contract are unreasonably delayed, then the CONTRACTOR may, upon seven (7) days' written notice to the DISTRICT (during which period the DISTRICT shall have the right to cure), stop the Work or terminate this Contract. In such event, the CONTRACTOR may recover from the DISTRICT payment for all Work executed prior to such termination.

15.3 REMOVAL OF EQUIPMENT

In the case of termination of this Contract before completion, and upon notification by the DISTRICT that it does not need such equipment and/or supplies to complete the Project, the CONTRACTOR shall promptly remove the CONTRACTOR's equipment and supplies from the Project site and, if CONTRACTOR fails to do so, the DISTRICT shall have the right to remove such equipment and supplies at CONTRACTOR's expense.

15.4 SUSPENSION OF THE WORK

The DISTRICT may at any time suspend the Work, or any part thereof, by giving notice to the CONTRACTOR in writing. The Work shall be resumed by the CONTRACTOR as soon as possible, but no later than ten (10) days after the date fixed in the notice to resume the Work. The DISTRICT shall reimburse the CONTRACTOR for appropriate and reasonable expenses incurred by the CONTRACTOR as a result of such suspension, except where such suspension is the result of the CONTRACTOR repeatedly or materially failing to carry out or correct the Work in accordance with the Contract Documents, and CONTRACTOR shall take all necessary steps to minimize such expenses. The right of the DISTRICT to suspend the Work shall not give rise to a duty on the part of the DISTRICT to exercise this right for the benefit of the CONTRACTOR or any other person or entity.

16.0 MISCELLANEOUS

16.1 GOVERNING LAW

This Contract and the rights and duties of the parties hereunder shall be governed by and construed, enforced and performed in accordance with the internal laws of the State of Washington, without regard to its principles of conflicts of law.

16.2 NONWAIVER

The failure of the DISTRICT to insist upon or enforce strict performance by the CONTRACTOR of any provision of this Contract, or to exercise any right under this Contract, shall not be construed as a waiver or relinquishment to any extent of the DISTRICT's right to assert or rely upon any such provision or right in that or any other instance; rather, the same shall be and remain in full force and effect.

16.3 LABOR PEACE

The CONTRACTOR shall be responsible for labor peace relating to its Work on the Project and shall at all times use its best efforts and exercise its best judgment as an experienced contractor to adopt and implement policies and practices designed to avoid work stoppages, slowdowns, disputes or strikes where reasonably possible and practical under the circumstances, and shall at all times cooperate in maintaining Project-wide labor harmony.

16.4 ASSIGNMENT

The DISTRICT and CONTRACTOR respectively bind themselves, their partners, successors, assigns and legal representatives to the other party hereto and to partners, successors, assigns and legal representatives of such other party in respect to covenants, agreements and obligations contained in the Contract Documents. Except as provided in this Section, neither party to the Contract shall assign the Contract as a whole without written consent of the other. If either party attempts to make such an assignment without such consent, that party shall nevertheless remain legally responsible for all obligations under the Contract. The CONTRACTOR also shall not assign to any third party any Claims it may have against the DISTRICT arising under the Contract or otherwise related to the Project.

16.5 INTEREST

Payments due and unpaid under the Contract Documents shall bear interest as specified by RCW 39.76, not to exceed the Bank of America prime rate plus 2%.

16.6 TIME LIMIT ON CLAIMS

The DISTRICT and CONTRACTOR shall commence all claims and causes of action, whether in contract, tort, breach of warranty or otherwise, against the other arising out of or related to the Contract in the manner set forth in the Contract, within the time period specified by applicable law, and within the time limits identified in the Contract Documents. The DISTRICT and CONTRACTOR waive all claims and causes of action not commenced in accordance with this Section.

16.7 RECORD KEEPING

16.7.1 The CONTRACTOR shall maintain books, ledgers, records, documents, estimates, bids, correspondence, logs, schedules, emails, and other tangible and electronic data and evidence relating or pertaining to the costs and/or performance of the Contract ("records") to such extent and in such detail as will properly reflect and fully support compliance with the requirements of the Contract Documents and with all costs, charges and other amounts of whatever nature. The CONTRACTOR shall preserve such records for a period of three (3) years following the date of Final Acceptance under the Contract and for such longer period as may be required by any other provision of the Contract. Within seven (7) days of the DISTRICT's request, the CONTRACTOR agrees to make available at the office of the CONTRACTOR during normal business hours all records for inspection, audit and reproduction (including electronic reproduction) by the DISTRICT or its representatives; failure to fully comply with this requirement shall constitute a material breach of contract and a waiver of all Claims by the CONTRACTOR.

16.7.2 Subcontractors of any tier shall maintain books, ledgers, records, documents, estimates, bids, correspondence, logs, schedules, electronic data and other evidence relating or pertaining to the costs and/or performance of the Contract ("records") to such extent and in such detail as will properly reflect and fully support compliance with the requirements of the Contract Documents and with all costs, charges and other amounts of whatever nature. Each Subcontractor of any tier shall preserve such records for a period of three (3) years following the date of Final Acceptance under the Contract and for such longer period as may be required by any other provision of the Contract. Within seven (7) days of the DISTRICT's request, a Subcontractor of any tier shall make available at the office of the Subcontractor during normal business hours all records for inspection, audit and reproduction (including electronic reproduction) by the DISTRICT or its representatives; failure to fully comply with this requirement shall constitute a material breach of contract and a waiver of all Claims by that Subcontractor.

16.7.3 The CONTRACTOR agrees, on behalf of itself and Subcontractors of any tier, that any rights under Chapter 42.56 RCW will commence at Final Acceptance, and that the invocation of such rights at any time by the CONTRACTOR or a Subcontractor of any tier, or their respective representatives, shall initiate an equivalent right to disclosures from the CONTRACTOR and Subcontractors of any tier for the benefit of the DISTRICT.

16.8 STATUTES

The CONTRACTOR shall abide by the provisions of all applicable Federal and Washington statutes and regulations. Although a number of statutes are referenced in the Contract Documents, these references are not meant to be a complete list and should not be relied upon as such.

16.8.1 Pursuant to RCW 39.06, "Registration, Licensing of Contractors," the CONTRACTOR shall be registered and licensed as required by the laws of the State of Washington, including but not limited to RCW 18.27, "Registration of Contractors." The CONTRACTOR shall also have a current state unified business identifier number; have industrial insurance coverage for the CONTRACTOR's employees working in Washington as required in Title 51 RCW; have an employment security department number as required in Title 50 RCW; have a state excise tax registration number as required in Title 82 RCW; and not be disqualified from bidding on any public works contract under RCW 39.06.010 (unregistered or unlicensed contractors) or RCW 39.12.065(3) (prevailing wage violations). The CONTRACTOR shall also satisfy all supplemental responsibility criteria set forth in the Instructions to Bidders and Contract Documents.

16.8.2 The CONTRACTOR shall comply with all applicable provisions of RCW 49.28 (“Hours of Labor”).

16.8.3 The CONTRACTOR shall comply with pertinent statutory provisions relating to public works of RCW 49.60, "Discrimination."

16.8.4 The CONTRACTOR shall comply with pertinent statutory provisions relating to public works of RCW 70.92, "Provisions in Buildings for Aged and Handicapped Persons," and the Americans with Disabilities Act.

16.8.5 Pursuant to RCW 50.24, "Contributions by Employers," in general and RCW 50.24.130 in particular, the CONTRACTOR shall pay contributions for wages for personal services performed under this Contract or arrange for a bond acceptable to the Commissioner (as defined in that statute).

16.8.6 The CONTRACTOR shall comply with pertinent provisions of RCW 49.17, "Washington Industrial Safety and Health Act," and Chapter 296-155 WAC, "Safety Standards for Construction Work."

16.8.7 Pursuant to RCW 49.70, "Worker and Community Right to Know Act," and WAC 296-62-054 et seq., the CONTRACTOR shall provide to the DISTRICT and have copies available at the Project site, a workplace survey or material safety data sheets for all "hazardous" chemicals under the control or use of CONTRACTOR or any Subcontractor of any tier.

16.8.8 All products and materials incorporated into the Project as part of the Work shall be certified as "asbestos-free" and "lead-free" by United States standards, and shall also be free of all hazardous materials. At the completion of the Project, the CONTRACTOR shall submit Certifications of Asbestos-Free and of Lead-Free Materials certifying that all materials and products incorporated into the Work meet the requirements of this Section, and shall also certify that materials and products incorporated into the Work are free of hazardous materials.

SECTION C
SPECIAL CONDITIONS

1.0 ACCESS

The CONTRACTOR shall provide the DISTRICT and its Separate Contractors and consultants access to the Work in preparation and progress wherever located.

2.0 COORDINATION AND COOPERATION REQUIREMENTS WITH SEPARATE CONTRACTORS

See Contract Documents, including Specifications, Sections 01010 and 01040, and Appendices.

The CONTRACTOR shall be responsible for the performance of all equipment furnished by CONTRACTOR or any Subcontractor of any tier under the Contract. Without limiting the general warranty and correction period requirements set forth in the General Conditions, the CONTRACTOR specifically warrants that all equipment furnished by CONTRACTOR or any Subcontractor of any tier under the Contract will be fit for its intended purpose, of merchantable quality, free from defects (latent and patent) and conform in all respects to the Contract Documents. In the event that CONTRACTOR-furnished equipment does not conform to the Contract Documents and/or contains or is subject to any defect in design, materials or manufacture, or suffers any breakdown or failure, and as a consequence the DISTRICT or a Separate Contractor suffers any delay, the CONTRACTOR shall be liable to the DISTRICT or Separate Contractor for any reasonably and properly incurred additional costs and expenses suffered or incurred as a result.

The CONTRACTOR shall comply with all reasonable instructions and directions given by Separate Contractor OpenHydro Technology Limited ("OpenHydro"), the turbine supplier, in relation to the terms of access to OpenHydro's manufacturing facilities, shore facilities, including the turbine mobilization site, and the turbine deployment site, and the conduct of the CONTRACTOR's personnel and operations at such facilities and sites. The CONTRACTOR shall be responsible for all losses and damage it causes to a turbine unit and/or to any of OpenHydro's plant, machinery and equipment. The CONTRACTOR shall also reimburse OpenHydro for reasonable costs that OpenHydro suffers or incurs to the extent caused by the CONTRACTOR's delays, improperly timed activities or defective performance.

The CONTRACTOR shall not communicate to the press or publicly make available information relating to the Project or this Contract without the DISTRICT's written consent, which shall not be unreasonably withheld.

3.0 CONFIDENTIAL INFORMATION/INTELLECTUAL PROPERTY

In addition to all other requirements in the Contract Documents, and to the extent permitted by law, CONTRACTOR shall protect and keep confidential any intellectual property or other confidential information of others, including OpenHydro, that CONTRACTOR receives during the Project. As used in these Special Conditions, "Confidential Information" means any information, whether printed, in machine readable form or otherwise, which is proprietary or confidential to the disclosing party and disclosed to the receiving party and which is disclosed by the disclosing party in writing and marked as "Confidential" (or like designation) at, or reasonably soon after, the time of disclosure, or in the case of non-tangible disclosures (discussions, briefings, etc.) identified as proprietary or confidential at the time of disclosure and summarized in writing by the disclosing party within thirty (30) days of disclosure.

Any Confidential Information received by either party (a "receiving Party") from the other party (a "disclosing Party") pursuant to the Contract shall be used, disclosed, or copied, only for the purposes of, and only in accordance with, the Contract. The receiving Party shall use, as a minimum, the same degree of care as it uses to protect its own Confidential Information of a similar nature, but no less than reasonable care, to prevent the unauthorized use, disclosure or publication of Confidential Information. Without limiting the generality of the foregoing:

i. the receiving Party shall only disclose Confidential Information to its bona fide employees, contractors or suppliers who need to obtain access thereto for purposes consistent with the Contact;

ii. the receiving Party shall not make or have made any copies of Confidential Information except those copies which are necessary for the purposes of the Contract; and

iii. the receiving Party shall retain on any copies it makes of the Confidential Information all proprietary notices or legends affixed to the Confidential Information as they appear on the copies of the Confidential Information originally received from the disclosing Party.

Confidential Information shall not include information that: (i) is or becomes publicly available without default hereunder by the receiving Party; (ii) is lawfully acquired by the receiving Party from a third party not under any obligation of confidentiality to the disclosing Party with respect to such information; (iii) is lawfully in the possession of the receiving Party in written or other recorded form at the time of its disclosure hereunder and not under any obligation of confidentiality to the disclosing Party with respect to such information; (iv) is disclosed to any third party by or with the written permission of the disclosing Party without restriction on further disclosure; or (v) is developed by the receiving Party independently. In addition, disclosure shall be permitted if and when required by law, provided that the disclosing Party gives (provided that it is lawful to do so) the other Party at least seven (7) days' advance notice before making such disclosure.

The CONTRACTOR shall hold the DISTRICT harmless from any liability or responsibility for, and shall defend and indemnify the DISTRICT against, any loss or fine arising out of third party's claim for infringement of a trademark, patent or copyright and/or any related design furnished by CONTRACTOR, or any other Intellectual Property under the control of the CONTRACTOR or its Subcontractors related to the Project. As used in this Section, "Intellectual Property" means patents, inventions, whether or not patentable, trademarks, service marks, trade names, domain names, rights in designs, database rights, copyrights (including rights in computer software), rights in know-how and other intellectual or industrial property rights (whether registered or unregistered and including applications for the registration of any of the foregoing), trade secrets and all rights or forms of protection having equivalent or similar effect to any of the foregoing which may subsist anywhere in the world or be defined under this Contract.

The DISTRICT and CONTRACTOR both acknowledge the critical importance of the other party's Intellectual Property, and each agree to take reasonable steps throughout the Project, to cooperate with the other for the ongoing protection of the other's Intellectual Property. Both parties shall retain ownership of their respective Intellectual Property. Each party undertakes that it shall neither take nor permit any action that could jeopardize or adversely affect the other party's Intellectual Property. In addition, for the avoidance of doubt, each party shall retain the right freely to use and dispose of its own Intellectual Property.

Each party also represents that, at the date of signature of the Agreement, such party's Intellectual Property, for the purposes of the Project, will be free and clear of any and all liens, encumbrances or other claims, including, but not limited to, claims based upon Intellectual Property rights of or in favor of any other person. If any party subsequently learns that such knowledge is not so free and clear, such party will inform the other party immediately by written notice.

The CONTRACTOR shall execute and submit a non-disclosure agreement in a form provided by the DISTRICT prior to the DISTRICT's issuance of the notice to proceed.

4.0 VESSEL AND MARINE REQUIREMENTS

All vessel and/or marine services related to the Project, whether performed by CONTRACTOR or Subcontractors, shall be performed in compliance with Chapter 551, Title 46 of the United States Code, and the regulations promulgated pursuant thereto.

5.0 LAND USED FOR THE WORK

The Work involves activities that will occur, in part, in marine conditions and, in part, on land. For portions of the Work that occur on land, the DISTRICT shall provide a general right to access the land upon which the Work is to be done, except that CONTRACTOR shall provide land required for the erection of temporary construction facilities and storage of CONTRACTOR's material, together with the right to access to same, unless otherwise

specified by the DISTRICT. It shall be the responsibility of the CONTRACTOR to obtain permission from all affected landowners for such temporary construction facilities, storage sites and access routes.

6.0 FEDERAL REQUIREMENTS

The DISTRICT has received partial funding for the Project through a Department of Energy (DOE) grant. As part of the DOE grant and 10 C.F.R. part 600, the DISTRICT has certain obligations to provide Project data to DOE. The CONTRACTOR shall provide, where available, the DISTRICT with all data required by DOE or necessary for the DISTRICT to comply with its obligations to DOE in the form and timeframe requested by the DOE.

The DOE grant also may impose requirements on the DISTRICT and/or the CONTRACTOR including requirements that the CONTRACTOR comply with certain requirements of federal law, or require the incorporation and application of certain contract terms. All such contract terms shall be incorporated into the Contract by this reference. In addition, in performing the Work and completing the Contract, CONTRACTOR shall comply with all applicable federal requirements, including any requirements imposed by the DOE.

7.0 DAVIS-BACON ACT WAGES REQUIRED

Subchapter IV of chapter 31 of title 40, United States Code (the Davis-Bacon Act) applies to the Project. In the event of any conflict between the wage rates set forth in the Davis-Bacon Act and the Washington Prevailing Wage Act, CONTRACTOR and Subcontractors of any tier shall pay the highest applicable wage rate. The CONTRACTOR shall defend, indemnify and hold the DISTRICT harmless, including attorneys' fees, from any violation or alleged violation by the CONTRACTOR or any Subcontractor of any tier of the Davis-Bacon Act.

The CONTRACTOR shall comply with all applicable requirements of the Davis-Bacon Act. The Department of Labor has issued regulations at 29 C.F.R. parts 1, 3, and 5 to implement the Davis-Bacon Act. Regulations in 29 C.F.R. § 5.5 instruct agencies to include the following standard contract provisions for contracts in excess of $2,000 for the actual construction, alteration or repair, including painting or decorating, of a public building or public work:

1. Minimum Wages.

(i) All laborers and mechanics employed or working upon the site of the Work, will be paid unconditionally and not less often than once a week, and without subsequent deduction or rebate on any account (except such payroll deductions as are permitted by regulations issued by the Secretary of Labor under the Copeland Act (29 C.F.R. part 3)), the full amount of wages and bona fide fringe benefits (or cash equivalents thereof) due at time of payment computed at rates not less than those contained in the wage determination of the Secretary of Labor, which is attached hereto and made a part hereof, regardless of any contractual relationship which may be alleged to exist between the CONTRACTOR and such laborers and mechanics.

Contributions made or costs reasonably anticipated for bona fide fringe benefits under section 1(b)(2) of the Davis-Bacon Act on behalf of laborers or mechanics are considered wages paid to such laborers or mechanics, subject to the provisions of Section (1)(iv) of this Amendment; also, regular contributions made or costs incurred for more than a weekly period (but not less often than quarterly) under plans, funds, or programs which cover the particular weekly period, are deemed to be constructively made or incurred during such weekly period. Such laborers and mechanics shall be paid the appropriate wage rate and fringe benefits on the wage determination for the classification of Work actually performed, without regard to skill, except as provided in Section (4) of this Amendment. Laborers or mechanics performing Work in more than one classification may be compensated at the rate specified for each classification for the time actually worked therein: provided, that the employer’s payroll records accurately set forth the time spent in each classification in which Work is performed. The wage determination (including any additional classification and wage rates conformed under Section (1)(ii) of this Amendment) and the Davis-Bacon poster (WH–1321) in applicable languages shall be posted at all times by

the CONTRACTOR and its Subcontractors at the site of the Work in a prominent and accessible place where it can be easily seen by the workers.

(ii) (A) Any class of laborers or mechanics, including helpers, which is not listed in the wage determination and which is to be employed under the Contract shall be classified in conformance with the wage determination. The DISTRICT will approve an additional classification and wage rate and fringe benefits therefore only when the following criteria have been met:

(1) The Work to be performed by the classification requested is not performed by a classification in the wage determination; and

(2) The classification is utilized in the area by the construction industry; and

(3) The proposed wage rate, including any bona fide fringe benefits, bears a reasonable relationship to the wage rates contained in the wage determination.

(B) If the CONTRACTOR and the laborers and mechanics to be employed in the classification (if known), or their representatives, and the DISTRICT agree on the classification and wage rate (including the amount designated for fringe benefits where appropriate), the DISTRICT will send a report of the action to the Administrator of the Wage and Hour Division, Employment Standards Administration, U.S. Department of Labor, Washington, DC 20210. The Administrator, or an authorized representative, will approve, modify, or disapprove every additional classification action within 30 days of receipt and so advise the DISTRICT or will notify the DISTRICT within the 30–day period that additional time is necessary.

(C) In the event the CONTRACTOR, the laborers or mechanics to be employed in the classification or their representatives, and the DISTRICT do not agree on the proposed classification and wage rate (including the amount designated for fringe benefits, where appropriate), the DISTRICT will refer the questions, including the views of all interested parties and the recommendation of the DISTRICT, to the Administrator for determination. The Administrator, or an authorized representative, will issue a determination within 30 days of receipt and so advise the DISTRICT or will notify the DISTRICT within the 30–day period that additional time is necessary.

(D) The wage rate (including fringe benefits where appropriate) determined pursuant to paragraphs (1)(ii)(B) or (C) of this Amendment, shall be paid to all workers performing Work in the classification under this Contract from the first day on which Work is performed in the classification.

(iii) Whenever the minimum wage rate prescribed in the Contract for a class of laborers or mechanics includes a fringe benefit which is not expressed as an hourly rate, the CONTRACTOR shall either pay the benefit as stated in the wage determination or shall pay another bona fide fringe benefit or an hourly cash equivalent thereof.

(iv) If the CONTRACTOR does not make payments to a trustee or other third person, the CONTRACTOR may consider as part of the wages of any laborer or mechanic the amount of any costs reasonably anticipated in providing bona fide fringe benefits under a plan or program, provided, that the Secretary of Labor has found, upon the written request of the CONTRACTOR, that the applicable standards of the Davis-Bacon Act have been met. The Secretary of Labor may require the CONTRACTOR to set aside in a separate account assets for the meeting of obligations under the plan or program.

2. Withholding. The DISTRICT shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld from the CONTRACTOR under this Contract or any other federally-assisted contract subject to Davis-Bacon prevailing wage requirements, which is held by the same CONTRACTOR, so much of the accrued payments or advances as may be considered

necessary to pay laborers and mechanics, including apprentices, trainees, and helpers, employed by the CONTRACTOR or any Subcontractor the full amount of wages required by the Contract. In the event of failure to pay any laborer or mechanic, including any apprentice, trainee, or helper, employed or working on the site of the Work, all or part of the wages required by the Contract, the DISTRICT may, after written notice to the CONTRACTOR, sponsor, applicant, or owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds until such violations have ceased.

3. Payrolls and Basic Records.

(i) Payrolls and basic records relating thereto shall be maintained by the CONTRACTOR during the course of the Work and preserved for a period of three years thereafter for all laborers and mechanics working at the site of the Work. Such records shall contain the name, address, and social security number of each such worker, his or her correct classification, hourly rates of wages paid (including rates of contributions or costs anticipated for bona fide fringe benefits or cash equivalents thereof of the types described in section 1(b)(2)(B) of the Davis-Bacon Act), daily and weekly number of hours worked, deductions made and actual wages paid. Whenever the Secretary of Labor has found under 29 C.F.R. 5.5(a)(1)(iv) that the wages of any laborer or mechanic include the amount of any costs reasonably anticipated in providing benefits under a plan or program described in section 1(b)(2)(B) of the Davis-Bacon Act, the CONTRACTOR shall maintain records which show that the commitment to provide such benefits is enforceable, that the plan or program is financially responsible, and that the plan or program has been communicated in writing to the laborers or mechanics affected, and records which show the costs anticipated or the actual cost incurred in providing such benefits. Contractors employing apprentices or trainees under approved programs shall maintain written evidence of the registration of apprenticeship programs and certification of trainee programs, the registration of the apprentices and trainees, and the ratios and wage rates prescribed in the applicable programs.

(ii) (A) The CONTRACTOR shall submit weekly for each week in which any Work is performed a copy of all payrolls to the DISTRICT, which may be obligated to transfer them to a relevant federal agency. The payrolls submitted shall set out accurately and completely all of the information required to be maintained under 29 C.F.R. 5.5(a)(3)(i), except that full social security numbers and home addresses shall not be included on weekly transmittals. Instead the payrolls shall only need to include an individually identifying number for each employee (e.g., the last four digits of the employee's social security number). The required weekly payroll information may be submitted in any form desired. Optional Form WH–347 is available for this purpose from the Wage and Hour Division Web site at http://www.dol.gov/whd/forms/wh347instr.htm or its successor site. The CONTRACTOR is responsible for the submission of copies of payrolls by all Subcontractors. CONTRACTOR and Subcontractors shall maintain the full social security number and current address of each covered worker, and shall provide them upon request to the DISTRICT, the CONTRACTOR, or the Wage and Hour Division of the Department of Labor for purposes of an investigation or audit of compliance with prevailing wage requirements. It is not a violation of this Amendment for the CONTRACTOR to require a Subcontractor to provide addresses and social security numbers to the CONTRACTOR for its own records, without weekly submission to the DISTRICT.

(B) Each payroll submitted shall be accompanied by a "Statement of Compliance," signed by the CONTRACTOR or Subcontractor or its agent who pays or supervises the payment of the persons employed under the Contract and shall certify the following:

(1) That the payroll for the payroll period contains the information required to be provided under § 5.5 (a)(3)(ii) of Regulations, 29 C.F.R. part 5, the appropriate information is being maintained under § 5.5 (a)(3)(i) of Regulations, 29 C.F.R. part 5, and that such information is correct and complete;

(2) That each laborer or mechanic (including each helper, apprentice, and trainee) employed on the Contract during the payroll period has been paid the full weekly wages earned, without rebate, either directly or indirectly, and that no deductions have been made either directly or indirectly from the full wages earned, other than permissible deductions as set forth in Regulations, 29 C.F.R. part 3;

(3) That each laborer or mechanic has been paid not less than the applicable wage rates and fringe benefits or cash equivalents for the classification of Work performed, as specified in the applicable wage determination incorporated into the Contract.

(C) The weekly submission of a properly executed certification set forth on the reverse side of Optional Form WH–347 shall satisfy the requirement for submission of the "Statement of Compliance" required by Section (3)(ii)(B) of this Amendment.

(D) The falsification of any of the above certifications may subject the CONTRACTOR or Subcontractor to civil or criminal prosecution under section 1001 of title 18 and section 231 of title 31 of the United States Code.

(iii) The CONTRACTOR or Subcontractor shall make the records required under Section (3)(i) of this Amendment available for inspection, copying, or transcription by authorized representatives of the DISTRICT or the Department of Labor, and shall permit such representatives to interview employees during working hours on the job. If the CONTRACTOR or Subcontractor fails to submit the required records or to make them available, the DISTRICT may, after written notice to the CONTRACTOR, sponsor, or applicant, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds. Furthermore, failure to submit the required records upon request or to make such records available may be grounds for debarment action pursuant to 29 C.F.R. 5.12.

4. Apprentices and Trainees.

(i) Apprentices. Apprentices will be permitted to work at less than the predetermined rate for the Work they performed when they are employed pursuant to and individually registered in a bona fide apprenticeship program registered with the U.S. Department of Labor, Employment and Training Administration, Office of Apprenticeship Training, Employer and Labor Services, or with a State Apprenticeship Agency recognized by the Office, or if a person is employed in his or her first 90 days of probationary employment as an apprentice in such an apprenticeship program, who is not individually registered in the program, but who has been certified by the Office of Apprenticeship Training, Employer and Labor Services or a State Apprenticeship Agency to be eligible for probationary employment as an apprentice. The allowable ratio of apprentices to journeymen on the job site in any craft classification shall not be greater than the ratio permitted to the CONTRACTOR as to the entire work force under the registered program. Any worker listed on a payroll at an apprentice wage rate, who is not registered or otherwise employed as stated above, shall be paid not less than the applicable wage rate on the wage determination for the Work actually performed. In addition, any apprentice performing Work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the Work actually performed. Where the CONTRACTOR or a Subcontractor is performing construction on a project in a locality other than that in which its program is registered, the ratios and wage rates (expressed in percentages of the journeyman's hourly rate) specified in the CONTRACTOR's or Subcontractor's registered program shall be observed. Every apprentice must be paid at not less than the rate specified in the registered program for the apprentice's level of progress, expressed as a percentage of the journeymen hourly rate specified in the applicable wage determination. Apprentices shall be paid fringe benefits in accordance with the provisions of the apprenticeship program. If the apprenticeship program does not specify fringe benefits, apprentices must be paid the full amount of fringe benefits listed on the wage determination for the applicable classification. If the Administrator determines that a different practice prevails for the applicable apprentice classification, fringes

shall be paid in accordance with that determination. In the event the Office of Apprenticeship Training, Employer and Labor Services, or a State Apprenticeship Agency recognized by the Office, withdraws approval of an apprenticeship program, the CONTRACTOR will no longer be permitted to utilize apprentices at less than the applicable predetermined rate for the Work performed until an acceptable program is approved.

(ii) Trainees. Except as provided in 29 C.F.R. 5.16, trainees will not be permitted to work at less than the predetermined rate for the Work performed unless they are employed pursuant to and individually registered in a program which has received prior approval, evidenced by formal certification by the U.S. Department of Labor, Employment and Training Administration. The ratio of trainees to journeymen on the job site shall not be greater than permitted under the plan approved by the Employment and Training Administration. Every trainee must be paid at not less than the rate specified in the approved program for the trainee's level of progress, expressed as a percentage of the journeyman hourly rate specified in the applicable wage determination. Trainees shall be paid fringe benefits in accordance with the provisions of the trainee program. If the trainee program does not mention fringe benefits, trainees shall be paid the full amount of fringe benefits listed on the wage determination unless the Administrator of the Wage and Hour Division determines that there is an apprenticeship program associated with the corresponding journeyman wage rate on the wage determination which provides for less than full fringe benefits for apprentices. Any employee listed on the payroll at a trainee rate who is not registered and participating in a training plan approved by the Employment and Training Administration shall be paid not less than the applicable wage rate on the wage determination for the classification of Work actually performed. In addition, any trainee performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the Work actually performed. In the event the Employment and Training Administration withdraws approval of a training program, the CONTRACTOR will no longer be permitted to utilize trainees at less than the applicable predetermined rate for the Work performed until an acceptable program is approved.

(iii) Equal employment opportunity. The utilization of apprentices, trainees and journeymen under this part shall be in conformity with the equal employment opportunity requirements of Executive Order 11246, as amended, and 29 C.F.R. part 30.

5. Compliance with Copeland Act Requirements. The CONTRACTOR shall comply with the requirements of 29 C.F.R. part 3, which are incorporated by reference in this Contract.

6. Subcontracts. The CONTRACTOR or Subcontractor shall insert in any subcontracts the clauses contained in 29 C.F.R. 5.5(a)(1) through (10) and such other clauses as the DISTRICT may by appropriate instructions require, and also a clause requiring the Subcontractors to include these clauses in any lower-tier subcontracts. The CONTRACTOR shall be responsible for the compliance by any Subcontractor of any tier with all the contract clauses in 29 C.F.R. 5.5.

7. Contract Termination: Debarment. A breach of the contract clauses in 29 C.F.R. 5.5 may be grounds for termination of the Contract, and for debarment as provided in 29 C.F.R. 5.12.

8. Compliance with Davis-Bacon and Related Act Requirements. All rulings and interpretations of the Davis-Bacon and Related Acts contained in 29 C.F.R. parts 1, 3, and 5 are herein incorporated by reference in this Contract.

9. Disputes Concerning Labor Standards. Disputes arising out of the federal labor standards provisions of this Contract shall not be subject to the dispute resolution provisions of this Contract. Such disputes shall be resolved in accordance with the procedures of the Department of Labor set forth in 29 C.F.R. parts 5, 6, and 7. Disputes within the meaning of this clause include disputes between the CONTRACTOR (or any of its Subcontractors) and the DISTRICT, the U.S. Department of Labor, or the employees or their representatives.

10. Certification of Eligibility.

(i) By entering into this Contract, the CONTRACTOR certifies that neither it (nor he or she) nor any person or firm who has an interest in the CONTRACTOR's firm is a person or firm ineligible to be awarded Government contracts by virtue of section 3(a) of the Davis-Bacon Act or 29 C.F.R. 5.12(a)(1).

(ii) No part of this Contract shall be subcontracted to any person or firm ineligible for award of a Government contract by virtue of section 3(a) of the Davis-Bacon Act or 29 C.F.R. 5.12(a)(1).

(iii) The penalty for making false statements is prescribed in the U.S. Criminal Code, 18 U.S.C. 1001.

In addition to the provisions set forth above, the following provisions also apply because the Contract Price exceeds $100,000:

11. Overtime requirements. No CONTRACTOR or Subcontractor contracting for any part of the Work which may require or involve the employment of laborers or mechanics (including watchmen and guards) shall require or permit any such laborer or mechanic in any workweek in which he or she is employed on such work to work in excess of forty hours in such workweek unless such laborer or mechanic receives compensation at a rate not less than one and one-half times the basic rate of pay for all hours worked in excess of forty hours in such workweek.

12. Violation; liability for unpaid wages; liquidated damages. In the event of any violation of the clause set forth in Section (11) of this Amendment, the CONTRACTOR and any Subcontractor responsible therefor shall be liable for the unpaid wages. In addition, such CONTRACTOR and Subcontractor shall be liable to the United States (in the case of work done under contract for the DISTRICT of Columbia or a territory, to such DISTRICT or to such territory), for liquidated damages. Such liquidated damages shall be computed with respect to each individual laborer or mechanic, including watchmen and guards, employed in violation of the clause set forth in Section (11) of this Amendment, in the sum of $10 for each calendar day on which such individual was required or permitted to work in excess of the standard workweek of forty hours without payment of the overtime wages required by the clause set forth in Section (11) of this Amendment.

13. Withholding for unpaid wages and liquidated damages. The DISTRICT will upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld, from any moneys payable on account of Work performed by the CONTRACTOR or Subcontractor under the Contract or any other Federal contract with the same CONTRACTOR, or any other federally-assisted contract subject to the Contract Work Hours and Safety Standards Act, which is held by the same CONTRACTOR, such sums as may be determined to be necessary to satisfy any liabilities of such CONTRACTOR or Subcontractor for unpaid wages and liquidated damages as provided in the clause set forth in Section (12) of this Amendment.

14. Subcontracts. The CONTRACTOR or Subcontractor shall insert in any subcontracts the clauses set forth in Section (11) through (14) of this Amendment and also a clause requiring the Subcontractors to include these clauses in any lower-tier subcontracts. The CONTRACTOR shall be responsible for compliance by any Subcontractor of any tier with the clauses set forth in paragraphs (11) through (14) of this Amendment.

8.0 INSURANCE

The DISTRICT intends to procure an owner-controlled insurance program ("OCIP") for the Project.

A. OCIP and Additional Non-Enrolled Coverage

1. Coverage Under the OCIP Insurance Policies.

(a) *Insured Parties*. Coverages and policy limits under the OCIP shall apply to all Work designated for inclusion by the DISTRICT in the OCIP performed at the site(s) set forth where the Project is constructed, stored or installed (hereafter "Project Site(s)"), and during transit between Project

Sites, and shall cover the DISTRICT, certain eligible contractors and subcontractors of every tier who have received written confirmation of enrollment in the OCIP as set forth below, and such other persons or interests as the DISTRICT in its sole discretion may designate (each such party who is insured under the OCIP, an "Insured Party," and all such parties are collectively the "Insured Parties").

(b) *Excluded Parties*. Coverage under the OCIP shall not apply to or be available for the following unless specifically authorized by the DISTRICT or OCIP Administrator:

(i) Janitorial services, demolition, blasting.

(ii) Vendors, suppliers, material dealers or others whose sole function is to transport, pickup, make deliveries, carry or move materials, supplies, tools, parts, or equipment to and from the Project Site(s).

(iii) Asbestos abatement, hazardous material remediation removal, abatement and/or transportation and their consultants.

(iv) Architectural, engineering and related professional services.

(v) Certain emergency work performed on an immediate, short-term basis.

(vi) Other individuals or entities not specifically identified as excluded from the OCIP, by the DISTRICT, in its sole discretion, even if otherwise eligible.

(c) The DISTRICT reserves the right, in its sole discretion, to include or exclude the CONTRACTOR or a Subcontractor of any tier from the OCIP, notwithstanding such party's apparent eligibility for same.

(d) Coverage under the OCIP shall apply only to the operations of each Insured Party performed at the Project Site(s), and during transit between Project Site(s), in connection with the Work. The OCIP shall only apply to an Insured Party's operations off the Project Site(s) if the "off-site" operations are identified to the OCIP Administrator as operations dedicated solely to the Project and such off-site location is approved for coverage by the OCIP Administrator. Coverage under the OCIP is contingent upon the off-site operations remaining at all times dedicated solely to the Project, and failure to do so voids OCIP coverage. It is the responsibility of the party seeking coverage to request that the OCIP Administrator include coverage for specified "off-site" operations. The OCIP shall not apply to such "off-site" operations until receipt by the party seeking coverage of written acknowledgment of such coverage from the OCIP Administrator.

(e) While coverage under the OCIP shall not apply to or be available for office, clerical and/or sales staff, an exception may be granted if the office, clerical and/or sales operations are:

(i) Physically located at the Project Site(s) or at an approved off-site location that exists solely to facilitate Work at the Project Site(s), and

(ii) Identified to the OCIP Administrator and approved for coverage. Coverage under the OCIP is contingent upon such operations and locations remaining at all times dedicated solely to the Project and failure to do so voids OCIP coverage. It is the responsibility of the party seeking coverage to request that the OCIP Administrator include coverage for specified office, clerical and/or sales operations. The OCIP shall not apply to such operations until receipt of written acknowledgment of such coverage from the OCIP Administrator.

2. Insured Party Responsibilities. The responsibilities of each Insured Party under the OCIP are more fully set forth in the Project OCIP insurance manual (the "Project Insurance Manual"), which is hereby incorporated by

reference and shall be a Contract Document. It is the obligation of the CONTRACTOR and each of its Subcontractors of any tier to enroll in the OCIP and to comply with all of the administrative, insurance and other requirements outlined in these Special Conditions, in the Project Insurance Manual, and in the Contract Documents. The CONTRACTOR shall be responsible for providing each of its Subcontractors of any tier with a copy of the Project Insurance Manual and for requiring in writing that each Subcontractor of any tier comply with, among other things, the provisions of the OCIP insurance policies, the provisions contained in the Project Insurance Manual, the provisions in this Section A.2, and the provisions of the Contract Documents. The failure of the DISTRICT to include the Project Insurance Manual in the bidding documents or Contract Documents, or the failure of the CONTRACTOR to provide each of its Subcontractors of any tier with a copy of the Project Insurance Manual shall not relieve the CONTRACTOR or any of its Subcontractors of any tier from any of the obligations contained therein.

3. Payment of OCIP Premiums; Insurance Credits; OCIP Policy Deductibles.

(a) The DISTRICT will pay the cost of premiums for the coverage provided by the OCIP. The DISTRICT will receive or pay, as the case may be, all adjustments to such costs, whether by way of dividends, retro adjustments, return premiums, audits or otherwise. The CONTRACTOR and each Subcontractor of any tier shall execute any instrument or assignment as may be necessary to permit the DISTRICT to receive or pay such adjustments, unless otherwise provided in the Contract Documents.

(b) Compensation payable for performance of Work shall exclude all of the CONTRACTOR's and its Subcontractors of any tiers' costs of insurance for coverages provided under the OCIP. The CONTRACTOR shall execute, and shall require each Subcontractors of any tier to execute, an OCIP Enrollment Application and Insurance Cost Worksheet (as found in the Project Insurance Manual) to certify that the Contract Price excludes all costs for any type of insurance coverage that is provided under the OCIP. By submitting a bid, the CONTRACTOR and each Subcontractor of any tier warrant that they have fully disclosed all costs for insurance provided by the OCIP insurance policies.

(c) All "Deductibles" shall be paid by the CONTRACTOR or Subcontractor up to the first $10,000 of each and every Insured Loss (regardless of whether or not the OCIP policy deductible is exceeded) in accordance with the terms specified in the Project Insurance Manual.

4. CONTRACTOR/Subcontractor Enrollment and Deduction Instructions. The CONTRACTOR is required to complete and submit, and shall cause all Subcontractors of any tier to complete and submit, within twenty-four (24) hours of the DISTRICT's request:

(a) The OCIP Insurance Enrollment Information Form and Insurance Cost Worksheet including copies of rate pages (as found in the Project Insurance Manual). Cost identification and removal should include the insurance costs of any Subcontractors of any tier expected to perform Work under the Contract Documents. Should information not be available at time of bid to provide those insurance costs, an estimate of at least 1% of subcontract value shall be included. Contracts will be awarded less this amount. This amount must be identified in a line item entry that will reduce the Contract Price.

Deductions calculated based upon anticipated premium returns of any insurance program, such as retrospective rating rates or dividend plans and the like, will not be accepted.

5. DISTRICT's Insurance Obligations; CONTRACTOR's Obligations. The DISTRICT assumes no obligation to provide insurance other than that contemplated under the Contract Documents, including the Project Insurance Manual. The CONTRACTOR and each Subcontractor of any tier shall review the OCIP coverages, limits of liability and insurance policies (when available) to satisfy themselves that the coverages offered meet their needs. Nothing contained herein shall be deemed to place any responsibility on the DISTRICT for ensuring that the insurance provided by the OCIP is sufficient for the conduct of the business or performance of Work by the CONTRACTOR or its Subcontractors of any tier. The DISTRICT reserves the right at its option, but without

obligation to do so, to furnish other insurance coverage of various types and limits, provided that such coverage is not less than that specified in the Contract Documents. The furnishing of insurance by the DISTRICT through the OCIP or otherwise shall in no way relieve or limit or be construed to relieve or limit the CONTRACTOR or any Subcontractor of any tier of any responsibility, liability, or obligation imposed by the Contract Documents or by law, including without limitation, any indemnification obligations which the CONTRACTOR or any of its Subcontractors of any tier have to the DISTRICT or other parties thereunder. The CONTRACTOR acknowledges by executing the enrollment application, and shall require all of its Subcontractors of any tier to acknowledge by executing the enrollment application, that the DISTRICT is not an agent, partner or guarantor of the insurance companies providing coverage under the OCIP (each such insurer, an "OCIP Insurer") or otherwise, and that the DISTRICT is not responsible for any claims or disputes between or among the CONTRACTOR, its Subcontractors of any tier, and any OCIP Insurer(s) or other insurers. The DISTRICT shall not be liable to any party (including, but not limited to, the CONTRACTOR and other contractors and Subcontractors of any tier) for any failure or delay by any insurer to honor any policy obligation, including extra-contractual obligations, for any reason, including, but not limited to, coverage disputes, coverage defenses, claims handling practices, the defense of or the failure to defend any claim, or insolvency, and the CONTRACTOR and its Subcontractors of any tier release the DISTRICT from any and all liability arising from or related to any such obligation.

Any type of insurance coverage or limits of liability not provided by the OCIP that the CONTRACTOR or any Subcontractor of any tier desire for its or their own protection, or which is required by applicable contracts, laws or regulations, shall be its or their sole responsibility. Any reference in this Contract, the Project Insurance Manual or elsewhere in any other Contract Documents as to amount, nature, type or extent of coverage provided under the OCIP and/or the potential applicability to any potential claim or loss is for reference only. The CONTRACTOR and its Subcontractors of any tier represent and warrant that they have not relied upon said reference and have relied solely upon their own independent review and analysis of the OCIP coverage, limits of liability and insurance policies, when available, in formulating any understanding and/or belief as to amount, nature, type or extent of any coverage provided by the OCIP insurance policies and/or the policies' potential applicability to any potential claim or loss.

6. Work to Begin On-Site Prior to Finalization of OCIP Coverage / DISTRICT's Election to Discontinue OCIP Coverages. If the DISTRICT, for any reason, is unable to furnish coverage prior to commencement of the Work by the CONTRACTOR or its Subcontractors of any tier at the Project Site(s), or elects to discontinue all or portions of the OCIP, modifies the insurance limits provided in the OCIP, or requests that the CONTRACTOR or any of its Subcontractors of any tier withdraw from the OCIP, then, upon thirty (30) days' written notice from the DISTRICT, the CONTRACTOR and/or one or more of its Subcontractors of any tier, as specified by the DISTRICT in the notice, shall obtain at the DISTRICT's commercially reasonable expense and thereafter maintain during the performance of Work, all (or a portion thereof, as specified by the DISTRICT) of the insurance provided or contemplated under the OCIP insurance policies, and the DISTRICT shall thereafter no longer be obligated to furnish all or a part of such insurance through the OCIP. The CONTRACTOR and its Subcontractors of any tier shall provide the OCIP Administrator and the DISTRICT with certificates and additional insured endorsements evidencing such insurance policies not later than thirty (30) days following the issuance of such notice, and certified copies of such insurance policies not later than ninety (90) days following the issuance of such notice. The form, content, limits and cost of such insurance and the insurer secured by the CONTRACTOR or its Subcontractors of any tier shall be subject to the DISTRICT's approval.

7. OCIP Policies Establish OCIP Coverage. The insurance coverages, agreements, conditions and exclusions contemplated in these Special Conditions, the Project Insurance Manual, and the other Contract Documents are set forth in full in their respective insurance policy forms. The descriptions of such policies in these Special Conditions, the Project Insurance Manual, and the other Contract Documents are not intended to be complete or to alter or amend any provision of the actual insurance policies and in matters, if any, in which the description herein conflicts with such insurance policies, the provisions of the actual insurance policies shall govern.

B. Insurance Coverages for Insured Parties

1. Scope of OCIP Insurance. Unless otherwise modified by the DISTRICT, the OCIP shall provide the following insurance to Insured Parties for Work performed at the Project Site(s).

(a) *Marine General Liability* covering bodily injury including wrongful death, third party property damage including loss of use thereof, premises/operations liability, products/completed operations, personal injury/advertising, contractual liability, fire damage legal liability, sudden and accidental pollution, amended exclusions for care, custody and control and watercraft liability to cover Work related to the Project. Coverage also shall extend to cover Stevedore's legal liability, wharfinger's legal liability, and charterer's legal liability. Coverage shall be on an occurrence basis, and limits of liability shall not be less than $25,000,000 per occurrence and $25,000,000 in the aggregate. The General Aggregate limit shall apply separately to each project.

2. OCIP Insurance Certificates and Policies. Prior to the time that Work is performed at the Project Site(s), certificates of insurance for the marine general liability and such additional insurance as the DISTRICT may, in its sole discretion, elect to provide will be issued to the CONTRACTOR and its Subcontractors of any tier, reflecting that the CONTRACTOR and its Subcontractors of any tier are Insured Parties.

3. Scope of Additional Insurance Purchased by DISTRICT. Unless otherwise modified by the DISTRICT, the DISTRICT shall also provide the following insurance to Insured Parties for Work performed at the Project Site(s).

(a) *Contractor's Pollution Liability* policy form providing coverage for liability from pollution conditions arising out of the operations of the CONTRACTOR. Coverage shall apply to bodily injury, property damage, including loss of use of damaged property or of property not physically injured, cleanup costs, and defense, including costs, attorneys' fees, and expenses incurred in the investigation, defense, or settlement of claims. The policy limit shall be no less than $5,000,000 per claim and $5,000,000 general aggregate. All activities contemplated in the Contract Documents shall be specifically scheduled on the policy as "covered operations." The policy shall provide coverage for the hauling of any waste from the Project Site(s) to the final disposal location, including non-owned disposal sites. There shall be no exclusion for Work in, on, or under water. Coverage shall be included on behalf of the insured for covered claims arising out of the actions of independent contractors. If the insured is using Subcontractors, the policy will include Work performed "by or on behalf" of the insured. Coverage shall apply on a primary non-contributing basis in relation to any other insurance or self-insurance, primary or excess, available to the DISTRICT or any employee or agent of the DISTRICT. Deductibles shall be addressed as set forth in the OCIP Manual.

(b) *Marine Builder's Risk/Installation Risk* "all risk" policy including delay in startup, during the construction phase and upon the entire Work at the Project Site. Such insurance shall include CONTRACTOR and Subcontractors of all tiers as additional insureds as their interests may appear. Such insurance shall not cover the DISTRICT's existing property outside the care, custody, and control of CONTRACTOR and such insurance shall terminate upon Final Acceptance of the Work. Deductibles shall be addressed as set forth in the OCIP Manual.

4. Additional Insurance Required from CONTRACTOR and Subcontractors. In addition to insurance coverages provided under the OCIP or the additional coverages described above that may be provided by the DISTRICT, the CONTRACTOR shall pay for and maintain, and shall require each of its Subcontractors of any tier to pay for and maintain, the insurance coverage specified in subsections (a) through (j) below. The cost of all premiums, deductibles and policy charges for the coverage required under this Section B.4 shall be paid by the party required to procure and maintain such insurance. This insurance shall be in a form acceptable to the DISTRICT and from insurance companies with a minimum A. M. Best Co. Key Rating Guide of A/VII. The insurance limits may be provided through a combination of primary and excess policies, including umbrella and/or bumbershoot form policies. Except with respect to state workers' compensation insurance and professional liability insurance, each policy required below shall name the DISTRICT and each of its Commissioners, directors, officers, agents, employees, consultants and representatives and all other indemnified parties defined in the Contract Documents, and any additional entities that the DISTRICT may request, as additional insureds. All policies of insurance required under this Section B.4 shall (i) provide for thirty (30) days' prior written notice to the DISTRICT and OCIP Administrator of cancellation, reduction of limits or material modification, and ten (10) days' prior written notice if cancellation is due to non-payment of premiums (ii) provide that the insurance shall be

primary insurance and no other insurance or self-insured retention carried or held by the DISTRICT shall be called upon to contribute to a loss covered by insurance for any Insured Party and (iii) shall contain a separation of insureds provision.

(a) *Hull and Machinery Insurance* covering all owned and/or operated watercraft used in performing Work and/or services related to the Project. This coverage shall be written on the American Institute Hull Clauses (6/2/1977) or equivalent form and shall include full collision and tower's liability, if not provided under the Protection and Indemnity coverage. The coverage amount shall be not less than the fair market value of the hull and machinery.

(b) *Protection and Indemnity Insurance* covering all owned or operated watercraft used in performing Work and/or services related to the Project. This coverage shall be written on the SP23 (1956) or equivalent form and shall include full collision and tower's liability, if not provided in the Hull and Machinery coverage. Coverage also shall include contractual liability extension, crew liability (if not in the Maritime Employer's Liability coverage) and excess collision and tower's liability (excess of any collision and tower's liability provided in the Hull and Machinery coverage). Limits of liability shall not be less than $1,000,000 and each vessel shall be separately insured.

(c) *Vessel Pollution Insurance* covering all owned or operated watercraft used in performing Work and/or services related to the Project. This coverage shall be written on the Water Quality Insurance Syndicate policy form, or equivalent, and shall include bodily injury. Limits of liability shall be in accordance with OPA90, but not less than $1,000,000 each occurrence. The vessel owner or operator shall also have Certificate of Financial Responsibility pursuant to OPA90, Coast Guard Regulations and State of Washington, as required.

(d) *Workers' Compensation, WA Stop Gap/Employer's Liability Insurance, Jones Act Liability and Maritime Employers Liability* extended to include coverage for U.S. Longshore & Harbor Workers Act. The policy shall contain an Alternate Employers endorsement in favor of the DISTRICT. This insurance shall provide statutory limits for compensation coverage with minimum limits of $1,000,000.00 for employers and maritime employer's liability. This insurance shall also provide a minimum of $1,000,000 in coverage for each accident, as well as $1,000,000 in disease coverage.

(e) *Automobile Liability* insurance with coverage at least as broad as the Insurance Service Office Form CA0001 (covering auto liability code 1 any auto), with minimum limits of $2,000,000 combined single limits. Insurance premiums and deductibles shall be the responsibility of the vehicle owner.

(f) *Cargo Insurance* for any cargo carried in conjunction with the Project. This coverage shall be placed on an "all risk" basis, including war risks, strikes, riots and civil commotion, debris removal, 50/50 clause and extensions for storage of goods that are temporarily staged and intended to become part of the Project. Goods insured are to be valued at cost plus 10%. At the option of the DISTRICT, coverage may be purchased for delay.

(g) *Property Insurance* for owned or leased equipment, machinery, tools, and materials, whether such is located at or away from a Project Site or "in transit." The CONTRACTOR and Subcontractors of any tier are solely responsible for any loss or damage to their personal property.

(h) *Contractor's Professional Liability Insurance* with minimum limits of $1,000,000. Covered professional services shall specifically include all Work to be performed under the Contract Documents and exclude any exclusions that may potentially affect the Work to be performed .

(i) *Commercial General Liability Insurance* for operations away from the Project Site(s) and which are not otherwise insured under the OCIP, in a form providing coverage on a general aggregate

per location basis and not less than the standard commercial general liability insurance policy ISO form CG 00010196, as further detailed in the OCIP Manual. The limits shall be:

Each Occurrence	$1,000,000
Annual General Aggregate Per Project	$2,000,000
Products/Completed Operations Aggregate	$2,000,000
Personal/Advertising Injury Limit	$1,000,000
Fire Damage	$50,000
Medical Expense	$5,000

(j) *Umbrella or Excess Liability* covering excess over Section B.4.(a-e), and (i) above. Such coverage shall be on a follow-form basis with a drop down provision where primary coverage is aggregated. Occurrence form. Limits of Liability shall not be less than $25,000,000.

C. Insurance Requirements for Excluded Parties

1. Insurance Requirements for Excluded Parties. Any Excluded Party performing Work shall pay for and maintain, and shall require each of its Subcontractors of any tier that is an Excluded Party, to pay for and maintain all insurance coverages set forth in Sections B.1 and B.4. The cost of all premiums, deductibles and policy charges for the coverage required under this Section C.1, including any charges for required waivers of subrogation, additional insured endorsements or any other endorsements, shall be paid by the party required to procure and maintain the insurance. The insurance shall be primary and non-contributing with any other insurance and shall be in a form acceptable to the DISTRICT and from insurance companies with a minimum Best rating of A/VII (or higher). The insurance limits may be provided through a combination of primary and excess policies, including umbrella and/or bumbershoot policies, with the excess and/or umbrella and/or bumbershoot policies having coverages at least as broad as each and every underlying policy. Except with respect to state workers' compensation insurance and professional liability insurance, each policy required under this Section C.1 shall name the DISTRICT and each of its Commissioners, directors, officers, agents, employees, consultants, representatives, all other indemnified parties defined in the Contract Documents, and any additional entities that the DISTRICT may request, as additional insureds. All policies of insurance required by this Section C.1 shall (i) provide for thirty (30) days' prior written notice to the DISTRICT and OCIP Administrator of cancellation, reduction of limits or material modification, and for ten (10) days' prior written notice if cancellation is due to non-payment of premiums, (ii) provide that the insurance shall be primary insurance and that no other insurance or self-insured retention carried or held by the DISTRICT shall be called upon to contribute to a loss covered by insurance for any insured, and (iii) shall contain a separation of insureds provision.

Excluded Parties shall deliver to the OCIP Administrator, prior to the commencement of Work, a certificate of insurance evidencing all insurance coverage under this Section C.1 on a standard ACORD form or other form acceptable to the DISTRICT. The commencement of Work by the CONTRACTOR or any of its Subcontractors of any tier without compliance with this or any other requirement the Contract Documents shall not constitute a waiver of any right of the DISTRICT nor a release or waiver of any duty or obligation owed by the CONTRACTOR or any Subcontractor of any tier. Upon the DISTRICT's request, the CONTRACTOR and/or any Subcontractor of any tier shall submit to the DISTRICT copies of the actual insurance policies or renewals or replacements thereof. All insurance furnished by the CONTRACTOR or any of its Subcontractors of any tier as required under this Section C.1 shall be in full force and effect during the performance of the Work by the CONTRACTOR and six (6) years after completion of the Work. The CONTRACTOR shall be responsible for obtaining satisfactory evidence of insurance coverage from each of its Subcontractors of any tier, whether Insured Parties or Excluded Parties, and submitting same to the DISTRICT prior to commencement of such Subcontractor's Work. The DISTRICT

reserves the right to increase or decrease the required limits of liability or require additional coverages based on the type and scope of Work performed.

2. Scope of Additional Insurance Purchased by DISTRICT. Unless otherwise modified by the DISTRICT or excluded under the Contract Documents, the DISTRICT shall provide Excluded Parties the insurance coverage in Section B.3 for Work performed at the Project Site(s).

D. General Provisions

1. Cooperation; Compliance; Audits. The CONTRACTOR and each of its Subcontractors of any tier shall (a) cooperate fully with the OCIP Administrator and the OCIP Insurers, as applicable, in its or their administration of the OCIP, and (b) comply with the terms and conditions of the insurance policies provided pursuant to the OCIP, the Project Insurance Manual, and other provisions of the Contract Documents. The CONTRACTOR shall provide, within five (5) business days of the OCIP Administrator's request, all requested documentation, including but not limited to certified copies of insurance policies, all underwriting, certified payroll, rating and prior loss history information if, in the opinion of the DISTRICT, it is needed to verify the accuracy of the insurance credit. The CONTRACTOR agrees that the DISTRICT, the OCIP Administrator, and/or any OCIP Insurer may audit the records and insurance policies of the CONTRACTOR or any of its Subcontractors of any tier to confirm the accuracy thereof, or of any insurance cost information hereafter provided by the CONTRACTOR or any of its Subcontractors of any tier in connection with the Work, or changes to the scope of Work pursuant to the Contract Documents. The obligations assumed in these Sections D.1 through D.6 shall be specifically enforceable.

2. Right to Withhold Payments. The DISTRICT, in addition to its other remedies, reserves the right to withhold progress payments or final payment if the CONTRACTOR or its Subcontractors of any tier fail to comply with any of the requirements in these Special Conditions.

3. Waiver of Subrogation. All Insured and Excluded Parties hereby waive all rights of recovery against each other, the DISTRICT, the OCIP Administrator, the program administrator, its or their officers, agents, or employees, and any other contractor or Subcontractor of any tier performing Work or rendering services on behalf of the DISTRICT in connection with the Project, to the extent any losses, claims or damages are covered by the OCIP or any other insurance required in these Special Conditions (except state workers' compensation) and further waives all rights of recovery for losses which are not covered by insurance because of deductible clauses, inadequacy of insurance limits, limitations or exclusions of coverage. The CONTRACTOR shall also require that all insurance policies related to the Work secured by the CONTRACTOR or its Subcontractors of any tier include clauses providing that each insurance underwriter waives all of its rights of recovery by subrogation, or otherwise, against all Insured Parties, the DISTRICT, the OCIP Administrator, and the program administrator, together with the same parties referenced immediately above in this Section D.3. The CONTRACTOR shall require similar written waivers and insurance clauses from each of its Subcontractors. The CONTRACTOR will provide to the OCIP Administrator, endorsements evidencing compliance with this requirement by both the CONTRACTOR and all Subcontractors of any tier, prior to the commencement of any Work pursuant to the Contract Documents. This provision shall apply to each CONTRACTOR and Subcontractor of any tier performing Work or rendering services on behalf of the DISTRICT in connection with the planning, development and construction of the Project, irrespective of whether or not it is enrolled in the OCIP. A waiver of subrogation shall be effective as to any individual or entity even if the individual or entity (a) would otherwise have a duty of indemnification, contractual or otherwise, (b) did not pay the insurance premium directly or indirectly, or (c) whether or not such individual or entity has an insurable interest in any property damaged.

4. Records Disclosure, Maintenance and Access. Prior to the commencement of Work, the CONTRACTOR shall furnish and shall cause each of its Subcontractors of any tier to furnish to the OCIP Administrator, in a form acceptable to the DISTRICT, an estimate of the total direct labor cost (listed by standard general liability insurance classification) to be incurred in connection with Work at the Project Site(s), and the total amount due each Subcontractor under its subcontract with the CONTRACTOR. The CONTRACTOR shall cause each of its Subcontractors of any tier to keep and maintain an accurate and classified record of its or their payroll data and information in accordance with the requirements of the OCIP Insurer(s) or any other Contract Document. The CONTRACTOR and its Subcontractors of any tier shall permit their books and records to be examined and audited periodically by the OCIP Insurer(s), the DISTRICT, or their respective representatives.

5. Failure to Maintain Insurance. The CONTRACTOR shall indemnify, defend and hold harmless the DISTRICT and its Commissioners, directors, officers, agents, employees, consultants, and representatives, from all claims and liabilities arising out of the failure of the CONTRACTOR, any of its Subcontractors of any tier or any other entity or person for whom the CONTRACTOR may be responsible, to maintain the insurance coverages as described and required herein. The DISTRICT, in addition to its other remedies, may withhold the CONTRACTOR's progress payments or final payment for any period in which (a) such insurance coverages are not in full force and effect or (b) the CONTRACTOR has not supplied the DISTRICT with required evidence of such insurance coverages.

6. Duty of Care. Nothing contained in these Special Conditions or the Project Insurance Manual shall relieve the CONTRACTOR or any of its Subcontractors of any tier of their respective obligations to exercise due care in the performance of their duties in connection with the Work and to complete the Work in strict compliance with the Contract Documents.

SECTION D

EXHIBITS

EXHIBIT A

BID BOND

KNOW ALL MEN BY THESE PRESENTS, that we, the VENDOR/CONTRACTOR,

_____

as Principal, and

_____,

as Surety, duly authorized and licensed to do business in the State of Washington, are held and firmly bound unto the PUBLIC UTILITY DISTRICT NO. 1 OF SNOHOMISH COUNTY, WASHINGTON, hereinafter referred to as 'DISTRICT," in the sum of

_____($_____)

(5% of the bid amount) to be paid to the said DISTRICT, its successors or assigns, the payment for which we do jointly and severally firmly bind ourselves, our successors and assigns, by these presents.

The condition of this obligation is such that if the accompanying bid or proposal of Principal for

_____

is accepted by the DISTRICT and the contract awarded to said Principal, and Principal shall, within ten days after such award is made, enter into a contract with the DISTRICT for the purchase/contract bid upon and provide performance security as required, then this obligation shall be null and void; otherwise, it shall remain in full force and effect.

IN WITNESS WHEREOF, the said Principal and the said Surety have caused this bond to be signed and sealed by their duly authorized officers this _____day of _____, 20_____.

PRINCIPAL:

_____

By: _____

Title: _____

SURETY:

_____

By: _____
Attorney-In-Fact

EXHIBIT B

PERFORMANCE AND PAYMENT BONDS

KNOW ALL BY THESE PRESENT: That _____, as principal ("Contractor"), and _____, a _____ _____ corporation, as Surety, are held and firmly bound unto the Public Utility District No. 1 of Snohomish County, Snohomish County, Washington, as obligee ("District"), for itself and for the use and benefit of Claimants as defined below, in the full and just sum of: _____ _____ Dollars ($_____ _____), lawful money of the United States of America, separately for each of the following bonds ("Bond Amount"), for the payment of which sum well and truly made, the Contractor and the Surety hereby bind themselves, their successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, the said Contractor has entered into a contract in writing with the District dated the _____ day of _____ , 2014 ("Contract") for the

Admiralty Inlet Tidal Project

("Project") according to the terms, conditions, and covenants specified in the Contract and the Drawings and Specifications, all of which are hereby referred to and made a part hereof as fully and completely as though set forth in detail herein,

PERFORMANCE BOND

NOW, THEREFORE, THE CONDITIONS OF THIS OBLIGATION ARE SUCH, that IF the Contractor shall promptly and faithfully perform all the provision of, and fully complete the Contract according to its terms, conditions and covenants, and shall hold the District harmless from any loss or damage to any person or property by reason of any carelessness or negligence upon the part of the Contractor or of any Subcontractors of any tier in the performance of the Work, THEN this obligation shall be null and void; otherwise this obligation shall remain in full force and effect, subject only to the following conditions:

1. The Surety hereby waives notice of any alteration or extension of time made or ordered by the District.

2. Whenever the Contractor shall be, and is declared by the District to be in default under the Contract, the District having performed its obligations under the Contract, the Surety shall either (1) promptly remedy the situation, or (2) promptly complete the Contract in accordance with its terms and conditions, or (3) obtain a bid or bids consistent with applicable statutory requirements, for completing the Contract in accordance with its terms and conditions, and upon determination by the Surety of the lowest responsible bidder, or, if the District elects, upon determination by the District and the Surety jointly of the lowest responsible bidder, arrange for a contract between such bidder and the District, and make available as Work progresses (even though there should be a default or a succession of defaults under the contract or contracts of completion arranged under this paragraph) sufficient funds to pay the cost of completion less the balance of the Contract Price, but not exceeding the Bond Amount for this Performance Bond, including other costs and damages for which the Surety may be liable hereunder, but not including the Bond Amount for the Payment Bond. The Surety shall also be liable for the costs incurred by the District related to the default, including architect, consultant, employee, and attorneys' fees and costs. The term "balance of the Contract Price," as used in this paragraph, shall mean the total amount payable by the District to the Contractor under the Contract and any amendments thereto, less the amount properly paid by the District to the Contractor.

3. Any suit under this bond must be instituted before the expiration of six years after the District's discovery of the factual basis for its suit.

4. No right of action shall accrue on this bond

to or for the use of any person or corporation other than the District named herein or its administrators, assigns or successors.

PAYMENT BOND

NOW, THEREFORE, THE CONDITIONS OF THIS OBLIGATION ARE SUCH, that IF the Contractor shall promptly and faithfully shall pay all Claimants, laborers, mechanics, subcontractors and material suppliers, and all persons who shall supply such person or persons or subcontractor with provisions and supplies for the carrying of the Work, or anyone permitted to claim under RCW 39.08, for all labor, material and equipment used or reasonably required for use in the performance of the Contract, THEN this obligation shall be null and void; otherwise this obligation shall remain in full force and effect, subject only to the following conditions:

1. The purpose of this obligation is to fully protect and indemnify the District from all claims or demands whatsoever of all laborers, mechanics, subcontractors and material suppliers, and all persons furnishing provisions or supplies therefor, and any person or persons performing such services or furnishing material to any subcontractor, as well as to provide for any and all bonding required in RCW 39.08 and as hereafter as amended.

2. A Claimant is defined as one having a direct contract with the Contractor or with a Subcontractor for labor, material, equipment, or both, used or reasonably required for use in the performance of the Contract, labor, material, and equipment being construed to include that part of water, gas, power, light, hear, oil, gasoline, telephone service or rental of equipment directly applicable to the Contract.

3. The Contractor and Surety hereby jointly and severally agree with the District that every Claimant who has not been paid in full may sue on this bond for the use of such Claimant, prosecute the suit to final judgment for such sum or sums as may be justly due Claimant and permitted under statute, and have execution thereon. The District shall not be liable for the payment of any costs or expenses of any such suit.

4. No suit or action shall be commenced under this Payment Bond by any Claimant:

(a) Unless the Claimant, other than one having a direct contract with the Contractor, shall have given timely written notice required by RCW 39.08.

(b) After expiration of one year following the date on which the Contractor ceased Work on the Contract; provided, however, that if any limitation embodied in this Payment Bond is prohibited by any law controlling the construction hereof, such limitation shall be deemed to be amended so as to be equal to the minimum period of limitation permitted by such law.

(c) Other than in a state court of competent jurisdiction in and for the County of Snohomish, Washington, or in the United States District Court of the Western District of Washington, and not elsewhere.

5. The amount of this Payment Bond shall be reduced by and to the extent of any payment or payments made in good faith under it, inclusive of the payment by Surety of mechanics' liens which may be filed of record against the Project's statutory retainage, whether or not claim for the amount of such lien be represented under and against this Payment Bond, but shall not be reduced by any payment under the Performance Bond.

Both the Performance Bond and the Payment Bond are signed, sealed and dated this _____ day of _____ , 2014.

Contractor

_____

Surety

_____

Address

_____

Attorney-In Fact

_____

EXHIBIT C

AFFIDAVIT OF WAGES PAID

State of Washington
DEPARTMENT OF LABOR AND INDUSTRIES
AFFIDAVIT OF WAGES PAID
ON PUBLIC WORKS CONTRACT

Date: _____
Contract No. _____
Description: _____
_____

STATE OF WASHINGTON)
COUNTY OF SNOHOMISH) SS

In compliance with RCW Chapter 39.12, I the undersigned, being a duly authorized representative of

_____
(CONTRACTOR or Subcontractor)

do hereby certify that in connection with the performance of work on the public improvement project above described for the period ending _____, 20____, the following rates per hour for each classification of laborers, workmen, and mechanics have been paid and no laborer, workman or mechanic so employed upon such work has been paid less than the prevailing rate of wage as specified by the Department of Labor and Industries.

Classification of Labor	Rate Hourly Pay	Value of Fringe Benefits

NOTE: Attach additional sheets as needed.

Subscribed to and sworn before me this _____ day of _____, 20 _____.

_____
Company Name

By: _____
Title: _____

_____
Notary Public in and for the State of Washington,
residing at _____.

Copies of this form must be completed by the CONTRACTOR and each of the CONTRACTOR'S subcontractors, certified by the Industrial Statistician of the Department of Labor and Industries, and submitted by the CONTRACTOR to the officer or person charged with the custody and disbursement of public funds under the Contract. CONTRACTORS are responsible for obtaining and filing affidavits of their subcontractors. Payments cannot lawfully be made until such affidavits are filed.

EXHIBIT D

PREVAILING WAGES AND DAVIS-BACON WAGES

ATTACHED AS;

D1 State of Washington Prevailing Wages
D2 Davis-Bacon Wages

The information in this Exhibit is offered for the convenience of the CONTRACTOR. The DISTRICT does not represent that the information is accurate or complete. It is the responsibility of the CONTRACTOR to verify the prevailing wages and Davis-Bacon wages that must be paid under this Contract.

EXHIBIT D1

STATE OF WASHINGTON PREVAILING WAGES

State of Washington
Department of Labor & Industries

Prevailing Wage Section - Telephone 360-902-5335
PO Box 44540, Olympia, WA 98504-4540

Washington State Prevailing Wage

The PREVAILING WAGES listed here include both the hourly wage rate and the hourly rate of fringe benefits. On public works projects, worker's wage and benefit rates must add to not less than this total. A brief description of overtime calculation requirements are provided on the Benefit Code Key.

Journey Level Prevailing Wage Rates for the Effective Date: 12/27/2013

County	Trade	Job Classification	Wage	Holiday	Overtime	Note
Island	Asbestos Abatement Workers	Journey Level	$41.69	5D	1H	
Island	Boilermakers	Journey Level	$28.04		1	
Island	Brick Mason	Brick And Block Finisher	$43.26	5A	1M	
Island	Brick Mason	Journey Level	$50.12	5A	1M	
Island	Brick Mason	Pointer-Caulker-Cleaner	$50.12	5A	1M	
Island	Building Service Employees	Janitor	$9.19		1	
Island	Building Service Employees	Shampooer	$9.19		1	
Island	Building Service Employees	Waxer	$9.19		1	
Island	Building Service Employees	Window Cleaner	$9.19		1	
Island	Cabinet Makers (In Shop)	Journey Level	$24.63		1	
Island	Carpenters	Acoustical Worker	$50.82	5D	1M	
Island	Carpenters	Bridge, Dock And Wharf Carpenters	$50.82	5D	1M	
Island	Carpenters	Carpenter	$50.82	5D	1M	
Island	Carpenters	Carpenters on Stationary Tools	$50.95	5D	1M	
Island	Carpenters	Creosoted Material	$50.92	5D	1M	
Island	Carpenters	Floor Finisher	$50.82	5D	1M	
Island	Carpenters	Floor Layer	$50.82	5D	1M	
Island	Carpenters	Scaffold Erector	$50.82	5D	1M	
Island	Cement Masons	Journey Level	$51.18	7A	1M	
Island	Divers & Tenders	Diver	$100.28	5D	1M	8A
Island	Divers & Tenders	Diver On Standby	$56.68	5D	1M	
Island	Divers & Tenders	Diver Tender	$52.23	5D	1M	
Island	Divers & Tenders	Surface Rcv & Rov Operator	$52.23	5D	1M	
Island	Divers & Tenders	Surface Rcv & Rov Operator Tender	$48.67	5A	1B	
Island	Dredge Workers	Assistant Engineer	$53.00	5D	3F	
Island	Dredge Workers	Assistant Mate (Deckhand)	$52.58	5D	3F	
Island	Dredge Workers	Boatmen	$52.30	5D	3F	
Island	Dredge Workers	Engineer Welder	$54.04	5D	3F	
Island	Dredge Workers	Leverman, Hydraulic	$55.17	5D	3F	
Island	Dredge Workers	Mates	$52.30	5D	3F	
Island	Dredge Workers	Oiler	$52.58	5D	3F	
Island	Drywall Applicator	Journey Level	$50.82	5D	1H	
Island	Drywall Tapers	Journey Level	$49.79	5P	1E	

Island	Electrical Fixture Maintenance Workers	Journey Level	$13.82		1	
Island	Electricians - Inside	Journey Level	$50.01		1	
Island	Electricians - Motor Shop	Craftsman	$15.37		1	
Island	Electricians - Motor Shop	Journey Level	$14.69		1	
Island	Electricians - Powerline Construction	Cable Splicer	$66.43	5A	4A	
Island	Electricians - Powerline Construction	Certified Line Welder	$60.75	5A	4A	
Island	Electricians - Powerline Construction	Groundperson	$42.36	5A	4A	
Island	Electricians - Powerline Construction	Heavy Line Equipment Operator	$60.75	5A	4A	
Island	Electricians - Powerline Construction	Journey Level Lineperson	$60.75	5A	4A	
Island	Electricians - Powerline Construction	Line Equipment Operator	$51.05	5A	4A	
Island	Electricians - Powerline Construction	Pole Sprayer	$60.75	5A	4A	
Island	Electricians - Powerline Construction	Powderperson	$45.39	5A	4A	
Island	Electronic Technicians	Journey Level	$44.78	7E	1D	
Island	Elevator Constructors	Mechanic	$77.70	7D	4A	
Island	Elevator Constructors	Mechanic In Charge	$84.24	7D	4A	
Island	Fabricated Precast Concrete Products	Journey Level - In-Factory Work Only	$13.50		1	
Island	Fence Erectors	Fence Erector	$13.80		1	
Island	Fence Erectors	Fence Laborer	$11.60		1	
Island	Flaggers	Journey Level	$35.34	7A	2Y	
Island	Glaziers	Journey Level	$53.76	7L	1Y	
Island	Heat & Frost Insulators And Asbestos Workers	Journeyman	$58.93	5J	1S	
Island	Heating Equipment Mechanics	Journey Level	$41.36		1	
Island	Hod Carriers & Mason Tenders	Journey Level	$42.99	7A	2Y	
Island	Industrial Power Vacuum Cleaner	Journey Level	$9.24		1	
Island	Inland Boatmen	Boat Operator	$52.51	5B	1K	
Island	Inland Boatmen	Cook	$48.89	5B	1K	
Island	Inland Boatmen	Deckhand	$49.13	5B	1K	
Island	Inland Boatmen	Deckhand Engineer	$50.12	5B	1K	
Island	Inland Boatmen	Launch Operator	$51.34	5B	1K	
Island	Inland Boatmen	Mate	$51.34	5B	1K	
Island	Inspection/Cleaning/Sealing Of Sewer & Water Systems By Remote Control	Cleaner Operator, Foamer Operator	$9.73		1	
Island	Inspection/Cleaning/Sealing Of Sewer & Water Systems By Remote Control	Grout Truck Operator	$11.48		1	
Island	Inspection/Cleaning/Sealing Of Sewer & Water Systems By Remote Control	Head Operator	$12.78		1	
Island	Inspection/Cleaning/Sealing Of Sewer & Water Systems By Remote Control	Technician	$9.19		1	
Island	Inspection/Cleaning/Sealing Of Sewer & Water Systems By Remote Control	Tv Truck Operator	$10.53		1	
Island	Insulation Applicators	Journey Level	$50.82	5D	1M	
Island	Ironworkers	Journeyman	$59.77	7N	1O	
Island	Laborers	Air, Gas Or Electric Vibrating Screed	$41.69	7A	2Y	
Island	Laborers	Airtrac Drill Operator	$42.99	7A	2Y	

Island	Laborers	Ballast Regular Machine	$41.69	7A	2Y	
Island	Laborers	Batch Weighman	$35.34	7A	2Y	
Island	Laborers	Brick Pavers	$41.69	7A	2Y	
Island	Laborers	Brush Cutter	$41.69	7A	2Y	
Island	Laborers	Brush Hog Feeder	$41.69	7A	2Y	
Island	Laborers	Burner	$41.69	7A	2Y	
Island	Laborers	Caisson Worker	$42.99	7A	2Y	
Island	Laborers	Carpenter Tender	$41.69	7A	2Y	
Island	Laborers	Caulker	$41.69	7A	2Y	
Island	Laborers	Cement Dumper-paving	$42.46	7A	2Y	
Island	Laborers	Cement Finisher Tender	$41.69	7A	2Y	
Island	Laborers	Change House Or Dry Shack	$41.69	7A	2Y	
Island	Laborers	Chipping Gun (under 30 Lbs.)	$41.69	7A	2Y	
Island	Laborers	Chipping Gun(30 Lbs. And Over)	$42.46	7A	2Y	
Island	Laborers	Choker Setter	$41.69	7A	2Y	
Island	Laborers	Chuck Tender	$41.69	7A	2Y	
Island	Laborers	Clary Power Spreader	$42.46	7A	2Y	
Island	Laborers	Clean-up Laborer	$41.69	7A	2Y	
Island	Laborers	Concrete Dumper/chute Operator	$42.46	7A	2Y	
Island	Laborers	Concrete Form Stripper	$41.69	7A	2Y	
Island	Laborers	Concrete Placement Crew	$42.46	7A	2Y	
Island	Laborers	Concrete Saw Operator/core Driller	$42.46	7A	2Y	
Island	Laborers	Crusher Feeder	$35.34	7A	2Y	
Island	Laborers	Curing Laborer	$41.69	7A	2Y	
Island	Laborers	Demolition: Wrecking & Moving (incl. Charred Material)	$41.69	7A	2Y	
Island	Laborers	Ditch Digger	$41.69	7A	2Y	
Island	Laborers	Diver	$42.99	7A	2Y	
Island	Laborers	Drill Operator (hydraulic,diamond)	$42.46	7A	2Y	
Island	Laborers	Dry Stack Walls	$41.69	7A	2Y	
Island	Laborers	Dump Person	$41.69	7A	2Y	
Island	Laborers	Epoxy Technician	$41.69	7A	2Y	
Island	Laborers	Erosion Control Worker	$41.69	7A	2Y	
Island	Laborers	Faller & Bucker Chain Saw	$42.46	7A	2Y	
Island	Laborers	Fine Graders	$41.69	7A	2Y	
Island	Laborers	Firewatch	$35.34	7A	2Y	
Island	Laborers	Form Setter	$41.69	7A	2Y	
Island	Laborers	Gabian Basket Builders	$41.69	7A	2Y	
Island	Laborers	General Laborer	$41.69	7A	2Y	
Island	Laborers	Grade Checker & Transit Person	$42.99	7A	2Y	
Island	Laborers	Grinders	$41.69	7A	2Y	
Island	Laborers	Grout Machine Tender	$41.69	7A	2Y	
Island	Laborers	Groutmen (pressure)including Post Tension Beams	$42.46	7A	2Y	
Island	Laborers	Guardrail Erector	$41.69	7A	2Y	
Island	Laborers	Hazardous Waste Worker (level A)	$42.99	7A	2Y	
Island	Laborers	Hazardous Waste Worker (level B)	$42.46	7A	2Y	
Island	Laborers	Hazardous Waste Worker (level C)	$41.69	7A	2Y	
Island	Laborers	High Scaler	$42.99	7A	2Y	

Island	Laborers	Jackhammer	$42.46	7A	2Y	
Island	Laborers	Laserbeam Operator	$42.46	7A	2Y	
Island	Laborers	Maintenance Person	$41.69	7A	2Y	
Island	Laborers	Manhole Builder-mudman	$42.46	7A	2Y	
Island	Laborers	Material Yard Person	$41.69	7A	2Y	
Island	Laborers	Motorman-dinky Locomotive	$42.46	7A	2Y	
Island	Laborers	Nozzleman (concrete Pump, Green Cutter When Using Combination Of High Pressure Air & Water On Concrete & Rock, Sandblast, Gunite, Shotcrete, Water Bla	$42.46	7A	2Y	
Island	Laborers	Pavement Breaker	$42.46	7A	2Y	
Island	Laborers	Pilot Car	$35.34	7A	2Y	
Island	Laborers	Pipe Layer Lead	$42.99	7A	2Y	
Island	Laborers	Pipe Layer/tailor	$42.46	7A	2Y	
Island	Laborers	Pipe Pot Tender	$42.46	7A	2Y	
Island	Laborers	Pipe Reliner	$42.46	7A	2Y	
Island	Laborers	Pipe Wrapper	$42.46	7A	2Y	
Island	Laborers	Pot Tender	$41.69	7A	2Y	
Island	Laborers	Powderman	$42.99	7A	2Y	
Island	Laborers	Powderman's Helper	$41.69	7A	2Y	
Island	Laborers	Power Jacks	$42.46	7A	2Y	
Island	Laborers	Railroad Spike Puller - Power	$42.46	7A	2Y	
Island	Laborers	Raker - Asphalt	$42.99	7A	2Y	
Island	Laborers	Re-timberman	$42.99	7A	2Y	
Island	Laborers	Remote Equipment Operator	$42.46	7A	2Y	
Island	Laborers	Rigger/signal Person	$42.46	7A	2Y	
Island	Laborers	Rip Rap Person	$41.69	7A	2Y	
Island	Laborers	Rivet Buster	$42.46	7A	2Y	
Island	Laborers	Rodder	$42.46	7A	2Y	
Island	Laborers	Scaffold Erector	$41.69	7A	2Y	
Island	Laborers	Scale Person	$41.69	7A	2Y	
Island	Laborers	Sloper (over 20")	$42.46	7A	2Y	
Island	Laborers	Sloper Sprayer	$41.69	7A	2Y	
Island	Laborers	Spreader (concrete)	$42.46	7A	2Y	
Island	Laborers	Stake Hopper	$41.69	7A	2Y	
Island	Laborers	Stock Piler	$41.69	7A	2Y	
Island	Laborers	Tamper & Similar Electric, Air & Gas Operated Tools	$42.46	7A	2Y	
Island	Laborers	Tamper (multiple & Self-propelled)	$42.46	7A	2Y	
Island	Laborers	Timber Person - Sewer (lagger, Shorer & Cribber)	$42.46	7A	2Y	
Island	Laborers	Toolroom Person (at Jobsite)	$41.69	7A	2Y	
Island	Laborers	Topper	$41.69	7A	2Y	
Island	Laborers	Track Laborer	$41.69	7A	2Y	
Island	Laborers	Track Liner (power)	$42.46	7A	2Y	
Island	Laborers	Traffic Control Laborer	$37.79	7A	2Y	8R
Island	Laborers	Traffic Control Supervisor	$37.79	7A	2Y	8R
Island	Laborers	Truck Spotter	$41.69	7A	2Y	
Island	Laborers	Tugger Operator	$42.46	7A	2Y	

Island	Laborers	Tunnel Work-Compressed Air Worker 0-30 psi	$60.06	7A	2Y	8Q
Island	Laborers	Tunnel Work-Compressed Air Worker 30.01-44.00 psi	$65.09	7A	2Y	8Q
Island	Laborers	Tunnel Work-Compressed Air Worker 44.01-54.00 psi	$68.77	7A	2Y	8Q
Island	Laborers	Tunnel Work-Compressed Air Worker 54.01-60.00 psi	$74.47	7A	2Y	8Q
Island	Laborers	Tunnel Work-Compressed Air Worker 60.01-64.00 psi	$76.59	7A	2Y	8Q
Island	Laborers	Tunnel Work-Compressed Air Worker 64.01-68.00 psi	$81.69	7A	2Y	8Q
Island	Laborers	Tunnel Work-Compressed Air Worker 68.01-70.00 psi	$83.59	7A	2Y	8Q
Island	Laborers	Tunnel Work-Compressed Air Worker 70.01-72.00 psi	$85.59	7A	1H	8Q
Island	Laborers	Tunnel Work-Compressed Air Worker 72.01-74.00 psi	$87.59	7A	1H	8Q
Island	Laborers	Tunnel Work-Guage and Lock Tender	$43.09	7A	2Y	8Q
Island	Laborers	Tunnel Work-Miner	$43.09	7A	2Y	8Q
Island	Laborers	Vibrator	$42.46	7A	2Y	
Island	Laborers	Vinyl Seamer	$41.69	7A	2Y	
Island	Laborers	Watchman	$32.12	7A	2Y	
Island	Laborers	Welder	$42.46	7A	2Y	
Island	Laborers	Well Point Laborer	$42.46	7A	2Y	
Island	Laborers	Window Washer/cleaner	$32.12	7A	2Y	
Island	Laborers - Underground Sewer & Water	General Laborer & Topman	$41.69	7A	2Y	
Island	Laborers - Underground Sewer & Water	Pipe Layer	$42.46	7A	2Y	
Island	Landscape Construction	Irrigation Or Lawn Sprinkler Installers	$17.31		1	
Island	Landscape Construction	Landscape Equipment Operators Or Truck Drivers	$23.76		1	
Island	Landscape Construction	Landscaping Or Planting Laborers	$16.60		1	
Island	Lathers	Journey Level	$50.82	5D	1H	
Island	Marble Setters	Journey Level	$50.12	5A	1M	
Island	Metal Fabrication (In Shop)	Fitter	$15.16		1	
Island	Metal Fabrication (In Shop)	Laborer	$11.13		1	
Island	Metal Fabrication (In Shop)	Machine Operator	$10.66		1	
Island	Metal Fabrication (In Shop)	Painter	$11.41		1	
Island	Metal Fabrication (In Shop)	Welder	$15.16		1	
Island	Millwright	Journey Level	$51.92	5D	1M	
Island	Modular Buildings	Journey Level	$9.19		1	
Island	Painters	Journey Level	$31.91		1	
Island	Pile Driver	Journey Level	$51.07	5D	1M	
Island	Plasterers	Journey Level	$49.29	7Q	1R	
Island	Playground & Park Equipment Installers	Journey Level	$9.19		1	
Island	Plumbers & Pipefitters	Journey Level	$50.50		1	
Island	Power Equipment Operators	Asphalt Plant Operators	$53.49	7A	3C	8P
Island	Power Equipment Operators	Assistant Engineer	$50.22	7A	3C	8P
Island	Power Equipment Operators	Barrier Machine (zipper)	$53.00	7A	3C	8P

Island	Power Equipment Operators	Batch Plant Operator, Concrete	$53.00	7A	3C	8P
Island	Power Equipment Operators	Bobcat	$50.22	7A	3C	8P
Island	Power Equipment Operators	Brokk - Remote Demolition Equipment	$50.22	7A	3C	8P
Island	Power Equipment Operators	Brooms	$50.22	7A	3C	8P
Island	Power Equipment Operators	Bump Cutter	$53.00	7A	3C	8P
Island	Power Equipment Operators	Cableways	$53.49	7A	3C	8P
Island	Power Equipment Operators	Chipper	$53.00	7A	3C	8P
Island	Power Equipment Operators	Compressor	$50.22	7A	3C	8P
Island	Power Equipment Operators	Concrete Pump: Truck Mount With Boom Attachment Over 42 M	$53.49	7A	3C	8P
Island	Power Equipment Operators	Concrete Finish Machine -laser Screed	$50.22	7A	3C	8P
Island	Power Equipment Operators	Concrete Pump - Mounted Or Trailer High Pressure Line Pump, Pump High Pressure.	$52.58	7A	3C	8P
Island	Power Equipment Operators	Concrete Pump: Truck Mount With Boom Attachment Up To 42m	$53.00	7A	3C	8P
Island	Power Equipment Operators	Conveyors	$52.58	7A	3C	8P
Island	Power Equipment Operators	Cranes: 20 Tons Through 44 Tons With Attachments	$53.00	7A	3C	8P
Island	Power Equipment Operators	Cranes: 100 Tons Through 199 Tons, Or 150' Of Boom (Including Jib With Attachments)	$54.04	7A	3C	8P
Island	Power Equipment Operators	Cranes: 200 Tons To 300 Tons, Or 250' Of Boom (including Jib With Attachments)	$54.61	7A	3C	8P
Island	Power Equipment Operators	Cranes: 45 Tons Through 99 Tons, Under 150' Of Boom (including Jib With Attachments)	$53.49	7A	3C	8P
Island	Power Equipment Operators	Cranes: A-frame - 10 Tons And Under	$50.22	7A	3C	8P
Island	Power Equipment Operators	Cranes: Friction 100 Tons Through 199 Tons	$54.61	7A	3C	8P
Island	Power Equipment Operators	Cranes: Friction Over 200 Tons	$55.17	7A	3C	8P
Island	Power Equipment Operators	Cranes: Over 300 Tons Or 300' Of Boom (including Jib With Attachments)	$55.17	7A	3C	8P
Island	Power Equipment Operators	Cranes: Through 19 Tons With Attachments A-frame Over 10 Tons	$52.58	7A	3C	8P
Island	Power Equipment Operators	Crusher	$53.00	7A	3C	8P
Island	Power Equipment Operators	Deck Engineer/deck Winches (power)	$53.00	7A	3C	8P
Island	Power Equipment Operators	Derricks, On Building Work	$53.49	7A	3C	8P
Island	Power Equipment Operators	Dozers D-9 & Under	$52.58	7A	3C	8P
Island	Power Equipment Operators	Drill Oilers: Auger Type, Truck Or Crane Mount	$52.58	7A	3C	8P
Island	Power Equipment Operators	Drilling Machine	$53.00	7A	3C	8P
Island	Power Equipment Operators	Elevator And Man-lift: Permanent And Shaft Type	$50.22	7A	3C	8P
Island	Power Equipment Operators	Finishing Machine, Bidwell And Gamaco & Similar Equipment	$53.00	7A	3C	8P
Island	Power Equipment Operators	Forklift: 3000 Lbs And Over With Attachments	$52.58	7A	3C	8P
Island	Power Equipment Operators	Forklifts: Under 3000 Lbs. With Attachments	$50.22	7A	3C	8P

Island	Power Equipment Operators	Grade Engineer: Using Blue Prints, Cut Sheets, Etc	$53.00	7A	3C	8P
Island	Power Equipment Operators	Gradechecker/stakeman	$50.22	7A	3C	8P
Island	Power Equipment Operators	Guardrail Punch	$53.00	7A	3C	8P
Island	Power Equipment Operators	Hard Tail End Dump Articulating Off-Road Equipment 45 Yards. & Over	$53.49	7A	3C	8P
Island	Power Equipment Operators	Hard Tail End Dump Articulating Off-road Equipment Under 45 Yards	$53.00	7A	3C	8P
Island	Power Equipment Operators	Horizontal/directional Drill Locator	$52.58	7A	3C	8P
Island	Power Equipment Operators	Horizontal/directional Drill Operator	$53.00	7A	3C	8P
Island	Power Equipment Operators	Hydralifts/boom Trucks Over 10 Tons	$52.58	7A	3C	8P
Island	Power Equipment Operators	Hydralifts/boom Trucks, 10 Tons And Under	$50.22	7A	3C	8P
Island	Power Equipment Operators	Loader, Overhead 8 Yards. & Over	$54.04	7A	3C	8P
Island	Power Equipment Operators	Loader, Overhead, 6 Yards. But Not Including 8 Yards	$53.49	7A	3C	8P
Island	Power Equipment Operators	Loaders, Overhead Under 6 Yards	$53.00	7A	3C	8P
Island	Power Equipment Operators	Loaders, Plant Feed	$53.00	7A	3C	8P
Island	Power Equipment Operators	Loaders: Elevating Type Belt	$52.58	7A	3C	8P
Island	Power Equipment Operators	Locomotives, All	$53.00	7A	3C	8P
Island	Power Equipment Operators	Material Transfer Device	$53.00	7A	3C	8P
Island	Power Equipment Operators	Mechanics, All (leadmen - $0.50 Per Hour Over Mechanic)	$54.04	7A	3C	8P
Island	Power Equipment Operators	Motor Patrol Grader - Non-finishing	$52.58	7A	3C	8P
Island	Power Equipment Operators	Motor Patrol Graders, Finishing	$53.49	7A	3C	8P
Island	Power Equipment Operators	Mucking Machine, Mole, Tunnel Drill, Boring, Road Header And/or Shield	$53.49	7A	3C	8P
Island	Power Equipment Operators	Oil Distributors, Blower Distribution & Mulch Seeding Operator	$50.22	7A	3C	8P
Island	Power Equipment Operators	Outside Hoists (elevators And Manlifts), Air Tuggers,strato	$52.58	7A	3C	8P
Island	Power Equipment Operators	Overhead, Bridge Type Crane: 20 Tons Through 44 Tons	$53.00	7A	3C	8P
Island	Power Equipment Operators	Overhead, Bridge Type: 100 Tons And Over	$54.04	7A	3C	8P
Island	Power Equipment Operators	Overhead, Bridge Type: 45 Tons Through 99 Tons	$53.49	7A	3C	8P
Island	Power Equipment Operators	Pavement Breaker	$50.22	7A	3C	8P
Island	Power Equipment Operators	Pile Driver (other Than Crane Mount)	$53.00	7A	3C	8P
Island	Power Equipment Operators	Plant Oiler - Asphalt, Crusher	$52.58	7A	3C	8P
Island	Power Equipment Operators	Posthole Digger, Mechanical	$50.22	7A	3C	8P
Island	Power Equipment Operators	Power Plant	$50.22	7A	3C	8P
Island	Power Equipment Operators	Pumps - Water	$50.22	7A	3C	8P
Island	Power Equipment Operators	Quad 9, Hd 41, D10 And Over	$53.49	7A	3C	8P
Island	Power Equipment Operators	Quick Tower - No Cab, Under 100 Feet In Height Based To Boom	$50.22	7A	3C	8P
Island	Power Equipment Operators	Remote Control Operator On Rubber Tired Earth Moving Equipment	$53.49	7A	3C	8P
Island	Power Equipment Operators	Rigger And Bellman	$50.22	7A	3C	8P
Island	Power Equipment Operators	Rollagon	$53.49	7A	3C	8P
Island	Power Equipment Operators	Roller, Other Than Plant Mix	$50.22	7A	3C	8P
Island	Power Equipment Operators	Roller, Plant Mix Or Multi-lift	$52.58	7A	3C	8P

		Materials				
Island	Power Equipment Operators	Roto-mill, Roto-grinder	$53.00	7A	3C	8P
Island	Power Equipment Operators	Saws - Concrete	$52.58	7A	3C	8P
Island	Power Equipment Operators	Scraper, Self Propelled Under 45 Yards	$53.00	7A	3C	8P
Island	Power Equipment Operators	Scrapers - Concrete & Carry All	$52.58	7A	3C	8P
Island	Power Equipment Operators	Scrapers, Self-propelled: 45 Yards And Over	$53.49	7A	3C	8P
Island	Power Equipment Operators	Service Engineers - Equipment	$52.58	7A	3C	8P
Island	Power Equipment Operators	Shotcrete/gunite Equipment	$50.22	7A	3C	8P
Island	Power Equipment Operators	Shovel , Excavator, Backhoe, Tractors Under 15 Metric Tons.	$52.58	7A	3C	8P
Island	Power Equipment Operators	Shovel, Excavator, Backhoe: Over 30 Metric Tons To 50 Metric Tons	$53.49	7A	3C	8P
Island	Power Equipment Operators	Shovel, Excavator, Backhoes, Tractors: 15 To 30 Metric Tons	$53.00	7A	3C	8P
Island	Power Equipment Operators	Shovel, Excavator, Backhoes: Over 50 Metric Tons To 90 Metric Tons	$54.04	7A	3C	8P
Island	Power Equipment Operators	Shovel, Excavator, Backhoes: Over 90 Metric Tons	$54.61	7A	3C	8P
Island	Power Equipment Operators	Slipform Pavers	$53.49	7A	3C	8P
Island	Power Equipment Operators	Spreader, Topsider & Screedman	$53.49	7A	3C	8P
Island	Power Equipment Operators	Subgrader Trimmer	$53.00	7A	3C	8P
Island	Power Equipment Operators	Tower Bucket Elevators	$52.58	7A	3C	8P
Island	Power Equipment Operators	Tower Crane Over 175'in Height, Base To Boom	$54.61	7A	3C	8P
Island	Power Equipment Operators	Tower Crane Up To 175' In Height Base To Boom	$54.04	7A	3C	8P
Island	Power Equipment Operators	Transporters, All Track Or Truck Type	$53.49	7A	3C	8P
Island	Power Equipment Operators	Trenching Machines	$52.58	7A	3C	8P
Island	Power Equipment Operators	Truck Crane Oiler/driver - 100 Tons And Over	$53.00	7A	3C	8P
Island	Power Equipment Operators	Truck Crane Oiler/driver Under 100 Tons	$52.58	7A	3C	8P
Island	Power Equipment Operators	Truck Mount Portable Conveyor	$53.00	7A	3C	8P
Island	Power Equipment Operators	Welder	$53.49	7A	3C	8P
Island	Power Equipment Operators	Wheel Tractors, Farmall Type	$50.22	7A	3C	8P
Island	Power Equipment Operators	Yo Yo Pay Dozer	$53.00	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Asphalt Plant Operators	$53.49	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Assistant Engineer	$50.22	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Barrier Machine (zipper)	$53.00	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Batch Plant Operator, Concrete	$53.00	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Bobcat	$50.22	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Brokk - Remote Demolition Equipment	$50.22	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Brooms	$50.22	7A	3C	8P
Island	Power Equipment Operators-	Bump Cutter	$53.00	7A	3C	8P

	Underground Sewer & Water					
Island	Power Equipment Operators-Underground Sewer & Water	Cableways	$53.49	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Chipper	$53.00	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Compressor	$50.22	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Concrete Pump: Truck Mount With Boom Attachment Over 42 M	$53.49	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Concrete Finish Machine -laser Screed	$50.22	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Concrete Pump - Mounted Or Trailer High Pressure Line Pump, Pump High Pressure.	$52.58	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Concrete Pump: Truck Mount With Boom Attachment Up To 42m	$53.00	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Conveyors	$52.58	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Cranes: 20 Tons Through 44 Tons With Attachments	$53.00	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Cranes: 100 Tons Through 199 Tons, Or 150' Of Boom (Including Jib With Attachments)	$54.04	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Cranes: 200 Tons To 300 Tons, Or 250' Of Boom (including Jib With Attachments)	$54.61	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Cranes: 45 Tons Through 99 Tons, Under 150' Of Boom (including Jib With Attachments)	$53.49	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Cranes: A-frame - 10 Tons And Under	$50.22	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Cranes: Friction 100 Tons Through 199 Tons	$54.61	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Cranes: Friction Over 200 Tons	$55.17	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Cranes: Over 300 Tons Or 300' Of Boom (including Jib With Attachments)	$55.17	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Cranes: Through 19 Tons With Attachments A-frame Over 10 Tons	$52.58	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Crusher	$53.00	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Deck Engineer/deck Winches (power)	$53.00	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Derricks, On Building Work	$53.49	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Dozers D-9 & Under	$52.58	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Drill Oilers: Auger Type, Truck Or Crane Mount	$52.58	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Drilling Machine	$53.00	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Elevator And Man-lift: Permanent And Shaft Type	$50.22	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Finishing Machine, Bidwell And Gamaco & Similar Equipment	$53.00	7A	3C	8P

Island	Power Equipment Operators-Underground Sewer & Water	Forklift: 3000 Lbs And Over With Attachments	$52.58	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Forklifts: Under 3000 Lbs. With Attachments	$50.22	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Grade Engineer: Using Blue Prints, Cut Sheets, Etc	$53.00	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Gradechecker/stakeman	$50.22	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Guardrail Punch	$53.00	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Hard Tail End Dump Articulating Off-Road Equipment 45 Yards. & Over	$53.49	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Hard Tail End Dump Articulating Off-road Equipment Under 45 Yards	$53.00	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Horizontal/directional Drill Locator	$52.58	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Horizontal/directional Drill Operator	$53.00	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Hydralifts/boom Trucks Over 10 Tons	$52.58	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Hydralifts/boom Trucks, 10 Tons And Under	$50.22	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Loader, Overhead 8 Yards. & Over	$54.04	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Loader, Overhead, 6 Yards. But Not Including 8 Yards	$53.49	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Loaders, Overhead Under 6 Yards	$53.00	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Loaders, Plant Feed	$53.00	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Loaders: Elevating Type Belt	$52.58	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Locomotives, All	$53.00	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Material Transfer Device	$53.00	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Mechanics, All (leadmen - $0.50 Per Hour Over Mechanic)	$54.04	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Motor Patrol Grader - Non-finishing	$52.58	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Motor Patrol Graders, Finishing	$53.49	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Mucking Machine, Mole, Tunnel Drill, Boring, Road Header And/or Shield	$53.49	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Oil Distributors, Blower Distribution & Mulch Seeding Operator	$50.22	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Outside Hoists (elevators And Manlifts), Air Tuggers,strato	$52.58	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Overhead, Bridge Type Crane: 20 Tons Through 44 Tons	$53.00	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Overhead, Bridge Type: 100 Tons And Over	$54.04	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Overhead, Bridge Type: 45 Tons Through 99 Tons	$53.49	7A	3C	8P
Island	Power Equipment Operators-	Pavement Breaker	$50.22	7A	3C	8P

	Underground Sewer & Water					
Island	Power Equipment Operators-Underground Sewer & Water	Pile Driver (other Than Crane Mount)	$53.00	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Plant Oiler - Asphalt, Crusher	$52.58	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Posthole Digger, Mechanical	$50.22	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Power Plant	$50.22	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Pumps - Water	$50.22	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Quad 9, Hd 41, D10 And Over	$53.49	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Quick Tower - No Cab, Under 100 Feet In Height Based To Boom	$50.22	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Remote Control Operator On Rubber Tired Earth Moving Equipment	$53.49	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Rigger And Bellman	$50.22	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Rollagon	$53.49	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Roller, Other Than Plant Mix	$50.22	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Roller, Plant Mix Or Multi-lift Materials	$52.58	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Roto-mill, Roto-grinder	$53.00	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Saws - Concrete	$52.58	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Scraper, Self Propelled Under 45 Yards	$53.00	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Scrapers - Concrete & Carry All	$52.58	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Scrapers, Self-propelled: 45 Yards And Over	$53.49	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Service Engineers - Equipment	$52.58	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Shotcrete/gunite Equipment	$50.22	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Shovel , Excavator, Backhoe, Tractors Under 15 Metric Tons.	$52.58	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Shovel, Excavator, Backhoe: Over 30 Metric Tons To 50 Metric Tons	$53.49	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Shovel, Excavator, Backhoes, Tractors: 15 To 30 Metric Tons	$53.00	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Shovel, Excavator, Backhoes: Over 50 Metric Tons To 90 Metric Tons	$54.04	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Shovel, Excavator, Backhoes: Over 90 Metric Tons	$54.61	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Slipform Pavers	$53.49	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Spreader, Topsider & Screedman	$53.49	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Subgrader Trimmer	$53.00	7A	3C	8P

Island	Power Equipment Operators-Underground Sewer & Water	Tower Bucket Elevators	$52.58	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Tower Crane Over 175'in Height, Base To Boom	$54.61	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Tower Crane Up To 175' In Height Base To Boom	$54.04	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Transporters, All Track Or Truck Type	$53.49	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Trenching Machines	$52.58	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Truck Crane Oiler/driver - 100 Tons And Over	$53.00	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Truck Crane Oiler/driver Under 100 Tons	$52.58	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Truck Mount Portable Conveyor	$53.00	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Welder	$53.49	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Wheel Tractors, Farmall Type	$50.22	7A	3C	8P
Island	Power Equipment Operators-Underground Sewer & Water	Yo Yo Pay Dozer	$53.00	7A	3C	8P
Island	Power Line Clearance Tree Trimmers	Journey Level In Charge	$43.76	5A	4A	
Island	Power Line Clearance Tree Trimmers	Spray Person	$41.51	5A	4A	
Island	Power Line Clearance Tree Trimmers	Tree Equipment Operator	$43.76	5A	4A	
Island	Power Line Clearance Tree Trimmers	Tree Trimmer	$39.10	5A	4A	
Island	Power Line Clearance Tree Trimmers	Tree Trimmer Groundperson	$29.44	5A	4A	
Island	Refrigeration & Air Conditioning Mechanics	Mechanic	$61.57	5A	1G	
Island	Residential Brick Mason	Journey Level	$50.12	5A	1M	
Island	Residential Carpenters	Journey Level	$39.62	5D	1M	
Island	Residential Cement Masons	Journey Level	$11.00		1	
Island	Residential Drywall Applicators	Journey Level	$39.62	5D	1M	
Island	Residential Drywall Tapers	Journey Level	$25.00		1	
Island	Residential Electricians	Journey Level	$25.76		1	
Island	Residential Glaziers	Journey Level	$35.10	7L	1H	
Island	Residential Insulation Applicators	Journey Level	$13.96		1	
Island	Residential Laborers	Journey Level	$12.70		1	
Island	Residential Marble Setters	Journey Level	$50.12	5A	1M	
Island	Residential Painters	Journey Level	$13.00		1	
Island	Residential Plumbers & Pipefitters	Journey Level	$38.71		1	
Island	Residential Refrigeration & Air Conditioning Mechanics	Journey Level	$36.44	5A	1G	
Island	Residential Sheet Metal Workers	Journey Level (Field or Shop)	$21.30		1	
Island	Residential Soft Floor Layers	Journey Level	$42.15	5A	3D	
Island	Residential Sprinkler Fitters (Fire Protection)	Journey Level	$31.09		1	
Island	Residential Stone Masons	Journey Level	$50.12	5A	1M	
Island	Residential Terrazzo Workers	Journey Level	$20.00		1	
Island	Residential Terrazzo/Tile Finishers	Journey Level	$15.82		1	
Island	Residential Tile Setters	Journey Level	$20.00		1	
Island	Roofers	Journey Level	$44.21	5A	1R	

Island	Roofers	Using Irritable Bituminous Materials	$47.21	5A	1R	
Island	Sheet Metal Workers	Journey Level (Field or Shop)	$56.69	7F	1E	
Island	Shipbuilding & Ship Repair	Carpenter	$15.53		1	
Island	Shipbuilding & Ship Repair	Electrician	$15.53		1	
Island	Shipbuilding & Ship Repair	Heat & Frost Insulator	$58.93	5J	1S	
Island	Shipbuilding & Ship Repair	Laborer	$9.19		1	
Island	Shipbuilding & Ship Repair	Operator	$15.53		1	
Island	Shipbuilding & Ship Repair	Painter	$15.53		1	
Island	Shipbuilding & Ship Repair	Pipefitter	$15.53		1	
Island	Shipbuilding & Ship Repair	Sheet Metal	$9.50		1	
Island	Shipbuilding & Ship Repair	Shipfitter	$15.53		1	
Island	Shipbuilding & Ship Repair	Welder/burner	$15.53		1	
Island	Sign Makers & Installers (Electrical)	Journey Level	$16.03		1	
Island	Sign Makers & Installers (Non-Electrical)	Journey Level	$26.55		1	
Island	Soft Floor Layers	Journey Level	$42.15	5A	3D	
Island	Solar Controls For Windows	Journey Level	$9.19		1	
Island	Sprinkler Fitters (Fire Protection)	Journey Level	$69.59	5C	1X	
Island	Stage Rigging Mechanics (Non Structural)	Journey Level	$13.23		1	
Island	Stone Masons	Journey Level	$50.12	5A	1M	
Island	Street And Parking Lot Sweeper Workers	Journey Level	$15.00		1	
Island	Surveyors	Assistant Construction Site Surveyor	$52.58	7A	3C	8P
Island	Surveyors	Chainman	$52.06	7A	3C	8P
Island	Surveyors	Construction Site Surveyor	$53.49	7A	3C	8P
Island	Telecommunication Technicians	Journey Level	$24.75		1	
Island	Telephone Line Construction - Outside	Cable Splicer	$36.01	5A	2B	
Island	Telephone Line Construction - Outside	Hole Digger/Ground Person	$20.05	5A	2B	
Island	Telephone Line Construction - Outside	Installer (Repairer)	$34.50	5A	2B	
Island	Telephone Line Construction - Outside	Special Aparatus Installer I	$36.01	5A	2B	
Island	Telephone Line Construction - Outside	Special Apparatus Installer II	$35.27	5A	2B	
Island	Telephone Line Construction - Outside	Telephone Equipment Operator (Heavy)	$36.01	5A	2B	
Island	Telephone Line Construction - Outside	Telephone Equipment Operator (Light)	$33.47	5A	2B	
Island	Telephone Line Construction - Outside	Telephone Lineperson	$33.47	5A	2B	
Island	Telephone Line Construction - Outside	Television Groundperson	$19.04	5A	2B	
Island	Telephone Line Construction - Outside	Television Lineperson/Installer	$25.27	5A	2B	
Island	Telephone Line Construction - Outside	Television System Technician	$30.20	5A	2B	
Island	Telephone Line Construction - Outside	Television Technician	$27.09	5A	2B	
Island	Telephone Line Construction -	Tree Trimmer	$33.47	5A	2B	

	Outside					
Island	Terrazzo Workers	Journey Level	$46.96	5A	1M	
Island	Tile Setters	Journey Level	$46.96	5A	1M	
Island	Tile, Marble & Terrazzo Finishers	Journey Level	$25.00		1	
Island	Traffic Control Stripers	Journey Level	$33.85		1	
Island	Truck Drivers	Asphalt Mix Over 16 Yards (W. WA-Joint Council 28)	$47.91	5D	3A	8L
Island	Truck Drivers	Asphalt Mix To 16 Yards (W. WA-Joint Council 28)	$47.07	5D	3A	8L
Island	Truck Drivers	Dump Truck	$22.62		1	
Island	Truck Drivers	Dump Truck And Trailer	$22.62		1	
Island	Truck Drivers	Other Trucks (W. WA-Joint Council 28)	$47.91	5D	3A	8L
Island	Truck Drivers	Transit Mixer	$34.63		1	
Island	Well Drillers & Irrigation Pump Installers	Irrigation Pump Installer	$11.60		1	
Island	Well Drillers & Irrigation Pump Installers	Oiler	$9.45		1	
Island	Well Drillers & Irrigation Pump Installers	Well Driller	$11.60		1	

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Overtime Codes

Overtime calculations are based on the hourly rate actually paid to the worker. On public works projects, the hourly rate must be not less than the prevailing rate of wage minus the hourly rate of the cost of fringe benefits actually provided for the worker.

1. ALL HOURS WORKED IN EXCESS OF EIGHT (8) HOURS PER DAY OR FORTY (40) HOURS PER WEEK SHALL BE PAID AT ONE AND ONE-HALF TIMES THE HOURLY RATE OF WAGE.

B. All hours worked on Saturdays shall be paid at one and one-half times the hourly rate of wage. All hours worked on Sundays and holidays shall be paid at double the hourly rate of wage.

C. The first two (2) hours after eight (8) regular hours Monday through Friday and the first ten (10) hours on Saturday shall be paid at one and one-half times the hourly rate of wage. All other overtime hours and all hours worked on Sundays and holidays shall be paid at double the hourly rate of wage.

D. The first two (2) hours before or after a five-eight (8) hour workweek day or a four-ten (10) hour workweek day and the first eight (8) hours worked the next day after either workweek shall be paid at one and one-half times the hourly rate of wage. All additional hours worked and all worked on Sundays and holidays shall be paid at double the hourly rate of wage.

E. The first two (2) hours after eight (8) regular hours Monday through Friday and the first eight (8) hours on Saturday shall be paid at one and one-half times the hourly rate of wage. All other hours worked Monday through Saturday, and all hours worked on Sundays and holidays shall be paid at double the hourly rate of wage.

F. The first two (2) hours after eight (8) regular hours Monday through Friday and the first ten (10) hours on Saturday shall be paid at one and one-half times the hourly rate of wage. All other overtime hours worked, except Labor Day, shall be paid at double the hourly rate of wage. All hours worked on Labor Day shall be paid at three times the hourly rate of wage.

G. The first ten (10) hours worked on Saturdays and the first ten (10) hours worked on a fifth calendar weekday in a four-ten hour schedule, shall be paid at one and one-half times the hourly rate of wage. All hours worked in excess of ten (10) hours per day Monday through Saturday and all hours worked on Sundays and holidays shall be paid at double the hourly rate of wage.

H. All hours worked on Saturdays (except makeup days if work is lost due to inclement weather conditions or equipment breakdown) shall be paid at one and one-half times the hourly rate of wage. All hours worked Monday through Saturday over twelve (12) hours and all hours worked on Sundays and holidays shall be paid at double the hourly rate of wage.

I. All hours worked on Sundays and holidays shall also be paid at double the hourly rate of wage.

J. The first two (2) hours after eight (8) regular hours Monday through Friday and the first ten (10) hours on Saturday shall be paid at one and one-half times the hourly rate of wage. All hours worked over ten (10) hours Monday through Saturday, Sundays and holidays shall be paid at double the hourly rate of wage.

K. All hours worked on Saturdays and Sundays shall be paid at one and one-half times the hourly rate of wage. All hours worked on holidays shall be paid at double the hourly rate of wage.

M. All hours worked on Saturdays (except makeup days if work is lost due to inclement weather conditions) shall be paid at one and one-half times the hourly rate of wage. All hours worked on Sundays and holidays shall be paid at double the hourly rate of wage.

1. N. All hours worked on Saturdays (except makeup days) shall be paid at one and one-half times the hourly rate of wage. All hours worked on Sundays and holidays shall be paid at double the hourly rate of wage.

   O. The first ten (10) hours worked on Saturday shall be paid at one and one-half times the hourly rate of wage. All hours worked on Sundays, holidays and after twelve (12) hours, Monday through Friday and after ten (10) hours on Saturday shall be paid at double the hourly rate of wage.

   P. All hours worked on Saturdays (except makeup days if circumstances warrant) and Sundays shall be paid at one and one-half times the hourly rate of wage. All hours worked on holidays shall be paid at double the hourly rate of wage.

   Q. The first two (2) hours after eight (8) regular hours Monday through Friday and up to ten (10) hours worked on Saturdays shall be paid at one and one-half times the hourly rate of wage. All hours worked in excess of ten (10) hours per day Monday through Saturday and all hours worked on Sundays and holidays (except Christmas day) shall be paid at double the hourly rate of wage. All hours worked on Christmas day shall be paid at two and one-half times the hourly rate of wage.

   R. All hours worked on Sundays and holidays shall be paid at two times the hourly rate of wage.

   S. The first two (2) hours after eight (8) regular hours Monday through Friday and the first eight (8) hours on Saturday shall be paid at one and one-half times the hourly rate of wage. All hours worked on holidays and all other overtime hours worked, except Labor Day, shall be paid at double the hourly rate of wage. All hours worked on Labor Day shall be paid at three times the hourly rate of wage.

   U. All hours worked on Saturdays shall be paid at one and one-half times the hourly rate of wage. All hours worked on Sundays and holidays (except Labor Day) shall be paid at two times the hourly rate of wage. All hours worked on Labor Day shall be paid at three times the hourly rate of wage.

   V. All hours worked on Sundays and holidays (except Thanksgiving Day and Christmas day) shall be paid at one and one-half times the hourly rate of wage. All hours worked on Thanksgiving Day and Christmas day shall be paid at double the hourly rate of wage.

   W. All hours worked on Saturdays and Sundays (except make-up days due to conditions beyond the control of the employer)) shall be paid at one and one-half times the hourly rate of wage. All hours worked on holidays shall be paid at double the hourly rate of wage.

   X. The first four (4) hours after eight (8) regular hours Monday through Friday and the first twelve (12) hours on Saturday shall be paid at one and one-half times the hourly rate of wage. All hours worked over twelve (12) hours Monday through Saturday, Sundays and holidays shall be paid at double the hourly rate of wage. When holiday falls on Saturday or Sunday, the day before Saturday, Friday, and the day after Sunday, Monday, shall be considered the holiday and all work performed shall be paid at double the hourly rate of wage.

   Y. All hours worked outside the hours of 5:00 am and 5:00 pm (or such other hours as may be agreed upon by any employer and the employee) and all hours worked in excess of eight (8) hours per day (10 hours per day for a 4 x 10 workweek) and on Saturdays and holidays (except labor day) shall be paid at one and one-half times the hourly rate of wage. (except for employees who are absent from work without prior approval on a scheduled workday during the workweek shall be paid at the straight-time rate until they have worked 8 hours in a day (10 in a 4 x 10 workweek) or 40 hours during that workweek.) All hours worked Monday through Saturday over twelve (12) hours and all hours worked on Sundays and Labor Day shall be paid at double the hourly rate of wage.

   Z. All hours worked on Saturdays and Sundays shall be paid at one and one-half times the hourly rate of wage. All hours worked on holidays shall be paid the straight time rate of pay in addition to holiday pay.

2 ALL HOURS WORKED IN EXCESS OF EIGHT (8) HOURS PER DAY OR FORTY (40) HOURS PER WEEK SHALL BE PAID AT ONE AND ONE-HALF TIMES THE HOURLY RATE OF WAGE.

B. All hours worked on holidays shall be paid at one and one-half times the hourly rate of wage.

C. All hours worked on Sundays shall be paid at one and one-half times the hourly rate of wage. All hours worked on holidays shall be paid at two times the hourly rate of wage.

F. The first eight (8) hours worked on holidays shall be paid at the straight hourly rate of wage in addition to the holiday pay. All hours worked in excess of eight (8) hours on holidays shall be paid at double the hourly rate of wage.

G. All hours worked on Sunday shall be paid at two times the hourly rate of wage. All hours worked on paid holidays shall be paid at two and one-half times the hourly rate of wage including holiday pay.

H. All hours worked on Sunday shall be paid at two times the hourly rate of wage. All hours worked on holidays shall be paid at one and one-half times the hourly rate of wage.

K. All hours worked on holidays shall be paid at two times the hourly rate of wage in addition to the holiday pay.

O. All hours worked on Sundays and holidays shall be paid at one and one-half times the hourly rate of wage.

R. All hours worked on Sundays and holidays and all hours worked over sixty (60) in one week shall be paid at double the hourly rate of wage.

U. All hours worked on Saturdays shall be paid at one and one-half times the hourly rate of wage. All hours worked over 12 hours in a day or on Sundays and holidays shall be paid at double the hourly rate of wage.

W. The first two (2) hours after eight (8) regular hours Monday through Friday and the first eight (8) hours on Saturday shall be paid at one and one-half times the hourly rate of wage. All other hours worked Monday through Saturday, and all hours worked on Sundays and holidays shall be paid at double the hourly rate of wage. On a four-day, ten-hour weekly schedule, either Monday thru Thursday or Tuesday thru Friday schedule, all hours worked after ten shall be paid at double the hourly rate of wage. The first eight (8) hours worked on the fifth day shall be paid at one and one-half times the hourly rate of wage. All other hours worked on the fifth, sixth, and seventh days and on holidays shall be paid at double the hourly rate of wage.

Y. All hours worked on Saturdays (except for make-up days) shall be paid at one and one-half times the hourly rate of wage. All hours worked Monday through Saturday over twelve (12) hours and all hours worked on Sundays and holidays shall be paid at double the hourly rate of wage.

3. ALL HOURS WORKED IN EXCESS OF EIGHT (8) HOURS PER DAY OR FORTY (40) HOURS PER WEEK SHALL BE PAID AT ONE AND ONE-HALF TIMES THE HOURLY RATE OF WAGE.

A. Work performed in excess of eight (8) hours of straight time per day, or ten (10) hours of straight time per day when four ten (10) hour shifts are established, or forty (40) hours of straight time per week, Monday through Friday, or outside the normal shift, and all work on Saturdays shall be paid at time and one-half the straight time rate. Hours worked over twelve hours (12) in a single shift and all work performed after 6:00 pm Saturday to 6:00 am Monday and holidays shall be paid at double the straight time rate of pay. Any shift starting between the hours of 6:00 pm and midnight shall receive an additional one dollar ($1.00) per hour for all hours worked that shift. The employer shall have the sole discretion to assign overtime work to employees. Primary consideration for overtime work shall be given to employees regularly assigned to the work to be performed on overtime situations. After an employee has worked eight (8) hours at an applicable overtime rate, all additional hours shall be at the applicable overtime rate until such time as the employee has had a break of eight (8) hours or more.

3. B. The first four (4) hours after eight (8) regular hours Monday through Friday and the first twelve (12) hours on Saturday shall be paid at one and one-half times the hourly rate of wage. All hours worked over twelve (12) hours Monday through Saturday, and all hours worked on Sundays and holidays shall be paid at double the hourly rate of wage.

C. Work performed in excess of eight (8) hours of straight time per day, or ten (10) hours of straight time per day when four ten (10) hour shifts are established, or forty (40) hours of straight time per week, Monday through Friday, or outside the normal shift, and all work on Saturdays shall be paid at one and one-half times the hourly rate of wage. All work performed after 6:00 pm Saturday to 5:00 am Monday and Holidays shall be paid at double the hourly rate of wage. After an employee has worked eight (8) hours at an applicable overtime rate, all additional hours shall be at the applicable overtime rate until such time as the employee has had a break of eight (8) hours or more.

D. All hours worked between the hours of 6:00 pm and 6:00 am, Monday through Saturday, shall be paid at a premium rate of 15% over the hourly rate of wage. All other hours worked after 6:00 am on Saturdays, shall be paid at one and one-half times the hourly rate of wage. All hours worked on Sundays and holidays shall be paid at double the hourly rate of wage.

E. All hours worked Sundays and holidays shall be paid at double the hourly rate of wage. Each week, once 40 hours of straight time work is achieved, then any hours worked over 10 hours per day Monday through Saturday shall be paid at double the hourly wage rate.

F. All hours worked on Saturday shall be paid at one and one-half times the hourly rate of wage. All hours worked on Sunday shall be paid at two times the hourly rate of wage. All hours worked on paid holidays shall be paid at two and one-half times the hourly rate of wage including holiday pay.

G. Work performed in excess of eight (8) hours of straight time per day, or ten (10) hours of straight time per day when four ten (10) hour shifts are established, or forty (40) hours of straight time per week, Monday through Friday, , and all work on Saturdays shall be paid at time and one-half the straight time rate. Hours worked over twelve hours (12) in a single shift and all work performed after 8:00 am Sunday to 8:00 am Monday and Holidays shall be paid at double the straight time rate of pay. After an employee has worked eight (8) hours at an applicable overtime rate, all additional hours shall be at the applicable overtime rate until such time as the employee has had a break of eight (8) hours or more.

4. ALL HOURS WORKED IN EXCESS OF EIGHT (8) HOURS PER DAY OR FORTY (40) HOURS PER WEEK SHALL BE PAID AT ONE AND ONE-HALF TIMES THE HOURLY RATE OF WAGE.

A. All hours worked in excess of eight (8) hours per day or forty (40) hours per week shall be paid at double the hourly rate of wage. All hours worked on Saturdays, Sundays and holidays shall be paid at double the hourly rate of wage.

Holiday Codes

5. A. Holidays: New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, Friday after Thanksgiving Day, and Christmas Day (7).

B. Holidays: New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, Friday after Thanksgiving Day, the day before Christmas, and Christmas Day (8).

C. Holidays: New Year's Day, Presidents' Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, the Friday after Thanksgiving Day, And Christmas Day (8).

D. Holidays: New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, the Friday and Saturday after Thanksgiving Day, And Christmas Day (8).

H. Holidays: New Year's Day, Memorial Day, Independence Day, Thanksgiving Day, the Day after Thanksgiving Day, And Christmas (6).

5. I. Holidays: New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, and Christmas Day (6).

J. Holidays: New Year's Day, Memorial Day, Independence Day, Thanksgiving Day, Friday after Thanksgiving Day, Christmas Eve Day, And Christmas Day (7).

K. Holidays: New Year's Day, Presidents' Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, Friday After Thanksgiving Day, The Day Before Christmas, And Christmas Day (9).

L. Holidays: New Year's Day, Martin Luther King Jr. Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, Friday After Thanksgiving Day, And Christmas Day (8).

N. Holidays: New Year's Day, Presidents' Day, Memorial Day, Independence Day, Labor Day, Veterans' Day, Thanksgiving Day, The Friday After Thanksgiving Day, And Christmas Day (9).

P. Holidays: New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, Friday And Saturday After Thanksgiving Day, The Day Before Christmas, And Christmas Day (9). If A Holiday Falls On Sunday, The Following Monday Shall Be Considered As A Holiday.

Q. Paid Holidays: New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, and Christmas Day (6).

R. Paid Holidays: New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, Day After Thanksgiving Day, One-Half Day Before Christmas Day, And Christmas Day. (7 1/2).

S. Paid Holidays: New Year's Day, Presidents' Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, And Christmas Day (7).

T. Paid Holidays: New Year's Day, Washington's Birthday, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, The Friday After Thanksgiving Day, Christmas Day, And The Day Before Or After Christmas (9).

Z. Holidays: New Year's Day, Memorial Day, Independence Day, Labor Day, Veterans Day, Thanksgiving Day, the Friday after Thanksgiving Day, And Christmas Day (8).

Holiday Codes Continued

6. A. Paid Holidays: New Year's Day, Presidents' Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, The Friday After Thanksgiving Day, And Christmas Day (8).

E. Paid Holidays: New Year's Day, Day Before Or After New Year's Day, Presidents Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, Day After Thanksgiving Day, Christmas Day, And A Half-Day On Christmas Eve Day. (9 1/2).

G. Paid Holidays: New Year's Day, Martin Luther King Jr. Day, Presidents' Day, Memorial Day, Independence Day, Labor Day, Veterans' Day, Thanksgiving Day, The Friday After Thanksgiving Day, Christmas Day, And Christmas Eve Day (11).

H. Paid Holidays: New Year's Day, New Year's Eve Day, Memorial Day, Independence Day, Labor Day,

Thanksgiving Day, Friday After Thanksgiving Day, Christmas Day, The Day After Christmas, And A Floating Holiday (10).

I. Paid Holidays: New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, Friday After Thanksgiving Day, And Christmas Day (7).

6. T. Paid Holidays: New Year's Day, Presidents' Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, The Friday After Thanksgiving Day, The Last Working Day Before Christmas Day, And Christmas Day (9).

Z. Holidays: New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, Friday after Thanksgiving Day, And Christmas Day (7). If a holiday falls on Saturday, the preceding Friday shall be considered as the holiday. If a holiday falls on Sunday, the following Monday shall be considered as the holiday.

Holiday Codes Continued

7. A. Holidays: New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, The Friday And Saturday After Thanksgiving Day, And Christmas Day (8). Any Holiday Which Falls On A Sunday Shall Be Observed As A Holiday On The Following Monday. If any of the listed holidays falls on a Saturday, the preceding Friday shall be a regular work day.

B. Holidays: New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, the Friday and Saturday after Thanksgiving Day, And Christmas Day (8). Any holiday which falls on a Sunday shall be observed as a holiday on the following Monday. Any holiday which falls on a Saturday shall be observed as a holiday on the preceding Friday.

C. Holidays: New Year's Day, Martin Luther King Jr. Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, The Friday After Thanksgiving Day, And Christmas Day (8). Any holiday which falls on a Sunday shall be observed as a holiday on the following Monday. Any holiday which falls on a Saturday shall be observed as a holiday on the preceding Friday.

D. Paid Holidays: New Year's Day, Memorial Day, Independence Day, Labor Day, Veteran's Day, Thanksgiving Day, the Friday after Thanksgiving Day, And Christmas Day (8). Unpaid Holidays: President's Day. Any paid holiday which falls on a Sunday shall be observed as a holiday on the following Monday. Any paid holiday which falls on a Saturday shall be observed as a holiday on the preceding Friday.

E. Holidays: New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, the Friday after Thanksgiving Day, And Christmas Day (7). Any holiday which falls on a Sunday shall be observed as a holiday on the following Monday. Any holiday which falls on a Saturday shall be observed as a holiday on the preceding Friday.

F. Holidays: New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, the Friday after Thanksgiving Day, the last working day before Christmas day and Christmas day (8). Any holiday which falls on a Sunday shall be observed as a holiday on the following Monday. Any holiday which falls on a Saturday shall be observed as a holiday on the preceding Friday.

G. Holidays: New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, and Christmas Day (6). Any holiday which falls on a Sunday shall be observed as a holiday on the following Monday.

H. Holidays: New Year's Day, Martin Luther King Jr. Day, Independence Day, Memorial Day, Labor Day, Thanksgiving Day, the Friday after Thanksgiving Day, the Last Working Day before Christmas Day and Christmas Day (9). Any holiday which falls on a Sunday shall be observed as a holiday on the following Monday. Any holiday which falls on a Saturday shall be observed as a holiday on the preceding Friday.

I. Holidays: New Year's Day, President's Day, Independence Day, Memorial Day, Labor Day, Thanksgiving Day, The Friday After Thanksgiving Day, The Day Before Christmas Day And Christmas Day (9). Any holiday which falls on a Sunday shall be observed as a holiday on the following Monday. Any holiday which falls on a Saturday shall be observed as a holiday on the preceding Friday.

7. J. Holidays: New Year's Day, Independence Day, Memorial Day, Labor Day, Thanksgiving Day and Christmas Day (6). Any holiday which falls on a Sunday shall be observed as a holiday on the following Monday. Any holiday which falls on a Saturday shall be observed as a holiday on the preceding Friday.

K. Holidays: New Year's Day, Memorial Day, Independence Day, Thanksgiving Day, the Friday and Saturday after Thanksgiving Day, And Christmas Day (8). Any holiday which falls on a Sunday shall be observed as a holiday on the following Monday. Any holiday which falls on a Saturday shall be observed as a holiday on the preceding Friday.

L. Holidays: New Year's Day, Memorial Day, Labor Day, Independence Day, Thanksgiving Day, the Last Work Day before Christmas Day, And Christmas Day (7). Any holiday which falls on a Sunday shall be observed as a holiday on the following Monday. Any holiday which falls on a Saturday shall be observed as a holiday on the preceding Friday.

M. Paid Holidays: New Year's Day, The Day after or before New Year's Day, President's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, the Friday after Thanksgiving Day, Christmas Day, And the Day after or before Christmas Day. 10). Any holiday which falls on a Sunday shall be observed as a holiday on the following Monday. Any holiday which falls on a Saturday shall be observed as a holiday on the preceding Friday.

N. Holidays: New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, the Friday after Thanksgiving Day, And Christmas Day (7). Any holiday which falls on a Sunday shall be observed as a holiday on the following Monday. When Christmas falls on a Saturday, the preceding Friday shall be observed as a holiday.

O. Paid Holidays: New Year's Day, The Day After Or Before New Year's Day, President's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, The Friday After Thanksgiving Day, Christmas Day, The Day After Or Before Christmas Day, And The Employees Birthday. 11). Any holiday which falls on a Sunday shall be observed as a holiday on the following Monday. Any holiday which falls on a Saturday shall be observed as a holiday on the preceding Friday.

P. Holidays: New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, Friday after Thanksgiving Day, And Christmas Day (7). Any holiday which falls on a Sunday shall be observed as a holiday on the following Monday.

Q. Holidays: New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, the Friday after Thanksgiving Day, the Last Working Day before Christmas Day and Christmas Day (8). Any holiday which falls on a Sunday shall be observed as a holiday on the following Monday. If any of the listed holidays falls on a Saturday, the preceding Friday shall be a regular work day.

R. Paid Holidays: New Year's Day, the day after or before New Year's Day, President's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, the Friday after Thanksgiving Day, Christmas Day, and the day after or before Christmas Day (10). If any of the listed holidays fall on Saturday, the preceding Friday shall be observed as the holiday. If any of the listed holidays falls on a Sunday, the day observed by the Nation shall be considered a holiday and compensated accordingly.

S. Paid Holidays: New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, Friday After Thanksgiving Day, Christmas Day, The Day After Christmas, And A Floating Holiday (9). If any of the listed holidays falls on a Sunday, the day observed by the Nation shall be considered a holiday and compensated accordingly.

Note Codes

8. A. In addition to the hourly wage and fringe benefits, the following depth premiums apply to depths of fifty feet or more:

Over 50’ To 100' -$2.00 per Foot for Each Foot Over 50 Feet
Over 100' To 150' -$3.00 per Foot for Each Foot Over 100 Feet
Over 150' To 220' -$4.00 per Foot for Each Foot Over 150 Feet
Over 220' -$5.00 per Foot for Each Foot Over 220 Feet

8 C. In addition to the hourly wage and fringe benefits, the following depth premiums apply to depths of fifty feet or more:
Over 50’ To 100' -$1.00 per Foot for Each Foot Over 50 Feet
Over 100' To 150' -$1.50 per Foot for Each Foot Over 100 Feet
Over 150' To 200' -$2.00 per Foot for Each Foot Over 150 Feet
Over 200' -Divers May Name Their Own Price

D. Workers working with supplied air on hazmat projects receive an additional $1.00 per hour.

L. Workers on hazmat projects receive additional hourly premiums as follows -Level A: $0.75, Level B: $0.50, And Level C: $0.25.

M. Workers on hazmat projects receive additional hourly premiums as follows: Levels A & B: $1.00, Levels C & D: $0.50.

N. Workers on hazmat projects receive additional hourly premiums as follows -Level A: $1.00, Level B: $0.75, Level C: $0.50, And Level D: $0.25.

P. Workers on hazmat projects receive additional hourly premiums as follows -Class A Suit: $2.00, Class B Suit: $1.50, Class C Suit: $1.00, And Class D Suit $0.50.

Q. The highest pressure registered on the gauge for an accumulated time of more than fifteen (15) minutes during the shift shall be used in determining the scale paid.

R. Effective August 31, 2012 – A Traffic Control Supervisor shall be present on the project whenever flagging or spotting or other traffic control labor is being utilized. A Traffic Control Laborer performs the setup, maintenance and removal of all temporary traffic control devices and construction signs necessary to control vehicular, bicycle, and pedestrian traffic during construction operations. Flaggers and Spotters shall be posted where shown on approved Traffic Control Plans or where directed by the Engineer. All flaggers and spotters shall possess a current flagging card issued by the State of Washington, Oregon, Montana, or Idaho. These classifications are only effective on or after August 31, 2012.

S. Effective August 31, 2012 – A Traffic Control Supervisor shall be present on the project whenever flagging or spotting or other traffic control labor is being utilized. Flaggers and Spotters shall be posted where shown on approved Traffic Control Plans or where directed by the Engineer. All flaggers and spotters shall possess a current flagging card issued by the State of Washington, Oregon, Montana, or Idaho. This classification is only effective on or after August 31, 2012.

T. Effective August 31, 2012 – A Traffic Control Laborer performs the setup, maintenance and removal of all temporary traffic control devices and construction signs necessary to control vehicular, bicycle, and pedestrian traffic during construction operations. Flaggers and Spotters shall be posted where shown on approved Traffic Control Plans or where directed by the Engineer. All flaggers and spotters shall possess a current flagging card issued by the State of Washington, Oregon, Montana, or Idaho. This classification is only effective on or after August 31, 2012.

EXHIBIT D2

DAVIS BACON WAGES

General Decision Number: WA130053 11/08/2013 WA53

Superseded General Decision Number: WA20120053

State: Washington

Construction Type: Building

County: Island County in Washington.

BUILDING CONSTRUCTION PROJECTS (does not include single family homes or apartments up to and including 4 stories).

Modification Number	Publication Date
0	01/04/2013
1	01/11/2013
2	01/18/2013
3	01/25/2013
4	02/01/2013
5	02/15/2013
6	02/22/2013
7	03/08/2013
8	03/22/2013
9	04/12/2013
10	06/07/2013
11	06/21/2013
12	07/05/2013
13	07/12/2013
14	07/26/2013
15	08/02/2013
16	08/23/2013
17	08/30/2013
18	09/06/2013
19	09/27/2013
20	11/01/2013
21	11/08/2013

ASBE0007-003 06/01/2013

	Rates	Fringes
ASBESTOS WORKER/HEAT & FROST INSULATOR (Pipe Insulation)	$ 42.46	16.35

BRWA0001-013 06/01/2013

	Rates	Fringes
TILE FINISHER	$ 24.50	13.29
TILE SETTER	$ 33.26	13.70

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* BRWA0001-014 06/01/2013

	Rates	Fringes
BRICKLAYER	$ 35.60	14.52

CARP0770-023 07/01/2013

	Rates	Fringes
CARPENTER (Acoustical Ceiling Installation)	$ 37.20	13.08
CARPENTER (Including Formwork and Drywall Hanging)	$ 37.20	13.08
MILLWRIGHT	$ 38.30	13.08

(HOURLY ZONE PAY: WESTERN AND CENTRAL WASHINGTON - ALL CLASSIFICATIONS EXCEPT MILLWRIGHTS AND PILEDRIVERS

Hourly Zone Pay shall be paid on jobs located outside of the free zone computed from the city center of the following listed cities:

Seattle	Olympia	Bellingham
Auburn	Bremerton	Anacortes
Renton	Shelton	Yakima
Aberdeen-Hoquiam	Tacoma	Wenatchee
Ellensburg	Everett	Port Angeles
Centralia	Mount Vernon	Sunnyside
Chelan	Pt. Townsend	

Zone Pay:

0 -25 radius miles	Free
26-35 radius miles	$1.00/hour
36-45 radius miles	$1.15/hour
46-55 radius miles	$1.35/hour
Over 55 radius miles	$1.55/hour

(HOURLY ZONE PAY: WESTERN AND CENTRAL WASHINGTON - MILLWRIGHT AND PILEDRIVER ONLY)

Hourly Zone Pay shall be computed from Seattle Union Hall, Tacoma City center, and Everett City center

Zone Pay:

0 -25 radius miles	Free
26-45 radius miles	$ .70/hour
Over 45 radius miles	$1.50/hour

ELEC0191-013 06/01/2013

	Rates	Fringes
ELECTRICIAN	$ 39.01	17.39

ENGI0302-023 06/01/2013

	Rates	Fringes
Power equipment operators:		
Group 1A	$ 37.39	16.65

Group 1AA	$ 37.96	16.65
Group 1AAA	$ 38.52	16.65
Group 1	$ 36.84	16.65
Group 2	$ 36.35	16.65
Group 3	$ 35.93	16.65
Group 4	$ 33.57	16.65

POWER EQUIPMENT OPERATORS CLASSIFICATIONS

GROUP 1AAA - Cranes-over 300 tons, or 300 ft of boom (including jib with attachments)

GROUP 1AA - Cranes 200 to 300 tons, or 250 ft of boom (including jib with attachments); Excavator/Trackhoe, Backhoes: Over 90 metric tons

GROUP 1A - Cranes, 100 tons thru 199 tons, or 150 ft of boom (including jib with attachments); Loaders-overhead, 8 yards and over; excavator/Trackhoe, backhoes: over 50 metric tons to 90 metric tons

GROUP 1 - Cranes 45 tons thru 99 tons, under 150 ft of boom (including jib with attachments); Excavator/Trackhoe, backhoes: over 30 metric tons to 50 metric tons; Loader-overhead 6 yards to, but not including 8 yards; Dozer D-10

GROUP 2 - Cranes, 20 tons thru 44 tons with attachments; Excavator/Trackhoe, backhoe: 15 to 30 metric tons; Loaders-overhead under 6 yards; Mechanic

GROUP 3 - Cranes-thru 19 tons with attachments; Dozers-D-9 and under; Roller-Plant Mix; Excavator/Trackhoe, backhoe: under 15 metric tons; Forklift: 3000 lbs and over with attachments

GROUP 4 - Roller-other than plant mix; Forklift: under 3000 lbs with attachments

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IRON0086-011 07/01/2013

	Rates	Fringes
IRONWORKER (Reinforcing, Structural and Ornamental)	$ 38.14	21.35

LABO0001-018 06/01/2013

	Rates	Fringes
Laborers:		
GROUP 3	$ 31.76	9.85
GROUP 4	$ 32.53	9.85
GROUP 5	$ 33.06	9.85

ZONE DIFFERENTIAL (ADD TO ZONE 1 RATES):
ZONE 2 - $1.00

ZONE 3 - $1.30

BASE POINTS: BELLINGHAM, MT. VERNON, EVERETT, SEATTLE, KENT, TACOMA, OLYMPIA, CENTRALIA, ABERDEEN, SHELTON, PT. TOWNSEND, PT. ANGELES, AND BREMERTON

ZONE 1 - Projects within 25 radius miles of the respective city hall
ZONE 2 - More than 25 but less than 45 radius miles from the respective city hall
ZONE 3 - More than 45 radius miles from the respective city hall

LABORERS CLASSIFICATIONS

GROUP 3: Mason Tender-Cement/Concrete

GROUP 4: Grade Checker; Pipe Layer

GROUP 5: Mason Tender-Brick

PAIN0005-029 07/01/2012

	Rates	Fringes
DRYWALL FINISHER/TAPER	$ 34.18	15.31

PAIN0005-037 07/01/2013

	Rates	Fringes
PAINTER (Brush and Roller, Excludes Spray and Drywall Finishing/Taping)	$ 28.15	10.39

PAIN0188-005 07/01/2013

	Rates	Fringes
GLAZIER	$ 38.75	14.90

PAIN1238-002 07/01/2013

	Rates	Fringes
SOFT FLOOR LAYER (Including Vinyl and Carpet)	$ 28.00	13.87

PLAS0528-004 06/01/2013

	Rates	Fringes
CEMENT MASON/CONCRETE FINISHER	$ 36.63	14.55

PLUM0026-014 01/01/2013

	Rates	Fringes
PIPEFITTER	$ 41.12	20.40

ROOF0054-010 06/01/2013

	Rates	Fringes
ROOFER (Includes Roof Tear Off, Waterproofing, and Installation of Metal Roofs)	$ 31.57	12.62

SFWA0699-006 07/01/2013

	Rates	Fringes
SPRINKLER FITTER (Fire Sprinklers)	$ 45.87	22.72

SHEE0066-032 06/01/2011

	Rates	Fringes
SHEETMETAL WORKER (HVAC Duct Work Only)	$ 35.13	16.45

SUWA2002-008 06/18/2009

	Rates	Fringes
LABORER: Common or General	$ 17.75	4.23
OPERATOR: Bobcat/Skid Steer/Skid Loader	$ 27.94	0.00
PAINTER: Spray	$ 17.80	4.18
PLUMBER	$ 35.00	0.00
SHEET METAL WORKER, Excludes HVAC Duct Installation	$ 24.83	0.00
TRUCK DRIVER: Dump Truck	$ 23.50	6.87

WELDERS - Receive rate prescribed for craft performing operation to which welding is incidental.

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Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clauses (29CFR 5.5 (a) (1) (ii)).

The body of each wage determination lists the classification and wage rates that have been found to be prevailing for the cited type(s) of construction in the area covered by the wage determination. The classifications are listed in alphabetical order of "identifiers" that indicate whether the particular rate is union or non-union.

Union Identifiers

An identifier enclosed in dotted lines beginning with characters other than "SU" denotes that the union classification and rate have found to be prevailing for that classification. Example: PLUM0198-005 07/01/2011. The first four letters , PLUM, indicate the international union and the four-digit number, 0198, that follows indicates the local union number or district council number where applicable , i.e., Plumbers Local 0198. The next number, 005 in the example, is an internal number used in processing the wage determination. The date, 07/01/2011, following these characters is the effective date of the most current negotiated rate/collective bargaining agreement which would be July 1, 2011 in the above example.

Union prevailing wage rates will be updated to reflect any changes in the collective bargaining agreements governing the rates.

0000/9999: weighted union wage rates will be published annually each January.

Non-Union Identifiers

Classifications listed under an "SU" identifier were derived from survey data by computing average rates and are not union rates; however, the data used in computing these rates may include both union and non-union data. Example: SULA2004-007 5/13/2010. SU indicates the rates are not union majority rates, LA indicates the State of Louisiana; 2004 is the year of the survey; and 007 is an internal number used in producing the wage determination. A 1993 or later date, 5/13/2010, indicates the classifications and rates under that identifier were issued as a General Wage Determination on that date.

Survey wage rates will remain in effect and will not change until a new survey is conducted.

WAGE DETERMINATION APPEALS PROCESS

1.) Has there been an initial decision in the matter? This can be:

* an existing published wage determination
* a survey underlying a wage determination
* a Wage and Hour Division letter setting forth a position on a wage determination matter
* a conformance (additional classification and rate) ruling

On survey related matters, initial contact, including requests for summaries of surveys, should be with the Wage and Hour Regional Office for the area in which the survey was conducted because those Regional Offices have responsibility for the Davis-Bacon survey program. If the response from this initial contact is not satisfactory, then the process described in 2.) and 3.) should be followed.

With regard to any other matter not yet ripe for the formal process described here, initial contact should be with the Branch of Construction Wage Determinations. Write to:

Branch of Construction Wage Determinations
Wage and Hour Division
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

2.) If the answer to the question in 1.) is yes, then an interested party (those affected by the action) can request review and reconsideration from the Wage and Hour Administrator (See 29 CFR Part 1.8 and 29 CFR Part 7). Write to:

Wage and Hour Administrator
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

The request should be accompanied by a full statement of the interested party's position and by any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

3.) If the decision of the Administrator is not favorable, an interested party may appeal directly to the Administrative Review Board (formerly the Wage Appeals Board). Write to:

Administrative Review Board
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

4.) All decisions by the Administrative Review Board are final.

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END OF GENERAL DECISION

General Decision Number: WA130072 11/01/2013 WA72

Superseded General Decision Number: WA20120072

State: Washington

Construction Type: Heavy
including water and sewer line construction

County: Island County in Washington.

HEAVY CONSTRUCTION PROJECTS (including sewer/water construction).

Modification Number	Publication Date
0	01/04/2013
1	01/18/2013
2	02/01/2013
3	02/15/2013
4	02/22/2013
5	03/08/2013
6	06/07/2013
7	06/21/2013
8	07/05/2013
9	07/12/2013
10	08/02/2013
11	08/23/2013
12	08/30/2013
13	09/06/2013
14	11/01/2013

* CARP0770-001 06/01/2013

	Rates	Fringes
CARPENTER	$ 37.20	13.08

(HOURLY ZONE PAY: WESTERN AND CENTRAL WASHINGTON - ALL CLASSIFICATIONS EXCEPT MILLWRIGHTS AND PILEDRIVERS

Hourly Zone Pay shall be paid on jobs located outside of the free zone computed from the city center of the following listed cities:

Seattle	Olympia	Bellingham
Auburn	Bremerton	Anacortes
Renton	Shelton	Yakima
Aberdeen-Hoquiam	Tacoma	Wenatchee
Ellensburg	Everett	Port Angeles
Centralia	Mount Vernon	Sunnyside
Chelan	Pt. Townsend	

Zone Pay:

0 -25 radius miles	Free
26-35 radius miles	$1.00/hour
36-45 radius miles	$1.15/hour

46-55 radius miles $1.35/hour
Over 55 radius miles $1.55/hour

(HOURLY ZONE PAY: WESTERN AND CENTRAL WASHINGTON - MILLWRIGHT AND PILEDRIVER ONLY)

Hourly Zone Pay shall be computed from Seattle Union Hall, Tacoma City center, and Everett City center

Zone Pay:
0 -25 radius miles Free
26-45 radius miles $ .70/hour
Over 45 radius miles $1.50/hour

ELEC0191-013 06/01/2013

	Rates	Fringes
ELECTRICIAN	$ 39.01	17.39

ENGI0302-001 06/01/2013

	Rates	Fringes
Power equipment operators:		
Group 1A	$ 37.39	16.65
Group 1AA	$ 37.96	16.65
Group 1AAA	$ 38.52	16.65
Group 1	$ 36.84	16.65
Group 2	$ 36.35	16.65
Group 3	$ 35.93	16.65
Group 4	$ 33.57	16.65

Zone Differential (Add to Zone 1 rates):
Zone 2 (26-45 radius miles) - $1.00
Zone 3 (Over 45 radius miles) - $1.30

BASEPOINTS: Aberdeen, Bellingham, Bremerton, Everett, Kent, Mount Vernon, Port Angeles, Port Townsend, Seattle, Shelton, Wenatchee, Yakima

POWER EQUIPMENT OPERATORS CLASSIFICATIONS

GROUP 1AAA - Cranes-over 300 tons, or 300 ft of boom (including jib with attachments)

GROUP 1AA - Cranes 200 to 300 tons, or 250 ft of boom (including jib with attachments); Tower crane over 175 ft in height, base to boom; Excavator/Trackhoe, Backhoes: Over 90 metric tons

GROUP 1A - Cranes, 100 tons thru 199 tons, or 150 ft of boom (including jib with attachments); Crane-overhead, bridge type, 100 tons and over; Tower crane up to 175 ft in height base to boom; Loaders-overhead, 8 yards and over; excavator/Trackhoe, backhoes: over 50 metric tons to 90

metric tons

GROUP 1 - Cranes 45 tons thru 99 tons, under 150 ft of boom (including jib with attachments); Crane-overhead, bridge type, 45 tons thru 99 tons; Derricks on building work;; Excavator/Trackhoe, backhoes: over 30 metric tons to 50 metric tons; Loader- overhead 6 yards to, but not including 8 yards; Dozer D-10

GROUP 2 - Cranes, 20 tons thru 44 tons with attachments; Crane-overhead, bridge type-20 tons through 44 tons;; Excavator/Trackhoe, backhoe: 15 to 30 metric tons; Loaders-overhead under 6 yards; Mechanic; Drilling Machine; Grader (finishing)

GROUP 3 - Cranes-thru 19 tons with attachments; A-frame crane over 10 tons;; Dozers-D-9 and under; Roller-Plant Mix; Excavator/Trackhoe, backhoe: under 15 metric tons; Forklift: 3000 lbs and over with attachments; Oiler; Grader (non-finishing);Boom Truck over 10 tons

GROUP 4 - Cranes-A frame-10 tons and under; Roller-other than plant mix; Forklift: under 3000 lbs with attachments; Boom Truck 10 tons and under

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IRON0086-012 07/01/2013

	Rates	Fringes
Ironworker (REINFORCING & STRUCTURAL)	$ 38.14	21.35

LABO0001-001 06/01/2013

ZONE 1:

	Rates	Fringes
Laborers:		
GROUP 2	$ 25.41	9.85
GROUP 3	$ 31.76	9.85
GROUP 4	$ 32.53	9.85
GROUP 5	$ 33.06	9.85

ZONE DIFFERENTIAL (ADD TO ZONE 1 RATES):
ZONE 2 - $1.00
ZONE 3 - $1.30

BASE POINTS: BELLINGHAM, MT. VERNON, EVERETT, SEATTLE, KENT, TACOMA, OLYMPIA, CENTRALIA, ABERDEEN, SHELTON, PT. TOWNSEND, PT. ANGELES, AND BREMERTON

ZONE 1 - Projects within 25 radius miles of the respective city hall
ZONE 2 - More than 25 but less than 45 radius miles from the respective city hall

ZONE 3 - More than 45 radius miles from the respective city hall

LABORERS CLASSIFICATIONS

GROUP 2: Flagger

GROUP 3: General or Common Laborer; Mason Tender-Cement/Concrete; Chipping Guns (Under 30 lbs)

GROUP 4: Grade Checker; Pipe Layer; Chipping Guns (Over 30 lbs); Groutmen

GROUP 5: Mason Tender-Brick

PAIN0005-008 07/01/2013

	Rates	Fringes
PAINTER (Brush, Roller and Spray)	$ 21.69	10.41

PLAS0528-004 06/01/2013

	Rates	Fringes
CEMENT MASON/CONCRETE FINISHER	$ 36.63	14.55

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* TEAM0174-002 06/29/2012

	Rates	Fringes
Truck drivers:		
ZONE A:		
GROUP 1:	$ 31.68	16.23
GROUP 2:	$ 30.84	16.23

ZONE B (25-45 miles from center of listed cities*): Add $.70 per hour to Zone A rates.
ZONE C (over 45 miles from centr of listed cities*): Add $1.00 per hour to Zone A rates.

*Zone pay will be calculated from the city center of the following listed cities:

BELLINGHAM	CENTRALIA	RAYMOND	OLYMPIA
EVERETT	SHELTON	ANACORTES	BELLEVUE
SEATTLE	PORT ANGELES	MT. VERNON	KENT
TACOMA	PORT TOWNSEND	ABERDEEN	BREMERTON

TRUCK DRIVERS CLASSIFICATIONS

GROUP 1 - Dump Trucks, side, end and bottom dump, including semi-trucks and trains or combinations thereof with 16 yards to 30 yards capacity: Over 30 yards $.15 per hour additional for each 10 yard increment.

GROUP 2 - Dump trucks, side, end and bottom dump, including semi-trucks and trains or combinations thereof with less than 16 yards capacity.

HAZMAT PROJECTS

Anyone working on a HAZMAT job, where HAZMAT certification is required, shall be compensated as a premium, in addition to the classification working in as follows:
LEVEL C: +$.25 per hour - This level uses an air purifying respirator or additional protective clothing.
LEVEL B: +$.50 per hour - Uses same respirator protection as Level A. Supplied air line is provided in conjunction with a chemical "splash suit."
LEVEL A: +$.75 per hour - This level utilizes a fully-encapsulated suit with a self-contained breathing apparatus or a supplied air line.

SUWA2009-038 08/07/2009

	Rates	Fringes
LABORER: Landscape	$ 14.67	0.00
PIPEFITTER	$ 30.00	8.35
TRUCK DRIVER: Water Truck	$ 24.36	8.30
TRUCK DRIVER: 10 Yard Truck	$ 24.61	8.34

WELDERS - Receive rate prescribed for craft performing operation to which welding is incidental.

==========

Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clauses (29CFR 5.5 (a) (1) (ii)).

The body of each wage determination lists the classification and wage rates that have been found to be prevailing for the cited type(s) of construction in the area covered by the wage determination. The classifications are listed in alphabetical order of "identifiers" that indicate whether the particular rate is union or non-union.

Union Identifiers

An identifier enclosed in dotted lines beginning with characters other than "SU" denotes that the union classification and rate have found to be prevailing for that classification. Example: PLUM0198-005 07/01/2011. The first four letters , PLUM, indicate the international union and the four-digit number, 0198, that follows indicates the local union number or district council number where applicable , i.e., Plumbers Local 0198. The next number, 005 in the example, is an internal number used in processing the wage determination. The date, 07/01/2011, following these characters is the effective date of the most current negotiated rate/collective bargaining agreement which would be July 1, 2011 in the above example.

Union prevailing wage rates will be updated to reflect any changes in the collective bargaining agreements governing the rates.

0000/9999: weighted union wage rates will be published annually each January.

Non-Union Identifiers

Classifications listed under an "SU" identifier were derived from survey data by computing average rates and are not union rates; however, the data used in computing these rates may include both union and non-union data. Example: SULA2004-007 5/13/2010. SU indicates the rates are not union majority rates, LA indicates the State of Louisiana; 2004 is the year of the survey; and 007 is an internal number used in producing the wage determination. A 1993 or later date, 5/13/2010, indicates the classifications and rates under that identifier were issued as a General Wage Determination on that date.

Survey wage rates will remain in effect and will not change until a new survey is conducted.

WAGE DETERMINATION APPEALS PROCESS

1.) Has there been an initial decision in the matter? This can be:

* an existing published wage determination
* a survey underlying a wage determination
* a Wage and Hour Division letter setting forth a position on a wage determination matter
* a conformance (additional classification and rate) ruling

On survey related matters, initial contact, including requests for summaries of surveys, should be with the Wage and Hour Regional Office for the area in which the survey was conducted

because those Regional Offices have responsibility for the Davis-Bacon survey program. If the response from this initial contact is not satisfactory, then the process described in 2.) and 3.) should be followed.

With regard to any other matter not yet ripe for the formal process described here, initial contact should be with the Branch of Construction Wage Determinations. Write to:

Branch of Construction Wage Determinations
Wage and Hour Division
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

2.) If the answer to the question in 1.) is yes, then an interested party (those affected by the action) can request review and reconsideration from the Wage and Hour Administrator (See 29 CFR Part 1.8 and 29 CFR Part 7). Write to:

Wage and Hour Administrator
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

The request should be accompanied by a full statement of the interested party's position and by any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

3.) If the decision of the Administrator is not favorable, an interested party may appeal directly to the Administrative Review Board (formerly the Wage Appeals Board). Write to:

Administrative Review Board
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

4.) All decisions by the Administrative Review Board are final.

==========

END OF GENERAL DECISION

EXHIBIT E

AGREEMENT BETWEEN
DISTRICT AND CONTRACTOR

THIS **AGREEMENT** is made and entered into on _____, 2014 by and between the **PUBLIC UTILITY DISTRICT NO. 1 OF SNOHOMISH COUNTY**, a State of Washington municipal corporation, hereinafter designated as the "**DISTRICT**," and:

The "**CONTRACTOR**": _____

The "**Project**" is: _____

The "**DISTRICT's representative**" is: _____

The "**CONTRACTOR's representative**" is: _____

BACKGROUND AND REPRESENTATIONS:

The DISTRICT has caused Drawings, Specifications, and other Contract Documents to be prepared for the performance of Work on the Project.

The DISTRICT publicly solicited bids on the Contract Documents. The CONTRACTOR submitted a bid to the DISTRICT on the _____ day of _____, 2014 to perform the Work.

The CONTRACTOR represents that it has the personnel, experience, qualifications, capabilities, and means to accomplish the Work in strict accordance with the Contract Documents, within the Contract Time and for the Contract Price, and that it and its Subcontractors satisfy the responsibility criteria set forth in the Instructions to Bidders and Contract Documents, including any supplemental responsibility criteria.

The CONTRACTOR further represents that it has carefully examined and is fully familiar with all provisions of the Contract Documents, including any Addenda, that it has fully satisfied itself as to the nature, location, difficulty, character, quality, and quantity of the Work required by the Contract Documents and the conditions and other matters that may be encountered at or near the Project site(s), or that may affect performance of the Work or the cost or difficulty thereof including all applicable safety and site responsibilities, and that it understands and can satisfy all scheduling and coordination requirements and interim milestones.

AGREEMENT:

The DISTRICT and the CONTRACTOR agree as follows:

1.0 CONTRACTOR TO FULLY PERFORM THE WORK

The CONTRACTOR shall fully execute and complete the entire Work described in the Contract Documents, except to the extent specifically indicated in the Contract Documents to be the responsibility of others. An enumeration of the Contract Documents, other than amendments and modifications, appears in this Agreement. The Contract Documents describe the terms and conditions under which the CONTRACTOR shall furnish the Work, including equipment, labor, material and appurtenances, together with the time and price for furnishing the Work.

2.0 DATE OF COMMENCEMENT

The date of commencement of the Work, which is the date from which the Contract Time is measured, shall be fixed in a Notice to Proceed issued by the DISTRICT.

3.0 COMPLETION AND LIQUIDATED DAMAGES

The CONTRACTOR shall achieve all interim milestones as set forth in the Contract Documents (see Specifications, Section 01050) and Substantial Completion of the entire Work not later than October 14, 2015, subject to adjustments of this Contract Time as provided in the Contract Documents. The CONTRACTOR shall achieve Final Completion of the Work within sixty (60) days of the date on which Substantial Completion is achieved.

The DISTRICT will incur serious and substantial damages if Substantial Completion of the Work does not occur within the Contract Time; however, it would be difficult if not impossible to determine the amount of such damages, which could include, for example, personnel and consultant costs, transportation costs, governmental fees, storage costs, rental costs, loss of use, and lost opportunities. Consequently, provisions for liquidated damages as a reasonable estimate of future loss, as of the date of this Agreement, are included in the Contract Documents. The parties agree that the stated liquidated damages are not penalties individually or cumulatively.

The DISTRICT will assess, and the CONTRACTOR will be responsible for, liquidated damages in the amounts of (1) $100 per calendar day for the first fifteen (15) days beyond the applicable Contract milestone (April 1, 2015 per Specifications, Section 01050) and $300 per day thereafter that Substantial Completion of the Power Conditioning and Control Building is not timely achieved; (2) $100 per calendar day for the first fifteen (15) days beyond the applicable Contract milestone (May 30, 2015 per Specifications, Section 01050) and $300 per day thereafter that Substantial Completion (including grid connection) of the Power Control and Conditioning Equipment is not timely achieved; (3) $2,500 per day for each calendar day beyond the applicable Contract milestone (tentatively set for August 20, 2015 per Specifications, Section 01050, but subject to change based on the DISTRICT's 40-day notification of readiness) that Substantial Completion (including installation, testing, and acceptance) of the first Trunk Cable is not timely achieved; (4) $2,500 per day for each calendar day beyond the applicable Contract milestone (no later than 28 days following the first Turbine Unit deployment or October 2, 2015, whichever occurs first, per Specifications, Section 01050, subject to change based on the DISTRICT's notification of readiness) that Substantial Completion (including installation, testing, and acceptance) of the second Trunk Cable is not timely achieved; and (5) an additional $1,000 per calendar day for each calendar day in excess of sixty (60) days after the contractual date of Substantial Completion of the overall Project that Final Completion is not attained.

The liquidated damages for each of the above milestones are cumulative and may be independently and concurrently assessed to the extent each milestone and the overall completion dates have not been timely achieved. The DISTRICT's right to liquidated damages is not affected by partial completion, any occupancy, or use.

4.0 CONTRACT PRICE

The DISTRICT shall pay the CONTRACTOR in current funds for the CONTRACTOR's performance of

the Contract the Contract Price of _____ United States dollars ($_____), subject to additions and deductions as provided in the Contract Documents. The Contract Price includes a $400,000 Contingency Account for the DISTRICT's exclusive use as an allowance as set forth in the Contract Documents. The Contract Price also includes a price for Schedule-2 Work, which will only be performed as requested in writing by the DISTRICT. The final Contract Price will be adjusted based on any unused portion of the Contingency Account or Schedule-2 Work not authorized.

State and local sales tax is not included in the Contract Price but will be paid by the DISTRICT with each progress payment. The CONTRACTOR shall pay all other taxes for the Work provided by the CONTRACTOR, including consumer, use, B & O, income, and similar taxes and any sales tax not due on the Contract Price.

5.0 ALTERNATES

The Contract Price is based upon the following Alternates, if any, which are described in the Contract Documents and are hereby accepted by the DISTRICT:

_____.

6.0 PERMITS AND FEES (see Specifications, Section 01550)

The CONTRACTOR shall coordinate and schedule all Work with permitting agencies, utility companies, and other agencies with jurisdictional authority necessary for completion of the Work. The CONTRACTOR shall apply for and secure all permits required for the Project not required by the Contract Documents to be supplied by the DISTRICT. Payment for permits for which the CONTRACTOR is responsible shall be made by the DISTRICT directly or reimbursed by the DISTRICT (out of the Contingency Account or otherwise) at actual cost. No mark-up or other costs shall be added. The CONTRACTOR shall pick up and, after execution of the Contract, coordinate all permits required for the Work. The CONTRACTOR shall be responsible for verifying all permit requirements prior to submitting a bid for the Project.

7.0 ENUMERATION OF CONTRACT DOCUMENTS

The Contract Documents are enumerated as follows, except for amendments or Contract modifications issued after execution of this Agreement:

7.1 This executed Agreement between the DISTRICT and CONTRACTOR, including the attached General Conditions.

7.2 The Special Conditions of the Agreement, including the Project insurance and OCIP requirements.

7.3 The Specifications, including material and system schedules, are as follows:

Section	**Pages**

7.4 The Drawings are as follows:

Section	**Pages**

7.5 The Addenda, if any, are as follows:

Number	**Date**	**Pages**

7.6 Other documents forming part of the Contract Documents include:

See Contract Documents
Department of Labor and Industries Prevailing Wage Rates
Davis-Bacon Wage Rates

8.0 INSURANCE AND BONDS

The CONTRACTOR shall purchase and maintain insurance and provide bonds as set forth in the General Conditions and Special Conditions, and shall comply with all conditions set forth in the Contract Documents and in the OCIP policy and OCIP Manual.

This Agreement is entered into as of the day and year first written above:

CONTRACTOR	**PUBLIC UTILITY DISTRICT NO. 1 OF SNOHOMISH COUNTY**
By: _____	By: _____
Title: _____	Title: _____
Date: _____	Date: _____

EXHIBIT F

AFFIDAVIT

_____, being first duly sworn on oath deposes and says that it is the principal CONTRACTOR under that certain Contract with the PUBLIC UTILITY DISTRICT NO. 1 OF SNOHOMISH COUNTY dated _____, 20 _____, for the performance of _____.

Affiant states that all Subcontractors and materialmen and claims of any nature for Work, services, and material, under said Contract have been paid, and that all taxes pertaining to said Work have been paid. Affiant further states that the purpose of this affidavit is to obtain the release of all remaining funds held by the DISTRICT upon said Contract.

SIGNED this _____ day of_____, 20 ____.

_____
Company Name

_____
By

_____
Title

Subscribed to and sworn before me this _____ day of _____, 20_____.

_____
Notary Public in and for the State
of Washington, residing at

_____.

EXHIBIT G

CONTRACTOR'S RELEASE

P.W.C. No. _____ DATE: _____

TITLE OF WORK: _____

CONTRACTOR: _____

CONTRACTOR for the above mentioned Public Works Contract, hereby certifies that all statements for services rendered to the DISTRICT under said Contract have been submitted, and upon receipt of a payment of
$_____ (including tax), CONTRACTOR acknowledges receipt of payment in full of all sums due on said Contract and further certifies that all claims of the CONTRACTOR against the DISTRICT pursuant to said Contract are fully satisfied and discharged.

It is understood that the retained fund of $ _____, which is included in the sum above mentioned, will be released to the CONTRACTOR in accordance with the laws and regulations of the State of Washington.

_____
CONTRACTOR

By: _____
Authorized Representative

Date: _____

Public Utility District No. 1 of Snohomish County (SnoPUD)

Admiralty Inlet Pilot Tidal Project OCIP

Project Insurance Manual

Marine General Liability and Contractor's Pollution Liability Only Owner Controlled Insurance Program (OCIP)

Edition - December 24, 2013

Contents

1. Introduction....1
- Directory....3
- Definitions....4

2. Overview of the Owner Controlled Insurance Program....6
- 2.1. Purpose....6
- 2.2. Application of OCIP to Contractors/Subcontractors....6
- 2.3. Scope of the OCIP....7
- 2.4. Contractors Not Included Under the OCIP....7
- 2.5. Safety Program....8
- 2.6. Questions about the OCIP....8
- 2.7. OCIP Q&A....8

3. Coverages Included at the Project Site Only....10
- 3.1. OCIP Marine General Liability....10
- 3.2. Contractors Pollution Liability....11
- 3.3. Marine Builders Risk....12

4. Insurance Required of Contractors/ Subcontractors of Any Tier....13
- 4.1. Required Insurance....13
- 4.2. Certificates of Insurance....16
- 4.3. Insurance Requirements for OCIP Non-Participants....16
- 4.4 Waiver of Subrogation…… 17

5. Contractor Responsibilities....18
- 5.1. Administrative Responsibilities....18
- 5.2. Insurance Costs....18
- 5.3. Contract Award Notification....19
- 5.4. Evidence of Insurance....19
- 5.5 Notice of Completion....19

6. Other Provisions....20
- 6.1. Contractual Obligations....20

- 6.2. Right to Terminate or Modify the OCIP.....20
- 6.3. Modifying the OCIP Procedures.....20

7. Claim Reporting Procedures.....21
- 7.1. Contractor/Subcontractor Responsibilities.....21
- 7.2. General Contactor Project Manager Responsibilities 22

8. OCIP Forms Checklist 26

1

Introduction

Public Utility District No. 1 of Snohomish County (SnoPUD) has arranged insurance for the Admiralty Inlet Pilot Tidal project to be covered under an Owner Controlled Insurance Program (OCIP). This manual describes the insurance coverages and operation of the Admiralty Inlet Pilot Tidal (SnoPUD) OCIP. We urge you to read it carefully and completely.

This OCIP provides **only Marine General Liability** for the Admiralty Inlet Pilot Tidal (SnoPUD) project covering enrolled parties whose employees perform actual ***on-site labor*** at the Project Site. Separately as described in the contract, the SnoPUD will also provide Contractors Pollution Liability coverage and Marine Builder's Risk/Installation coverage for the Project.

OCIP Marine General Liability: Enrolled Contractors/Subcontractors are covered by the following coverage while they work at the Project Site:

- Marine General Liability (MGL), including Completed Operations (for the period of time allowed by law, in effect at the inception date)

Other coverages provided by the SnoPUD for the benefit of the Contractors/ Subcontractors performing construction activities at the Project Site include (and do not require enrollment for coverage to apply):

Contractor's Pollution Liability:

- Limits: $5,000,000 per claim; $10,000,000 aggregate
- Named Insured: includes all Contractors and Subcontractors of any tier performing work on the defined Project Site.

Marine Builder's Risk/Installation Risk:

- Limits: no less than Project value.
- Named Insured: includes all Contractors and Subcontractors of any tier performing construction activities on the defined Project Site.

This manual specifies insurance requirements Contractors and Subcontractors must maintain apart from those provided by the OCIP, as well as enrollment steps that Contractors and Subcontractors must complete in order to be covered by the OCIP ***prior*** to the commencement of work on the Project. Each Contractor/Subcontractor must comply with the obligations for enrollment and claims and safety program requirements. **Each Contractor is responsible for following these procedures and for making sure its eligible Subcontractors receive a copy of this manual and are properly enrolled prior to performing on-site activities, and are required to do the same for their Subcontractors and so on for every subtier.** Contractors unsure about eligibility must call the OCIP Administrator listed in the Directory of this manual.

This Manual is meant to provide only a general overview of the OCIP for convenience of reference. In connection with the foregoing, the provisions of this manual (1) are subject in all respects to the terms and conditions of the actual insurance policies and related contracts between the parties and (2) shall in no manner alter, amend or affect the terms or provisions of such insurance policies or related contracts. Accordingly, all parties are advised that they should obtain and review all applicable insurance policies and related contracts with the assistance of their independent brokers, attorneys and other appropriate advisors, which they may deem appropriate.

The provisions herein for the OCIP shall in no way be interpreted as relieving the enrolled parties of any responsibility under their contracts.

Copies of the policies that comprise the Project are available upon request to the OCIP Administrator.

Directory

(Manual will not be updated for change in personnel listed below)

Company & Address		Contact Information
OCIP Administration/Insurance Broker		
Marsh Risk & Insurance Services 345 California Street San Francisco, CA 94104		Marsh USA Inc. 111 SW Columbia, Suite 500 Portland, OR 97201
OCIP Administrator	Telephone: e-mail Fax	503-248-1263 Ann.S.Anderson@Marsh.com 503-248-1220
OCIP Project Manager	Telephone: e-mail Fax	To Be Determined
OCIP Program Executive	Telephone: e-mail Cell	To Be Determined
Owner – SnoPUD		
	Tel: Email:	
General Contractor ("Contractor")		
Project Manager:		
Marine General Liability Claims		
TBD		
Contractors Pollution Liability Claims		
TBD		
Marine Builders Risk Claims		
TBD		

Definitions

Note: *The following list of words and phrases include an explanation of meanings. However, they may be defined differently in other policy documents or contracts, and in that case, the definitions given in such documents will take precedence.*

Word/Phrase	Meaning
Accident or Occurrence	An unforeseen and unintended event or sudden happening, including any repeated exposure to conditions which result in injury to people or damage to property.
Claim	A demand for compensation, including a benefit request, for injuries or damages caused by an insured loss.
Claim Administrator	The insurance company representative responsible for processing all Claim reports and initial follow-up.
Contract	A written agreement between Owner (or its designee), General Contractor, or between General Contractor and Subcontractors, or by and between Subcontractors of any tier.
Contractor	Any individual, firm, or corporation undertaking construction or other services under Contract with the Owner and/or General Contractor requiring labor at or from the Project Site.
Employer	The Owner, General Contractor, Subcontractor, or any person who contracts to pay for and secures the right to direct and control the services of any person.
Enrolled Party	A company who has complied with the enrollment procedures and is named as an insured on the Certificate of Insurance, as provided by the OCIP Administrator.
Enrollment Forms	Those forms required to be supplied to the OCIP Administrator prior to working onsite, further identified in Section 8
Excluded Parties	The Marine General Liability coverage does not apply to parties identified in Section 2.4 of this manual.
General Contractor	
Insured Loss	The total cost, charges, and expense relating to an Accident or Occurrence and insured by polices under the OCIP.
Insureds	SnoPUD, [General Contractor], enrolled Contractors/Subcontractors and other parties listed as Named Insureds on the Project insurance policies.
Insurers	The Insurance Companies named on the Policies and Certificates of Insurance.
Owner Controlled Insurance Program or "OCIP"	The program under which Marine General Liability insurance is procured by the Owner on behalf of the General Contractor, eligible Contractors and Subcontractors of all tiers while they are working at the Project Site. (Also called a wrap-up program.)
OCIP Administrator	Representatives from the insurance brokerage firm of Marsh USA Inc.

Word/Phrase	Meaning
Owner/Developer	Public Utility District No. 1 of Snohomish County (SnoPUD)
Project	Admiralty Inlet Pilot Tidal (SnoPUD) project
Project Site	As defined in the Special Conditions of the PWC Contract as "the site(s) where the Project is constructed, stored or installed".
Subcontractor	An entity with whom Contractor has entered into any subcontract to perform any part of the work or to provide any materials, equipment or supplies to or on behalf of Contractor in connection with the work (including any entity at any tier with whom any Subcontractor has further subcontracted any part of the work).
Substantial Completion	As defined in the PWC Contract, section 9.9

2

Overview of the Owner Controlled Insurance Program

2.1. Purpose

Owner has implemented an OCIP to provide certain insurance coverage for eligible Contractors/Subcontractors performing work on the Admiralty Inlet Pilot Tidal (SnoPUD) Project Site.

This manual is meant to provide only a general overview of the OCIP and does not in any way alter the actual insurance policy language. If the wording in this manual seems ambiguous, the policies will govern.

2.2. Application of OCIP to Contractors/Subcontractors

OCIP coverages are designed to cover Owner and all eligible Contractors/Subcontractors enrolled in the OCIP (unless excluded by the criteria in Section 2.4). OCIP coverage is summarized in Section 3.

*Enrollment by all eligible Contractors/Subcontractors is **mandatory**, but **not automatic**.* Enrollment is subject to satisfactory review and approval of Enrollment Forms by the OCIP Administrator.

All Insureds must comply with OCIP provisions and procedures including the established Project safety program. Each Contractor must ensure its Subcontractors are properly enrolled in the OCIP and comply with these provisions and procedures.

The OCIP Administrator will make every effort to give enrolled Contractors/Subcontractors the appropriate evidence of OCIP insurance outlined in Section 3 before the **Notice to Proceed** with work is issued for the Project Site.

2.3. Scope of the OCIP

The Owner has procured the following insurance coverages on behalf of enrolled Contractors/Subcontractors performing construction operations on the Project Site, as detailed further in **Section 3**:

- **Marine General Liability**
  Enrolled Contractors/Subcontractors (as defined in Section 1, subject to eligibility described in Section 2.4) are covered by the following insurance while they work at the Project Site:

- Marine General Liability (MGL), including Completed Operations (for the period of time allowed by law, in effect at the inception date).

As specified in Section 4, Contractors/Subcontractors must carry their own general liability and excess liability insurance for off-site activities and exposures not covered by the OCIP. ***NOTE:*** Off-site locations to the Project Site may be covered under the OCIP, subject to approval by the Owner and OCIP insurance company, but ***must be*** dedicated to the Project and ***must be*** scheduled on the insurance policies.

Other coverages provided by the SnoPUD for the benefit of the Contractors/ Subcontractors performing construction activities at the Project Site include (and do not require enrollment for coverage to apply) Contractor's Pollution Liability and Marine Builder's/Installation Risk coverage.

2.4. Contractors Not Included Under the OCIP (Excluded Parties)

Contractors/Subcontractors whose contracted work includes one or more of the following ***will not*** be included under the OCIP unless specifically authorized by the Owner or the OCIP Administrator:

- Janitorial services, demolition, blasting.
- Vendors, suppliers, material dealers or others whose sole function is to transport, pickup, make deliveries, carry or move materials, supplies, tools, parts, or equipment to and from the Project Site.
- Asbestos abatement, hazardous material remediation removal, abatement and/or transportation and their consultants
- Architectural, engineering and related professional services.
- Certain emergency work performed on an immediate, short-term basis.
- Other individuals or entities not specifically identified as excluded from the OCIP, by the Owner, in its sole discretion, even if otherwise eligible.

2.5. Safety Program

A coordinated safety program will be in effect on the Project Site. Contractors/ Subcontractors will refer to the General Contractor's project safety requirements and to their Contracts for accident prevention, safety, and loss control requirements and procedures.

2.6. Questions about the OCIP

Direct any questions about the OCIP coverages to the OCIP Client Advisor or Executive and questions regarding procedures to the OCIP Administrator:

Marsh USA Inc.
OCIP Administrator
111 SW Columbia, Suite 500
Portland, OR 97201
Direct Lines: 503-248-1263
Fax: 503-248-1220
Email: Ann.S.Anderson@Marsh.com

2.7. OCIP Q&A

Questions Commonly Asked in Owner Controlled Insurance Programs

2.7.1. What does this OCIP cover?

See Section 3

1. It will **not** provide other types of insurance such as workers' compensation, off-site general liability or marine general liability, automobile liability, contractors' equipment, hull and machinery insurance, protection and indemnity, vessel crew coverage (Jones Act), vessel pollution, cargo insurance, aviation operations, professional liability, automobile physical damage, contractor's tools or other risks of the contractors (although separate project-specific coverage is provided by the Owner subject to the terms of the actual policies for marine builder's/installation risk and contractor's pollution liability).

2. It will **not** cover contractors for any operations not associated with this specific Project.

3. All participating Contractors will receive a certificate of insurance evidencing Marine General Liability, indicating participants as named insureds, but only for work performed on the site of this OCIP Project. The coverage provided in this OCIP is further summarized in Section 3.

4. The Marine General Liability policy will be on an occurrence basis, and will extend completed operations coverage for all named insureds for 6 years after Substantial Completion of the Project.

2.7.2. What is the reason for having an OCIP?

To enhance stability and continuity in insurance coverage for the Project Owner and participating Contractors, engaging a major insurer whose current financial stability suggests that it will still be there to cover claims when and if they occur.

To reduce the potential for adversarial relationship between Contractors, Subcontractors, and the Project owner at the time of a claim, allowing the claim to be defended and settled in a proactive manner, reducing claim costs for all participants.

To reduce the cost and redundancy of insurance associated with this construction Project.

2.7.3. How can I be sure my insurer will not charge me for the OCIP risk?

You should notify your insurers of the OCIP, through your agent or directly, giving a description of the risk and OCIP coverage.

You must keep separate revenue and payroll records specifically allocated to the OCIP project to avoid duplicate premium charges for your work performed under the OCIP program. *(See Section 5.2 for detail regarding OCIP insurance credits)*

If you have questions about these issues as the bidding and work proceed, your broker, agent or underwriter should be able to assist you. The OCIP Administrator is also available to help answer any questions about this program.

2.7.4. Is there coverage beyond the completion of my work?

Yes, the Marine General Liability program extends completed operations coverage for 6 years after the Substantial Completion of the Project (or the maximum period of time allowed by law, in effect at the inception date). In addition the program extends premises coverage for warranty work.

3

Coverages Included at the Project Site Only

3.1. OCIP Marine General Liability

Marine General Liability	
Insurer	TBD
A.M. Best Rating at inception	TBD
Policy Term	TBD
Coverage Limits:(Final program structure may vary with limits being achieved in a layered program)	
Each Occurrence	$25,000,000
General Aggregate (annual reinstatement)	$25,000,000
Products Completed Operations Aggregate *(single limit)*	$25,000,000
Personal Injury/Advertising Aggregate *(single limit)*	$25,000,000
Notable Coverage Features:	▪ Amended exclusion for care, custody and control ▪ Amended exclusion for watercraft liability ▪ Extend to cover stevedores legal liability, wharfinger's legal liability, and charterer's legal liability, when applicable
Notable Exclusions:	▪ Others per policy form

DEDUCTIBLE:
To the fullest extent allowable by law, and notwithstanding the foregoing, the Contractor or Subcontractors shall be responsible up to the first $10,000 of each and every Insured Loss under this insurance (or the amount of the Insured Loss, if less than $10,000) including cost of defense such as court costs and attorneys' fees. Contractor shall allocate responsibility between itself and the Subcontractors, to the extent Insured Losses payable are attributable to its acts or omissions, or the acts or omissions of its Subcontractors of any tier or any other entity or person for whom it may be responsible as determined by Contractor. The deductible chargeback applying to the Contractor and Subcontractors is the responsibility of the Contractor and Subcontractors and may be withheld from progress payments if not reimbursed.

3.2. Contractors Pollution Liability *(For the benefit of all other Contractors and Subcontractors of any tier under contract for Admiralty Inlet Pilot Tidal (SnoPUD) project – Contractor DOES NOT have to be enrolled under this policy for coverage to apply)*

Contractors Pollution Liability	
Insurer	TBD
A.M. Best Rating at inception	TBD
Policy Term	
Coverage Limits:	
Each Claim	$ 5,000,000
General Aggregate	$5,000,000
Notable Coverage Features:	▪ TBD ▪
Notable Exclusions:	▪ TBD ▪

3.3. Marine Builders Risk *(For the benefit of all other Contractors and Subcontractors of any tier under contract for Admiralty Inlet Pilot Tidal (SnoPUD) – Contractor DOES NOT have to be enrolled under this policy for coverage to apply)*

Builder's Risk	
Insurer	TBD
A.M. Best Rating at inception	TBD
Policy Term	
Coverage Limits:	
Each	TBD
Notable Coverage Features:	▪ TBD ▪
Notable Exclusions:	▪ TBD ▪

Contractors' equipment and materials not incorporated into the completed Project are **NOT** covered under the OCIP.

Copies of the policies that comprise the Project are available upon request to the OCIP Administrator.

4

Insurance Required of Contractors/ Subcontractors of Any Tier

4.1. Required Insurance

The OCIP coverage as outlined in Section 3 will not furnish all the insurance needed by a Contractor/Subcontractor. Other coverages carried by the Contractor/Subcontractor — regardless of whether the insurance is required by law, by the Owner or for the Contractor's own additional protection — must be obtained at the Contractor/Subcontractor's own expense, unless otherwise specified in the Contract. The insurance requirements are identified in the Subcontract Agreements and at minimum those will include:

(1) **Workers' Compensation, Employers Liability (Stop Gap in WA)/Jones Act Liability/Maritime Employers Liability, and USL&H:**

Workers' Compensation	Statutory
USL&H	Statutory
Employer's Liability/Maritime Employers Liability:	
Each Accident	$1,000,000
Disease - Policy Limit	$1,000,000
Disease - Each Employee	$1,000,000

Coverage must include: Alternate Employers endorsement in favor of SnoPud.

(2) **Commercial Automobile Liability – including owned, non-owned and hired automobiles on a form at least as broad as ISO Form CA0001 (covering auto liability code 1 any auto),**

Bodily Injury and Property Damage Combined Limit	$2,000,000

(3) **Commercial General Liability and/or Marine General Liability Insurance (Off Site and/or not covered by OCIP) – Occurrence Form**

Bodily Injury / Property Damage

Each Occurrence	$1,000,000
General Aggregate	$2,000,000
Products-Completed Operations Aggregate	$2,000,000
Personal/Advertising Injury	$1,000,000
Fire Damage	$50,000
Medical Expense	$5,000

Coverage must include: Contractual Liability Coverage, Stop Gap Coverage, Broad Form Property Damage Liability Coverage, Independent Contractors Coverage, Sudden and Accidental Pollution, Stevedores Legal Liability, Wharfinger's Legal Liability and Charterer's Legal Liability, where applicable. Also to include Personal Injury Coverage with Contractual and Fellow Employee Exclusion deleted.

(4) **Hull and Machinery Insurance – covering all owned and/or operated watercraft used in performing work and/or services related to this Project:**

Coverage shall be written on the American Institute Hull Clauses (6/2/1977) or equivalent and shall include full collision and tower's liability, if not provided under the Protection and Indemnity coverage. Amount of coverage shall be not less than the fair market value of the hull and machinery.

(5) **Protection and Indemnity Insurance – covering all owned or operated watercraft used in performing work and/or services related to this Project:**

Coverage shall be written on the SP23 (1956) Form or equivalent and shall include full collision and tower's liability, if not provided in the Hull and Machinery coverage. Coverage also shall include contractual liability extension, crew liability (if not in the Marine Employer's Liability coverage) and excess collision and tower's liability (excess of any collision and tower's liability provided in the Hull and Machinery coverage).

Limits of Liability shall not be less than:

Each Vessel (separately)	$1,000,000

(6) **Cargo Insurance – for any cargo carried in conjunction with this Project:**

Coverage shall be placed on an "all risk" basis, including war risks, strikes, riots and civil commotion, debris removal, 50/50 clause and extensions for storage of goods which are temporarily stages and intended to become part of the Project. Goods insured are to be valued at cost plus 10%. At the option of SnoPUD, coverage may be

purchased for Delay in Start-up.

(7) **Vessel Pollution Insurance – for all owned or operated watercraft used in performing work and/or services related to this Project:**

Coverage shall be written on the Water Quality Insurance Syndicate policy form, or equivalent, and shall include bodily injury. Limits of liability shall be in accordance with OPA90, but not less than $1,000,000 each occurrence. The vessel owner or operator shall also have Certificate of Financial Responsibility pursuant to OPA90, Coast Guard Regulations and State of Washington, as required.

(8) **Umbrella or Excess Liabilities** covering excess over 4.1(1-5 and 7) above. Such coverage shall be on a follow-form basis with a drop down provision where primary coverage is aggregated. Occurrence form.
Limits of Liability shall not be less than $25,000,000

(9) **Property Insurance – for each party's owned or leased equipment / machinery / tools and materials:**

Coverage shall be arranged by each party for their owned or leased equipment, machinery, tools, and materials, whether such equipment is located at or away from a Project Site or "in transit". Each party is solely responsible for any loss or damage to their personal property.

(10) **Contractors Professional Liability Insurance:**

Coverage shall be maintained with minimum limits of $1,000,000. Covered professional services shall specifically include all work to be performed under the Contract and delete any exclusions that may potentially affect the work to be performed.

Other than for coverage provided by SnoPUD in Section 3.1, the insurance shall be primary and non-contributing with any other insurance and shall be in a form acceptable to the SnoPUD and from insurance companies with a minimum Best rating of A/VII (or higher). The insurance limits may be provided through a combination of primary and excess policies, including umbrella and/or bumbershoot policies, with the excess and/or umbrella and/or bumbershoot policies having coverages at least as broad as each and every underlying policy.

Except with respect to state Workers' Compensation Insurance and Professional Liability Insurance, each policy required under this Section 4.1 shall name the SnoPUD and each of its commissioners, directors, officers, agents, employees, consultants, representatives, all other indemnified parties defined in the PWC Contract Documents, and any additional entities as the SnoPUD may request, as additional insureds. All policies of insurance required by this Section 4.1 shall (i) provide for thirty (30) days prior written notice to the SnoPUD and OCIP program

administrator of cancellation, reduction of limits or material modification, ten (10) day prior written notice if cancellation is due to non-payment of premiums, (ii) other than for coverage purchased by SnoPUD in Section 3.1, provide that the insurance shall be primary insurance and that no other insurance or self-insured retention carried or held by the SnoPUD shall be called upon to contribute to a loss covered by insurance for any insured, and (iii) contain a separation of insureds provision.

4.2. Certificates of Insurance

All Subcontractors will provide [General Contractor] properly executed Certificates of Insurance as required in the Contract, before performing any Project Site work. The certificates of insurance must be on the industry standard form (ACORD).

Every Subcontractor will also require all its Sub-subcontractors to furnish similar certificates of insurance. Copies must be filed with and approved by [General Contractor] before beginning work.

Even if the certificate of insurance is not filed, these parties are still responsible for carrying and maintaining the insurance. Owner and General Contractor have the right to prevent any party from entering the Project Site until the certificates are filed with the General Contractor.

4.3. Insurance Requirements for OCIP Non-Participants

For any Company entering the job site that is **not** eligible for the OCIP, all insurance requirements in its Contract will be required at all times. Any Excluded Party performing Work shall pay for and maintain, and shall require each of its Subcontractors of any tier, that is an Excluded Party, to pay for and maintain, all insurance coverages set forth in Sections 3.1 and 4.1 for both on and off- site. The cost of all premiums, deductibles and policy charges for the coverage required under this Section 4.3, including any charges for required waivers of subrogation, additional insured endorsements or any other endorsements, shall be paid by the party required to procure and maintain the insurance. The insurance shall be primary and non-contributing with any other insurance and shall be in a form acceptable to the SnoPUD and from insurance companies with a minimum Best rating of A/VII (or higher). The insurance limits may be provided through a combination of primary and excess policies, including umbrella and/or bumbershoot and/or excess policies, with the excess and/or umbrella and/or bumbershoot policies having coverages at least as broad as each and every underlying policy.

Except with respect to state workers' compensation insurance, each policy required under this Section 4.3 shall name the SnoPUD and each of its commissioners, directors, officers, agents, employees, consultants, representatives, all other indemnified parties defined in the Contract Documents, and any additional entities as the SnoPUD may request, as additional insureds. All policies of insurance required by this Section 4.3 shall (i) provide for thirty (30)

days prior written notice to the SnoPUD and OCIP program administrator of cancellation, reduction of limits or material modification, ten (10) day prior written notice if cancellation is due to non-payment of premiums, (ii) provide that the insurance shall be primary insurance and that no other insurance or self-insured retention carried or held by the SnoPUD shall be called upon to contribute to a loss covered by insurance for any insured and (iii) contain a separation of insureds provision.

Excluded Parties shall deliver to the OCIP Administrator, prior to the commencement of the work, a certificate of insurance evidencing all insurance coverage under this Section 4.3 on a standard ACORD form or other form acceptable to the SnoPUD. The commencement of the work by the Contractor or any of its Subcontractors of any tier without compliance with this or any other requirements shall not constitute a waiver of any right of the SnoPUD nor a release or waiver of any duty or obligation owed by the Contractor or any Subcontractor of any tier. Upon the SnoPUD's request, the Contractor and/or any Subcontractor of any tier shall submit to the SnoPUD copies of the actual insurance policies or renewals or replacements thereof. All insurance furnished by the Contractor or any of its Subcontractors of any tier as required under this Section 4.3 shall be in full force and effect during the performance of the work by the Contractor, and six (6) (or applicable statutes) years after completion of the work. The Contractor shall be responsible for obtaining satisfactory evidence of insurance coverage from each of its Subcontractors of any tier, whether Insured Parties or Excluded Parties, and submitting same to the SnoPUD prior to commencement of such subcontractor's Work. The SnoPUD reserves the right to increase or decrease the required limits of liability or require additional coverages based on the type and scope of work performed.

4.4. Waiver of Subrogation

To the greatest extent allowable by law as pertains to coverages outlined in Sections 3 and 4.1 (except state workers' compensation), the Enrolled Parties and Excluded Parities each on their own behalf and on behalf of anyone claiming by, through or under them, whether by way of subrogation or otherwise, hereby waive any and all subrogation rights which they may now or hereafter have against each other and the parent, related and affiliated companies, the successors and assigns of each other, in connection with the performance of the work to the extent such subrogation rights are not the result of any intentional wrongful act or omission of the party causing such loss and are covered losses under such insurance.

5

Contractor Responsibilities

5.1. Administrative Responsibilities

Contractors/Subcontractors are required to cooperate with the Owner and OCIP Administrator in OCIP administration and operation. These responsibilities include, but are not limited to:

- Providing necessary contract, operations, and insurance information;
- Including OCIP provisions in all subcontracts, including Project Insurance Manual, for every tier of subcontract;
- Providing advance notice to the OCIP Administrator of all subcontracts awarded;
- Complying and actively supporting the General Contractor's safety program and OCIP insurance company claim reporting procedures;
- Cooperating with OCIP insurer and complying with their requirements on safety and claims

5.2. Insurance Costs

Owner has arranged for OCIP coverages and pays the applicable premiums for the benefit of covered Contractors/Subcontractors. Contractors/Subcontractors in return will:

- ***Identify*** all costs of insurance and losses (if under a loss-sensitive program), including profit and overhead, associated with the Marine General Liability coverage that is being provided by the OCIP. Identification of those costs will be based upon the Insurance Cost Worksheet (Form 1, page 2 – see Section 8), per the bidding instructions provided by [General Contractor] and determined by Owner in cooperation with [General Contractor]. Cost identification and removal should include the insurance costs of

Subcontractors of any tier expected to perform work under the contract. Should information not be available at time of bid to provide those insurance costs, an estimate of at least 1% of subcontract value shall be included. Contracts will be awarded less this amount. This amount must be identified in a line item entry that will reduce the awarded contract amount.

- Submit any change orders ***excluding*** the cost of insurance and losses in the same manner to which they were removed from the original bid.

- Assign to the Owner all return premiums, dividends, refunds, or other credits due (or that will become due) associated with the OCIP insurance policies.

- Be responsible for the contractor deductible as noted in Section 3.1

Contractors/Subcontractors agree to execute necessary OCIP documents and agreements prior to beginning work on the Project Site.

5.3. Contract Award Notification

Eligible Contractors/Subcontractors are not covered under the OCIP until necessary enrollment information is properly completed and submitted to the OCIP Administrator, and written confirmation of enrollment has been issued by OCIP Administrator.

After receiving Contract award notification from Contractor, the OCIP Administrator will contact each Contractor/Subcontractor to begin enrollment.

Each Contractor is responsible for reporting any Subcontractor of any tier to the OCIP Administrator and the General Contractor. The Contractor must notify the OCIP Administrator of Subcontractor awards via Form 2 (see Section 8 – Forms).

5.4. Evidence of Insurance

When the OCIP Administrator has received and approved all completed forms, the Contractor/Subcontractor is enrolled in the OCIP and is sent written confirmation of OCIP Marine General Liability coverage with copies provided to their awarding Contractor/Subcontractor and the General Contractor.

5.5 Notice of Completion

The enrolled parties must complete a “Notice of Work Completion” form 4 (see Section 8 – Forms) for each contract that has been completed on the Project Site. Once the form has been completed it should be submitted to the OCIP Administrator via fax or e-mail with a copy to the General Contractor.

6

Other Provisions

6.1. Contractual Obligations

The insurance, as provided by the Owner for Contractors and Subcontractors under the OCIP or otherwise, is not intended to, and shall not be construed to limit, qualify, or waive any liabilities or obligations of Contractors and Subcontractors, assumed or otherwise, under their Contracts.

6.2. Right to Terminate or Modify the OCIP

While the Owner intends to keep the OCIP in force throughout the Project, it reserves the right to terminate or change the terms and conditions of the OCIP coverage. To exercise this option, Owner will give 30-calendar day's advance written notice to all Contractors/Subcontractors covered under the OCIP of intent to terminate or change coverage.

If OCIP is terminated in whole or in part by the Owner, Contractors/ Subcontractors will be required to immediately obtain replacement coverage. The cost of replacement will be charged to the Owner through a Contract modification, but only to the extent of the unearned credit. The Owner reserves the right to audit Contractor/Subcontractor insurance costs.

Replacement coverage must satisfy the minimum insurance requirements of the Contract, unless specifically modified by the Owner. Written evidence of replacement insurance must be supplied to the Owner and Contractor as specified in the Contract.

6.3. Modifying the OCIP Procedures

The Owner may from time to time alter these procedures for efficient OCIP operation and will endeavor to (but not be required to) provide advance written notice to each enrolled Contractor/Subcontractor. (Procedure changes will not reduce or modify coverage terms.) Job site safe work standards and claims procedures may be revised when deemed necessary by the Owner.

7

Claim Reporting Procedures

7.1. Contractor/Subcontractor Responsibilities

All accidents, including any third party bodily injury, property damage and pollution-related incidents, are to be immediately reported by the Contractor/Subcontractor foremen or involved worker directly to [General Contractor]'s Project Manager (see Directory) and others as directed by [General Contractor].

Contractors/Subcontractors shall instruct crews or individuals working on the Project to report all accidents or incidents of any type.

Examples of accidents/incidents that must be immediately reported include:

- All job site injuries to third parties (such as vendors, suppliers, guests, visitors, etc.)
- All property damage to third parties
- All complaints from neighbors or the public
- All damage to the work or material to be used on the Project
- Anything likely to affect the quality of the work

Contractors/Subcontractors remain responsible for notifying their offices and, when required, the OSHA office having jurisdiction. OSHA injury and illness record keeping requirements remain the responsibility of the Contractor/Subcontractor and are not changed by enrollment in the OCIP.

Should the [General Contractor] Project Manager be unavailable, any incident involving bodily injury or property damage to a third party should be reported to the General Liability Claim Administrator (see Directory). The Contractor/Subcontractor involved is required to complete accident/incident investigation form for all accidents.

Contractors/Subcontractors shall cooperate with Owner personnel, [General Contractor] personnel and Owner's Claim Administrator during investigation and/or claims adjusting of OCIP claims.

7.2. General Contactor Project Manager Responsibilities

All Accidents/Incidents

[General Contractor]'s Project Manager, upon notification of an accident/incident, will:

- For injury accidents, verify that appropriate emergency medical treatment has been obtained. If paramedics have been called, coordinate spotters to escort paramedics from main road to accident site.
- Have the responsible party (or parties) take action to stop the unsafe act or to correct the unsafe condition in order to prevent further injury or damage.
- Investigate incident by completing report forms, obtaining witness statements, taking pictures, etc.
- Cooperate with the insurance company, adjusters and representatives.

Reporting Third Party Claims and Damage to Property (or Materials)

- Bodily Injuries to the public (including pedestrians, vendors, job site visitors, neighbors, etc.) and Property Damage incidents are reported on the carrier's claims reporting form or an ACORD "General Liability Notice of Occurrence/Claim." (Form 3, see Section 8 – Forms)
- The Project Manager is responsible for completing the claims form and notifying the Owner and the Claim Administrator.

The Project Manager or other Contractor representatives shall abide by the following:

DO Be courteous and sympathetic.

DO Obtain names and addresses of potential claimants even if their injury is slight or their accident was not witnessed.

DO Determine if the injured person contributed to the accident by an unsafe act (careless, intoxication) or handicap and report these in the "Remarks" section of the claims reporting form.

DO Determine whether the area involved is under OCIP responsibility to control. If not, determine who has the duty or responsibility for the area.

DO Identify witnesses and, if possible, get written statements from them. Record names, addresses, phone numbers.

DON'T Argue

DON'T Make any comments on negligence or fault. Do not express an opinion regarding the incident to anyone or offer to pay for anything.

DON'T Discuss potentially defective building or equipment or equipment conditions.

DON'T Attempt to apply first aid yourself unless trained and certified. On minor injuries, offer the first-aid kit to the injured. On serious injuries, do not move the person, call 911.

DON'T Transport an injured party yourself, even if requested. You and the company could be liable for further injury.

Instructions for use of claims reporting form (ACORD Notice of Occurrence)

- This form is needed to report and investigate potential General Liability claims. It is to be completed by the [General Contractor]'s Project Manager and returned to the carrier within twenty-four (24) hours after knowledge of the injury or property damage.

- Not all blanks will need to be filled in. Do not hold up reporting the incident waiting for more information. It is not necessary to complete the sections titled "Policy Information" and "Type of Liability."

Key information will include the following:

a. **Date:** Enter the date the report is completed.

b. **Date of Occurrence & Time of Loss:** Important, enter the date the loss occurred and approximate time.

c. **Authority Contacted:** Enter the name of any police or fire department notified or other emergency assistance requested (i.e., "911" paramedic).

d. **Description of Occurrence:** Brief but detailed description of incident (i.e., vendor slipped and fell on drywall mud while entering building). Do not describe injuries here.

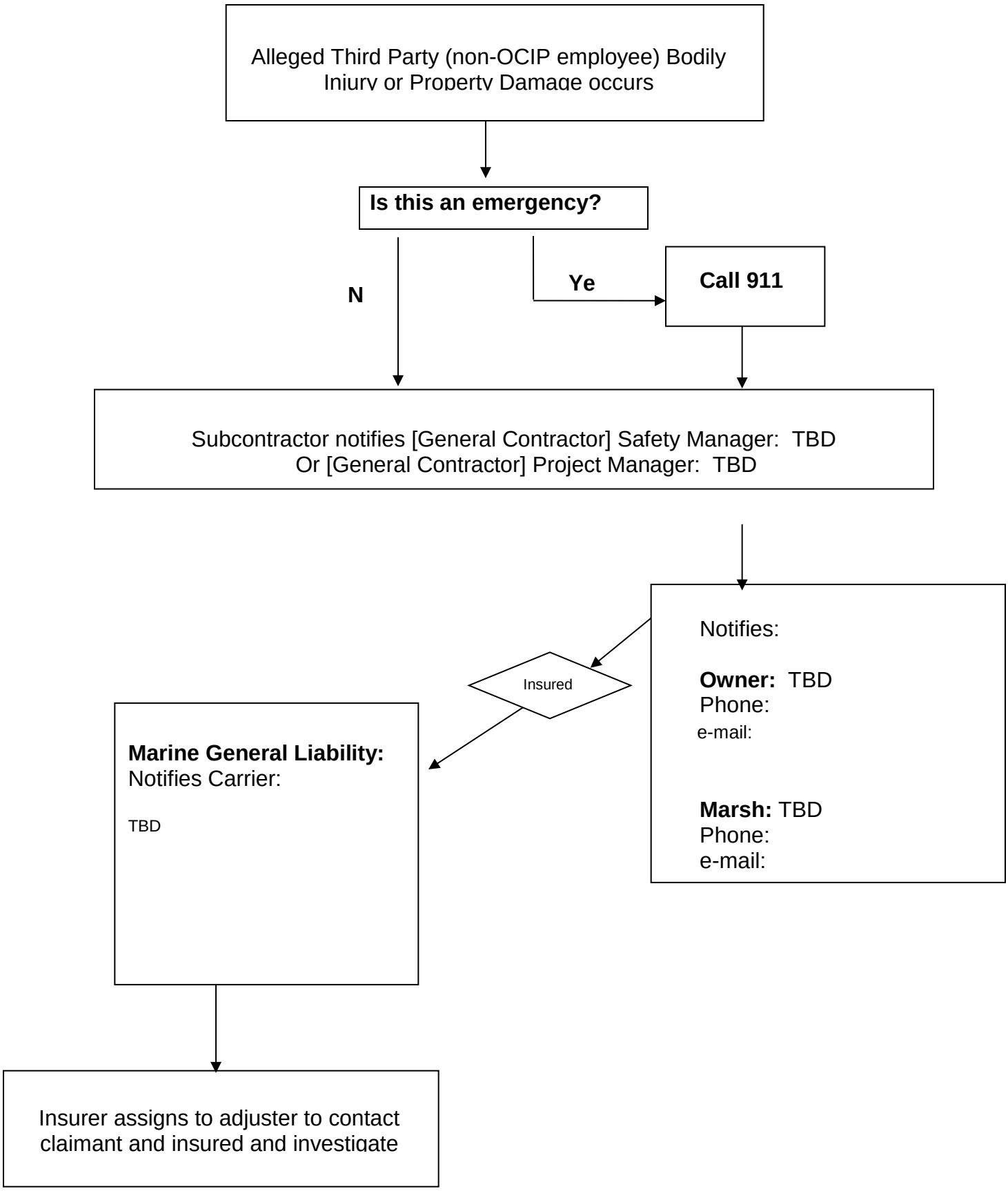
e. **Injury/Property Damaged:** Complete entire section on the injured parties or describe property damage.

f. **Witnesses:** Name, address, and phone number of anyone who witnessed the incident. Also, obtain their handwritten statements.

g. **Remarks:** Any additional remarks you feel are important. Also, what was done to prevent recurrence.

h. **Reported By:** Name of person completing loss notice. Again, usually the Contractor Project Manager.

i. **Take Pictures** and **Preserve Evidence**, as needed.


Alleged Third Party (non-OCIP employee) Bodily Injury or Property Damage occurs
Is this an emergency?
N
Ye
Call 911
Subcontractor notifies [General Contractor] Safety Manager: TBD
Or [General Contractor] Project Manager: TBD
Notifies:
Owner: TBD
Phone:
e-mail:
Marsh: TBD
Phone:
e-mail:
Insured
Marine General Liability:
Notifies Carrier:
TBD
Insurer assigns to adjuster to contact claimant and insured and investigate

8

OCIP Forms Checklist

Admiralty Inlet Pilot Tidal (SnoPUD) Project

Owner Controlled Insurance Program (OCIP) Enrollment Checklist

To do now	☐ **Read the Owner Controlled Insurance Program Enrollment Manual**	
To return within 2 weeks (before Project Site entry)	☐ Insurance Enrollment Information Form and Insurance Cost Worksheet (including copies of rate pages)	Form 1 (2 pages)
	☐ Enrollment Notification of Subcontractors (if applicable)	Form 2
	☐ Email/Fax to: OCIP Administrator MARSH USA INC. e-mail: TBD FAX: 503-248-1220	
	☐ Certificate of Insurance to GC per Contract	Sample
After incident	☐ Claims Reporting form or ACORD General Liability Notice of Occurrence	
At Project completion	☐ Notice of Completion	Form 4

For any questions please contact OCIP Administrator, [To be Determined]
at [Marsh's – Portland office]

Admiralty Inlet Pilot Tidal (SnoPUD) Project

OCIP Enrollment Application and Insurance Cost Worksheet (Form 1) page 1 of 2

(LIABILITY ONLY – DOES NOT INCLUDE WORKERS COMPENSATION)

THIS FORM MUST BE COMPLETED BY EACH CONTRACTOR* AND ALL *SUB-TIER CONTRACTOR(S) AND SUBMITTED FOR ENROLLMENT. NO CERTIFICATE OF INSURANCE CAN BE PROVIDED UNDER THE OCIP UNLESS A COMPLETED FORM IS RECEIVED.

(a) I. CONTRACTOR INFORMATION		
Legal Company:		
Address (Not P.O. Box):		
Office Contact: Email:	Phone:	Fax:
Payroll Contact: Address (if different):	Phone:	Fax:
FEIN (Federal ID No.):		

II. CONTRACT INFORMATION			
Contract #: _____			
What is the scope of your contract? _____			
Contract Amount: _____ Est Payroll: _____ Est Manhours: _____			
Job Name/Description:			
Awarding Contractor:			
Start Date:	Est Completion Date:	% Self Performed :	Your Payroll:
% Subcontracted:	Estimated # of Subs:	Est. Total of all Subs Payroll:	
List any designated subs that will work for you under this contract:			
Will your company lease employees for this job? ☐ Yes ☐ No		*NOTE: If your company uses "temp"/lease employees, the employee leasing company must also enroll in the OCIP program*	
Will you have any off-site location(s) 100% dedicated to this Project? ☐ Yes ☐ No			

Admiralty Inlet Pilot Tidal (SnoPUD) Project

OCIP Enrollment Application and Insurance Cost Worksheet (Form 1) page 2 of 2

III. INSURANCE COST IDENTIFICATION

NOTE: It is suggested you reference your General Liability (GL) Policy prior to answering questions.

A. Your Marine **General Liability Premiums**:

M.G.L. Classification (if applicable)	**M.G.L. Code** (if applicable)	**M.G.L. Rate**	**Estimated site Payroll or Projected Receipts (circle one)**	**Premium**
1.		X	=	
2.		X	=	
3.		X	=	
		Total	**$**	**$**
			Total General Liability A=	**$**
Identify amount of Deductible on your policy:				
B. Excess Liability Premium Rate _____ X Payroll/Receipts_____ B =				**$**
C. Profit Rate _____% C (Subtotal x rate) =				
D. TOTAL COSTS (A + B + C) D = **This amount must equal the insurance credit indicated on your bid proposal.**				**$**

IV. AGREEMENT

1) The undersigned, a Contractor/Subcontractor under a construction contract insured under Admiralty Inlet Pilot Tidal (SnoPUD) Owner Controlled Insurance Program (OCIP), for good and valuable consideration, hereby assigns absolutely unto SnoPUD all return premiums, premium refunds, dividends, and other monies due or to become due to the undersigned in connection with said insurance. This assignment shall pertain to the OCIP policy(ies) as now written and as subsequently modified, rewritten or replaced by SnoPUD and/or OCIP insurance company, including any additional amount or coverages as a result thereof. The undersigned also assigns to SnoPUD its rights of cancellation of all such policies.
2) "Total Costs" indicated in D represent the amount of insurance premiums the contractor would have paid if providing their own insurance, including profit. SnoPUD is paying for and providing the specified construction insurance.
3) The undersigned warrants that all the costs indicated above for OCIP Insurance have been accurately identified and will be **removed** from their Contract.
4) All change orders will also identify and remove insurance costs for OCIP provided coverages.
5) It is each Contractor's responsibility to notify its own insurance carrier to exclude all general liability and excess liability work to be done under this contract from your current insurance program.
6) Copies of Declaration and Rate pages are being submitted with this form.
7) I, the undersigned, understand and recognize that I have the right to request copies of the insurance policies covering me under the OCIP and should the policies not be available, be provided copies of binders and/or declaration of coverage.

Signed _____Title _____ Date _____

Mail or fax completed form to:

Marsh USA Inc., Attn: [Name], 111 SW Columbia, Portland, OR 97201 | Fax: (503) 248-1220 | Phone [To Be Determined | Email [TBD]

Admiralty Inlet Pilot Tidal (SnoPUD) Project

OCIP Subcontractor Enrollment Notification (Form 2 – if applicable)

Awarding Contractor Name:	
Date:	

Project ID/Name/Location:			
1) Subcontractor Name:			
Contact Person:		Phone Number:	
Estimated Contract Value:		Email Address:	
Estimated Start Date:		Estimated Duration:	
Scope of Work:			

Project ID/Name/Location:			
2) Subcontractor Name:			
Contact Person:		Phone Number:	
Estimated Contract Value:		Email Address:	
Estimated Start Date:		Estimated Duration:	
Scope of Work:			

To be completed by any subcontractor who has a subtier who will be involved in the Admiralty Inlet Pilot Tidal project prior to the start date of that subcontractor. This form must be **faxed** or **emailed** to OCIP Administrator**, prior to work commencing.**

Mail or fax completed form to:

Marsh USA Inc., Attn: Attn: [Name], 111 SW Columbia, Portland, OR 97201 | Fax: (503) 248-1220 | Phone [To be determined] | Email [TBD]

Admiralty Inlet Pilot Tidal (SnoPUD) Project

General Liability ACORD Notice of Occurrence (Form 3) (4 pages)

GENERAL LIABILITY LOSS NOTICE OF OCCURRENCE / CLAIM

DATE (MM/DD/YYYY)

AGENCY	INSURED LOCATION CODE	DATE AND TIME OF LOSS ☐ AM ☐ PM
	CARRIER	NAIC CODE
	POLICY NUMBER	
CONTACT NAME:		
PHONE (A/C, No, Ext):		
FAX (A/C, No):		
E-MAIL ADDRESS:		
CODE: SUBCODE:		
AGENCY CUSTOMER ID:		

INSURED

NAME OF INSURED (First, Middle, Last)		INSURED'S MAILING ADDRESS
DATE OF BIRTH	FEIN (if applicable)	
PRIMARY PHONE # ☐ HOME ☐ BUS ☐ CELL	SECONDARY PHONE # ☐ HOME ☐ BUS ☐ CELL	PRIMARY E-MAIL ADDRESS:
		SECONDARY E-MAIL ADDRESS:

CONTACT ☐ CONTACT INSURED

NAME OF CONTACT (First, Middle, Last)		CONTACT'S MAILING ADDRESS
PRIMARY PHONE # ☐ HOME ☐ BUS ☐ CELL	SECONDARY PHONE # ☐ HOME ☐ BUS ☐ CELL	
WHEN TO CONTACT		PRIMARY E-MAIL ADDRESS:
		SECONDARY E-MAIL ADDRESS:

OCCURRENCE

LOCATION OF OCCURRENCE STREET:	POLICE OF FIRE DEPARTMENT CONTACTED
CITY, STATE, ZIP:	REPORT NUMBER
COUNTRY:	

DESCRIBE LOCATION OF OCCURRENCE IF NOT A SPECIFIC STREET ADDRESS:

DESCRIPTION OF OCCURRENCE (Attach ACORD 101, Additional Remarks Schedule, if more space is required)

TYPE OF LIABILITY

PREMISES: INSURED IS ☐ OWNER ☐ OWNER ☐	TYPE OF PREMISES	
OWNER'S NAME & ADDRESS (If not Insured)	PRIMARY PHONE # ☐ HOME ☐ BUS ☐ CELL	SECONDARY PHONE # ☐ HOME ☐ BUS ☐ CELL
	PRIMARY E-MAIL ADDRESS:	
	SECONDARY E-MAIL ADDRESS:	
PRODUCTS: INSURED IS ☐ MANUFACTURER ☐ VENDOR ☐	TYPE OF PRODUCT	
MANUFACTURER'S NAME & ADDRESS (If not Insured)	PRIMARY PHONE # ☐ HOME ☐ BUS ☐ CELL	SECONDARY PHONE # ☐ HOME ☐ BUS ☐ CELL
	PRIMARY E-MAIL ADDRESS:	
	SECONDARY E-MAIL ADDRESS:	
WHERE CAN PRODUCT BE SEEN?		

ACORD 3 (2012/05) PAGE 1 of 4 © ACORD CORPORATION 1986-2012. All Rights Reserved.
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AGENCY CUSTOMER ID: ____

INJURY / PROPERTY DAMAGED

NAME & ADDRESS (Injured/Owner)		EMPLOYER'S NAME & ADDRESS	
PRIMARY PHONE # ☐ HOME ☐ BUS ☐ CELL	SECONDARY PHONE # ☐ HOME ☐ BUS ☐ CELL	PRIMARY PHONE # ☐ HOME ☐ BUS ☐ CELL	SECONDARY PHONE # ☐ HOME ☐ BUS ☐ CELL
PRIMARY E-MAIL ADDRESS:		PRIMARY E-MAIL ADDRESS:	
SECONDARY E-MAIL ADDRESS:		SECONDARY E-MAIL ADDRESS:	
AGE / SEX / OCCUPATION		DESCRIBE INJURY	
WHERE TAKEN		WHAT WAS INJURED DOING?	
DESCRIBE PROPERTY (Type, model, etc.)	ESTIMATE AMOUNT	WHERE CAN PROPERTY BE SEEN?	

WITNESSES

NAME AND ADDRESS	PRIMARY PHONE # ☐ HOME ☐ BUS ☐ CELL	SECONDARY PHONE # ☐ HOME ☐ BUS ☐ CELL
	PRIMARY E-MAIL ADDRESS:	
	SECONDARY E-MAIL ADDRESS:	
NAME AND ADDRESS	PRIMARY PHONE # ☐ HOME ☐ BUS ☐ CELL	SECONDARY PHONE # ☐ HOME ☐ BUS ☐ CELL
	PRIMARY E-MAIL ADDRESS:	
	SECONDARY E-MAIL ADDRESS:	
NAME AND ADDRESS	PRIMARY PHONE # ☐ HOME ☐ BUS ☐ CELL	SECONDARY PHONE # ☐ HOME ☐ BUS ☐ CELL
	PRIMARY E-MAIL ADDRESS:	
	SECONDARY E-MAIL ADDRESS:	

REMARKS (Attach ACORD 101, Additional Remarks Schedule, if more space is required)

REPORTED BY **Marsh**	REPORTED TO

AGENCY CUSTOMER ID: ____

APPLICABLE IN ALASKA

A person who knowingly and with intent to injure, defraud, or deceive an insurance company files a claim containing false, incomplete, or misleading information may be prosecuted under state law.

APPLICABLE IN ARIZONA

For your protection, Arizona law requires the following statement to appear on this form. Any person who knowingly presents a false or fraudulent claim for payment of a loss is subject to criminal and civil penalties.

APPLICABLE IN ARKANSAS, DELAWARE, KENTUCKY, LOUISIANA, MAINE, MICHIGAN, NEW JERSEY, NEW MEXICO, NEW YORK, NORTH DAKOTA, PENNSYLVANIA, RHODE ISLAND, SOUTH DAKOTA, TENNESSEE, TEXAS, VIRGINIA, AND WEST VIRGINIA

Any person who knowlingly and with intent to defraud any insurance company or another person, files a statement of Claim containing any materially false information, or conceals for the purpose of misleading, information concerning any fact, material thereto, commits a fraudulent insurance act, which is a crime, subject to criminal prosecution and [NY: substantial] civil penalties. In LA, ME, TN, andVA, insurance benefits may also be denied.

APPLICABLE IN CALIFORNIA

For your protection, California law requires the following to appear on this form: Any person who knowingly presents a false or fraudulent claim for payment of a loss is guilty of a crime and may be subject to fines and confinement in state prison.

APPLICABLE IN COLORADO

It is unlawful to knowingly provide false, incomplete, or misleading facts or information to an insurance company for the purpose of defrauding or attempting to defraud the company. Penalties may include imprisonment, fines, denial of insurance, and civil damages. Any insurance company or agent of an insurance company who knowingly provides false, incomplete, or misleading facts or information to a policy holder or claimant for the purpose of defrauding or attempting to defraud the policy holder or claimant with regard to a settlement or award payable from insurance proceeds shall be reported to the Colorado Division of Insurance within the Department of Regulatory Agencies.

APPLICABLE IN THE DISTRICT OF COLUMBIA

Warning: It is a crime to provide false or misleading information to an insurer for the purpose of defrauding the insurer or any other person. Penalties include imprisonment and/or fines.

APPLICABLE IN FLORIDA

Pursuant to S. 817.234, Florida Statutes, any person who, with the intent to injure, defraud, or deceive any insurer or insured, prepares, presents, or causes to be presented a proof of loss or estimate of cost or repair of damaged property in support of a claim under an insurance policy knowing that the proof of loss or estimate of claim or repairs contains any false, incomplete, or misleading information concerning any fact or thing material to the claim commits a felony of the third degree, punishable as provided in S. 775.082, S. 775.083, or S. 775.084, Florida Statutes.

APPLICABLE IN HAWAII

For your protection, Hawaii law requires you to be informed that presenting a fraudulent claim for payment of a loss or benefit is a crime punishable by fines or imprisonment, or both.

APPLICABLE IN IDAHO

Any person who knowingly and with the intent to injure, defraud, or deceive any insurance company files a statement of claim containing any false, incomplete or misleading information is guilty of a felony.

APPLICABLE IN INDIANA

A person who knowingly and with intent to defraud an insurer files a statement of claim containing any false, incomplete, or misleading information commits a felony.

APPLICABLE IN KANSAS

A person who knowingly, and with intent to defraud, presents, causes to be presented or prepares with knowledge or belief that it will be presented to or by an insurer, purported insurer, broker or any agent thereof, any written statement as part of, or in support of, an application for the issuance of, or the rating of an insurance policy for personal or commercial insurance, or a claim for payment or other benefit pursuant to an insurance policy for personal or commercial insurance which such person knows to contain materially false information concerning any fact material thereto; or conceals, for the purpose of misleading, information concerning any fact material thereto commits a fraudulent insurance act.

AGENCY CUSTOMER ID: ____

APPLICABLE IN MARYLAND

Any person who knowingly and [or]* willfully presents a false or fraudulent claim for payment of a loss or benefit or who knowingly and [or]* willfully presents false information in an application for insurance is guilty of a crime and may be subject to fines and confinement in prison. *[or] effective 01-01-2013.

APPLICABLE IN MINNESOTA

A person who files a claim with intent to defraud or helps commit a fraud against an insurer is guilty of a crime.

APPLICABLE IN NEVADA

Pursuant to NRS 686A.291, any person who knowingly and willfully files a statement of claim that contains any false, incomplete or misleading information concerning a material fact is guilty of a felony.

APPLICABLE IN NEW HAMPSHIRE

Any person who, with purpose to injure, defraud or deceive any insurance company, files a statement of claim containing any false, incomplete or misleading information is subject to prosecution and punishment for insurance fraud, as provided in RSA 638:20.

APPLICABLE IN OHIO

Any person who, with intent to defraud or knowing that he/she is facilitating a fraud against an insurer, submits an application or files a claim containing a false or deceptive statement is guilty of insurance fraud.

APPLICABLE IN OKLAHOMA

WARNING: Any person who knowingly and with intent to injure, defraud or deceive any insurer, makes any claim for the proceeds of an insurance policy containing any false, incomplete or misleading information is guilty of a felony.

APPLICABLE IN WASHINGTON

It is a crime to knowingly provide false, incomplete, or misleading information to an insurance company for the purpose of defrauding the company. Penalties include imprisonment, fines and denial of insurance benefits.

Admiralty Inlet Pilot Tidal (SnoPUD) Project

OCIP Notice of Work Completion (Form 4)

Subcontractor Name: _____

Project #/Subcontract# _____

Description of Work Performed: _____

Date Work Completed: _____

A. Original Contract Value: _____

B. Total Amount of Change Orders: _____

C. Total Contract Value (A+B) _____

D. Final Self-Performed Contract Value: _____

E. Final Self-Performed Payroll: _____

The following Subcontractors have completed their Work at the Project Site:
(Add attachment if more space is needed)

A Subcontractor's Name	b Subcontract Number	c Description of Work	d Date Completed

The undersigned acknowledges request for termination of coverage under the OCIP as of the date indicated above for the specified Subcontract. Should we return to the work Site, we will be working under our own insurance program and must provide a Certificate of Insurance showing our own coverage as detailed in our Subcontract.

Signed by:

_____ _____

Name & Title Date

Approved by:

_____ _____

Construction Manager (Name & Title) Date

Mail or fax completed form to:

Marsh USA Inc., Attn: Attn: [Name], 111 SW Columbia, Portland, OR 97201 | Fax: (503) 248-1220 | Phone [To Be Determined] | Email [TBD]

Marsh Risk & Insurance Services
345 California Street
San Francisco, CA 94104-2679

Marsh USA Inc.
111 SW Columbia, Suite 500
Portland, OR 97201

California Insurance License #0437153

LEGAL27887060.4

The information contained in this document provides only a general overview of subjects covered, is not intended to be taken as advice regarding any individual situation, and should not be relied upon as such. Insureds should consult their insurance and legal advisors regarding specific coverage issues. All insurance coverage is subject to the terms, conditions, and exclusions of the applicable individual policies. Marsh cannot provide any assurance that insurance can be obtained for any particular client or for any particular risk.

EXHIBIT I

MAINTENANCE BOND

KNOW ALL BY THESE PRESENT: That _____, as principal ("Contractor"), and _____, a _____ corporation, as Surety, are held and firmly bound unto the Public Utility District No. 1 of Snohomish County, Snohomish County, Washington, as obligee ("District"), for itself and for the use and benefit of Claimants as defined below, in the full and just sum of: _____ _____ Dollars ($_____), lawful money of the United States of America ("Bond Amount"), for the payment of which sum well and truly made, the Contractor and the Surety hereby bind themselves, their successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, the said Contractor has entered into a contract in writing with the District dated the _____ day of _____ , 2014 ("Contract") for the

Admiralty Inlet Tidal Project

("Project") according to the terms, conditions, and covenants specified in the Contract and the Drawings and Specifications, all of which are hereby referred to and made a part hereof as fully and completely as though set forth in detail herein,

NOW, THEREFORE, THE CONDITIONS OF THIS OBLIGATION ARE SUCH, that IF the Contractor shall promptly and faithfully perform all the provision of, and fully complete Schedule-2 Work of the Contract according to its terms, conditions and covenants, and shall hold the District harmless from any loss or damage to any person or property by reason of any carelessness or negligence upon the part of the Contractor or of any Subcontractors of any tier in the performance of the Work, THEN this obligation shall be null and void; otherwise this obligation shall remain in full force and effect, subject only to the following conditions:

1. The Surety hereby waives notice of any alteration or extension of time made or ordered by the District.

2. Whenever the Contractor shall be, and is declared by the District to be in default under the Contract for Schedule-2 Work, the District having performed its obligations under the Contract, the Surety shall either (1) promptly remedy the situation, or (2) promptly complete the Contract in accordance with its terms and conditions, or (3) obtain a bid or bids consistent with applicable statutory requirements, for completing Schedule-2 Work of the Contract in accordance with its terms and conditions, and upon determination by the Surety of the lowest responsible bidder, or, if the District elects, upon determination by the District and the Surety jointly of the lowest responsible bidder, arrange for a contract between such bidder and the District, and make available as Work progresses (even though there should be a default or a succession of defaults under the contract or contracts of completion arranged under this paragraph) sufficient funds to pay the cost of completion less the balance of the Contract Price, but not exceeding, including other costs and damages for which the Surety may be liable hereunder, the Bond Amount. The Surety shall also be liable for the costs incurred by the District related to the default, including architect, consultant, employee, and attorneys' fees and costs. The term "balance of the Contract Price," as used in this paragraph, shall mean the total amount payable by the District to the Contractor under the Contract, and any amendments thereto, for Schedule-2 Work, less the amount properly paid by the District to the Contractor for Schedule-2 Work.

3. Any suit under this bond must be instituted before the expiration of six years after the District's discovery of the factual basis for its suit.

4. No right of action shall accrue on this bond to or for the use of any person or corporation other

than the District named herein or its administrators, assigns or successors.

x

x

This Maintenance Bond is signed, sealed and dated this _____ day of _____ , 2014.

Contractor

_____

Surety

_____

Address

_____

Attorney-In Fact

_____

TABLE OF CONTENTS

DIVISION 1
SECTION 01010 – SUMMARY OF WORK

1.01 PROJECT DESCRIPTION
1.02 SCOPE OF WORK AND LOCATION
1.03 MAIN PROJECT FEATURES
1.04 WORK INCLUDED – TO BE PROVIDED BY CONTRACTOR
1.05 WORK AND EQUIPMENT PROVIDED BY THE DISTRICT
1.06 CONTRACT DOCUMENTS
1.07 DELIVERY SCHEDULE
1.08 CONTRACT WORK TIMES
1.09 PREVAILING WAGES/DAVIS-BACON ACT WAGES
2.01 SOURCES FOR MATERIALS
3.01 GENERAL WORK SEQUENCE

SECTION 01025 – MEASUREMENT AND PAYMENT

1.0 MEASUREMENT AND PAYMENT
1.1 ADMINISTRATION
1.2 BID ITEMS
1.3 SCHEDULE OF VALUES LIST
1.4 FORCE (CONTINGENCY) ACCOUNT WORK
1.5 NON-PAYMENT FOR REJECTED OR SURPLUS PRODUCTS OR WORK
1.6 SUBSTITIONS

SECTION 01040 – PROJECT COORDINATION

1.1 PROJECT MANAGER
1.2 MEETINGS
1.3 FIELD ENGINEERING AND SURVEY
1.4 COORDINATION WITH OTHERS
1.5 DIVISION OF WORK
1.6 ARCHAEOLOGICAL INVESTIGATIONS
1.7 CONTRACT CHANGES
1.8 DIFFERING SITE CONDITION
1.9 CONSTRUCTION PROGRESS SCHEDULES
1.10 DISTRICT OCCUPANCY
1.11 SUPERINTENDENT
1.12 CLEAN UP

CHANGE ORDER PROPOSAL (COP)
ENGINEERING CHANGE DIRECTIVE (ECD)
REQUEST FOR INFORMATION (RFI)
PROPOSAL REQUEST (PR)

SECTION 01050 – CONSTRUCTION SCHEDULE AND FAILURE TO MEET COMPLETION DATE/LIQUIDATED DAMAGES

1.01 DESCRIPTION
1.02 REQUIRED COMPLETION DATES
1.03 LIQUIDATED DAMAGES

SECTION 01080 – OPERATION AND MAINTENANCE INFORMATION

1.01 REQUIREMENTS INCLUDED
1.02 QUALITY ASSURANCE
1.03 FORM OF SUBMITTALS
1.04 CONTENTS OF O&M DATA SUBMITTALS
1.05 O&M DATA SUBMITTAL SCHEDULE

SECTION 01090 – EQUIPMENT WARRANTIES FOR CONTRACTOR-SUPPLIED EQUIPMENT

1.01 REQUIREMENTS INCLUDED
1.02 SUBMITTAL REQUIREMENTS
1.03 SUBMITTALS
1.04 CORRECTIONS OF DEFECTS
1.05 RIGHT TO OPERATE UNSATISFACTORY EQUIPMENT
1.06 REQUIRED WARRANTY TERMS

SECTION 01300 – SUBMITTALS AND SHOP DRAWINGS

1.01 SCOPE
1.02 REQUIREMENTS INCLUDED
1.03 RELATED REQUIREMENTS
1.04 POST-BID SUBMISSION REQUIREMENTS
1.05 SUBMITTALS AND SHOP DRAWINGS DURING CONSTRUCTION
1.06 ”OR EQUAL” CLAUSE OR SUBSTITUTIONS
1.07 AS-BUILT DRAWINGS
1.08 COLOR SAMPLES
1.09 DISTRICT’S REVIEW

SECTION 01400 – QUALITY CONTROL

1.1 REFERENCE STANDARDS
1.2 INSPECTION, TESTING, AND CERTIFICATION

SECTION 01500 – CONSTRUCTION CONTROLS AND TEMPORARY FACILITIES

1.01 DESCRIPTION
1.02 TEMPORARY LIGHT AND POWER
1.03 ROADWAY AND TRAFFIC CONTROL
1.04 SECURITY AND ACCESS
1.05 SAFETY
1.06 DUST CONTROL
1.07 TEMPORARY DRAINAGE PROVISIONS
1.08 POLLUTION CONTROL

SECTION 01550 – PROTECTION OF THE ENVIRONMENT

1.01 DESCRIPTION
1.02 RELATED SECTIONS
1.03 PERMITS
1.04 SUBMITTALS
2.01 PRODUCTS - GENERAL
3.01 WATER POLLUTION AND ENVIRONMENTAL PROTECTION
3.02 REMOVAL OF TEMPORARY FACILITIES
3.03 ENVIRONMENTAL MANAGEMENT PLAN

SECTION 01600 – PRODUCT DELIVERY, STORAGE, AND HANDLING

1.01 PACKAGING, SHIPPING, AND STORAGE

SECTION 01700 – CONTRACT CLOSEOUT

1.1 DOCUMENTS REQUIRED UPON COMPLETION OF WORK

SECTION 01710 – CLEANING

1.01 RELATED REQUIREMENTS SPECIFIED ELSEWHERE
1.02 DESCRIPTION
1.03 SAFETY REQUIREMENTS
2.01 MATERIALS
3.01 DURING CONSTRUCTION
3.02 FINAL CLEANING

SECTION 01720 – PROJECT AS-BUILT DOCUMENTS

1.01 RELATED REQUIREMENTS SPECIFIED ELSEWHERE
1.02 DESCRIPTION
1.03 MAINTENANCE OF DOCUMENTS
1.04 MARKING DEVICES
1.05 RECORDING

SECTION 01735 – COMMISSIONING, START-UP, AND TESTING

1.01 DISTRICT-FURNISHED EQUIPMENT
1.02 CONTRACTOR-FURNISHED EQUIPMENT

DIVISION 2 – SITE WORK

SECTION 02001 – HORIZONTAL DIRECTIONAL DRILLING
SECTION 02110 – PROTECTION OF ENVIRONMENT
SECTION 02200 – EARTHWORK
SECTION 02210 – SITE CLEARING
SECTION 02250 - TRENCH SAFETY SYSTEMS
SECTION 02275 – CMU RETAINING WALL
SECTION 02510 – ASPHALTIC CONCRETE PAVING
SECTION 02700 – SITE DRAINAGE
SECTION 02710 – SUBDRAINAGE

DIVISION 3 – CONCRETE
SECTION 03300 – CAST IN PLACE CONCRETE
SECTION 03366 – CONCRETE SEALER/HARDENER
SECTION 03600 – GROUTING

DIVISION 4-5
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DIVISION 6 – WOOD AND PLASTIC
SECTION 06100 – ROUGH CARPENTRY
SECTION 06190 – WOOD TRUSSES
SECTION 06200 – EXTERIOR FINISH CARPENTRY

DIVISION 7 – THERMAL AND MOISTURE PROTECTION
SECTION 07210 – BUILDING INSULATION
SECTION 07260 – AIR-WEATHER BARRIER
SECTION 07410 – METAL ROOF PANELS
SECTION 07462 – FIBER CEMENT SIDING
SECTION 07620 – SHEET METAL FLASHING AND TRIM
SECTION 07900 – JOINT SEALERS

DIVISION 8 – DOORS AND WINDOWS
SECTION 08100 – METAL DOORS AND FRAMES
SECTION 08360 – SECTIONAL OVERHEAD DOORS
SECTION 08710 – DOOR HARDWARE

DIVISION 9 – FINISHES
SECTION 09120 – ACOUSTICAL SUSPENSION SYSTEMS
SECTION 09250 – GYPSUM BOARD
SECTION 09510 – ACOUSTICAL LAY-IN PANEL CEILINGS
SECTION 09900 – PAINTING

DIVISION 10 – SPECIALTIES
SECTION 10200 – LOUVERS AND VENTS
SECTION 10522 – FIRE EXTINGUISHERS
SECTION 10719 – FLOOD BARRIERS

DIVISION 11 – 14
INTENTIONALLY LEFT BLANK

DIVISION 15 – MECHANICAL
SECTION 15010 – COMMON WORK RESULTS FOR MECHANICAL
SECTION 15090 – HANGERS AND SUPPORTS
SECTION 15250 – INSULATION
SECTION 15421 – CONDENSATE PIPING
SECTION 15509 – CLEAN-AGENT FIRE EXTINGUISHING STSYEMS
SECTION 15810 – SPLIT SYSTEM HEAT PUMPS
SECTION 15811 – SPLIT SYSTEM HEAT PUMPS WALL MOUNT
SECTION 15840 – HVAC DUCTS AND CASINGS
SECTION 15860 – DUCT ACCESSORIES
SECTION 15870 – AIR OUTLETS AND INLETS
SECTION 15900 – ELECTRIC AND ELECTRONIC CONTROL SYSTEM

SECTION 15905 – SEQUENCE OF OPERATION
SECTION 15950 – TESTING, ADJUSTING, BALANCING
SECTION 15995 – COMMISSIONING

DIVISION 16 – ELECTRICAL
SECTION 16010 – ELECTRICAL GENERAL REQUIREMENTS
SECTION 16050 – BASIC MATERIALS & METHODS
SECTION 16060 – GROUNDING & BONDING
SECTION 16148 – OCCUPANCY SENSORS
SECTION 16302 – UNDERGROUND ELECTRICAL DISTRIBUTION
SECTION 16400 – ELECTRICAL DISTRIBUTION
SECTION 16500 – LIGHTING
SECTION 16720 – SECURITY ACCESS SYSTEMS
SECTION 16741 – TELECOMMUNICATIONS PREMISES WIRING

DIVISION 17
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DIVISION 18 – MARINE OPERATIONS
SECTION 18000 – MARINE OPERATIONS
SECTION 18010 – MARINE CABLE
SECTION 18020 - MARINE CABLE ACCESSORIES

DIVISION 1

GENERAL REQUIREMENTS

SECTION 01010

SUMMARY OF WORK

1.01 PROJECT DESCRIPTION

The Public Utility District No.1 of Snohomish County (DISTRICT) is installing two tidal turbines in Admiralty Inlet to generate electricity and gather data to inform the technical, economic, and environmental viability of tidal energy generation.

This research project is funded in part by the U.S. Department of Energy and licensed by the Federal Energy Regulatory Commission (FERC) through its pilot licensing program. Once the FERC license is obtained, the DISTRICT will have 10-years to construct, operate and remove the turbines and associated equipment. It is a Project objective to obtain 5-years of operational data within this 10-year period. The DISTRICT has partnered with the University of Washington ("UW") to develop an environmental monitoring plan, which will include cameras and other monitoring equipment fastened to the turbines for this purpose.

The Work associated with this Project includes the coordination, oversight and construction necessary to construct a fully operational tidal energy generation system including all marine and land operations excluding those specifically related to the delivery and placement of the DISTRICT-furnished tidal Turbine Units (defined below) and the procurement of other specified materials. The DISTRICT is contracting directly with OpenHydro, based in Greenore, Ireland, to procure two 6-meter diameter turbines ("Turbines") and two subsea base structures ("Subsea Bases"). Upon completion of the integration of the Turbines with their respective Subsea Bases, OpenHydro will then deliver the integrated devices ("Turbine Units") to the seafloor via an OpenHydro Deployment barge. OpenHydro will also supply the power conditioning and control equipment, which will be installed in the Power Conditioning and Control Building (PCCB) on shore by the CONTRACTOR. The method for deployment of the Turbine Units (by others) is further described in the Contract Documents. The CONTRACTOR shall be responsible for marine operations including the cable and termination procurements, cable lays and shore landings utilizing horizontal directional drilling (HDD), cable connections to the Turbine Units and coordination with other marine and terrestrial operations of the Project. The CONTRACTOR shall also be responsible for site preparation, construction of the 720sf PCCB, and integration with OpenHydro, UW, and other providers to result in a complete and operational tidal energy project.

1.02 SCOPE OF WORK AND LOCATION

The CONTRACTOR shall furnish all labor, equipment, tools, goods, materials, and incidentals necessary to procure and install the following items and other system appurtenances as specified in the Contract Documents. The scope of Work includes, but is not limited to:

A. Mobilization/demobilization.

B. Temporary construction facilities.

C. Erosion and sedimentation control measures.

D. Installation of on shore splicing vault and associated disconnect switch (provided by the DISTRICT).

E. Installation of conduit(s) via HDD.

F. Construction of the PCCB and related site improvements.

G. Procurement, testing and verification of two 2.4km trunk cables (Trunk Cables), six 200-meter Turbine Umbilical (TU) cables and associated dry-connection terminations for same.

H. Engineering and fabrication of the Turbine Umbilical Storage Platform ("TUSP") (qty-2).

I. Coordination of TUSP deliveries to the Turbine Mobilization Site.

J. Oversight of TUSP attachments to the Subsea Bases and connection of the TU cables to the Turbine Units (qty-2).

K. Installation and testing of two 2.4km Trunk Cables from the area adjacent to the respective Turbine Unit location to the shore vault.

L. Recovery and connection of the TU cables to the Trunk Cables for each Turbine Unit.

M. Installation and wiring of all electrical and mechanical equipment associated with construction of the PCCB and related site improvements.

N. Supply of all mechanical and electrical equipment associated with the PCCB and related site improvements.

O. Assistance with Project commissioning and start-up.

P. Contingency Account work, as required.

Q. Safety program and systems for the site, including but not limited to trench safety and coordination.

R. Incidental work and activities as follows:

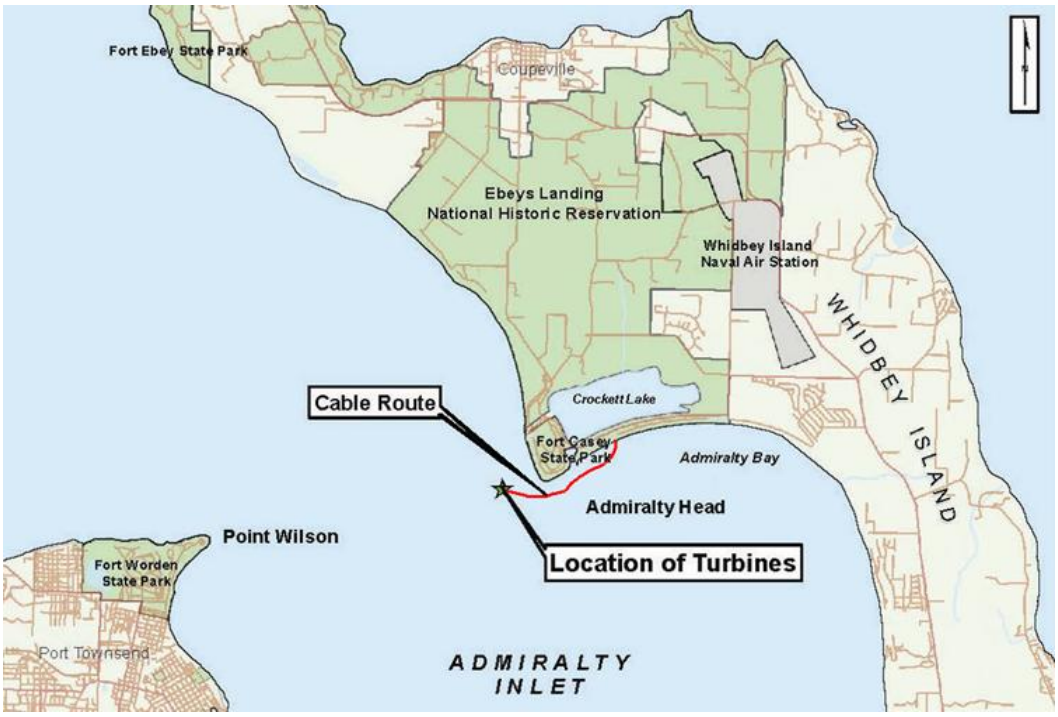
1. Become familiar with the Project site, including the required schedule, sequence, completion milestones, construction routes and specified materials.

2. Prepare for and perform de-watering of excavated areas if required in accordance with approved temporary erosion/sedimentation protection measures and permit conditions.

3. Provide suitable waste disposal sites for any waste materials. The CONTRACTOR shall be responsible for the proper disposal offsite of all solid and liquid waste materials generated from the Project per Washington State and Island County standards.

4. Restore to pre-construction conditions all road shoulders, ditches, and culverts and any other items or property disturbed by the CONTRACTOR'S construction operations.

The Project site is shown in the following map:



Driving Instructions to Power Commissioning and Control Building site:

Address:
13254 SR-20
Coupeville, WA 98239

<u>From Mukilteo-Clinton Ferry:</u>
Exit the ferry in Clinton and head northwest on SR-525 for 21.7 miles. Turn left onto SR-20 (Follow Signs to Keystone Ferry). The Project site is located approximately ¼ mile prior to reaching the Ferry dock.

From Oak Harbor (North)
Follow SR-20 South out of Oak Harbor towards Coupeville for 9.5 miles. Turn right on Main Street, continue on to Engle Road and ultimately to the ferry terminal where the road turns in to SR-20. The Project site is approximately ¼ mile past the ferry terminal on the right.

GPS Coordinates: 48 Deg. 09' 38" N / 122 Deg. 39' 53" W.

1.03 MAIN PROJECT FEATURES

A. The Power Commissioning and Control Building (PCCB) will be an above-ground, wood-framed structure that houses the equipment required to transfer the three-phase variable voltage, variable frequency power generated by the Turbines to consistent 7.2 kV, single-phase, grid compliant power for integration with Puget Sound Energy's distribution network. The equipment is designed with a SCADA (remote operator's terminal) system that will allow remote monitoring and control of the plant. Other PCCB features include security components, lighting, heating/cooling, ventilation and miscellaneous appurtenances.

B. Tidal Turbine/Generators: The 6-meter diameter Turbine Units for the Project will be provided by the DISTRICT via a supply agreement with OpenHydro, an Irish technology company that designs and manufactures marine turbines to generate renewable energy from tidal streams. The Turbines are being manufactured at the OpenHydro facility in Greenore, Ireland. The Turbines will be shipped to the Turbine Mobilization Site, a shipyard in the greater Puget Sound region, where they will be mated with Subsea Bases being fabricated specifically for this purpose. With the exception of some limited coordination involving the CONTRACTOR, the above effort shall be conducted by OpenHydro.

Turbine design parameters:

Turbine size	6 meter
Turbine/Generator qty	2 each
Nameplate kW	300kW
Depth of Turbine/Generator	58 meters (190-feet)
Generator Type	PMG Synchronous AC – 3-phase
Generator Output Voltage	Variable 0-400VAC – 3-phase
Generator Output Frequency	Variable 10-60Hz
Peak kW output - total	300 kW
Avg. kW output - total	28 kW
Est. Annual kWh	244,600 kWh/year
Grid Connection Voltage	7.2 kV, single-phase
Qty of sea to shore cables	2 each
Sea to Shore cable voltage	4 kV – 3-phase

C. Trunk Cables (qty-2) – The proposed subsea cables supplied by the CONTRACTOR are approximately 2.4km in length each. Each cable is roughly

2" in diameter, contains twelve (12) single mode optical fibers, nine (9) high power elements and twelve (12) low power elements.

D. Turbine Umbilical Storage Platform (TUSP) (qty-2) – The TUSP is the platform that stores the Turbine Umbilical (TU) cables for the duration of proposed multi-year Turbine deployment. The TUSP and the integrated TU cables shall be completely engineered, fabricated and supplied by the CONTRACTOR to the Turbine Mobilization Site, where they will be connected to the Turbine Units by others, under the direct supervision of the CONTRACTOR. While performance data and other information is provided in the Contract Documents, the ultimate engineering and fabrication of the TUSP is the CONTRACTOR's responsibility and shall be engineered around the marine operational plans proposed through the submittal process outlined herein.

E. Horizontal Directional Drilled Conduit(s) – The CONTRACTOR shall install high density polyethylene conduit(s) through an HDD operation in order to pass the cables under the shoreline environment and the beach, ultimately emerging on private property. The conduit(s) will be approximately 650-feet long and will extend to roughly 19-meters depth in the marine environment.

F. The Power Conditioning and Control Building (PCCB), together with the immediate surrounding site, will house the equipment that converts the generated tidal energy to grid-compliant power. The equipment consists of banks of batteries capable of storing the tidal energy connected to inverters which ultimately deliver it to the grid on a prescribed schedule. This specific equipment shall be provided by the DISTRICT; however, the PCCB and all the supporting infrastructure will be the responsibility of the CONTRACTOR.

G. The Project site is defined as the deployment site in Admiralty Bay, including the cable route to shore, shore landing and PCCB. See map above.

1.04 WORK INCLUDED - TO BE PROVIDED BY CONTRACTOR

The Work under this Contract includes but is not limited to the following:

A. SCHEDULE-1 WORK

1. Assistance in the development of the Hazard Identification and Risk Assessment (HIRA) required by the FERC license requirements as outlined in Appendix-K. CONTRACTOR shall attend meetings, provide input, and participate in the completion of the HIRA. The DISTRICT shall lead this effort with input from the CONTRACTOR and other marine contractors involved in the Project.

2. Coordination and supervision of specific marine operations to ensure the HDD, cable lay and cable connection operations are successfully completed on schedule.

3. Coordination with the DISTRICT and others as required to satisfy all technical and contractual obligations associated with the Project. Coordination shall include multiple meetings at the DISTRICT's headquarters and Turbine Mobilization Site, the transport of materials and equipment as required, labor associated with the cable inspection and handling.

4. The transport of materials, equipment and personnel as required to and from the Turbine Mobilization Site and Project site for the purposes of coordination, inspections and testing.

5. Provision of temporary construction facilities other than those provided by the DISTRICT, including provision and set up of field offices, temporary power, communications, and sanitary facilities on shore at the Project site for the CONTRACTOR and DISTRICT.

6. Procurement and installation of two (2) 2.4 kilometer cables and associated connections in accordance with the Contract Documents. The cables are set on the seafloor (not trenched) in an aquatic lease to the DISTRICT from the Washington State Department of Natural Resources. CONTRACTOR shall provide the DISTRICT with ROV video footage and coordinates of the entire installation.

7. Turbine Umbilical cable procurement (qty-6) – The TU cables will be approximately 200-meters in length each. The TU cables shall be identical to and cut from the same production run as the Trunk Cables. Integrated dry-connection terminators have been specified on both ends of each TU cable. Two umbilical cables will be used for the initial deployment and the remaining set aside as spares for subsequent deployments as required.

8. Umbilical Delivery (qty-2) - The CONTRACTOR shall engineer and fabricate two (2) Turbine Umbilical Storage Platforms (TUSPs) in accordance with the CONTRACTOR's Cable Connection Plan (CCP). Once fabricated, umbilical cable sections shall be arranged within the TUSPs and delivered to the Turbine Mobilization Site as a complete ROV compatible assembly. Upon its arrival, the DISTRICT will receive the TUSPs, review TU cable integrity, and perform the integration of its components with the Turbine Unit(s).

9. Coordination and completion of two marine operations, one for each Turbine Unit, where the TU cables are connected to the Trunk Cable. The

TU cables are recovered from the TUSP and the previously installed Trunk Cable end is recovered from the seafloor and a dry-connection is performed on the CONTRACTOR's Cable Connection Vessel (CCV). The connected cable is subsequently re-laid into a service loop on the seafloor. The CONTRACTOR shall provide ROV video footage of the entire installation.

10. Installation of horizontally directionally drilled (HDD) conduit(s). The CONTRACTOR shall install high density polyethylene conduit(s) via an HDD operation in order to pass the cable through the shoreline environment and the beach, ultimately landing on private property. The CONTRACTOR may elect to drill and install one larger diameter conduit with sub-ducts necessary to convey the two proposed cables to shore, or may elect to drill and install two separate, smaller diameter conduits to achieve the same objective. In either scenario, the conduit(s) will be approximately 650-feet long and will extend to roughly 19-meters in depth in Admiralty Bay.

11. Construction of a 720-square-foot Power Conditioning and Control Building (PCCB), including but not limited to furnishing and installing the wood framed structure, doors, and finishes.

12. Performance of all site Work improvements associated with the PCCB.

13. Supply, installation and wiring of mechanical, security, communications, and electrical equipment in the PCCB not supplied by the DISTRICT (including HVAC, lighting, etc.).

14. Installation and wiring of DISTRICT-supplied energy storage systems, control panels, and auxiliary equipment in the PCCB (see more complete list of DISTRICT-Furnished Equipment detailed in Paragraph 1.05 of this Section).

15. Erosion and sedimentation control measures as required by the Drawings, Specifications and Project permits.

16. Commissioning and start-up assistance, including testing of installed components, assisting the DISTRICT's staff and equipment supply contractor with check-out and commissioning of plant equipment and systems, and plant start-up and testing.

17. The CONTRACTOR shall comply with RCW 39.04.180 regarding trench safety systems. In any Work or operation involving trenching where the depth will exceed four (4) feet, the CONTRACTOR will provide adequate safety systems for such trenching and excavation that meets the requirements of the Washington Industrial Safety and Health Act, RCW

Chapter 49.17. The CONTRACTOR shall furnish the DISTRICT with a separate cost estimate for all required trench safety systems, and such cost shall be included in the designated location on the Bid form.

B. SCHEDULE-2 WORK

1. As requested by the DISTRICT on an as needed basis for up to three years following deployment of the Turbine Units and Substantial Completion of the Schedule-1 Work, coordinate and complete the marine operations and support required to recover one or both of the previously deployed Turbine Units. The operations include but are not limited to the preparation of the Turbine Unit(s) for recovery by OpenHydro or others, including severing the umbilical cable adjacent to the Subsea Base, preparation and delivery of the integrated TUSP and replacement umbilical, oversight and inspection of the wiring on the Subsea Base, and reconnection of the Trunk Cable to the TU cable in accordance with marine operations procedures to be prepared by CONTRACTOR in the CCP consistent with those in Schedule-1.

2. Commissioning and start-up assistance, including testing of installed components, assisting the DISTRICT's staff and equipment supply contractor with check-out and commissioning of plant equipment and systems, and plant start-up and testing.

3. Coordination and supervision of specific marine operations to ensure that operations are successful, safe and completed on schedule.

1.05 WORK AND EQUIPMENT PROVIDED BY THE DISTRICT

A. The major equipment items to be provided by the DISTRICT include the following, which are further described in the Contract Documents. The CONTRACTOR shall also be required to coordinate delivery, receiving, temporary storage and crane Work as necessary.

1. The DISTRICT, through its supply agreement with OpenHydro, will furnish and deliver to the seabed, two (2) open centre tidal Turbine Units at the locations identified in the Drawings.

2. The 15kv switch cabinet designed to be placed on the CONTRACTOR-supplied vault will be supplied by the DISTRICT. The CONTRACTOR shall provide the DISTRICT with two weeks' notice prior to the desired delivery date. The CONTRACTOR shall supply a crane and other support necessary to remove the switch from the delivery truck.

3. The DISTRICT, through OpenHydro, will supply all of the inverters and battery cabinets, together with their internal components as identified in the Contract Documents. The CONTRACTOR shall be required to furnish all

necessary labor, materials and equipment necessary to complete the integration and wiring associated with all of these cabinets.

4. The DISTRICT will furnish two transformers located between the shore vault/switch and the PCCB. All labor, materials and equipment associated with the installation and wiring of these transformers shall be provided by the CONTRACTOR.

5. The DISTRICT, through its supply agreement with OpenHydro, will supply the software and integration services associated with the Turbine Units and power conversion SCADA systems.

B. The CONTRACTOR will provide field assistance for the DISTRICT during construction, testing and commissioning.

1.06 CONTRACT DOCUMENTS

A. Drawings: The CONTRACTOR's Work shall conform to the Drawings, all of which are made a part of this Contract.

B. Shop Drawings and Product Data submitted by the CONTRACTOR and reviewed and accepted by the DISTRICT shall be consistent with the Contract Documents. Time and scope of submittal requirements for outline, detailed, final, and installation Shop Drawings are specified in Section 01300 – Submittals and Shop Drawings, and in Division 18000-Marine Operations.

1.07 DELIVERY SCHEDULE

A. The CONTRACTOR shall complete designated portions of the Work required under these Contract Documents within the Contract Time specified in the Agreement. Time shall be computed starting with the date of the Notice to Proceed.

B. Upon receipt of the Notice to Proceed, the CONTRACTOR shall submit Product Data, schedules and other specified data in accordance with Section 01300 – Submittals and Shop Drawings.

C. The point of delivery of all DISTRICT-Furnished Equipment to be installed by the CONTRACTOR has been designated as the Project site. The DISTRICT's equipment suppliers will be instructed to provide reasonable advance notice of shipping and a 48-hour confirming notice of impending arrival at the site. The site address is:

Public Utility District No. 1 of Snohomish County
Attn: Admiralty Inlet Pilot Tidal Project
13254 SR-20
Coupeville, WA 98239

(Refer to site location map and driving directions as specified in 1.02 of this Section)

All items should be clearly marked:

"For Admiralty Inlet Pilot Tidal Project"

D. Submittals of Manufacturer's Instructions, Operation and Maintenance Manuals, and as-built drawings for all equipment supplied by the CONTRACTOR shall be provided in accordance with submittal requirements in Section 01300 – Submittals and Shop Drawings.

The CONTRACTOR shall supply all materials necessary to complete the Work required by this Contract except for those materials to be supplied by the DISTRICT or others as listed above.

In all cases, the DISTRICT's Contract is with the CONTRACTOR, and it is the CONTRACTOR's responsibility to ensure all Work required to provide a complete and operational facility is included in the CONTRACTOR's Bid. When possible, the DISTRICT has attempted to reference Work which should be coordinated with various trades, but it is the CONTRACTOR's responsibility to coordinate and schedule the Work of all Subcontractors, trades, and suppliers to assure the proper and timely prosecution and completion of all items of Work.

The CONTRACTOR shall take field measurements and verify field conditions and shall carefully compare such field measurements and conditions and other information known to the CONTRACTOR with the Contract Documents before commencing activities. Errors, inconsistencies or omissions discovered shall immediately be reported to the DISTRICT.

1.08 CONTRACT WORK TIMES

Contract Work times for shore activities shall generally be Monday through Friday between 7 a.m. and 6 p.m., excluding holidays, or as otherwise approved by the DISTRICT.

The CONTRACTOR shall submit a weekly proposed Work plan showing required inspections for Monday through Sunday of the following week. This Work plan shall be given to the DISTRICT for approval by 9:00 a.m. every Thursday, in conjunction with the coordination meeting as described in Section 01040 – Project Coordination.

Work not specifically detailed on the weekly Work plan as requiring inspection shall not be performed unless approved by the DISTRICT. The CONTRACTOR shall reimburse the DISTRICT for all inspection of Work not previously scheduled or approved by the DISTRICT. Work requiring inspection shall be determined solely by the DISTRICT.

Other suppliers, contractors, consultants, and the DISTRICT will be working at and near the site during construction. It shall be the responsibility of the CONTRACTOR to coordinate its Work with all other entities.

The CONTRACTOR shall also be responsible to minimize disruptions to local access roads. Directions of the DISTRICT and/or inspector shall be followed at all times.

1.09 PREVAILING WAGES/DAVIS-BACON ACT WAGES

In addition to the requirements of the General Conditions, the CONTRACTOR shall post on the Project site a copy of its Statement of Intent to Pay Prevailing Wages. Current prevailing wage rates for this Project, including Davis-Bacon Act wages, are included as Exhibit D of the General Conditions and available online. CONTRACTOR shall comply with all applicable requirements.

Payments cannot be released by the DISTRICT until the DISTRICT has received a Statement of Intent to Pay Prevailing Wages and an Affidavit of Wages Paid has been filed with the Washington Department of Labor & Industries. Additional information regarding these submittals can be obtained by calling the Department of Labor & Industries, Prevailing Wage at 360-902-5335, or by visiting their website.

PART 2 - PRODUCTS

2.01 SOURCES FOR MATERIALS

The CONTRACTOR shall be responsible for the supply of all construction materials not indicated as DISTRICT-supplied or supplied by others (refer to Paragraph 1.05 of this Section).

PART 3 - EXECUTION

3.01 GENERAL WORK SEQUENCE

The actual Work sequence and means and methods for this Work is the CONTRACTOR's responsibility. In general, however, it is envisioned that the Work will proceed in the following sequence:

A. Prepare submittals, perform design reviews and submit for long-lead delivery items such as subsea cables and connectors.
B. Order long-lead items.

C. Attend meetings as required, including those outlined in the Contract Documents, including Section 18000.
D. Prepare submittals as required by the Contract Documents.
E. Mobilize to shore-side landing site.
F. Clearing and site preparation at the building site.
G. Mobilize and execute HDD.
H. Install disconnect switch and associated vault.
I. Install all subsurface conduits.
J. Construct Power Conditioning and Control Building.
K. Receive and install battery storage and power conversion equipment supplied by the DISTRICT.
L. Perform the installation, wiring and integration of all equipment, both DISTRICT-supplied and CONTRACTOR-supplied.
M. Install all communications and security wiring, racks and associated equipment.
N. Coordinate and install interconnection equipment to Puget Sound Energy grid.
O. Prepare and mobilize cable lay barge/vessel.
P. Install subsea Trunk Cables with ROV inspection. Terminate at shore-side disconnect switch.
Q. Perform prescribed testing of Trunk Cables
R. Install remainder of equipment, both DISTRICT and CONTRACTOR-supplied
S. Prepare all systems for connection to the tidal Turbine Units.
T. Upon successful Turbine Unit deployment, perform cable connections (qty-2) between the TU cables and Trunk Cables. Anticipate multi-week separation between each Turbine Unit deployment, and multiple mobilizations.
U. Provide support for system start-up and commissioning.

Other Work sequences are possible. Determination of the actual sequence is the CONTRACTOR's responsibility.

Target on-line date for the Project is on or before October 14, 2015.

DISTRICT-Furnished Equipment has already been arranged. Delivery dates for DISTRICT-Furnished Equipment are outlined in Section 01050. The DISTRICT intends but is not bound to deliver DISTRICT-Furnished Equipment by the specified dates.

END OF SECTION

SECTION 01025

MEASUREMENT AND PAYMENT

1.0 MEASUREMENT AND PAYMENT

Payment at the unit and lump sum prices agreed upon shall be in full for the completed Work and shall cover all expenditures incidental to completion of the Project as described and specified. All costs and expenses for items of Work, tools, equipment, materials, transportation, and shipping needed to complete the Project and reasonably inferable from the Contract Documents, shall be considered incidental to the Project; no separate payment of any kind shall be made for such incidental items. No separate payment of any kind will be made for any additional Work or materials required due to the CONTRACTOR's failure to properly execute the Work as specified herein and as reasonably inferable on the Contract Documents. The DISTRICT shall determine properly executed Work. No separate payment shall be made for materials which are used for purposes other than those specified herein or in the Contract Documents.

Certified material delivery tickets and/or invoices from material suppliers shall be furnished to the DISTRICT by the CONTRACTOR for all materials delivered to the Work site.

1.1 ADMINISTRATION

A. Authority

Payment will be made monthly based on the Schedule of Values (SOV). The SOV shall be prepared and submitted by the CONTRACTOR for approval by the DISTRICT at least 10 business days before submittal of first invoice for the Work, or as otherwise indicted by the DISTRICT's representative. All lump sum items shall be broken down by the CONTRACTOR in its submittal. Percent completion will be calculated by the DISTRICT based on SOV and material on hand and will be reviewed with the CONTRACTOR at the last weekly progress meeting of each month. Material not located at the Project site will not be paid for without the DISTRICT's written permission. Once material is on hand, it will be considered part of the Project and shall not be removed for any reason until the entire Project is complete.

In case Work is suspended or if insignificant progress is being made, the DISTRICT may, at its discretion, make progress estimates at intervals longer than once a month.

Invoices shall be mailed to the attention of:

Eric Schneider - DISTRICT's Representative
Public Utility District No. 1 of Snohomish County
PO Box 1107
Everett, WA 98206-1107

NOTE: All questions regarding Contract status or payments should be directed to the DISTRICT's Representative.

B. Unit Quantities Specified

Any quantities indicated in the Bid form are for bidding purposes only. Adjustments to the Contract Price due to changes in quantity shall be in accordance with the Contract Documents.

The DISTRICT reserves the right to delete any Work from the Contract by notifying the CONTRACTOR in writing of its intent. In the event of deleted Work, the CONTRACTOR's sole compensation shall be the money due the CONTRACTOR for materials that had been purchased and obtained by the CONTRACTOR prior to the deletion of the Work.

C. Contract Price

The lump sum and any unit bid prices shall be full and complete compensation for the Contract Work, together with all appurtenances incidental thereto, including materials, equipment, tools, labor, and all the costs to the CONTRACTOR for completing the Contract in accordance with the Contract Documents.

All Work not specifically described or mentioned in the Contract Documents, but required to be constructed to achieve complete and operable systems, structures or amenities shall be considered incidental items of Work, not separately compensable, and included in the Contract Price.

D. Non-Payment for Rejected or Surplus Products

Payment will not be made for any of the following:
1. Products wasted or disposed of in a manner that is not acceptable.
2. Products determined as unacceptable before or after placement.
3. Products not completely unloaded from the transporting vehicle.
4. Products placed beyond the lines and levels of the required Work.
5. Products remaining on hand after completion of the Work.
6. Loading, hauling and disposing of rejected products.

1.2 BID ITEMS

SCHEDULE-1

(BID ITEM #1) TIDAL ENERGY SYSTEM INSTALLATION

The Work under this item shall include all labor, materials and equipment necessary to construct the specified infrastructure for the tidal energy system, in accordance with the Contract Documents. A schedule of values (SOV) for this item shall be developed in coordination with the DISTRICT and shall be in accordance with Section 01025-1.3.

A. MOBILIZATION/DEMOBILIZATION (SOV shall not exceed 5% of the Contract Price)

i. Mobilization/Demobilization payment shall constitute full compensation for all labor, equipment, and materials necessary to mobilize to the Project site, prepare Work areas, demobilize, including clean up, and site restoration. Phases of the Project may require multiple mobilizations/demobilizations by some Subcontractors. Mobilization/demobilization will only be paid once regardless of the number of mobilizations and demobilizations, except as noted below.

ii. Separate mobilization/demobilization amounts will be developed for the horizontal directional drilling, the cable lay operation and the cable connection marine operation, and shall not be considered in the 5% limitation described above.

iii. Mobilization for the Project is intended to include the necessary preparatory Work prior to beginning construction and following construction of tasks including movement of personnel, equipment, supplies and incidentals to the Project site, establishment of an on-site office and storage facilities, establishment of temporary power and service facilities, including sanitation and water, and any other Work and operations which must be performed or costs which must be incurred incidental to beginning and ending Work for this Project.

iv. All facilities and equipment that are established or brought to the Project site shall be subject to the provisions of this Section unless the DISTRICT specifically provides otherwise in writing for a particular item or items. The CONTRACTOR shall be solely responsible for the adequacy, efficiency, use, protection, maintenance, repair and preservation of all of CONTRACTOR's facilities and equipment. The facilities and equipment covered by this Section shall not be dismantled or removed from the Project site prior to completion of the Work under the Contract without the written authorization of the DISTRICT.

v. All facilities and equipment on the Project site shall be subject to the DISTRICT's right to take possession of and utilize the same for the purposes of completion of the Work should the DISTRICT terminate the Contract. In addition, any encumbrance, lien or other security interest on any such facilities or equipment shall be subordinated to the DISTRICT's right to utilize all facilities and equipment to complete Work under the Contract, and CONTRACTOR agrees to take any and all steps necessary to remove any such encumbrances, liens, and security interests. The CONTRACTOR further agrees to provide evidence acceptable to the DISTRICT that it has performed this duty.

vi. It shall be the responsibility of the CONTRACTOR to provide all temporary services as needed and as described in Section 01500 – Construction Controls and Temporary Facilities.

vii. For mobilization/demobilization, 70% will be paid upon completion of the initial mobilization and Project site preparation. The remaining 30% will be paid upon completion of all site restoration and clean up at the end of the Project.

B. CONSTRUCTION OF POWER CONDITIONING AND CONTROL BUILDING (PCCB)

i. The Work will include all labor, materials and equipment to construct the Power Conditioning and Control Building (PCCB) to include architectural, site and structural work, electrical, HVAC, lighting, roofing, security, sewer, excavation, foundation, doors, sidewalks, painting and water proofing, and other work in accordance with the Contract Documents.

ii. CONTRACTOR shall include in this item, the cost of achieving the final grades shown on the Contract Documents beginning with the existing conditions as represented in the site survey and the Geotechnical Report (Appendix-F), and included in the Contract Documents. All excavation to suitable bearing soil, furnishing and installing all construction aggregates and compaction required to achieve the final grades shall be included in this item. Efforts associated with soil management, including utilizing on-site mineral soils as structural fill and placing materials in the designated fill areas in accordance with the Contract Documents, are also included in this item.

iii. Additional Work incidental to the construction of the PCCB and associated site Work shall include connecting all utilities to the existing utility provider to make the building completely usable and operable.

iv. The DISTRICT will pay all permanent utility connection costs either via the Contingency Account with no CONTRACTOR mark-up or directly to the utility provider.

v. A percent of the SOV amount shall be paid each pay period based upon the estimated percent of completion as determined by the DISTRICT's representative.

C. INSTALLATION AND WIRING OF DISTRICT SUPPLIED MECHANICAL AND ELECTRICAL EQUIPMENT FOR PCCB

i. The Work will include all labor, equipment and materials necessary for the installation, wiring, testing and certification of mechanical and electrical equipment in and around the PCCB, which equipment will be supplied by the DISTRICT as indicated in the Contract Documents. Items include but are not limited to power control and conditioning equipment, the battery cabinets in the fence area and the vault and switch on the site. Item shall include payment for the unloading and storage of DISTRICT-Furnished Equipment delivered to the Project site. Work also includes, but is not limited to the DISTRICT-Furnished Equipment listed in Section 01010 – Summary of Work, Paragraph 1.05.

ii. A percent of the SOV amount shall be paid each pay period based upon the estimated percent of completion as determined by the DISTRICT's representative.

D. INSTALLATION AND MAINTENANCE OF EROSION & SEDIMENTATION CONTROL MEASURES

i. Payment shall constitute full compensation for all labor, equipment, and materials necessary to install, maintain and remove at the end of the job, all erosion and sedimentation control measures as required by the Contract Documents and Project permits.

ii. SOV payments shall be made on a lump sum basis with 50% payment upon completion of initial installation of all measures and 50% upon completion of the Project, provided measures are properly maintained and performing throughout the duration of the Project.

E. HIGH DENSITY POLYETHYLENE CONDUIT(s) INSTALLED VIA HORIZONTAL DIRECTIONAL DRILLING

i. Payment shall constitute full compensation for all labor, equipment, and materials necessary to install high density polyethylene conduit(s) (diameter and number of conduits to be determined by the CONTRACTOR to meet the requirements detailed in the Contract Documents as required to individually convey the subsea Trunk Cables to shore). Item shall also include mobilization and demobilization. Installation shall meet the general lines and dimensions outlined in the Contract Documents.

ii. A percent of the SOV amount shall be paid each pay period based upon the estimated percent of completion as determined by the DISTRICT's representative.

F. TRUNK CABLE SUPPLY AND INSTALLATION (QTY-2)

i. Payment shall constitute full compensation for all labor, equipment, vessels and materials necessary to provide for the engineering, planning, mobilization, demobilization and successful execution of the Cable Lay Plan (CLP) as outlined in the Contract Documents. Item shall also include but not be limited to engineering and fabrication of the inline pressure vessel (IPV), subsea cable skid (SCS) and other components outlined herein, in-process testing, ROV footage of cable touchdown, pulling of cables into the HDD conduit(s), termination of Trunk Cables into the switch vault (on shore), mobilization and demobilization, and as-built track line suitable for easement preparation by a land surveyor.

ii. Procurement of the Trunk Cables and associated materials in accordance with the Construction Schedule is the CONTRACTOR's responsibility. Long lead time items shall be ordered in accordance with Section 18000.

iii. A percent of the SOV amount shall be paid each pay period based upon the estimated percent of completion as determined by the DISTRICT's representative.

G. TURBINE UMBILICAL SUPPLY AND INSPECTION (QTY-2)

i. Payment shall constitute full compensation for all labor, equipment, and materials necessary to provide for the engineering, planning, fabrication and supply of the Turbine Umbilical (TU) cables integrated with the Turbine Umbilical Storage Platform (TUSP) as outlined in the Contract Documents. Item shall also include but not be limited to in-process testing, ROV testing prior to delivery, inspection of TU cable connections to the Turbine, and inspections during DISTRICT mobilization operations and sea-trials. Item shall also include delivery of the complete, tested assembly to the Turbine Mobilization Site (Location TBD - Greater Puget Sound Area).

ii. Procurement of the TU cables and associated materials in accordance with the Construction Schedule is the CONTRACTOR's responsibility. Long lead time items shall be ordered in accordance with Section 18000.

iii. A percent of the SOV amount shall be paid each pay period based upon the estimated percent of completion as determined by the DISTRICT's representative.

H. CABLE CONNECTION MARINE OPERATION

i. Payment shall constitute full compensation for all labor, equipment, vessels and materials necessary to provide for the planning, mobilization, demobilization and successful execution of the cable connection per the Cable Connection Plan (CCP) as outlined in the Contract Documents. Item shall also include but not be limited to mobilization and demobilization, in-process testing, allowance time for testing by others and ROV footage of cable touchdown and as built cable location.

ii. A percent of the SOV amount shall be paid each pay period based upon the estimated percent of completion as determined by the DISTRICT's representative.

I. TURBINE UMBILICAL SPARES (SUPPLY ONLY)

Payment shall constitute full compensation for all labor, equipment, and materials necessary to provide for the planning, fabrication and supply, testing and delivery of four (4) spare turbine umbilical (TU) cables (six (6) TU cables total). A percent of the SOV amount shall be paid each pay period based upon the estimated percent of completion as determined by the DISTRICT's representative.

J. PROJECT START-UP AND COMMISSIONING

i. Payment shall constitute full compensation for all labor, equipment, and materials necessary to support the commissioning and start-up of the completed tidal energy project, including testing of installed components, assisting the DISTRICT with check-out and commissioning of plant equipment and systems, and plant start-up and testing as required by the Contract Documents and Project permits.

ii. CONTRACTOR shall provide a lead electrical foreman and a journeyman electrician (both having had active roles in the original installations) as required for a minimum of 15 working days.

(BID ITEM #2) TRENCH SAFETY SYSTEMS

Trench safety systems payment shall constitute full compensation for all labor, equipment, and materials necessary for the installation, maintenance, and removal of all trench safety and shoring apparatus as required. Training in the use and installation of the safety apparatus shall be included.

Payment shall be made on a lump sum basis for all Work required to meet or exceed applicable safety standards.

(BID ITEM #3) CONTINGENCY ACCOUNT

The Contingency Account bid item is an allowance that can be earned by the CONTRACTOR and utilized by the DISTRICT, if necessary, only to reimburse the CONTRACTOR for contingencies arising during the performance of the Work, as further described below. The Contingency Account is earned only as utilized with the DISTRICT's approval. "Contingencies" are items of additional Work which, due to unforeseen circumstances discovered during the progress of the Project, have become required for completion of matters within the Project scope of Work and are changes to the Contract.

If Work, materials or equipment are to be paid for from the Contingency Account, payment amounts will be determined in accordance with the General Conditions and, if payment is to be made pursuant thereto, the DISTRICT shall approve such payment and CONTRACTOR shall contemporaneously prepare, keep and maintain records segregated and allocated by time, location and item of Work. Such records must be countersigned by the DISTRICT's representative (or his or her designee) within 24 hours of the provision of any such item of labor, materials or equipment. Any records not countersigned by the DISTRICT's representative (or designee) shall be excluded from payment under this Section.

Under no circumstances shall the amount payable from the Contingency Account exceed the lump sum amount set forth in the Bid form.

SCHEDULE-2

(BID ITEM #4) PERFORM SPECIFIC RECOVERY AND REDEPLOYMENT SERVICES (DISCONNECTION/RECONNECTION, ONE TURBINE UNIT ONLY)

As requested by the DISTRICT, the Work under this item includes all labor, materials and equipment necessary to perform one Turbine Unit recovery and redeployment in accordance with the Contract Documents. A schedule of values (SOV) for this item shall be developed in coordination with the DISTRICT and shall be in accordance with Section 01025-1.3.

A. MOBILIZATION/DEMOBILIZATION

i. A mobilization/demobilization payment shall constitute full compensation for all labor, equipment, and materials necessary to mobilize to the Project site, prepare any Work areas, and demobilize, including clean up and site restoration. Phases of this item may require multiple mobilizations/demobilizations by certain Subcontractors. Only a single payment will be made for mobilization/demobilization regardless of the number of mobilizations and demobilizations that are required.

ii. Mobilization for this item shall include the necessary preparatory Work prior to beginning recovery operations.

iii. All facilities and equipment that are established for or brought to the Project site shall be subject to the provisions of this Section unless the DISTRICT specifically provides otherwise in writing for a particular item or items. The CONTRACTOR shall be solely responsible for the adequacy, efficiency, use, protection, maintenance, repair and preservation of all of the CONTRACTOR's facilities and equipment. The facilities and equipment covered by this Section shall not be dismantled or removed from the Project site prior to completion of the Work under the Contract without the written authorization of the DISTRICT.

iv. For mobilization/demobilization, 50% will be paid upon completion of the initial operations prior to Turbine Unit recovery. The remaining 50% will be paid upon completion of the Cable Connection marine operation.

B. CABLE CONNECTION MARINE OPERATION

i. Payment for cable connection shall constitute full compensation for all labor, equipment, vessels and materials necessary to provide for the planning, mobilization, demobilization and successful execution of the Recover Redeploy Plan (RRP) as outlined in the Contract Documents. Item shall also include but not be limited in-process testing, allowance time for testing by others, and ROV footage of the cable touchdown and as built cable location.

ii. A percent of the SOV amount shall be paid each pay period based upon the estimated percent of completion as determined by the DISTRICT's representative.

C. PROJECT START-UP AND COMMISSIONING

i. Payment shall constitute full compensation for all labor, equipment, and materials necessary to support commissioning and start-up, including testing of installed components, assisting DISTRICT with check-out and commissioning of plant equipment and systems and plant start-up and

testing as required by the Contract Documents and Project permits.

ii. CONTRACTOR shall provide a lead electrical foreman and a journeyman electrician (both having had active roles in the original installations) as required for a minimum of five working days.

(BID ITEM #5) PERFORM SPECIFIC RECOVERY AND REDEPLOYMENT SERVICES (DISCONNECTION/RECONNECTION, BOTH TURBINE UNITS)

As required by the DISTRICT, the Work under this item shall include all labor, materials and equipment necessary to perform the recovery and redeployment operations for both Turbine Units in accordance with the Contract Documents. A schedule of values (SOV) for this item shall be developed in coordination with the DISTRICT and shall be in accordance with Section 01025, Paragraph 1.3.

A. MOBILIZATION/DEMOBILIZATION

i. A mobilization/demobilization payment shall constitute full compensation for all labor, equipment, and materials necessary to mobilize to the Project site, prepare any Work areas, and demobilize, including clean up and site restoration. Phases of this item may require multiple mobilizations/demobilizations by certain Subcontractors. Only a single payment will be made regardless of the number of mobilizations and demobilizations.

ii. Mobilization for this item shall include the necessary preparatory Work prior to beginning recovery operations.

iii. All facilities and equipment that are established or brought to the Project site shall be subject to the provisions of this Section unless the DISTRICT specifically provides otherwise in writing for a particular item or items. The CONTRACTOR shall be solely responsible for the adequacy, efficiency, use, protection, maintenance, repair and preservation of all of CONTRACTOR's facilities and equipment. The facilities and equipment covered by this Section shall not be dismantled or removed from the Project site prior to completion of the Work under the Contract without the written authorization of the DISTRICT.

iv. For mobilization/demobilization, 50% will be paid upon completion of the initial operations prior to Turbine Unit recovery. The remaining 50% will be paid upon completion of the Cable Connection marine operation.

B. CABLE CONNECTION MARINE OPERATION

i. Payment shall constitute full compensation for all labor, equipment, vessels and materials necessary to provide for the planning, mobilization,

demobilization and successful execution of the Recover Redeploy Plan (RRP) as outlined in the Contract Documents. Item shall also include but not be limited to mobilization and demobilization, in-process testing, allowance time for testing by others and ROV footage of cable touchdown and as built cable location.

ii. A percent of the SOV amount shall be paid each pay period based upon the estimated percent of completion as determined by the DISTRICT's representative.

C. PROJECT START-UP AND COMMISSIONING

iii. Payment shall constitute full compensation for all labor, equipment, and materials necessary to support commissioning and start-up, including testing of installed components, assisting DISTRICT with check-out and commissioning of plant equipment and systems and plant start-up and testing as required by the Contract Documents and Project permits.

iv. CONTRACTOR shall provide a lead electrical foreman and a journeyman electrician (both having had active roles in the original installations) as required for a minimum of five working days.

1.3 SCHEDULE OF VALUES LIST

As required by Section 01300 – Submittals and Shop Drawings, Paragraph 1.02, a Schedule of Values shall be submitted by the CONTRACTOR at least ten (10) days before the first payment application. The following list shall be used by the CONTRACTOR as a typical breakdown for the Schedule of Values, as applicable, required for this Project, with additional breakdown within each item. For all components of Work, the CONTRACTOR shall determine the unit of measure such as lump sum (LS), each (EA), feet (FT), ton (TON), or cubic yard (CY), etc., and the estimated quantities which will be used to determine payment. A final Schedule of Values will be prepared by CONTRACTOR, submitted and approved by the DISTRICT's representative and will be used by the DISTRICT's representative to calculate monthly payment for percent completion as indicated in this Section 01025 – Measurement and Payment. The Schedule of Values should include at least the following components.

Mobilization - Includes General Overhead and Expenses (not to exceed 5% of the Contract Price)

1. Permits/Bonds/Insurances
2. As-Built Drawings
3. General Submittals
4. General Punch List and Closeout
5. Supervision
6. Coordination Meetings

Construction of Power Conditioning and Control Building (PCCB)

7. Mobilization/Demobilization
8. Survey and Layout
9. Site Clearing and Preparation
10. Building Foundation Excavation, Foundation, Backfill, and Compaction
11. Finish Grading
12. All Site Conduits
13. Utility Coordination
14. Structural Framing and Close-in
15. Insulation and Gypsum Wallboard
16. Metal Roofing and Flashing
17. Door Frames and Doors
18. Garage Doors and Door Dams
19. Painting
20. Fire Extinguishers and Cabinets
21. HVAC Equipment
22. Electrical Rough-In
23. Panel, Gear, and Fuses
24. Communication Cabling, cable trays and equipment racks
25. Grounding
26. Fire Alarm System Wiring

Installation and Wiring of Mechanical and Electrical Equipment in PCCB – Supplied by DISTRICT

27. Receiving and temporary storage and handling of DISTRICT-Furnished Equipment
28. Installation of DISTRICT-Furnished Equipment
29. Termination of DISTRICT-Furnished Equipment

HDPE Conduit(s) Installed Via Horizontal Directional Drilling

30. Mobilization/Demobilization and site preparations
31. Submittal of HDD plan in accordance with the Contract Documents
32. Waste fluids management
33. HDD drilling
34. Conduit(s) installation

Supply and Installation of Trunk Cables

35. Approval of Marine Cable (MC) and Marine Cable Accessories (MCA) designs
36. MC and MCA order placement
37. MC production and testing
38. MCA fabrication, testing and delivery
39. CLV and associated equipment Mobilization
40. Installation Readiness Review (IRR) approved
41. Preparation of Submittals and CLP
42. Trunk Cable procurement
43. Cable lay vessel mobilizations

44. Cable#1 lay
45. Cable #2 lay
46. ROV installation inspections
47. HDD pull for cable #1
48. HDD pull for cable #2
49. Termination and testing
50. As-built drawing submitted and approved

Turbine Umbilical Supply and Inspection

51. Approval of Marine Cable (MC) and Marine Cable Accessories (MCA) designs
52. MC and MCA order placement
53. MC production and testing
54. MCA fabrication, testing and delivery
55. TUSP design acceptance
56. TUSP fabrication
57. TUSP ROV testing
58. TUSP/TU cables prepared for delivery
59. TU cable (low voltage, high voltage and fiber) testing
60. Assembly delivery
61. Turbine Mobilization Site and sea-trials inspections
62. TU cable spare supply (qty-4)

Cable Connection Marine Operations

63. CCV and associated equipment mobilization and demobilization
64. Installation Readiness Review (IRR) approved
65. Preparation of Submittals and CCP
66. ROV operations
67. Cable connection of cable #1
68. Cable connection of cable #2
69. As-built drawing submitted and approved

Supply and Installation of Trunk Cables

70. Approval of Marine Cable (MC) and Marine Cable Accessories (MCA) designs
71. MC and MCA order placement
72. MC production and testing
73. MCA fabrication, testing and delivery
74. Spare TU cable procurement
75. CLV and associated equipment mobilization and demobilization
76. Preparation of Submittals and CLP
77. ROV operations
78. Trunk Cable installation #1
79. Trunk Cable installation #2
80. As-built drawing submitted and approved

Recover and Redeployment of Cable Connection Marine Operations (as required)

81. CCV and associated equipment mobilization and demobilization

82. Installation Readiness Review (IRR) approved
83. Preparation of Submittals and RRP
84. ROV operations
85. Cable connection of cable #1
86. Cable connection of cable #2 (if required)
87. As-built drawing submitted and approved

1.5 NON-PAYMENT FOR REJECTED OR SURPLUS PRODUCTS OR WORK

Payment will not be made for Work rejected by the DISTRICT. Products or Work not meeting Contract requirements shall be replaced by the CONTRACTOR at no expense to the DISTRICT, regardless of the impact to Work, schedule or cost.

1.6 SUBSTITUTIONS

A. Summary - This Section includes:
   1. Submission requirements for substitution requests.
   2. Procedure for selection and approval of substitution requests.

B. Submission Requirements
   1. The CONTRACTOR may at any time during the course of the Work propose the use of alternate materials, equipment, plans, or procedures to the DISTRICT by submitting the proposed substitute to the DISTRICT's Representative in writing. CONTRACTOR shall: (a) describe the proposed substitute in detail; (b) explain why the substitute is being proposed and the advantages of the proposed substitute; (c) state the amount to be added or deleted from the Contract Price based on the proposed substitute; and (d) provide any other information required by the Contract Documents. Failure to provide any of the information required under this Paragraph may result in rejection of the proposed substitute.
   2. The DISTRICT will review each substitution request and inform CONTRACTOR if the substitute is accepted. If accepted, a Change Order shall be prepared and signed by the parties to incorporate the substitute into the Work. No change will be effective unless made in accordance with a signed Change Order.
   3. If accepted, the CONTRACTOR shall then incorporate the substitute into the Work, and shall coordinate related Work and modify surrounding Work to integrate each substitute with the Contract Documents at no cost to the DISTRICT.

END OF SECTION

SECTION 01040

PROJECT COORDINATION

1.1 PROJECT MANAGER

The DISTRICT'S representative for the Admiralty Inlet Pilot Tidal Project is Mr. Eric Schneider, P.E. The DISTRICT's representative shall be the DISTRICT's sole representative for purposes of the Contract, except where the DISTRICT is legally required to act through its Board of Commissioners or General Manager. CONTRACTOR shall coordinate all construction management activities through the DISTRICT's representative and no Change Order, modification of Contract Documents, or other direction from the DISTRICT shall be binding upon the DISTRICT unless reduced to writing and signed by the DISTRICT's representative except as otherwise required by the DISTRICT'S procedures. Unless otherwise specified, all communications required to be delivered to the DISTRICT shall be delivered to the DISTRICT's representative.

Any and all changes to the Specifications or Drawings, except for those that cannot reasonably be anticipated at the time of the Notice to Proceed, shall be approved by the DISTRICT's representative in writing prior to commencing any Work.

Bidder inquiries regarding technical Specifications may be directed to Mr. Eric Schneider at (425) 783-8624.

The DISTRICT has retained Sound and Sea Technology Inc., as a Consulting Engineer for purposes of the Admiralty Inlet Pilot Tidal Project. To the extent CONTRACTOR desires to communicate with the Consulting Engineer for any reason, CONTRACTOR shall seek approval of the DISTRICT's representative for such communications and shall route all such communications through the DISTRICT's representative. No communications of any kind from the Consulting Engineer shall be read to bind the DISTRICT in any manner unless explicitly approved in writing by the DISTRICT's representative.

1.2 MEETINGS

A. Pre-Construction Meeting

Following award of the Contract, the DISTRICT will notify the CONTRACTOR of the time and date of the pre-construction meeting to be held at the DISTRICT's Electric Building, 2320 California St., Everett, Washington.

Minutes of the pre-construction meeting will be sent to the CONTRACTOR and all meeting attendees. Recipients of the pre-construction meeting minutes will be required to direct any comments or changes to these minutes to the DISTRICT within seven (7) days from the date of receipt. If no changes or comments are

received within the seven (7) days, the meeting minutes will become final and will become part of the DISTRICT's Project file.

B. Site Meetings

During construction of the PCCB and while site Work is ongoing, the DISTRICT will schedule weekly meetings at the Project site and in addition may schedule meetings prior to each major phase or section of Work, prior to installing major pieces of equipment as identified by the DISTRICT, and on an as-needed basis. Attendance is required of the CONTRACTOR, site superintendent and major Subcontractors at all such meetings. The DISTRICT will notify the CONTRACTOR of all required site meetings during the pre-construction meeting.

Minutes of the each weekly site meeting will be sent to the CONTRACTOR and all meeting attendees. Recipients of the site Meeting weekly meeting minutes will be required to direct any comments or changes to these minutes to the DISTRICT within seven (7) days from the date of receipt. If no changes or comments are received within the seven (7) days, the meeting minutes will become final and will become part of the DISTRICT's Project file.

C. Coordination Meeting With Other Contractors and Suppliers

While this Project is underway, there will be other contractors performing Work at or near the Project site. This includes the deployment of the tidal Turbine Units by OpenHydro. In addition, DISTRICT-Furnished Equipment, including the power conditioning and control equipment, will be delivered to the Project site from time to time for unloading by the CONTRACTOR.

CONTRACTOR shall be required to coordinate with the DISTRICT and all other Project participants (OpenHydro, UW, etc.) as required to satisfy all technical and contractual obligations associated with the Project. Coordination shall include multiple trips to the Project site and Turbine Mobilization Site for meetings, the transport of materials and equipment as required, and labor associated with the cable inspection and handling.

These meetings shall be attended by the CONTRACTOR, including the CONTRACTOR's representative, project manager, and superintendent, and DISTRICT representatives. These meetings will be to discuss any concerns which might affect the CONTRACTOR's or the DISTRICT's Work plans. Adequate notice for major activities must be included in the CONTRACTOR's schedule and addressed at these meetings to allow for coordination with other contractors and the DISTRICT, in order to mitigate the disruption caused by specific construction activities.

D. Security and Communication Coordination

1. A security and communications coordination meeting shall be conducted following award of the Contract and before equipment is ordered. The DISTRICT's representative will notify the CONTRACTOR of the time and date of the Security and Communication Coordination Meeting and other coordination meetings as may be required. Seven (7) days prior to the date of the Security and Communication Coordination Meeting, the CONTRACTOR shall provide in writing a list of questions that need to be clarified for supply, installation, and termination of the security and communications systems to the DISTRICT's representative. The DISTRICT's security consultant, the DISTRICT's representative, the CONTRACTOR's superintendent and any Subcontractors involved in the proposed security installation shall attend the meeting.

2. Other required onsite coordination meetings will be scheduled as building coordination issues are identified by the DISTRICT or CONTRACTOR and those meetings must be attended by all relevant Subcontractors.

3. CONTRACTOR shall make provisions for the DISTRICT's security consultant to inspect the installations. The installations shall occur after the electrical trim package has been completed, or earlier at a time mutually agreeable to all parties.

E. The CONTRACTOR shall plan to have the marine operations planner and superintendent attend weekly meetings as required by Division 18000 (Marine Operations) of this Specification. A considerable amount of time and effort is expected from the CONTRACTOR in order to meet the operational plan requirements for the Cable Lay, Cable Connection and the HDD operations.

CONTRACTOR should expect to participate in multiple meetings throughout the course of the Project. While most will be held at the DISTRICT's headquarters building (2320 California St, Everett, WA), several meetings may be held at various locations throughout the Puget Sound region.

1.3 FIELD ENGINEERING AND SURVEY

A. Survey Reference Points

The CONTRACTOR shall: (1) protect survey control points prior to starting site Work and preserve permanent reference points during construction; (2) promptly report to the DISTRICT the loss or destruction of any reference point or relocation required because of changes in grades or any other reason; and, (3) replace survey control points damaged by the CONTRACTOR and compensate the DISTRICT for survey control points replaced by the DISTRICT.

B. Established By the DISTRICT

The DISTRICT shall establish survey control points at four (4) locations at the PCCB site. CONTRACTOR shall locate baselines, structure locations, concrete slab and building foundation locations, conduits, utility vault locations, and all other improvements by reference to the survey control points established by the DISTRICT. CONTRACTOR's Work shall conform to the horizontal and vertical controls unless deviations are authorized in writing by the DISTRICT.

The CONTRACTOR shall inform the DISTRICT at least four (4) business days in advance of performing any phase of Work so that the DISTRICT may furnish any required survey control points.

The DISTRICT may adjust or relocate any portion of the Project to meet site requirements or to improve the Project without additional compensation to the CONTRACTOR, provided such adjustments do not materially increase appreciable costs for labor and materials supplied by the CONTRACTOR, as reasonably determined by the DISTRICT.

C. To Be Established and Maintained By CONTRACTOR

Based upon the information provided by the DISTRICT, all other lines, grades, and detail surveys necessary for the execution and completion of the Work, including slope stakes and other working points, lines and elevations, shall be established and maintained by the CONTRACTOR.

After lines and grades for any part of the Work have been given by the DISTRICT, the CONTRACTOR shall be held responsible for the proper execution of the Work to such lines and grades, and all bench marks, reference points and stakes given shall be carefully preserved by the CONTRACTOR until the DISTRICT authorizes their removal. The CONTRACTOR shall be responsible for any mistakes that may be caused by the unnecessary loss or disturbance of such bench marks, reference points and stakes.

The DISTRICT reserves the right to check all Work, shall have free access to all Work, and shall have the full cooperation of the CONTRACTOR in conducting such inspections of the Work.

1.4 COORDINATION WITH OTHERS

A. Other Work Underway

The DISTRICT and other contractors will be working at and near the Project site during the time of construction. It shall be the responsibility of the CONTRACTOR to coordinate its Work with the DISTRICT, all other agencies, neighboring residents, and other contractors.

The CONTRACTOR shall also be responsible to minimize disruptions to access roads, local access and for the protection of the public and workers. Emergency access must be maintained at all times.

The CONTRACTOR shall be responsible for coordinating and scheduling its Work around the work to be performed by the DISTRICT, such as turbine deployment, so that it does not interfere with the DISTRICT's work (including any work performed by a subcontractor or equipment supplier of the DISTRICT).

All construction activities shall be coordinated with the DISTRICT at least weekly during the initial stages of design, and daily once construction operations are underway. CONTRACTOR shall immediately notify the DISTRICT of changes to the schedule that may alter dates shown as milestones on the schedule and such changes shall be effective only if approved in writing by the DISTRICT. The CONTRACTOR shall coordinate with the DISTRICT on a daily basis to minimize any and all disruptions caused by any change in the Construction Schedule.

B. Schedule and Coordination of Work

The CONTRACTOR shall coordinate scheduling, submittals, and all Work specified herein to assure efficient and orderly sequence of the installation of interdependent construction elements, including provisions for accommodating later-installed items of equipment or materials.

The CONTRACTOR shall coordinate all marine operations within the immediate vicinity of the Washington State Ferry route between the Port Townsend and Keystone terminals. Coordination records shall be provided to the DISTRICT.

Local Contact for ferry operations at the Project site:
Kevin Christie, Terminal Supervisor
Coupeville Ferry Terminal
Washington State Ferries
Phone: 206-264-3565 and fax: 206-264-3598

Or contact Kojo Fordjour @ (206) 515-3650

1.5 DIVISION OF WORK

A. Material Furnished and Installed By CONTRACTOR

The CONTRACTOR shall furnish and pay for all necessary materials (except DISTRICT-furnished) and shall provide all labor, tools, equipment, supervision, and perform all Work incidental to the completion of the Project as contemplated by the Contract and in accordance with the Contract Documents.

Each Subcontractor shall furnish and install all materials and equipment unless otherwise specified.

Requests for use of alternate materials shall be submitted in accordance with Section 01300 – Submittals and Shop Drawings, Paragraph 1.06 – "Or Equal" Clause or Substitutions.

B. DISTRICT-Furnished Material Installed By CONTRACTOR

All material received by the CONTRACTOR shall become the responsibility of the CONTRACTOR and the CONTRACTOR shall be liable for any materials lost or damaged after receipt (reference Section 01600 – Product Delivery, Storage and Handling). The DISTRICT will provide equipment and services as described in Section 01010 – Summary of Work, Paragraph 1.05.

C. Work to Be Done By DISTRICT

The DISTRICT will provide all materials and perform specific Work as described in Section 01010 – Summary of Work.

Items noted N.I.C. (not in contract) on the Drawings will be furnished and installed by the DISTRICT or another DISTRICT contractor before or concurrently with the Work of this Contract and are not included in this Contract.

The CONTRACTOR shall be responsible for coordinating and scheduling the Work to be performed by the DISTRICT so that Work to be performed by the DISTRICT coincides with related Work to be performed by the CONTRACTOR.

1.6 ARCHAEOLOGICAL INVESTIGATIONS

Preliminary review indicates there are no cultural resources present. However, if cultural resources are discovered as part of this Project, CONTRACTOR shall immediately suspend Work in the affected area and contact the DISTRICT. At the DISTRICT's direction, an archaeological evaluation may be required prior to continuation of Work in the affected area. CONTRACTOR shall not continue Work in the affected area until directed to do so by the DISTRICT.

Based upon the findings of such an archaeological evaluation, the CONTRACTOR may be required to change its location or method of operation to minimize or eliminate impacts to archaeological resources.

If the delay or Work stoppage associated with discovery of archaeological resources exceeds ten (10) days, the CONTRACTOR may to request additional time to complete the Contract. If the delay or Work stoppage exceeds thirty (30) days, the DISTRICT may terminate the Contract and determine reasonable compensation to the CONTRACTOR for Work completed plus a cost as agreed by the DISTRICT to demobilize from the Project site.

As an alternative to closing down and terminating the Contract, the DISTRICT may choose to negotiate a mutually acceptable suspension of the Work which includes compensation for reasonable costs caused by the temporary stoppage. No claim for additional compensation will be considered unless the delay or stoppage for the certain Work exceeds thirty (30) days and the stoppage has caused actual monetary damages to the CONTRACTOR.

1.7 CONTRACT CHANGES

The DISTRICT has developed four (4) forms to facilitate and track communications with the CONTRACTOR. These are the **Request for Information (RFI), Engineering Change Directive (ECD), Proposal Request (PR),** and **Change Order Proposal (COP)**. These forms are included in the Contract Documents.

The **Request for Information (RFI)** shall be used by the CONTRACTOR whenever written direction is desired to clarify perceived conflicts in the Drawings or Specifications, insufficient or unclear detail is shown, or any other issue which should be documented arises. The DISTRICT may also use the form to inquire on CONTRACTOR's methods, schedule or other issues not warranting more formal letter correspondence. The CONTRACTOR shall number each RFI consecutively, and shall number any RFI received from the DISTRICT at the time of receipt.

The **Engineering Change Directive (ECD)** shall be used by the DISTRICT to transmit new or revised Drawings, issue additions or modifications to the Contract or furnish any other direction which should be documented. ECDs are effective immediately. Should the CONTRACTOR believe that such ECD will result in either a change in the Contract Price or Contract Time, CONTRACTOR shall notify the DISTRICT prior to commencing such Work and, if possible, submit a **Change Order Proposal (COP)** prior to the start of such Work, but in no case, less than seven (7) days from receipt of said ECD.

In the event the DISTRICT does not receive a **Change Order Proposal** from the CONTRACTOR within seven (7) days of the CONTRACTOR's receipt of an ECD from the DISTRICT, the CONTRACTOR shall have no claim for extra cost or time or impacts attributable to the Work required by the ECD. The DISTRICT shall number ECDs consecutively. Once the DISTRICT and the CONTRACTOR have established a price for the changes required by the ECD or any other request by the DISTRICT for a change in the Work, including if the DISTRICT signs a **Change Order Proposal** reflecting the agreed upon price, it is agreed and understood that the price reflected shall include all direct costs, indirect costs, and the CONTRACTOR's estimate of impacts to its Work, including but not limited to delay impacts, and shall represent a full and final settlement of all issues pertaining to the Work.

The **Proposal Request (PR)** shall be used by the DISTRICT to request pricing on a possible change in the Drawings or additional Work. The PR may also be used to request credits for deletion or changes in scope of Work. The CONTRACTOR shall respond to such requests with a **Change Order Proposal** within seven (7) days from receipt of said PR unless the DISTRICT agrees in writing to extend this deadline. PRs shall be numbered consecutively by the DISTRICT.

The **Change Order Proposal (COP)** shall be used by the CONTRACTOR to respond to DISTRICT-issued PRs or ECDs, or when the CONTRACTOR believes that changed conditions or omitted, but necessary, Work items exist that may materially affect the cost of the Work or the Construction Schedule. COPs shall be consecutively numbered by the CONTRACTOR and, in the case of revision or resubmission of the same COP, the number shall be hyphenated with the letter "B", "C", etc.

1.8 DIFFERING SITE CONDITION

Differing site conditions shall be administered in accordance with the General Conditions. CONTRACTOR shall have no claim for additional costs or Work if it fails to submit a written notice of Claim and **Request for Information (RFI)** to the DISTRICT immediately upon encountering any claimed differing site condition, conflicts in the Drawings, Specifications, or constructability issues.

The CONTRACTOR shall promptly, and before disturbing any conditions, notify the DISTRICT of problems with subsurface conditions at the site, problems or conflicts in the Drawings or Specifications or problems with constructability. A written **Request for Information (RFI)** shall be submitted by the CONTRACTOR when such problems are encountered or direction is required.

The DISTRICT shall promptly investigate the conditions reported in the RFI. If the DISTRICT concludes that adjustment to the Contract is appropriate, such adjustments shall be memorialized. No claim by the CONTRACTOR relating to any differing site condition shall be allowed unless the DISTRICT agrees in writing to the change proposed by the CONTRACTOR.

Should the DISTRICT desire extra Work to be performed, a **Proposal Request (PR)** shall be sent to the CONTRACTOR**.**

The CONTRACTOR shall submit in advance and in writing, a **Change Order Proposal (COP)** for changes in the scope of Work and/or Contract Price. This proposal shall be either accepted or rejected in writing by the DISTRICT prior to Work commencing. When no agreement can be reached, the DISTRICT may order extra Work.

When conditions creating an immediate threat to life, health, safety, or an immediate violation of applicable law, are encountered, the CONTRACTOR shall notify the DISTRICT as soon as possible that extra Work is required or the DISTRICT shall notify the CONTRACTOR that extra Work is required to address the immediate threat. In such circumstances, the DISTRICT may issue a verbal or a handwritten **Engineering Change Directive**. Within seven (7) days of discovering the emergency condition, the CONTRACTOR shall submit a written **Change Order Proposal** for any changes necessary to address the emergent condition.

1.9 CONSTRUCTION PROGRESS SCHEDULES

CONTRACTOR shall submit and update at least monthly the Construction Schedule in accordance with Section 01050 – Construction Schedule and Failure to Meet Guaranteed Completion Dates/Liquidated Damages.

1.10 DISTRICT OCCUPANCY

The DISTRICT reserves the right to use or to occupy any substantially completed part of the Project, and to use equipment installed under the Contract prior to the date of Final Acceptance. Such use or occupancy shall not constitute acceptance of the Work.

1.11 SUPERINTENDENT

The CONTRACTOR shall employ competent superintendents, including at least one for marine operations and another for terrestrial operations, who shall be present at the Project site at all times during the entire progress of the Work, except those times when the CONTRACTOR is demobilized. The superintendents shall be acceptable to the DISTRICT, and shall have full authority to act on CONTRACTOR’s behalf.

A superintendent with relevant experience shall be required for all aspects of the Work. With operations required at sea and on land, the CONTRACTOR will need to provide at least two superintendents to meet the experience requirements.

It will be the superintendent’s responsibility to have a set of Contract Documents, including Specification at the Project site at all times during the progress of the Work. The foreman shall mark or record on the Contract Documents all changes made during construction. Such “as-built” drawings shall be available to the DISTRICT at all times and shall be delivered to the DISTRICT upon completion of the Work.

The superintendent initially assigned to the Project by the CONTRACTOR shall remain superintendent for the duration of the Contract. If the superintendent is replaced, all Work shall stop on CONTRACTOR's account until an additional pre-construction meeting with the DISTRICT is held. CONTRACTOR shall submit the resume of the replacement superintendent for the DISTRICT's review and approval. The Contract Time shall remain unchanged, regardless of any Work stoppage.

NOTE: The final payment portion of payment due under this Contract shall not be released for any reasons until complete "as-built" drawings are received and approved by the DISTRICT.

1.12 CLEAN UP

A. DAILY

The CONTRACTOR and the DISTRICT inspector will walk the site or marine facilities daily and as required to determine the clean-up and restoration required.

All areas shall be left safe, clean and free of debris.

Surplus excavation, conduit material, tools, temporary structures, dirt and rubbish shall be regularly removed and disposed of by the CONTRACTOR, and the construction site shall be left clean to the satisfaction of the DISTRICT.

Clean-up is considered incidental to the Project and no separate payment will be allowed.

CONTRACTOR shall collect waste daily and legally dispose of waste off site.

Clean-up of any area impacted by the construction shall be done weekly or as directed/instructed by the DISTRICT.

END OF SECTION

SNOHOMISH COUNTY PUD
PUBLIC UTILITY DISTRICT NO. 1

CHANGE ORDER PROPOSAL (COP)

Project Name: _____ Date: _____

Specification No:_____ Contract No: _____ COP No:_____
(Numbered by CONTRACTOR)

CONTRACTOR Name: _____ Ref. No: _____
(Prop Request or Eng Change Dir.)

Title:
Scope of Change Order / Work
(Attach DISTRICT Proposal Request when applicable)
☐ Sketch Attached ☐ Drawing Attached ☐ Additional Pages Attached

Cost/Credit $ _____

Time Extension Request _____

Submitted by: _____
CONTRACTOR

The change order includes <u>all</u> CONTRACTOR(s) labor, material, overhead, profit, and all direct and/or indirect costs associated with the change in the scope of Work.

☐ Approved ☐ Disapproved ☐ Resubmit

Comments:

_____ _____
Snohomish County DISTRICT No. 1 ***Date***

Prior to any extra Work or within seven (7) days of discovery of any issue, the CONTRACTOR shall submit a written proposal for changes in the scope of Work and/or Contract Price using this Change Order Proposal.

SNOHOMISH COUNTY PUD
PUBLIC UTILITY DISTRICT NO. 1

ENGINEERING CHANGE DIRECTIVE (ECD)

ECD NO: ☐
(Numbered By DISTRICT)

Date: _____ Project Title: _____

Contract No:_____ Specification No: _____

CONTRACTOR Name: _____ Ref. No: _____
(RFI, etc.)

Title:
You are directed to make the following modification(s) in the scope of Work of this Contract
☐ Sketch Attached ☐ Drawing Attached ☐Additional Pages Attached

This document becomes effective upon receipt by the CONTRACTOR, with signature of a representative of the DISTRICT. The CONTRACTOR shall then commence with the modification(s) listed above. Signature by the CONTRACTOR signifies agreement that the proposed modifications will not, may, or will result in a claim for changes in the Contract Price or the Contract Time.

Signed By: _____ Date: _____
Snohomish County PUD No. 1

Signed By: _____ Date: _____
CONTRACTOR (Check Box Below)

This construction change directive: ☐ will not; ☐ may; ☐ will; result in a claim supported by filing of a **Change Order Proposal** prior to any extra Work, but not later than seven (7) days.

SNOHOMISH COUNTY PUD
PUBLIC UTILITY DISTRICT NO. 1

REQUEST FOR INFORMATION (RFI)

RFI NO: ☐
(Numbered By CONTRACTOR)

Date: _____ Project Title: _____

Specification No: _____ Ref. No: _____
(If Available, ECD, etc.)

ARCHITECT:

DISTRICT:
Snohomish County PUD No. 1
2320 California Street
Everett, WA. 98206

CONTRACTOR:

SUBJECT:

☐ Architectural ☐ Civil ☐ Structural ☐ Mechanical ☐ Electrical ☐ Other

Request/Recommended Solutions:

☐ Attachments Date Required For Response: _____ Initiated By: _____
NAME

_____
General CONTRACTOR

Response:

☐ Attachments Response Date: _____ Response By: _____
Name

_____
Firm

Note: Prior to any extra Work or within seven (7) days of discovery of any issue, the CONTRACTOR shall submit a written proposal for changes in the Scope of Work and/or Contract Price using the ***Change Order Proposal***.

DISTRICT Approval:
The DISTRICT (Snohomish County PUD No. 1) reviewed the foregoing request and finds the response to be in order.

Reviewed By: _____ _____
DISTRICT's representative Date

Copies: ☐ DISTRICT ☐ Consultants ☐ File ☐ _____ ☐ _____

SNOHOMISH COUNTY PUD
PUBLIC UTILITY DISTRICT NO. 1

PROPOSAL REQUEST (PR)

Project Name: _____ Date: _____

Specification No:_____ Contract No: _____ Proposal Request No. _____
(Numbered By DISTRICT)

CONTRACTOR Name: _____ Ref. No: _____
(If Applicable)

Please submit a breakdown of the proposed costs for modification(s) to the Contract Price and/or Contract Time associated with the proposed changes in the scope of Work and to the Contract Documents described below. ***This is not a change order or a notice to proceed with the Work described below.***

Title:
Description of proposed changes:
☐ Sketch Attached ☐ Drawing Attached ☐ Additional Pages Attached

Submitted By:

Signed By: _____ Date: _____
Snohomish County PUD No. 1

Signed By: _____ Date: _____
CONTRACTOR (Check Box Below)

This proposal shall include all CONTRACTOR(s) labor, material, overhead, profit and all direct and/or indirect costs associated with the change in scope of Work.

SECTION 01050

CONSTRUCTION SCHEDULE AND FAILURE TO MEET COMPLETION DATE/LIQUIDATED DAMAGES

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work under this Section will include the preparation and submittal of a Construction Schedule to be used by the CONTRACTOR and DISTRICT to effectively plan and track the Work and to establish progress payments for the CONTRACTOR. The CONTRACTOR shall prepare schedules per the requirements listed herein.

B. A minimum of three (3) paper copies and one (1) native electronic copy of the prepared schedules are to be submitted to the DISTRICT. Schedules shall be provided in native electronic format such as a Microsoft Project file on a CD or electronically. Schedules shall be legibly typed and copied or printed on at least 11" X 17" bond paper, capable of being reproduced if needed. The Construction Schedule shall include, as a minimum, the following information:

1. CONTRACTOR's name, address and phone number.
2. Project name.
3. Date of the schedule.
4. A block for the DISTRICT to note its review of the schedule.
5. An itemized breakdown of Project tasks.
6. Milestones and critical dates as well as completion dates for a minimum of four (4) items for each lump sum bid item including all major activities and a maximum of 100 separate tasks comprising the Work.
7. The critical path for the Project which will alert both the DISTRICT and CONTRACTOR to crucial dates and delivery or activity milestones for the Project.
8. Expected delivery dates for all DISTRICT-supplied materials.
9. The schedule shall be prepared to include any permit requirements such as in-water Work windows as required by agencies having jurisdiction over the Project.

C. Timing of Schedule Submittals

1. Schedule Following Award - A schedule shall be submitted promptly following award to communicate the CONTRACTOR's plan to complete all Work associated with the Project. The schedule shall identify all required activities with special emphasis on the Marine Operations outlined in Division-18000.

2. Monthly Updates - An updated progress schedule shall be submitted with each monthly payment request to assist the DISTRICT and the DISTRICT's representative in accurately determining the percentage of Work completed to date on the Project.

D. Form of Schedule

The Construction Schedule shall:

1. Be prepared in the form of Microsoft Project horizontal bar chart or other format, subject to DISTRICT review.

2. The CONTRACTOR's schedule shall be incorporated into the DISTRICT's master schedule upon receipt and acceptance by the DISTRICT. The DISTRICT shall maintain the master schedule based on schedule updates from the CONTRACTOR and other parties involved in the Project. The CONTRACTOR shall provide the DISTRICT with timely updates to the CONTRACTOR's schedule, including any changes that may affect others.

3. Provide a separate horizontal bar column for each trade or operation.

4. Appear in chronological order, including the dates of beginning and completion of each item of Work, and percentages of completion.

5. Identify each column:
   a. By major Specification Section number.
   b. By distinct graphic delineation.

6. Provide a horizontal time scale that identifies the first work day of each week.

7. Provide scale and spacing to allow space for updating.

8. Include dates of material acquisition and delivery to the site.

9. Include a critical path schedule prepared using Microsoft Project.

10. An electronic file on CD/DVD shall be submitted along with hard copy.

11. Be printed on 11" x 17" paper.

E. Content of Construction Schedule

The Construction Schedule shall contain at least the following content:

1. A complete sequence of procurement, planning and construction by activity identifying critical path.

2. Shop Drawings, Project Data, and Samples:
   a. Submittal dates.
   b. Dates reviewed submittals will be required.

3. Decision dates for:
   a. Products specified by allowances.

4. Product procurement and delivery dates.

5. Dates for beginning, and completion of, each element of construction.

6. Projected percentage of completion for each item of Work as of the first day of each two-week period.

7. A separate sub-schedule, showing submittals, review times, procurement schedules, and delivery dates, as directed by the DISTRICT.

8. Sub-schedules if needed to define critical portions of the entire schedule.

9. CONTRACTOR's projection of the critical path to completion.

10. All schedules shall include the following milestones:
    a. All Marine Work shall be in accordance with the FERC mandated work window, currently 7/16/2015 to 10/14/2015.
    b. The CONTRACTOR shall coordinate with the DISTRICT and its equipment suppliers as required to complete the PCCB in accordance with the schedule objectives outlined herein.
    c. All Project improvements with the exception of the cable connection marine operation shall be installed, tested and completely prepared for receiving energy from the Turbine Units prior to the scheduled deployment date of the first Turbine Unit on or before 8/27/2015. In order to meet these objectives, the following milestones shall be incorporated into the CONTRACTOR's schedule and met by the CONTRACTOR:
        i. PCCB shall be substantially complete to accommodate the delivery and installation of the DISTRICT-furnished power conditioning and control equipment on or before 4/1/2015.
        ii. Grid connection of the power control and conditioning equipment to the adjoining distribution line shall be completed on or before 5/30/2015.
        iii. Horizontally Directionally Drilled (HDD) conduits shall be installed and functional in advance of the cable lay operations. CONTRACTOR's attention is called to the limited in-water work window and associated scheduling challenges.
        iv. At a minimum, one of the two proposed Trunk Cables (the one intended for the first Turbine Unit installation) shall be installed, terminated, tested, accepted and completely prepared for connection and use on or before 8/20/2015.
        v. Complete installation, testing and acceptance of all infrastructure improvements (excluding the Turbine Units and the associated Cable

Connections) required to receive, store and deliver energy from the first Turbine Unit installation to the local grid shall be completed on or before 8/20/2015.

vi. The CONTRACTOR has the option to: 1) install one Trunk Cable before and the other after the initial Turbine Unit deployment or 2) install both cables before the initial Turbine Unit deployment. Should the CONTRACTOR elect #1 above, the second Trunk Cable shall be terminated, tested, accepted and completely prepared for connection and use within 28-calendar days of the initial Turbine Unit deployment or 10/2/2015, whichever occurs first.

vii. Similar to the initial Turbine Unit deployment the CONTRACTOR shall again verify the complete installation, testing and acceptance of all infrastructure improvements required to integrate energy from the second Turbine Unit into the system on or before 10/2/2015.

d. CONTRACTOR shall execute each Cable Connection Plan operation within 48-hours of each successful Turbine Unit deployment.

F. Updating

The Construction Schedule shall be updated by the CONTRACTOR monthly to:

1. Show all changes occurring since previous submission of the updated schedule.

2. Indicate progress of each activity, showing completion dates.

3. Include:
   a. Changes in scope.
   b. Activities modified since previous updating.
   c. Revised projections due to changes.
   d. Other identifiable changes.

4. Provide narrative report, including:
   a. Discussion of problem areas, including current and anticipated delays, and their impact.

5. Corrective action taken, or proposed, and its effect.

6. Effect of change in schedule on subcontracts.

7. Description of revisions:
   a. Effect on schedule due to change of scope.
   b. Revisions in duration of activities.
   c. Other changes that may affect schedule.

G. Request extensions of time, if warranted, in accordance with the Contract.

1.02 REQUIRED COMPLETION DATES

A. Substantial Completion: Substantial Completion is defined in the General Conditions.

B. Final Completion: Final Completion is also defined in the General Conditions. In general, the date of Final Completion shall be the date all equipment is installed, successfully tested and operating, punch list items are all 100% complete, and the DISTRICT certifies that the goods, equipment, materials, structures, and services furnished under this Contract conform to the Contract requirements for Final Completion specified in Section 01700 - Contract Closeout.

1.03 LIQUIDATED DAMAGES

A. In case of failure on the part of the CONTRACTOR to meet certain pre-established milestones and the required dates for Substantial Completion and Final Completion, including Substantial Completion of designated phases of the Work, the CONTRACTOR shall pay to the DISTRICT liquidated damages as set forth in the Agreement.

END OF SECTION

SECTION 01080

OPERATION AND MAINTENANCE INFORMATION

PART 1 - GENERAL

1.01 REQUIREMENTS INCLUDED

A. CONTRACTOR shall prepare and submit operating and maintenance (O&M) data on all CONTRACTOR-supplied equipment as specified in this Section and as referenced in other Sections of the Contract Documents, and shall compile Product Data and related information appropriate for the DISTRICT's use of equipment furnished under these Contract Documents.

1.02 QUALITY ASSURANCE

A. Preparation of data required in this Section shall be performed done by CONTRACTOR's personnel:

1. Trained and experienced in maintenance and operation of described products.
2. Familiar with requirements of this Section.
3. Skilled as technical writers to the extent required to communicate essential data.
4. Skilled as drafters competent to prepare required drawings.

1.03 FORM OF SUBMITTALS

A. CONTRACTOR shall prepare data in the form of an Operation and Maintenance instruction manual ("O&M Manual") for use by the DISTRICT's personnel for all equipment provided and installed by the CONTRACTOR.

1.04 CONTENTS OF O&M DATA SUBMITTALS

A. For each Product or piece of CONTRACTOR-supplied equipment, the O&M Manual shall include:

1. Supplier, name of responsible principal, address, and telephone number.

B. Product data:

1. Include only those sheets pertinent to the specific product.
2. Annotate each sheet to:
   a. Clearly identify specific product or part installed.
   b. Clearly identify data applicable to installation.
   c. Delete references to inapplicable information.

C. Drawings:

1. Supplement product data with Drawings as necessary to clearly illustrate:
   a. Relations of component parts of equipment and systems.
   b. Control and flow diagrams.

2. Coordinate Drawings with information in Project as-built documents to assure correct illustration of completed installation.

D. Parts lists:

1. Cross reference product data and Drawings to facilitate identification and location of parts.
2. Identify local source of parts not of special manufacture.
3. Include only actual parts and spare parts and components supplied.

E. Copy of each warranty issued to and executed in the name of the DISTRICT in accordance with Section 01090 – Equipment Warranties, for CONTRACTOR-Supplied Equipment.

1. Provide information sheet for the DISTRICT's personnel, listing:
   a. Proper procedures in event of failure.
   b. Occurrences that might affect validity of warranties or bonds.

1.05 O&M DATA SUBMITTAL SCHEDULE

A. Schedule: Submit two (2) copies of all O&M data at least 45 days prior to the completion of installation of Substantial Completion.

B. Quantity: In accordance with Section 01300 – Submittals And Shop Drawings, and Section 01700 – Contract Closeout, submit three (3) complete sets of O&M data in hard copy in 3-ring binders in DISTRICT-approved format with clearly labeled tabs and a table of contents.

C. In accordance with Section 01300 – Submittals and Shop Drawings, and Section 01700 – Contract Closeout, submit one (1) complete set of O&M manual in digital format on CD-ROM.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 01090

EQUIPMENT WARRANTIES FOR CONTRACTOR-SUPPLIED EQUIPMENT

PART 1 - GENERAL

1.01 REQUIREMENTS INCLUDED

A. Compile specified warranties.

B. Review submittals to verify compliance with Contract Documents.

C. Submit to the DISTRICT for review.

D. Minimum acceptable warranty is 12 months after Final Acceptance of the Project by the DISTRICT, with the following exception:

Minimum acceptable warranty for all cables outlined in Division 18010 shall be 12 months after the completion, testing and verification of the Cable Connection Plan (Division 18000) for each respective Turbine Unit or 24 months after completion and acceptance of Factory Acceptance Testing, whichever occurs first.

1.02 SUBMITTAL REQUIREMENTS
The CONTRACTOR shall:

A. Assemble warranties and guarantees executed by each manufacturer, supplier, and Subcontractor responsible for CONTRACTOR-provided equipment supplied to the DISTRICT under this Contract.

B. Number or original signed copies required: Two (2) each.

a. Provide a Table of Contents that is neatly typed, with numbered sequence.

b. Provide complete information for each Product or Work item.

1. Manufacturer, with name of principal, address and telephone number.
2. Scope.
3. Date of beginning of warranties and guarantee.
4. Duration of warranty or guarantee.
5. Provide information for the DISTRICT’s personnel:
   a. Proper procedure in case of failure.
   b. Occurrences that might affect the validity of warranty.
6. CONTRACTOR, name of responsible principal, address and telephone number.

1.03 SUBMITTALS

A. Prepare in duplicate using the following format:

1. Size 8-1/2 inches by 11 inches; punch sheets for standard commercial quality 3-ring binder; fold larger sheets to fit binders.
2. Identify binder with typed or printed title "WARRANTIES" and list the Project title along with the name of CONTRACTOR. Warranties may be included as a separate Section in the O&M Manual.

B. Time of Submittals:

1. For equipment or component parts of equipment put into service during progress of construction submit documents within ten (10) days after inspection and acceptance.
2. Otherwise, make submittals pursuant to General Conditions or otherwise prior to final request for payment.
3. Submit warranties as follows:
   a. Manufacturer's warranties: CONTRACTOR shall provide such warranties to the DISTRICT.

1.04 CORRECTION OF DEFECTS

Repairs or alterations required of the CONTRACTOR shall be made by the CONTRACTOR at such times as directed, in a manner as will effect a minimum interruption of service to the DISTRICT.

1.05 RIGHT TO OPERATE UNSATISFACTORY EQUIPMENT

The DISTRICT shall have the right to operate any and all equipment as soon as the equipment is in operating condition, whether or not such equipment has been accepted as complete and satisfactory.

1.06 REQUIRED WARRANTY TERMS

A copy of all warranties shall be included in the O&M Manual described in Section 01080.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 01300

SUBMITTALS AND SHOP DRAWINGS

1.01 SCOPE

This Section covers procedures for submittals made by the CONTRACTOR. Submittals include, but are not limited to, construction schedules, shop drawings, product data, samples, manufacturer's instructions and certifications, construction photographs, and operations and maintenance information.

1.02 REQUIREMENTS INCLUDED

A. At a minimum, the following submittals shall be provided:

1. Submittals schedule.
2. Construction Schedule.
3. Schedule of Values.
4. Quality control plan with names of firms subcontracted to perform various required quality assurance tasks such as soils compaction testing and concrete testing not supplied by the DISTRICT.
5. Job Hazard Analysis per Section 01500, Paragraph 1.05A
6. Environmental Management Plan per Section 01550, Paragraph 3.03
7. All submittals required by Divisions 2 through 18.
8. Concrete mix design.
9. Shop drawings and product data, including rebar detail Drawings.
10. Operation and maintenance information.
11. Results of quality assurance testing performed by the CONTRACTOR.
12. Other submittals as called for in various sections of the Contract Documents.
13. Manufacturer's major components list, including an instrument list.
14. Spare parts list.
15. Installation instructions.
16. Interconnecting wiring diagrams for CONTRACTOR-supplied equipment.

1.03 RELATED REQUIREMENTS

A. Section 01010: Summary of Work
B. Section 01080: Operation and Maintenance Information
C. Section 01090: Equipment Warranties for CONTRACTOR-Supplied Equipment

1.04 POST-BID SUBMISSION REQUIREMENTS

1. Requested Bidders shall furnish the following items:
   a. Preliminary Construction Schedule as required in Section 01050, to demonstrate to the DISTRICT that the Project Work has been planned in accordance with Drawings, Specifications and permit requirements. The CONTRACTOR's Construction Schedule shall include a detailed phasing plan for all on-shore Work and marine Work.
   b. Within 24-Hours of the DISTRICT's request, a list of significant Subcontractors, including each Subcontractor's address, telephone number, and contact person to be used on this Project. At a minimum, this list shall include the marine operations firm and the horizontal directional drilling firm.
   c. Within 24-Hours of the DISTRICT's request, the name of the CONTRACTOR's Project superintendent(s), for marine, terrestrial and HDD work, together with resumes, references and work history information that satisfies the requirements of the respective Specification Sections.
   d. Within 24-Hours of the DISTRICT's request, a list of products, principal suppliers and fabricators for at least the Marine Cable and Marine Cable Accessories.
   e. Within 24-Hours of the DISTRICT's request, evidence of marine operation experience and other information to demonstrate that the CONTRACTOR can meet or exceed all responsibility criteria set forth in the Instructions to Bidders and Contract Documents.

2. At the Pre-Construction Meeting, CONTRACTOR shall provide:
   a. Complete list of Subcontractors
   b. Work hazard analysis
   c. Detailed Construction Schedule in accordance with Section 01050
   d. Schedule of Values.
   e. OpenHydro NDA (Appendix-V) executed by CONTRACTOR.

1.05 SUBMITTALS AND SHOP DRAWINGS DURING CONSTRUCTION

Submittals and shop drawings submitted by the CONTRACTOR as specified herein are intended to show the CONTRACTOR's compliance with the Contract Documents. Signatures, corrections or comments made on submittals do not relieve the CONTRACTOR from compliance with requirements of the Contract Documents. Neither acceptance nor approval of submittals adds to or deletes from any Contract requirements regardless of the wording of the submittals. Submittals may not be reviewed or approved when the term "By Others" is used. Submittals are reviewed or approved for general conformance with the design concept of the Project and general compliance with the information given in the Contract Documents. The CONTRACTOR is responsible for confirming and correlating all quantities and dimensions, selecting fabrication processes and techniques of construction, coordinating its Work with that of other contractors and agencies, and performing its Work in a safe and satisfactory manner. Related submittals shall be submitted as packages.

A. Submittals Procedures

1. Submittal Requirements: Submit as specified in the Contract Documents. Submittals not requested may not be processed.

2. Transmittal Form: Accompany each submittal with transmittal letter, in triplicate. Transmittal form will be supplied by the DISTRICT.

3. Submittal Numbering: Sequentially number transmittal forms in order submitted. Add alphabetic suffix to where a numbered submittal is re-submitted.

4. Submittal Identification: Include Project, CONTRACTOR, Subcontractor or supplier, pertinent Drawing and detail number, Specification Section number, manufacturer, fabrication, product, material, as appropriate.

5. CONTRACTOR's Certification: Apply CONTRACTOR's stamp, signed or initialed, certifying that review, verification or products required, field dimensions, adjacent construction Work, and coordination of information is in accordance with the requirements of the Contract Documents.

6. CONTRACTOR shall review submittals for adequate installation interface for all Work prior to submitting them to the DISTRICT.

7. Schedule of Submittals: Deliver to the DISTRICT, promptly, to meet critical path, and lead times as required to expedite the Project.

8. Turn-Around Time: Allow from time of receipt at least fourteen (14) working days for each submittal and each re-submittal to be reviewed by the DISTRICT.

9. Critical Issues: Prior to submittal, communicate with the DISTRICT reason for critical issue. Upon approval, allow at least ten (10) working days turn-around time from time of receipt by the DISTRICT.

10. Coordination and Consolidation of Submittals: Submit related items, sections or trades under one (1) submittal package for each unit of Work or system where possible.

11. Deviations on Submittals: Identify deviations, including products and systems, not conforming with Contract Documents.

12. Product and System Limitations: Indicate conditions that may be detrimental to successful performance or completion of Work.

13. Substitutions to Specified Items: Submit for approval in accordance with Paragraph 1.06 of this Section. Do not indicate or otherwise imply substitutions to specified items, except as approved.

14. Project Site Office Records: Maintain one (1) copy of every submittal, regardless of status, along with a current submittal log. Ensure that the most current stamped shop drawings and product data are distributed and subsequently used in connection with the Work.

15. Re-Submittal Requirements: Revise rejected submittal as directed and re-submit following procedures specified for the initial submittal. Make any corrections or changes required by the DISTRICT. Revise and make any further re-submittals until no exceptions are taken. Identify changes on re-submittal made since previous submittal.

16. Other Pertinent Submittals: Provide templates, inserts, and other submittals in a in timely fashion,.

B. Schedule of Submittals

1. Within ten (10) days of the DISTRICT's written Notice to Proceed, prepare schedule of submittals for shop drawings, product data, samples, and as specified in the Contract Documents. Update as requested by the DISTRICT.
2. Identify individual delivery, long lead times, and critical ordering deadlines. Include ordering dates for each item including individual parts of major submittals.
3. Indicate specified time allocated for review, turn-around and distribution.
4. Identify decision dates for items not scheduled or otherwise approved.
5. Within ten (10) days after Notice to Proceed, and in accordance with the conditions of the Contract, submit list of major products proposed for use with name of manufacturer, trade name, and model number of each product.
6. For products specified only by reference standards, give manufacturer, tradesman, model or catalog designation and reference standards.

C. Each Submittal shall contain:

1. The Project title.

2. The current date of the submitted item and an indication of previous versions by a numbered revision symbol and notation with dates.

3. Job file number and CONTRACTOR's identifying number, if different.

4. Identification of the product or category of Work shown.

5. The names of manufacturers and suppliers.

6. Principal dimensions, with the controlling features and required clearances clearly identified. Give particular attention to the interface points.

7. Applicable standards, such as ASTM or ANSI numbers.

8. Identification of revisions on re-submittals by cloud and numbered revision symbol.

9. A 5-inch by 3-inch blank space for DISTRICT's review stamp.

10. CONTRACTOR's stamp, initialed or signed, certifying it has completed its review of the submittal before it was submitted as follows:

CONTRACTOR'S NAME This certifies that this submittal has been reviewed by the CONTRACTOR and the information presented has been coordinated with, and conforms to, all requirements of the Contract Documents. Comments: _____ By: _____ Date: _____

D. Shop Drawings

1. Number and Format: Submit one (1) electronic copy and three (3) paper copies.

2. Submittal Procedure: Submit for DISTRICT's review in accordance with submittal procedures specified in this Section. After approved shop drawings are returned, the CONTRACTOR shall reproduce and distribute copies to Subcontractors and others, as applicable. Maintain one (1) copy of each shop drawing at field office and one (1) copy for Project as-built documents to be delivered to the DISTRICT at Project completion.

3. Maximum Sheet Size: 24-inches by 36-inches. Other allowable sizes are of 8-1/2-inches by 11-inches and/or 11-inches by 17-inches.

4. Identification: Reference shop drawing details identical to references on Contract Documents, including sheet and detail descriptions, schedules and room numbers. Indicate by whom materials, products, work, and installations are supplied, performed or installed. Do not use the expression "by others."

5. Presentation: Hand drafted or computer generated, delineated to present information in a clear and thorough manner. Freehand shop drawings are not allowed.

6. Variations from Contract Documents due to Standard Shop Practices: Submit a transmittal outlining variation.

7. Changes to Submittals that affect Contract Sum or Contract Time: Notify DISTRICT immediately in writing.

8. Mechanical and electrical, utilities, equipment and appliance: Include electrical characteristics, connection requirements, rough-ins, location of outlets, wiring, piping diagrams, weight where significant, and other information as required to describe installation requirements.

E. Product Data

1. Number of Copies: Submit one (1) electronic copy and two (2) hard copies to be retained by the DISTRICT.

2. Submittal Procedures: Submit for DISTRICT review in accordance with submittal procedures specified in this Section. After review, distribute to Subcontractors and others. Maintain one (1) copy for Project as-built documents to be delivered to the DISTRICT at Project completion.

3. Identification: Mark each copy to identify specific products, models, options, tolerances, dimensions, and other pertinent data.

4. Manufacturer's Standard Data: Modify shop drawings and diagrams to delete inapplicable information. Supplement to provide pertinent information unique to the Project.

5. Mechanical and electrical utilities, equipment, and appliance: Where not shown by shop drawings, include electrical characteristics, connection requirements, rough-ins, location of outlets, wiring, piping diagrams, controls, weight where significant, and other information as required to describe installation requirements. Correct published product data to correlate with specific Project requirements.

F. Electronic Files of Manuals (from Vendors):

1. Electronic manuals must be submitted in .PDF format compatible with the latest version of Adobe Professional.

2. Manuals should be scanned at 300 DPI or original electronic media.

3. Color originals should be scanned to color images.

4. All .PDF files should be scanned using Optical Character Recognition (OCR).

5. A manual must be submitted as a single .PDF file; addendums and attachments (may or may not include Drawings) should not be submitted separately, or in different file formats.

6. Manuals that consist of multiple volumes should be submitted as individual files.

7. Manuals comprised of several sections or chapters should be bookmarked by the vendor.

8. If a vendor includes security settings (so that documents are "read-only"), that is acceptable provided that the DISTRICT can view and print from the file.

G. Samples

1. Quantity or Number: Submit one (1) sample to be retained by the DISTRICT, except as otherwise specified by individual Specification Sections. Submit additional samples as required by CONTRACTOR for distribution.

2. Submittal Procedure: Submit for the DISTRICT's review in accordance with submittal procedures specified in this Section. After review, distribute to applicable entities.

3. Size and Completeness: As specified in the Specifications. When not specified, submit samples of sufficient size and completeness to clearly illustrate product.

4. Identification: Label each sample with Project title and complete product identification, including manufacturer, model number, descriptive name, supplier, and as other relevant identification.

5. Functional Characteristics: Include parts, attachments, and components, as applicable. Coordinate with interfacing Work.

6. Aesthetic Characteristics: As required for selection of colors, finishes, patterns, and as needed or requested to finalize selection process. Furnish full range of manufacturer's custom and standard selections. Where selection is specified, submit as required to show conformance to Contract Documents.

H. Fabrication

Begin no fabrication or Work which requires review of submittals until return of submittals with DISTRICT's review comments. Any manufacturing Work or fabrication performed before the DISTRICT's review and acceptance shall be at CONTRACTOR's sole risk.

I. Engineering Details

All engineering details shall be submitted to the DISTRICT by the CONTRACTOR for review and approval prior to commencing any construction. This includes designs, loads and computations on foundations, connections, columns, beams, and complete details of all structural members and structural connections. The CONTRACTOR shall be required to submit plans, calculations, and all required materials to the applicable authority to obtain necessary permits.

J. Seismic Requirements

1. All CONTRACTOR-supplied equipment and supports shall be engineered to resist the design lateral seismic force as required by the current version of the IBC and as specified herein.

2. Stresses shall be calculated as the effect of the lateral force applied at the center of gravity of the equipment from any horizontal direction, and all such calculations shall be submitted to the DISTRICT.

K. Manufacturer Instructions and Certificates

Number: Submit one (1) copy of both the manufacturer instructions and certificates.

Content: Include manufacturer's printed instructions for delivery, storage, preparation, assembly, installation, start-up, adjusting, balancing, and finishing as specified in individual Specification Sections. Include special procedures, Project conditions, and environmental criteria required for application or installation.

L. Code Compliance Certificates

Submit information required as a condition of building permit issued by code authority, including certificate of occupancy, certificate of approval from Fire Marshal, and certificate of code compliance from state electrical inspector.

1.06 "OR EQUAL" CLAUSE OR SUBSTITUTIONS

A. Prior to Bid Opening

Substitutions will generally be considered prior to the bid opening only as specified in the General Conditions. Submit all questions to the DISTRICT's representative.

B. After Bid Award

Proposed substitution and deviation requests shall be reviewed after bid award.

Substitution and deviation requests will generally be received and considered only as specified in the General Conditions and when one or more of following conditions are satisfied:

1. The specified product or method of construction cannot receive necessary approval by a governing authority, and the requested substitution can be approved.
2. The specified product or method of construction cannot be provided in a manner that is compatible with other materials.
3. A substantial advantage is offered to the DISTRICT, in terms of cost, time, or otherwise.
4. The product as specified includes the statement, "or equal" and one of the above conditions governs.

C. The DISTRICT's decision on all substitution or deviation requests shall be final.

D. General

When the DISTRICT approves a substitution, the CONTRACTOR shall guarantee the substituted article to be equal to, or better than, the article specified in all respects. The DISTRICT will judge the suitability, reliability, and service availability of a proposed substitute. To be considered by the DISTRICT, the request for substitution shall be submitted on the form provided as Section 01040 – Project Coordination, accompanied with complete physical and technical data, manufacturer data, photographs, samples, and the address of the nearest authorized service representative, as applicable.

1.07 AS-BUILT DRAWINGS

A. Submit in accordance with the submittal schedule specified above.

B. Before Final Acceptance of the Work under this Contract, provide complete set of all Drawings:

1. Drawings shall be sent electronically.
2. Include all changes and revisions made during engineering, fabrication, and assembly as accepted by the DISTRICT up to delivery and acceptance of the Work. As-built drawings shall be numbered, titled, and provided in indexed sets, complete in one submittal. Partial submittals are not acceptable.

1.08 COLOR SAMPLES

The CONTRACTOR shall be required to submit all color samples for the entire Project at one time. The submittal shall include roofing, flashing, base, paint, fixtures, stain, etc. The CONTRACTOR will make a color board for the building upon approval of the samples by the DISTRICT. Related submittals shall be submitted together.

Prepare color board of all approved samples that will physically fit on board. Do not include glass samples or others specifically excluded by the DISTRICT. Color board shall be suitable for presentations.

Samples may be smaller than specified if so required to fit on the color board as long as they are large enough to show color, texture, and other required details. Color board shall include Project name, approved manufacturer, and Contract number. Board shall not be less than 16-inches by 20-inches or more than 24-inches by 36-inches unless otherwise approved by the DISTRICT. Samples not included on the color board shall be submitted separately.

1.09 DISTRICT'S REVIEW

A. DISTRICT will review submittals with reasonable promptness and in accordance with the accepted submittal schedule, and will endeavor not to exceed 14 working days from date of receipt. DISTRICT will review submittals and first re-submittals. Costs for additional reviews of two or more re-submittals for the same item will be back-charged to the CONTRACTOR at a rate of $100/hour for review time.

B. The DISTRICT's representative will affix his review stamp and initials or signature, and indicate the status of the submittal.

C. The DISTRICT will return submittals to CONTRACTOR for action in accordance with the status defined as follows:

1. **No Exceptions Taken** - Revision of the submittal is not required. CONTRACTOR shall apply a stamp saying "Final" or wording of similar intent, shall transmit copies as specified, and is authorized to proceed with the Work covered by the submittal.

2. **Exceptions Taken as Noted:**
   a. If CONTRACTOR agrees with DISTRICT's comments, resubmittal for review is not required. CONTRACTOR shall revise the submittal, incorporating DISTRICT's comments, shall stamp the revised submittal and transmit copies as provided above under "No Exceptions Taken" and is authorized to proceed with the Work covered by the submittal.
   b. If the CONTRACTOR does not agree with the DISTRICT's comments, CONTRACTOR shall not proceed and shall immediately inform the DISTRICT.

3. **Revise and Resubmit** - CONTRACTOR shall revise the submittal and resubmit for DISTRICT's review and shall not proceed with the Work covered by the submittal.

4. **Rejected** - The submittal is inadequate. DISTRICT will not review but will comment, in general, to explain the reason for rejection. CONTRACTOR shall correct the deficiency and submit as an original submittal. CONTRACTOR is not authorized to proceed with the Work covered by the submittal.

D. Review of submittals will not relieve the CONTRACTOR of responsibility for conformity to the Contract Documents and responsibility for correct detail and fit of parts when installed.

E. No revision of any kind shall be made after a Drawing has been marked "CONFORMS TO DESIGN CONCEPT" without resubmitting a Drawing for review.

F. The applicable parts of the requirements specified above for Drawings shall apply equally to design data, catalog cuts, illustrations, printed Specifications, draft reports or any other submittal furnished for review.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 01400

QUALITY CONTROL

1.1 REFERENCE STANDARDS

Reference to standards, Specifications, manuals or codes of any technical society, organization, or association, or to the laws or regulations of any governmental authority, whether such reference is specific or by implication, shall mean the latest Specification manual, code, or laws or regulations in effect at the time of the bid opening, except as may be otherwise specifically stated. No provision of any referenced standard, Specification, manual, or code (whether or not specifically incorporated by reference in the Contract Documents) shall be effective to change the duties and responsibilities of the DISTRICT, CONTRACTOR, or DISTRICT's representative, or employees from those set forth in the Contract Documents, unless explicitly so stated.

Any part of the Work not specifically covered by these Specifications shall be performed in accordance with the applicable Section of the latest edition of the "Standard Specifications for Road, Bridge and Municipal Construction," as prepared by the Washington State Department of Transportation and the Washington State Department of Public Works Association (APWA), as amended by the latest APWA Amendment No. 1.

1.2 INSPECTION, TESTING AND CERTIFICATION

A. INSPECTION

Construction inspection and testing for the DISTRICT will be performed by a testing firm to be selected by the DISTRICT or others designated. Additional and more specific inspection requirements are included in the Contract Documents.

1. The DISTRICT will prepare a construction inspection checklist to be presented to the CONTRACTOR at the pre-construction meeting. The checklist will include all inspections typically required by local, city and county officials as well as other items identified by the DISTRICT's representative.

2. The CONTRACTOR shall be required to contact the DISTRICT at least 24 hours in advance of all construction activities listed on the checklist, have the indicated activity inspected, and secure the signature or initial of the DISTRICT's inspector indicating that the Work was performed in accordance with the appropriate technical provision.

3. The checklist shall be posted and be available for review by the DISTRICT at all times. These inspections shall be in addition to any required inspections by state or local jurisdictions.

4. Pre-Final Inspection: CONTRACTOR shall notify the DISTRICT's representative in writing when all Work or portions of Work are complete and ready for inspection. The DISTRICT's representative will make a "punch list" and forward it the CONTRACTOR for prompt completion.

5. Final Inspection: CONTRACTOR shall notify the DISTRICT's representative in writing when all punch list items have been completed. The DISTRICT's representative will promptly set a time for final inspection at which time the DISTRICT's representative and CONTRACTOR shall jointly inspect the Work. The CONTRACTOR will promptly correct any further deficiencies noted.

B. LABORATORY SERVICES

Testing for quality control certification or special inspections as required by the Contract Documents or permitting authorities will be conducted by the DISTRICT and/or an independent laboratory furnished and paid for by the DISTRICT. Subsequent sampling and testing of rejected material shall be paid for by the CONTRACTOR.

The DISTRICT may reject all or any portion of material that fails to achieve the specified standards. All costs associated with replacement materials or any delays caused by such failure shall be borne by the CONTRACTOR.

It shall be the CONTRACTOR's responsibility to prepare test specimens as required for special inspection as required by permitting authorities or the DISTRICT's representative and the cost shall be incidental to the Contract and included in the Contract Price.

C. PERMIT INSPECTIONS

The CONTRACTOR shall comply with the requirements of all permits. It shall be the CONTRACTOR's responsibility to contact the permitting authorities and schedule all required inspections. The CONTRACTOR shall notify the DISTRICT representative of all scheduled inspections.

D. BUILDING ELECTRICAL

The CONTRACTOR shall obtain an electrical permit(s) from the State of Washington Labor and Industries for the structure and as otherwise required. The building electrical inspection shall be requested and managed by the CONTRACTOR and shall be performed by the State of Washington.

E. UNDERGROUND ELECTRICAL

Underground electrical inspection of the electrical conduits from the PCCB to the utility pole interface shall be coordinated with the DISTRICT representative and all construction activities shall conform to Puget Sound Energy standards. It is the CONTRACTOR's responsibility to notify Puget Sound Energy when inspection is needed.

END OF SECTION

SECTION 01500

CONSTRUCTION CONTROLS AND TEMPORARY FACILITIES

PART 1 - GENERAL

1.01 DESCRIPTION

A. The CONTRACTOR shall provide such temporary enclosures and facilities as the Work may warrant. Facilities shall include:

1. CONTRACTOR's office, waste areas, and storage facilities.
2. Shelters for crews, including potable water supply and sanitary facilities conforming to local codes and applicable regulatory requirements.
3. Temporary light and power.
4. Safety equipment.
5. Construction warning, protection, and control devices for maintenance and safety of vehicular and pedestrian traffic.
6. Temporary fencing, gates, barriers, locks, and signage required to secure the Work areas against vandalism and prevent entry of unauthorized parties. At a minimum, the CONTRACTOR shall provide on-site security guards when DISTRICT-Furnished Equipment is on site and not secured inside the locked PCCB.
7. Temporary construction roads.
8. First aid facilities.
9. Communications and telephone service.
10. Portable compressed air sources as required.
11. Temporary walks, rails, guards, construction fences, and similar safeguards, when required or as necessary until Final Completion of the Work.
12. Repair or replacement of any damaged or stolen public and private materials or property in performance of the Work.

B. Before proceeding with the placement or erection of any temporary structures, equipment, offices, and/or trailers, CONTRACTOR shall provide the dimensions, description and proposed location of all such temporary facilities to the DISTRICT's representative for approval.

C. There is no potable domestic water supply in the Work area. CONTRACTOR shall provide drinking water from portable sources for use by CONTRACTOR and DISTRICT personnel at the site.

D. There shall be no release of contaminated water or concrete waste or truck wash water at the Work site.

E. The CONTRACTOR shall provide fire protection for permanent and temporary Project facilities for the duration of the Project, including:

1. Provide adequate numbers and types of fire extinguishers.
2. Store combustible materials in fire-safe containers in fire-safe locations.
3. Prohibit smoking in hazardous, fire-exposure locations.
4. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition.

1.02 TEMPORARY LIGHT AND POWER

A. CONTRACTOR Responsibilities:

1. Provide all necessary labor, equipment and cabling for the installation and removal of a temporary electrical power and lighting system.
2. All such temporary electrical Work shall meet the requirements of applicable regulatory requirements.
3. Provide all necessary temporary power service required for the Project site, including electric power for the CONTRACTOR trailer, if desired.
4. Secure and pay for all required permits, certificates, notarizations, back charges for work performed by others, and other expenses incidental to the installation of the temporary electric service.
5. CONTRACTOR shall furnish and install any temporary wiring of a special nature required for the Work.

1.03 ROADWAY AND TRAFFIC CONTROL

A. Traffic Coordination

All traffic controls on this Project shall adhere to the latest edition of the "Manual on Uniform Traffic Control Devices." Adequate access shall be provided for local and emergency vehicle traffic at all times.

It is the CONTRACTOR's responsibility to provide all traffic control and signage for the Project to the satisfaction of the DISTRICT and all costs shall be incidental to the Project and included in the Contract Price.

B. Traffic Signs and Signals

The CONTRACTOR shall be responsible for all temporary signage and barricades placed at or near the Project site to control traffic and protect the public from construction operations.

The supply, placement, and maintenance of all traffic controls shall be the responsibility of the CONTRACTOR and shall be in accordance with the "Manual on Uniform Traffic Control Devices."

1.04 SECURITY AND ACCESS

CONTRACTOR shall comply with the DISTRICT's security policies and procedures and take adequate precaution to protect DISTRICT property and employees.

1.05 SAFETY

A. Job Hazard Analysis

The CONTRACTOR and Subcontractors shall thoroughly review the Project scope of Work. The CONTRACTOR will be responsible to develop and provide a work hazard analysis in the form of "Job Hazard Analysis Report," which shall be submitted to the DISTRICT within 30 days of Contract award. This report shall include any known or potential safety issues or phases of construction that may require specific safety procedures as identified by WISHA or OSHA regulations, and/or prudent construction practices; i.e., shoring, fall protection, scaffolding, hazardous materials, asbestos removal, etc. A copy of this report shall be maintained at the Project site (accessible to the DISTRICT at all times).

The DISTRICT may require the CONTRACTOR to clarify or detail its safety procedures for ensuring safe working conditions for conditions not listed in the original report, and/or explain how the procedures meet current safety regulations. In no case shall the CONTRACTOR commence Work until the Job Hazard Analysis Report has been reviewed and accepted without objection by the DISTRICT.

1.06 DUST CONTROL

The CONTRACTOR shall take reasonable measures to prevent unnecessary dust. Earth surfaces subject to dusting shall be kept moist with water or by application of a chemical dust suppressant if consistent with applicable environmental laws and regulations. Dusty materials in piles or in transit shall be covered when practicable to prevent blowing.

Buildings or operating facilities which may be affected adversely by dust shall be adequately protected from dust. Existing or new machinery, motors, instrument panels, or similar equipment shall be protected by suitable dust screens. Proper ventilation shall be included with dust screens.

1.07 TEMPORARY DRAINAGE PROVISIONS

The CONTRACTOR shall provide for the drainage of storm water and such water as may be applied or discharged on the site in performance of the Work. Drainage facilities shall be adequate to prevent damage to the Work, the site, and adjacent property. All temporary drainage and storm water handling features must fully comply with the Storm Water Pollution Prevention Plan (SWPPP).

1.08 POLLUTION CONTROL

CONTRACTOR shall prevent pollution, including from sanitary waste, sediment, debris, and other substances resulting from construction activities. No sanitary waste will be permitted to enter any drain or waterway. No sediment, debris, or other substances will be permitted to enter any drain or waterway.

The CONTRACTOR shall maintain oil absorption pads at the Project site whenever any equipment is present to immediately catch and contain any oil and/or fuel leaks.

The CONTRACTOR shall follow all of the provisions listed in the Erosion and Sedimentation Control Plan (ESCP) and maintain a copy of the plan on site whenever construction is in progress. Should the erosion and sedimentation control measures initially installed prove to be inadequate, the CONTRACTOR shall immediately install additional facilities as necessary to protect adjacent properties, sensitive areas, natural water sources and/or storm drainage systems. In addition, the CONTRACTOR shall review and follow all requirements of the various Project permits.

The CONTRACTOR shall identify a trained pollution control inspector who will be on-site, or on-call and readily accessible to the site, at all times while construction activities are occurring that may affect the quality of ground and surface water.

The pollution control inspector shall have the authority to ensure proper implementation of this plan, and impose additional corrective actions necessary because of changing field conditions. If the pollution control inspector issues an order necessary to implement a portion of this plan to prevent pollution from reaching any surface waters, all of the CONTRACTOR's employees shall immediately comply with that order.

PART 2 - PRODUCTS

2.01 CONTRACTOR's facilities shall be of sufficient size and configuration to allow for the adequate administration of the Contract, storage of materials required for installation, and provision of shelter for all personnel.

2.02 Equipment required for worker safety shall be furnished in full compliance with all local, state, and federal requirements.

2.03 Signs, barricades, warning lights, and all necessary equipment for the protection of the public shall be furnished and maintained.

2.04 Any temporary facilities, equipment, or vehicles shall be clearly marked with CONTRACTOR's business name or logo, be adequate for the intended purpose and be in conformance with the requirements of all applicable regulations.

PART 3 - EXECUTION

3.01 Field office and storage trailers or buildings shall be sited in approved locations and properly set up for all potential weather conditions.

3.02 Sanitary conveniences, in sufficient numbers, for the use of all persons present at the Project site, including the DISTRICT, shall be maintained and screened from public observation at suitable locations. The CONTRACTOR shall rigorously enforce the use of the provided sanitary facilities. When no longer required, such facilities shall be removed from the Project site and the contents disposed of in a satisfactory manner consistent with all applicable environmental laws and regulations. CONTRACTOR shall also provide trash bins and arrange for the proper disposal of the contents and for the removal of the bins upon Project completion.

3.03 The CONTRACTOR shall conduct its operations in a manner that, with the use of proper equipment, will provide maximum safety for workers and the public.

3.04 All compressed air hose couplings must be affixed with a safety device to prevent uncoupling during use.

END OF SECTION

SECTION 01550

PROTECTION OF THE ENVIRONMENT

PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section covers, but is not limited to, the following:

1. Handling, storage, spill preventions and clean-up of oil and other hazardous substances.
2. Handling and disposal of solid waste.
3. Preparation and submittal by CONTRACTOR of an Environmental Management Plan.

B. The CONTRACTOR shall perform all Work necessary to comply with the requirements of Project permits.

C. Erosion and sediment control is part of the Work by the CONTRACTOR, and is covered under this Section and in related Sections in Division 2.

D. All Work required in this Section, including erosion and sediment control facilities, shall be installed prior to any ground disturbing activity.

E. CONTRACTOR shall comply with the requirements of the Environmental Management Plan.

1.02 RELATED SECTIONS

A. Section 02100 – Dewatering and Care of Water.

B. Section 02910 – Erosion and Sediment Control.

1.03 PERMITS

A. DISTRICT permit applications

The DISTRICT has made application to the applicable authorities for the following permits and authorizations:

1. Federal
   a. FERC Hydrokinetic Water Power License and Amendments
   b. Coast Zone Management Act (CZMA) Permit
   c. National Environmental Policy Act (NEPA)

2. State
   a. Washington Department of Ecology Water Quality Certification (401)
   b. Washington Department of Fish and Wildlife Hydraulic Project Approval (HPA).
   c. Aquatic Resources Use Authorization (DNR)
   d. State Environment Policy Act (SEPA) Determination

3. County
   a. Island County Building Permit.
   b. Island County Shoreline Conditional Use Permit.
   c. Island Count Flood Development Permit

4. Other
   a. Certificate of Appropriateness (Ebey Historical Reserve)

The CONTRACTOR will be responsible for picking up these permits if not already included in this Specification. Reimbursement for these actual permit fees will be made or paid by the DISTRICT directly to the agency, as applicable, with no CONTRACTOR markup. The CONTRACTOR shall apply for, obtain, maintain, and pay for all other required permits.

B. CONTRACTOR-furnished permits:

1. The CONTRACTOR shall be responsible for identifying, obtaining and complying with all permits required for construction activities, including, plumbing, electrical, heating, approvals from Washington State Department of Labor & Industries, WISHA, OSHA, and other permits required for permanent construction, as well as permits for temporary activities such as temporary buildings, debris disposal, overweight loads, burning permits, etc.
2. The CONTRACTOR shall obtain separate permits or revisions to permits for any activities not covered by the permits furnished by the DISTRICT.
3. The CONTRACTOR shall perform any and all activities required to obtain the CONTRACTOR-furnished permits, including contacting respective agencies, filing applications and paying any required application fees as part of the Contract Price.

1.04 SUBMITTALS

1. The CONTRACTOR shall submit for review all procedures for control of Project related activities to protect the environment including dust control measures, handling and disposal of solid wastes, oil and hazardous substances handling, storage, spill prevention and clean-up.

2. The CONTRACTOR shall prepare and submit an Environmental Management Plan as described in Paragraph 3.03 below.

3. If required by the DISTRICT, CONTRACTOR shall submit information and product data for materials and equipment used for erosion and sediment control.

PART 2 - PRODUCTS

2.01 GENERAL

A. The CONTRACTOR shall be responsible for the selection and adequacy of all materials and equipment for the Work in this Section including water quality control systems, except as otherwise specified.

B. Erosion and sediment control products include silt fences, straw bales, and fabric or netting to reestablish vegetation on disturbed slopes.

PART 3 - EXECUTION

3.01 WATER POLLUTION AND ENVIRONMENTAL PROTECTION

A. All water that has been polluted or contaminated by materials such as sediment, oil, grease, cement and fresh concrete, and chemicals used by the CONTRACTOR's operation shall be disposed of in an approved manner and in accordance with all applicable permits and local, state, and federal requirements and shall not be released into waterways.

B. CONTRACTOR's construction activities shall be performed by methods that will minimize erosion, and prevent entrance or accidental spillage of solid waste into the bay, creeks, waterways, water storage reservoirs and/or underground water sources. Such pollutants and waste include, but are not limited to, refuse, garbage, cement, concrete, grout, sewage effluent, industrial waste, mercury, oil and other petroleum products, aggregate processing tailings, mineral salts, excess earth materials, and thermal pollution. It shall be the CONTRACTOR's responsibility to abide by the conditions of all permits required for construction.

C. All exposed and unworked soils shall be stabilized by application of effective BMPs that protect the soil from erosion by raindrop impact and flowing water.

D. CONTRACTOR shall have available in sufficient quantity oil absorbent booms and pads to absorb any petroleum products spilled or present in the runoff. Oils, petroleum, waste products, and chemicals shall not be allowed to drain onto soil, but shall be confined in sealed containers or sealed sumps for removal by the CONTRACTOR to disposal sites approved by governmental authorities having jurisdiction for water quality control. On-site spill response kits will be placed at centralized locations.

E. Sanitary waste shall be disposed offsite.

F. Mechanized equipment, other than vessels designed specifically for that purpose, shall not be operated in flowing water. Mobile equipment shall be maintained to avoid release of petroleum products.

G. Fuel hoses, oil drums, oil or fuel transfer valves and fittings shall be checked regularly for drips/leaks and shall be maintained and stored properly to prevent spills, and shall be secured to prevent vandalism.

H. Refueling or maintenance shall be done on absorbent pad(s) or using drip pans with absorbent pads when done at other locations. The fueling pad and/or any other spill location shall be immediately cleaned, with waste materials appropriately disposed, following any discharge or spill incident.

I. Measures shall be taken to prevent concrete from entering streams, reservoirs or waterways. Concrete equipment shall be washed at sites where wash water will not enter streams or waterways. Debris from concrete operations shall be removed and disposed legally by CONTRACTOR at an off-site location.

3.02 REMOVAL OF TEMPORARY FACILITIES

A. Upon completion of all Work or, as otherwise required, the CONTRACTOR shall remove all temporary facilities constructed for dewatering and control of sediment and water.

B. Upon completion of all Work, the CONTRACTOR shall remove and legally dispose all sediment collected behind or in installed erosion and sediment control measures.

3.03 ENVIRONMENTAL MANAGEMENT PLAN

The CONTRACTOR shall prepare and submit an Environmental Management Plan covering all Project Work. This document must contain all information related to environmental protection for the term of the Work. It shall include the following:

A. A listing of on-site personnel with first aid training.
B. Location and directions to the nearest hospital.
C. Emergency phone numbers for CONTRACTOR, Subcontractors and DISTRICT personnel.
D. Emergency phone numbers for fire, ambulance and rescue.
E. Emergency spill procedures.
F. A plan Drawing showing the layout and location of all erosion and sediment control measures. An example has or will be supplied by the DISTRICT.
G. Procedures for inspections/maintenance of erosion and sediment control measures and storm water control measures (checklist).

The Environmental Management Plan should also include erosion and sedimentation control measures planned in order to comply with Section 02110.

END OF SECTION

SECTION 01600

PRODUCT DELIVERY, STORAGE AND HANDLING

PART 1 - GENERAL

1.01 PACKAGING, SHIPPING AND STORAGE

A. General

1. All equipment supplied by the CONTRACTOR shall be adequately prepared for shipment and for its expected period of outdoor storage.
2. Equipment shall be adequately supported for shipment. All loose parts shall be crated or boxed for shipment and appropriately identified. Where shipment is braced internally, it shall be marked conspicuously, "Remove internal braces before testing and operation."
3. All large and heavy shipping units shall have suitable skids for moving. Crating shall also be adequate for lifting with slings. If location of slings is critical, these locations shall be marked accordingly. Lifting lugs, if required, shall be provided and installed by CONTRACTOR.

B. Site Handling and Storage of Materials and Equipment

1. CONTRACTOR shall be responsible for delivery of all of CONTRACTOR-supplied materials to the Project site or a location designated by the DISTRICT, for unloading by the CONTRACTOR.

2. CONTRACTOR shall be responsible for acceptance, unloading and safe storage of all DISTRICT-supplied materials to the Project site.

3. Maintenance of storage locations at the Project site will be the responsibility of the CONTRACTOR. Where required to protect against condensation and humidity, sufficient desiccant for the prescribed storage conditions shall be provided by the CONTRACTOR and its presence, noting the need of periodic removal, dry-out or replacement, shall be conspicuously marked. When electric space heaters are provided for that purpose, these shall be wired by the CONTRACTOR such that the space heaters can be energized immediately upon receipt without disassembly of crates, etc. This also requires that no combustible material be left inside the equipment or crate.

4. All material and equipment shall be protected against loss, damage by corrosion, weather, overstressed components, or contamination by foreign materials. CONTRACTOR shall repair or replace any material or equipment damaged during delivery, at no cost to the DISTRICT, and without impact to the Construction Schedule.

5. Materials shall be delivered to the Project site in the manufacturer's original containers, bundles or packages unopened with the seals unbroken and the labels intact. Each type of material shall be of the same make and quality throughout. Manufactured articles, materials and equipment shall be installed in accordance with each manufacturer's written directions, unless otherwise specified.

6. All materials and equipment to be provided under this Contract shall conform to the laws of the State of Washington and the United States. Equipment shall meet appropriate ANSI, OSHA, WISHA, and all other federal, state, and local standards for the type of equipment provided.

7. Equipment shall meet appropriate ANSI, OSHA, WISHA, and all Federal, state, and local standards for the type of equipment provided.

8. The CONTRACTOR shall deliver, store and handle products according to manufacturer's written instructions, using means and methods that will prevent damage, deterioration, and loss, including theft.

9. The CONTRACTOR shall inspect products at the time of delivery for compliance with the Contract Documents and to ensure items are undamaged and properly protected. The CONTRACTOR shall store heavy items in a manner that will not endanger supporting construction and shall store products subject to damage on platforms or pallets, under cover in a weather tight enclosure, with ventilation adequate to prevent condensation. The CONTRACTOR shall maintain temperature and humidity within the range required to prevent damage to stored materials and equipment.

10. All DISTRICT-supplied products shall be inspected at the time of delivery for damage and compliance with the Contract Documents by the DISTRICT and CONTRACTOR. Any damage and/or non-compliance will be documented and signed by both the DISTRICT and CONTRACTOR. The DISTRICT will be responsible for notifying the supplier of the damage and/or non-compliance of the product.

PART 2 - EXECUTION

2.01 All products shall be delivered to:

Public Utility District No. 1 of Snohomish County
Attn: Admiralty Inlet Pilot Tidal Project
13254 SR-20
Coupeville, WA 98239
USA

and clearly marked:

"For Admiralty Inlet Pilot Tidal Project "

Public Utility District No. 1 of Snohomish County
Attn: Admiralty Inlet Pilot Tidal Project
13254 SR-20
Coupeville, WA 98239

2.02 Transportation to the Admiralty Inlet Pilot Tidal Project Site:

CONTRACTOR shall be responsible for shipping its materials and equipment to the Project site and shall make all necessary investigations of clearance, etc. Direction to the site are as follows:

From Mukilteo-Clinton Ferry:
Exit the ferry in Clinton and head northwest on SR-525 for 21.7 miles. Turn left onto SR-20 (Follow Signs to Keystone Ferry). Site is located approximately ¼ mile prior to reaching the Ferry dock.

From Oak Harbor (North)
Follow SR-20 South out of Oak Harbor towards Coupeville for 9.5 miles. Turn right on Main Street, continue on to Engle Road and ultimately to the ferry terminal where the road turns in to SR-20. Site is approximately ¼ mile past the ferry terminal on the right.

GPS Coordinates: 48 Deg. 09' 38" N / 122 Deg. 39' 53" W.

2.03 Unloading of DISTRICT-Furnished Equipment

CONTRACTOR is responsible to accept delivery and unload DISTRICT-Furnished Equipment, including but not limited to the shore vault, power conditioning and control equipment and associated batteries and enclosures.

END OF SECTION

SECTION 01700

CONTRACT CLOSEOUT

1.1 DOCUMENTS REQUIRED UPON COMPLETION OF WORK

A. Close Out Procedures

The CONTRACTOR shall notify the DISTRICT in writing when identified tasks are complete and ready for inspection. The DISTRICT will make the inspection and forward the results to the CONTRACTOR. The CONTRACTOR shall promptly correct any deficiencies noted.

The CONTRACTOR shall notify the DISTRICT in writing when all punch list deficiencies have been completed. The DISTRICT will promptly set a time for final inspection, at which time the DISTRICT and the CONTRACTOR shall jointly inspect the Work. The CONTRACTOR will promptly correct any deficiencies noted.

Other contractors and the DISTRICT will be working at and near the Project site during construction. It shall be the responsibility of this CONTRACTOR to coordinate the Work with other agencies and/or contractors (Refer to Section 01050 – Project Construction Schedule And Failure To Meet Guaranteed Completion Dates/Liquidated Damages, Paragraph 1.02, B).

B. Final Documentation

Upon completion of the Work and before final payment is made, the CONTRACTOR shall deliver to the DISTRICT, in addition to such other items specified in the other Contract Documents, the following documents:

1. "As-Built" Drawings

"As-built" drawings and specifications of new or revised Work, shown in red ink, provided by the general, mechanical, electrical contractors and/or Subcontractors, including all addenda, change orders, deviations, changes, elevations, and dimensions of Work that vary from the Drawings and other Contract Documents. As-built drawings shall be updated monthly during the construction. Monthly payments will not be made until all as-built records are updated.

Two (2) copies of all shop and construction Drawings used for the Project, the final as-built drawings (to reflect the actual installation), including one (1) reproducible set of all Drawings and AutoCAD files, if applicable.

NOTE: Final payment under this Contract may not be released until "as-built" drawings are received and approved by the DISTRICT. As-built drawings will be prepared in accordance with Section 01720.

2. Maintenance and Operation Manuals

Three (3) complete sets of maintenance and operation manuals and supplement drawings and one (1) electronic manual (.PDF), for the care and maintenance of materials and equipment items installed. These manuals shall be prepared by the manufacturer's representatives, and collected and bound by the CONTRACTOR. The CONTRACTOR shall also instruct the DISTRICT's personnel so that the DISTRICT's maintenance personnel are trained to provide care and maintenance as directed by the manufacturers.

This manual shall include information on all air handling equipment, air balancing data, electrical and other mechanical equipment. It shall also include all appliances, products, equipment, and other material as herein specified.

The electronic manual shall be formatted as follows:

a. Electronic manuals must be submitted in .PDF and compatible with the latest version of Adobe Professional.
b. Manuals should be scanned at 300 DPI or original electronic media.
c. Color originals should be scanned to color images, if possible.
d. All .PDF files should be scanned at using Optical Character Recognition (OCR).
e. A manual must be submitted as a single .PDF file; addendums and attachments (may or may not include Drawings) should not be submitted separately, or in different file formats.
f. Manuals that consist of multiple volumes should be submitted as individual files.
g. Manuals with multiple sections or chapters should be bookmarked by the vendor.
h. If a vendor wishes to include security settings (so that their documents are "read-only"), the DISTRICT must be able to view and print all documents.

3. All Guarantees and/or Agreements

a. The CONTRACTOR shall submit to the DISTRICT at the completion of the Project all guarantees, warranties, and/or agreements for such equipment and materials that carry such guarantees.

b. The CONTRACTOR shall submit to the DISTRICT at the completion of the Project a roofing warranty for the PCCB structure, guaranteeing the roof for a period of at least two (2) years. Any defect or leak that occurs during such two (2) year period shall be promptly remedied by the CONTRACTOR at no expense to the DISTRICT. The roofing manufacturer shall supply at least a twenty (20) year warranty.

4. Spare Materials

   a. List of ready-mixed paints and colors used in the building and a list of paint samples given to the DISTRICT.

   b. Certificate of hardware supplier that items have been properly installed and are functioning properly.

5. Mechanical and Electrical Subcontractors Shall Also Provide:

   a. All test and certification requirements of the mechanical and electrical Specification Sections.

   b. Complete report of startup testing of systems and instruction of operation and maintenance to the DISTRICT.

6. Electrical Contractor's Test Results as Specified

7. Final Clean Up (See Section 01710 - Cleaning)

   All surfaces disturbed shall be restored to a condition equal to that before the Work began.

   Surplus conduit material, tools, temporary structures, dirt and rubbish shall be removed and disposed of by the CONTRACTOR, and the Project site shall be left clean to the satisfaction of the DISTRICT.

   Clean-up is considered incidental to the Project and no separate payment will be allowed for cleanup in excess of the Contract Price.

   Achieve Substantial Completion and Final Completion as required by the General Conditions and obtain a final certificate of occupancy and final inspections from authorities having jurisdiction.

END OF SECTION

SECTION 01710

CLEANING

PART 1 - GENERAL

1.01 RELATED REQUIREMENTS SPECIFIED ELSEWHERE

A. Summary of Work: Section 01010

B. Contract Closeout: Section 01700

C. Cleaning for Specific Products or Work: See the specific Specification Section for Work.

1.02 DESCRIPTION

A. Maintain premises and the Project site free from accumulations of waste, debris, and rubbish.

B. At completion of Work, remove waste materials, rubbish, tools, equipment, machinery, and surplus materials, and clean all sight-exposed surfaces; leave Project clean and ready for occupancy.

1.03 SAFETY REQUIREMENTS

A. Standards: Maintain Project in accordance with at least the following safety standards:

1. OSHA standards.
2. WISHA standards

B. Hazards Control:

1. Store volatile wastes in covered metal containers, and remove from premises daily.
2. Prevent accumulation of any waste that create hazardous conditions.
3. Provide adequate ventilation during use of volatile or noxious substances.

C. Conduct cleaning and disposal operations to comply with local ordinances and anti-pollution requirements:

1. Do not burn or bury rubbish or waste materials at the Project site unless any required permits are first obtained from agencies having jurisdiction, and the DISTRICT approves in advance.

2. Do not dispose of volatile wastes such as mineral spirits, oil, or paint thinner in storm or sanitary drains or allow any such materials to get into waterways.

3. Do not dispose of wastes into streams, reservoirs or waterways.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Use only cleaning materials recommended by the manufacturer for the surface to be cleaned.

B. Use cleaning materials only on surfaces recommended by cleaning material manufacturer.

PART 3 - EXECUTION

3.01 DURING CONSTRUCTION

A. Execute cleaning to ensure that the Project site and surrounding property are maintained free from accumulations of waste materials and rubbish.

B. Wet down dry materials and rubbish to lay dust and prevent blowing dust.

C. At reasonable intervals during progress of Work, clean site and dispose of waste materials debris, and rubbish.

D. Provide on-site containers for collection of waste materials, debris, and rubbish.

E. Remove and legally dispose of waste materials, debris and rubbish from the Project site.

F. Handle materials in a controlled manner with as few handlings as possible; do not drop or throw materials from heights.

G. Schedule cleaning operations so that dust and other contaminants resulting from the cleaning process will not fall on wet, newly painted surfaces.

3.02 FINAL CLEANING

A. Prior to Substantial Completion of the building structures, conduct final inspection of exposed interior and exterior surfaces and concealed spaces. After all trades have completed their Work, and just prior to occupancy, the general CONTRACTOR shall:

1. Vacuum clean the interior of the building.

2. Leave the entire building perfectly clean.
3. Clean hardware and fixtures.
4. Dust removal of all interior surfaces.
5. Remove all temporary facilities and CONTRACTOR equipment.
6. Remove labels that are not permanent.
7. Wipe surfaces of mechanical and electrical equipment. Remove excess lubrication.
8. Clean the entire Site. Sweep paved areas and walkways. Remove stains, spills, and foreign deposits. Rake grounds to a smooth, even textured surface.

B. Repair, patch, and touch-up marred surfaces to specified finish, to match adjacent surfaces.

C. Broom clean exterior concrete surfaces; rake clean other surfaces of grounds.

D. Maintain cleaning until Project, or portion thereof, is occupied by DISTRICT.

END OF SECTION

SECTION 01720

PROJECT AS-BUILT DOCUMENTS

PART 1 - GENERAL

1.01 RELATED REQUIREMENTS SPECIFIED ELSEWHERE

A. Submittals and Shop Drawings: Section 01300

B. Contract Closeout: Section 01700

1.02 DESCRIPTION

A. Keep accurate as-built documents for all additions, substitution of material, variations in Work, and any other revisions to the Contract Documents.

B. At least two (2) complete sets of Drawings shall be designated for mark-up purposes to depict field changes for submission to the DISTRICT's representative. Deviations may not change the intent of the design or necessitate engineering redesign, but require approval by the DISTRICT's representative. Changes shall be recorded on the "as-built" set of Drawings as implemented. Light green pencil shall be used to indicate deletions; red to show additions and changes.

1.03 MAINTENANCE OF DOCUMENTS

A. Maintain at the Project site, at least one copy of:

1. Drawings.
2. Specifications.
3. Addenda.
4. Reviewed Shop Drawings.
5. Change Orders.
6. Other Modifications to the Contract (Proposal Requests, Change Order Proposals, etc.).
7. Request for Information
8. Engineering Change Directives.
9. Field and Laboratory Test Records.
10. Certificates of Compliance.
11. CONTRACTOR's Daily Progress and Inspection Reports.
12. Construction Photographs.
13. Other Documentation Required by Agencies Having Jurisdiction.
14. All Permits.
15. Site Safety Plan.

16. Meeting Minutes.

B. Store documents in a dry safe place, apart from documents used for construction.

C. Do not use as-built documents for construction purposes.

D. Make documents available at all times for inspection by the DISTRICT, the DISTRICT's Representative, and others.

1.04 MARKING DEVICES

A. Use ball point pen or similar permanent marker for all marking.

1.05 RECORDING

A. CONTRACTOR shall designate in writing one employee to ensure that changes are being recorded. The name of the person identifying an error or change, as well as the error and change itself, shall be properly recorded and incorporated on the as-built drawings.

B. CONTRACTOR shall instruct its employees to notify the designated employee of all changes that they discover.

C. Label each document "PROJECT RECORD" in 2-in. high printed letters.

D. Keep as-built documents current.

E. Do not permanently conceal any Work until required information has been recorded.

F. Drawings: Legibly record actual construction, as applicable:

1. Depths of various elements of anchors in relation to survey data.
2. Horizontal and vertical location of anchors referenced to permanent surfaces.
3. Location of utilities adjacent to or concealed in construction referenced to visible and accessible features of structures.
4. Field changes of dimension and detail.
5. Changes made by Change Order, Engineering Change Directive, or other reason.
6. Details not on original Drawings.

G. Specifications and Addenda: legibly mark up each Section to record:

1. Manufacturer, trade name, catalog number, and supplier of each product and item of Work.
2. Changes made by Engineering Change Directive or otherwise.

3. Other items not originally specified.

H. Shop Drawings: Maintain as as-built documents; legibly annotate Drawings to record changes made after review.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 01735

COMMISSIONING, START-UP AND TESTING

PART 1 – GENERAL

1.01 Upon successful completion of all systems, including integration, infrastructure improvements and equipment installations, the DISTRICT shall coordinate commissioning, startup and testing for the Project. While the DISTRICT has ultimate responsibility for commissioning the integrated systems, other parties (including the CONTRACTOR) shall be responsible for their respective roles in the Project. These parties and their respective roles are defined below:

a. The CONTRACTOR shall be responsible for verifying that all CONTRACTOR-supplied equipment is properly installed and operating in accordance with the Contract Documents. This includes but is not limited to the Turbine Umbilicals, Trunk Cables, all Marine Cable Accessories, the horizontally drilled and installed conduits, the Power Conditioning and Control Building and associated building systems (HVAC, lighting, electrical, fire alarm, communications, and flood protection systems). The Contractor shall also be responsible for verifying that all DISTRICT-Furnished Equipment, installed by the CONTRACTOR, has been installed and is operating in accordance with the Contract Documents. This includes but is not limited to conduits, wiring, battery cabinets, inverters, control cabinets, etc. as indicated in the Contract Documents. The CONTRACTOR shall furnish a minimum of 120 man-hours of electrical foreman labor for the purposes of assisting the DISTRICT and other parties during Project commissioning and troubleshooting, as required.

b. The DISTRICT's Turbine supplier, OpenHydro shall have commissioning responsibilities including but not be limited to all operational performance associated with the Turbine Units and the Power Control and Conditioning Equipment.

1.02 CONTRACTOR shall furnish all labor, materials and equipment necessary to perform and complete the commissioning, start-up and testing of CONTRACTOR-furnished and installed equipment. CONTRACTOR shall also provide all labor, materials and equipment necessary to adjust or otherwise modify CONTRACTOR-furnished and CONTRACTOR-installed equipment as required to successfully commission the Project.

The DISTRICT (via OpenHydro) shall furnish all labor and equipment necessary to perform and complete the commissioning, start-up and testing of DISTRICT-furnished, CONTRACTOR-installed equipment. The DISTRICT (via OpenHydro) shall also provide all labor and materials necessary to adjust or otherwise modify DISTRICT-furnished, CONTRACTOR-installed equipment as required to successfully commission the Project.

CONTRACTOR shall furnish all labor and equipment necessary to support the commissioning, start-up and testing of DISTRICT-furnished, CONTRACTOR-installed equipment. CONTRACTOR shall also provide all labor and equipment necessary to adjust or otherwise modify the connections and terminations to DISTRICT-furnished, CONTRACTOR-installed equipment as required to successfully commission the Project.

END OF SECTION

SECTION 02001 – HORIZONTAL DIRECTIONAL DRILLING

PART 1 GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall furnish all labor, equipment, and materials necessary to install high density polyethylene (HDPE) conduit(s), sized in coordination with the requirements of the marine trunk cable, by horizontal directional drilling (HDD) as indicated on the Project Drawings. The DISTRICT is prepared to accept HDD plans from the CONTRACTOR that includes:

   A. One larger conduit complete with three sub-ducts, or

   B. Two smaller, individually drilled HDD conduits, without sub-ducts.

   In either scenario, it shall be the CONTRACTOR's responsibility to coordinate and verify the sizing with the requirements included in the Marine Operations (Division-18000) specifications included herein.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Installation of Pipelines by Horizontal Directional Drilling, Pipeline Research Committee, American Gas Association, PR-227-9424, April 1995.

B. Horizontal Directional Drilling Good Practices Guidelines, 2008, 2004, 2001, HDD Industry Consortium, 300pp.

C. API Bulletin 13D, 1985. Bulletin on the Rheology of Oil-Well Drilling Fluids, Second Edition, Dallas, Texas, American Petroleum Institute.

D. API Recommended Practice 13B-1, 1990. Standard Procedures for Field Testing Water-Based Drilling Fluids, First Edition, Dallas, Texas, American Petroleum Institute.

E. Installation of Pipelines Beneath Levees Using Horizontal Directional Drilling, US Army Corps of Engineers, Waterways Experiment Station, Final Report, CPAR-GL-98-1, April 1998.

F. API Specification 13A, 1993. Specification for Drilling Fluid Materials, Fifteenth Edition, Dallas, Texas. American Petroleum Institute.

G. IADC Drilling Manual, 1992. Eleventh Edition, Houston, Texas, International Associated of Drilling Contractors.

H. Tables for Hydraulic Design of Pipes and Sewers, American Society for Civil Engineers, 5th ed., 1990.

1.3 SUBMITTALS

A. The Contractor shall submit the following information, providing sufficient detail to allow the DISTRICT to determine whether the proposed equipment, materials, and procedures meet the Contract requirements. Review and acceptance of the CONTRACTOR's Submittals by the DISTRICT shall not be construed in any way as relieving the CONTRACTOR of its responsibilities under this Contract.

B. **Horizontal Directional Drilling Work Plan:** Submit a HDD Work Plan complete with drawings and written description identifying all details of the proposed method of construction and the sequence of operations to be performed during construction.

C. **Qualifications:** Submit written documentation of the HDD Contractor, HDD Superintendent and drill rig operator. Provide evidence of the following qualifications:

1. The HDD Contractor shall have successfully completed at least five (5) HDD projects that include the installation of 6-inch pipe or greater, with a minimum drilling length of 500 LF for each project. At least three (3) of the projects must have been installations with one of the HDD endpoints located in a tidally influenced water body at a water depth of at least 50 feet.

2. The HDD Superintendent shall have successfully completed at least five (5) projects of 6-inch diameter (or greater) with pull lengths of 500 feet (or greater) in the last 5 years. At least two (2) of the projects must have been installations with one of the HDD endpoints located in a tidally influenced water body at a water depth of at least 60 feet.

3. The HDD drill rig operator shall have successfully completed at least three (3) projects of 6-inch diameter (or greater) with pull lengths of 500 feet (or greater) in the last 5 years.

D. **Shop Drawings:** The drawings shall include all equipment, equipment setup areas, pipe layout areas, and any excavations or mud recirculating pits. The CONTRACTOR shall confirm that all operations shall be completely contained within the temporary construction easement shown on the Drawings.

E. **Schedule:** The CONTRACTOR shall submit a detailed schedule showing all major construction activities and durations, with starting and completion dates shown. The schedule shall include:

1. "One call" utility locate requests and visual confirmation of all crossing utilities and all parallel utilities within twenty (20) feet laterally of the bore centerline.

2. Site preparation.

3. Rig mobilization and setup.

4. Pilot bore drilling (including contingency plan for potential problems).

5. Reaming (including contingency plan for potential problems).

a. Layout and fusing of pipe.

b. Final reaming (swab) and pullback of pipe (including contingency plan for potential problems).

c. Annulus grouting after conduit(s) installation.

d. Cleanup, surface restoration, and demobilization.

F. **Description of Methods, Equipment and Materials:** The CONTRACTOR shall submit detailed descriptions of all methods, equipment, and materials to be used for the pipeline installation. Description of drilling fluid shall be accompanied by Materials Safety Data Sheets (MSDS) and manufacturers' descriptions and warranties. Descriptions of equipment shall include manufacturers' specifications, calibrations, appropriate drawings, photographs, and descriptions of any modifications since manufacture.

G. **Surveying, Equipment and Procedures:** The CONTRACTOR shall submit records of equipment calibrations and certifications for all equipment used for downhole surveys and tracking of the drill head. Procedures for operating the downhole survey tools shall be described, including measures to verify the accuracy of the equipment readings.

H. **Drilling and Reaming Rates:** The CONTRACTOR shall submit maximum anticipated drilling and reaming rates for pilot bore and each reaming pass and confirm that pump capacity is adequate for these anticipated drilling rates for the drilling fluid weights anticipated.

I. **Pipe Filling Methods:** The CONTRACTOR shall submit methods and procedures for buoyancy control during pullback.

J. **Calculations for Pullback:** The CONTRACTOR shall submit calculations for pullback loads for the conditions and operating practices anticipated. All assumptions used in the calculations shall be provided. These calculations shall be made and stamped by a licensed Professional Engineer registered in the State of Washington.

K. **Pipe Stress Calculations:** The CONTRACTOR shall submit calculations for pipe stresses expected to result from the pullback, bending, fluid buckling loads, earth loads, groundwater loads, break-over stresses during entry into the bore, and any other installation and service loads expected to be exerted on the pipe. All assumptions used in the calculations shall be provided. Calculations shall include a minimum pipe wall thickness. These calculations shall be made and stamped by a licensed Professional Engineer registered in the State of Washington.

L. **Calculations of Maximum Allowable Drilling Fluid Pressure:** The CONTRACTOR shall submit calculations identifying the critical downhole pressure that would cause hydrofracture (Frac-Out) or inadvertent drilling fluid returns. The calculations shall identify the critical points in the alignment. The calculations shall identify all parameters used and state all assumptions made in the calculations. The calculations shall be sealed and stamped by a licensed Professional registered in the State of Washington.

M. **Frac-Out and Surface Spill Contingency Plan:** The CONTRACTOR shall submit a Frac-Out and Surface Spill Contingency Plan describing procedures for preventing drilling fluid losses or spills into the marine environment and/or fluid returns to the surface. The plan shall address roles and responsibilities of involved parties, monitoring, prevention, containment, cleanup, and documentation procedures, and observations to be made and plans for containment and cleanup, if spills or hydrofracture occur. The plan shall also address changes that may be required to CONTRACTOR's operations to avoid recurrences. CONTRACTOR shall provide waste storage capacity calculations for a onshore frac-out scenario and provide the same capacity in their Contingency Plan and onsite for the duration of the HDD work. Plan shall also include a list of materials and equipment that will be onsite and available should a frac-out occur. Plan shall include diver inspection of the exit point during key points of the initial pilot bore(s) as mitigation for controlling the release of drilling fluids into the marine environment. Plan shall correlate specific drilling activity with diver observation.

N. **Rig Capacity:** The CONTRACTOR shall submit details on the capacity of the drill rig verifying that the pullback capacity is greater than the required pullback calculated and submitted by the CONTRACTOR.

O. **Soil Separation Plant:** The CONTRACTOR shall submit details on the pump and cleaning plant. Include dimensions, manufacturer's specifications, pump capacity and noise rating on the system.

P. **Plans for Disposal of Spoils and Drilling Fluids:** The CONTRACTOR shall submit plans for disposal of waste materials resulting from the pipeline(s) construction, including drilling fluids, cuttings, waste oil, fuel, discharge water, etc. The CONTRACTOR shall identify the disposal site and submit a letter indicating willingness and legal authority to accept the described and anticipated waste products. All onsite storage of waste materials shall be stored in above-grade watertight storage containers. CONTRACTOR shall provide calculations that outline and demonstrate that the storage provided onsite will address the needs of both typical and those identified in the Contingency Plan.

Q. **Contingency Plans for Potential Problems:** The CONTRACTOR shall submit contingency plans for remediation of potential problems that may be encountered during the drilling operations. The contingency plans shall address the observations that would lead to the discovery of the problem and the methods that would be used to mitigate the problem. Potential problems that shall be addressed include:

1. Natural or man-made obstructions encountered (such as buried logs, boulders, etc.).

2. Utility strike.

3. Loss of circulation.

4. Deviation from planned bore path.

5. Inability to advance drill or product pipe.

6. Hydrolock.

7. Drill or product pipe twisted off or broken off in borehole.

8. Pipe collapses or pipe deformations exceed maximum allowable tolerances.

9. Frac-out (both on and off-shore).

R. **Safety Plan:** The CONTRACTOR shall submit a Safety Plan, including the name of the CONTRACTOR'S Site Safety Representative, emergency telephone numbers for medical facilities, and precautions for handling and disposal of any hazardous or flammable materials. The Safety Plan shall include a code of safe practices and an emergency plan in accordance with OSHA and Washington/OSHA requirements.

S. The following shall be submitted as construction progresses and at the completion of construction.

1. Daily Logs and Records: Daily logs and records shall be maintained by the CONTRACTOR and shall include drilling lengths, location of drill head, installation loads, drilling fluid pressures and flow rates, drilling fluid losses, inadvertent returns, drilling times required for each pipe joint, any instances of retraction and re-drilling of the pilot bore or segments thereof, and any other relevant observations, including any hard drilling zones, steering problems, circulation problems, observed settlement, heave, frac-outs, or surface spills. Daily logs and records shall be submitted by noon of the following day to which the records correspond.

2. Variations in Plan and Profile: The CONTRACTOR shall document any variations between the actual plan and profile of the bore path and the location shown on the Drawings and specifications herein. The CONTRACTOR shall notify the DISTRICT immediately upon discovery of any deviations that exceed design tolerances.

3. Mud Weights: The CONTRACTOR shall submit measured drilling fluid viscosity and density at least three (3) times per shift with at least two (2) hours between readings, using calibrated Marsh funnel and mud balance. Measurements shall be made during each stage of the drilling process. These measurements shall be included in daily logs submitted to the DISTRICT. The CONTRACTOR shall document modifications to the drilling fluids, by noting the types and quantities of drilling fluid additives and the dates and times when introduced. The reason for the addition of drilling fluid additives or other modifications shall be documented and reported.

4. Pilot Bore As-Built Profile: The CONTRACTOR shall submit an as-built profile of the pilot bore within 48 hours of completion of the pilot bore.

1.4 MARINE REQUIREMENTS

A. The CONTRACTOR shall comply at all times with the requirements of the United States Coast Guard (USCG) concerning the movement and position of the CONTRACTOR's floating equipment used to complete the installation.

B. In the event of any drilling fluid escape into the marine environment, the CONTRACTOR shall, at his own expense, immediately restore the affected seabed or area to its original profile to the satisfaction of the DISTRICT.

C. The CONTRACTOR shall permit the USCG to inspect operations at any reasonable time.

D. Ordinary business, marine operations and activity will continue during the conduit installation, and the CONTRACTOR's operations shall be carried out in such a way as to avoid interference with marine traffic unless approved in advance in writing by the USCG and other responsible authorities. The CONTRACTOR shall attend meeting with said authorities and the DISTRICT as necessary.

E. The CONTRACTOR shall, during marine operations and at all other times, be particularly careful to keep interference with navigation to a minimum and, if required, shall attach buoys to all anchors of all floating equipment and exhibit proper and necessary lights and signals, and shall obey instructions on these matters issued at any time by the USCG or any other relevant statutory authority.

1.5 DEFINITIONS

A. **Annular Space**: The space between the excavated HDD final reamed bore diameter and the product pipe or the space between product pipe and conductor casing.

B. **Bent Sub:** A bent sub is a section of drill pipe behind the cutting tools that is inclined at an angle from the axis of the bore in the desired direction of steering. The bent sub allows steering while rotating the cutting tools.

C. **Horizontal Directional Drilling:** Horizontal Directional Drilling (HDD) is a guided, steerable drilling system used for the trenchless installation of pipes, conduits, and cables. A pilot bore path is excavated in a shallow arc from a surface-launched drill rig. Excavation takes place with fluid assisted cutting from a drilling tool on the drill string. The pilot bore is directed by the positioning of a bent sub. The bore is filled with drilling mud/fluid for stabilization. The bore path is enlarged with subsequent multiple reaming passes until the desired diameter is achieved. As a final step, the product pipe, conduit, or cable is pulled into the fluid-stabilized bore.

D. **Drilling Fluid/Mud:** A mixture of water and bentonite continuously pumped to the drilling tool or bit cutting head to facilitate the removal of soil cuttings, and stabilization of the bore. These fluids also cool the cutting tools and lubricate the pipe string.

E. **Pilot Bore:** The action of creating the first guided pass of the HDD process which is

then reamed in multiple passes to the size required to allow pullback of the pipe.

F. **Drilling Tool/Bit:** Any tool or system of tools that excavate at the face of a bore.

G. **Pullback:** That part of a horizontal directional drilling process in which the drill string and product pipe are pulled back through the bore to the entry.

H. **Pullback Loads:** The tensile load (force) applied to a drill string and product pipe during the pullback process.

I. **Frac-out**: The fracturing or failure of the soil around the bore hole as a result of excessive drilling fluid pressure generally resulting in drilling mud being released to the surface.

1.6 DESIGN CRITERIA

A. **Equipment:** The CONTRACTOR shall provide all equipment, materials, and personnel necessary for completing the installation as shown on the Drawings and specified herein. The equipment and materials shall include but are not limited to:

1. Directional drilling rig with all ancillary equipment, including drill pipe, drilling fluid, cutting tools, reaming bits, swivels, expanders, motors, generator, pumps, hoses, mixing equipment, drilling fluid processing equipment (cuttings separation equipment), downhole survey equipment, energized surface grid, fluid pressure and flow rate monitoring equipment, spare parts, pipe handling equipment, crane, backhoe, roller, side boom tractors, control cabin, control equipment, waste storage and containment and office equipment.

2. Drilling fluids, water, fuel, lubricant, polymers, or other additives.

3. Any other expendable or reusable materials, supplies, and equipment needed for the installation.

B. The drilling equipment shall be capable of advancing through the geologic conditions to be encountered at the site as depicted in the geotechnical report, included in this specification in Appendix-F, and as anticipated by the CONTRACTOR.

C. The drilling fluid shall be designed for the geologic conditions to be encountered at the site as depicted in the geotechnical report and as anticipated by the CONTRACTOR.

D. The capacity of the directional drilling rig used by the CONTRACTOR shall be adequate to install the specified pipeline.

E. The pump used by the CONTRACTOR shall be adequate to supply the required flow rate and pressures at the anticipated drilling fluid viscosity at all times. Drilling speeds shall not exceed pump capacity.

F. The drilling system shall contain an electronic data logger to track rate of penetration, rotational torque, thrust/pullback, and annular pressure.

G. The drilling system shall include a fluid pump and separation plant that can manage the

rates of drilling fluid pumping, spoil separation, and slurry cleaning required by the CONTRACTOR to achieve planned production rates for the soils anticipated. Shaker screens, hydrocyclones, and centrifuges may be required for efficient separation of spoils.

H. All spoil and slurry must be contained in trucks, tanks, approved recirculation pits, or other containers at all times. Dumping of spoil or slurry on the ground, discharge into sewers, or discharge into water bodies shall not be permitted. All spoils shall be transported and disposed of off-site at an approved disposal facility that meets all State of Washington and local requirements.

I. Perform all work within work areas shown on the Drawings.

J. Any deviation to the radii of curvatures or entry and exit angles shown on the Drawings should be submitted in writing to the DISTRICT for approval.

1.7 Surface settlement or heave, of the ground surface or utilities and/or other features above the HDD centerlines and within the zone influenced by the HDD construction shall be limited to values that avoid damage. The CONTRACTOR shall repair any damage resulting from settlement or heave caused by HDD activities at no additional cost to the DISTRICT. The CONTRACTOR shall grout any voids caused by or encountered during drilling.

A. The CONTRACTOR shall allow access to the DISTRICT and shall furnish necessary assistance and cooperation to aid the DISTRICT in observations and data and sample collection, including, but not limited to the following:

1. The CONTRACTOR shall allow the DISTRICT and/or DISTRICT's Representative full access to the operator control container prior to, during, and following all HDD operations. This shall include, but not be limited to, providing access to the operator console including visual access to real-time operator control screens, gauges, and indicators during all drilling operations.

2. The CONTRACTOR shall allow the DISTRICT and/or DISTRICT's Representative full access to the slurry separation plant prior to, during, and following all HDD operations. This shall include, but not be limited to, full access to shaker screens, hydrocyclones, conveyor belts, and slurry and spoil holding tanks. The CONTRACTOR shall allow the DISTRICT to collect soil samples from the shaker screens and/or spoil holding tanks on the slurry separation plant a minimum of once per drill pipe, and whenever changes in conditions are observed or suspected.

3. Subject to 4 hours notice, the CONTRACTOR shall arrange for the transport of the DISTRICTand/or DISTRICT's Representative and their staff between the shore and any and all marine craft involved in the conduit(s) installation. The CONTRACTOR shall provide all necessary safety and rescue equipment for personnel.

PART 2 PRODUCTS

2.1 MATERIALS

A. **Pipe:** The pipe thickness must conform to the most conservative design with respect to design calculations for the critical combination of internal and external pressure, pullback, and bending as determined by the HDD CONTRACTOR. Minimum pipe wall thickness shall be as shown in calculations submitted in accordance with this specification.

B. **Water:** The CONTRACTOR shall secure a suitable source of water, and shall be responsible for transporting, storing, and disposing of any water required. There is no water source available to the contractor onsite. Water will need to be imported as required.

C. **Drilling Fluids:** The CONTRACTOR shall select the bentonite drilling fluid mixture proportions to ensure continuous circulation, bore stability, reduce drag on the pipe, and completely fill the annular space between the bore and the pipe to control settlement. Management and disposal of drilling fluids shall be the CONTRACTOR's responsibility.

D. **Drill Pipe:** The CONTRACTOR shall provide high quality drill pipe that has been inspected and determined to be adequate for the project requirements. Bent, cracked, or fatigued drill pipes shall not be used. Threads must be in good condition.

PART 3 EXECUTION

3.1 GENERAL

A. The CONTRACTOR shall not initiate HDD until all submittals are received, reviewed, and accepted by the DISTRICT.

B. The CONTRACTOR shall not initiate HDD until all required permits are obtained.

C. The CONTRACTOR shall have the equipment listed in the submitted and approved Frac-Out and Surface Spill Contingency Plan prior to commencing drilling operations.

3.2 WORK STAGING AREA

A. **Work Staging:** The CONTRACTOR shall limit staging and work operations to the areas shown on the Drawings, or as otherwise accepted in writing by the DISTRICT, for storage of equipment and materials, parking, pipe layout, drilling, and other work.

B. **Control of Drilling Fluids:** The CONTRACTOR shall follow all requirements of the Frac-Out and Surface Spill Contingency Plan and control operational pressures, drilling mud weights, drilling speeds, and any other operational factors required to avoid hydrofracture fluid losses into the surrounding formations, and control drilling fluid spillage. This includes any spillages, inadvertent fluid, or slurry returns at entry and exit locations or at any intermediate point. All inadvertent returns or spills shall be promptly contained and cleaned up on the land portion of the bore. For the marine portion of the bore the CONTRACTOR shall, upon notice from divers, immediately modify their drilling practices as necessary such that the amount of drilling fluid released on the sea floor is kept to a minimum, all in accordance with the CONTRACTOR submitted, Frac-Out and Surface Spill Contingency Plan. The CONTRACTOR shall maintain on-site mobile spill containment and removal

equipment on site at all times. The CONTRACTOR shall be capable of quickly containing and removing spills. The CONTRACTOR shall immediately notify the DISTRICT of any inadvertent returns or spills and immediately clean up the inadvertent return or spill.

C. **Combustible Materials:** Combustible materials (fuel, oil, lubricants, etc.) shall be stored off-site or in a well-ventilated storage facility removed from the immediate vicinity of the drilling area by at least twenty (20) feet.

D. **Site Security:** The CONTRACTOR shall install an enclosure fence around the work area. The enclosure fence shall include a lockable gate and should prevent entry of unauthorized persons.

3.3 MOBILIZATION

A. The CONTRACTOR shall mobilize all equipment, materials, and personnel necessary to construct the pipeline using the HDD process at the locations shown on the Drawings.

1. Entry Area: The CONTRACTOR shall set up temporary workspace within the areas delineated on the Drawings. Appropriate precautions and measures shall be employed by the CONTRACTOR to prevent erosion, surface drainage, and spillage of drilling fluids or other materials that could adversely impact the environmental quality of the site. Silt fences, hay wattles, and hay bales shall be used to line the work area to minimize erosion and contain any spillages or runoff.

3.4 HORIZONTAL DIRECTIONAL DRILLING

A. **Bore Tracking and Monitoring:**

1. Downhole Wireline and Surface Grid Tracking System: The CONTRACTOR shall monitor and record x, y, and z coordinates relative to an established surface survey bench mark, from downhole survey data using a downhole wireline system. The grids shall be surveyed to establish horizontal and vertical position to 0.1 feet accuracy. The data shall be continuously monitored and recorded at least once per drill pipe length or at thirty (30) feet or thirty (30) minute intervals during drilling, whichever is most frequent. The completed borehole shall be surveyed with the downhole locating system after all reaming is completed and prior to pullback of the pipe. This information shall be collected and provided to the DISTRICT prior to commencement of pullback.

2. Deviations between the recorded and design bore path shall be calculated and reported on the daily report. If the deviations exceed tolerances shown of the drawings, such occurrences shall be reported immediately to the DISTRICT. The CONTRACTOR shall undertake all necessary measures to correct deviations and return to design line and grade.

3. Drilling Fluid Pressures and Flow Rates: Drilling fluid pressures and flow rates shall be continuously monitored and recorded by the CONTRACTOR. The pressures shall be monitored at the pump, and shall be made during pilot bore drilling, reaming, and pullback operations. Maximum allowable drilling speeds shall be calculated for pilot boring and each reaming pass and shall not be exceeded for pilot boring or reaming passes. Annular pressure measurements shall be

continuous and shall be recorded using a data logging system.

4. Drilling Fluid Viscosity and Density (Mud Weight): The CONTRACTOR shall measure and record drilling fluid viscosity and density at least three (3) times per shift with at least two (2) hours between readings, using calibrated Marsh funnel and mud balance. These measurements shall be included in daily logs submitted to the DISTRICT.

B. **Location of Entry and Exit Points:** Entry and exit points shall be as shown on the Drawings, unless otherwise approved in writing by the DISTRICT. The CONTRACTOR shall employ licensed, experienced surveyors to locate the entry and exit points, and to establish horizontal and vertical datum for the bore and the pipe layout and fabrication areas.

C. **Entry and Exit Angles:** Drill entrance and exit angles shall be as shown on the Drawings, unless otherwise approved in writing by the DISTRICT.

D. **Pilot Bore:** The pilot bore shall follow the design path of the bore shown on the Drawings.

1. Horizontal and Vertical Tolerances: Horizontal and vertical deviations shall be no more than plus or minus five (5) feet from the design path centerline or within the tolerances shown on the drawings, as indicated.

2. Entry and Exit Tolerances**:** The location of the entry and exit points shall be within the tolerances shown on the Drawings. The CONTRACTOR shall be solely responsible for all work necessary to correct excessive deviations from line and grade, including re-drilling, redesigning connections, and acquiring additional easement, at no additional cost to the DISTRICT and without schedule extension.

E. **Reaming:** The pilot bore shall be reamed using equipment and methods submitted by the CONTRACTOR. The CONTRACTOR shall completely ream the bore to the final diameter prior to pullback.

F. **Swab Pass:** The CONTRACTOR shall complete a swab pass of the bore prior to pullback of the pipe.

G. **Pipe Pullback**:

1. The pipe shall be installed by pulling it into the reamed bore hole behind a final reaming tool selected by the CONTRACTOR.

2. The pipe shall be isolated from excessive torsional and axial stresses by a swivel device.

3. The HDPE pipe shall be filled with water in accordance with approved submittal as it enters the bore to reduce pullback loads.

4. The CONTRACTOR shall monitor and record installation loads once per drill pipe or every 30 feet, whichever is more frequent.

5. The CONTRACTOR shall cease operations if the pipe is damaged and shall remove

the pipe from the bore and repair the pipe using the manufacturer's recommended procedure or replace the damaged pipe before resuming installation.

6. Damage to the pipe resulting from installation or grouting of the annulus is the responsibility of the CONTRACTOR, including costs for replacement and labor and materials.

7. The CONTRACTOR shall cap the conduit exit points to prevent silt and debris from entering the conduit.

8. The CONTRACTOR shall leave 18 inches of conduit protruding from the exit point for attachment of the bellmouth assembly by divers used during the cable pull.

9. The CONTRACTOR shall leave a pulling line installed in the HDPE conduit for access by divers during the cable pull. The pulling line shall have adequate tensile strength to allow the trunk cable (TC) to be pulled in.

H. **Site Restoration and Demobilization:** The CONTRACTOR shall remove all equipment, materials, drilling fluids, muck, waste, and debris from the site and restore the site to its original condition upon completion of the installation.

END OF SECTION

SECTION 02110 - PROTECTION OF ENVIRONMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Conforming to the requirements of permits furnished by others and obtaining other permits required to perform the work.
2. Planning, designing, constructing and maintaining of silt barriers, and holding and sedimentation facilities necessary or required to divert, remove, treat and dispose of water from construction areas.
3. Installing and implementing dust control measures.

B. The Contractor shall perform all work necessary to comply with the requirements of permits furnished by others and Contractor-furnished permits governing this work.

C. All work required in this section, including all erosion and sediment control facilities, shall be installed prior to any ground disturbing activity requiring the use of the facilities.

D. This work shall consist of temporary measures that may be shown in the plans, proposed by the Contractor, and approved by the DISTRICT or ordered by the DISTRICT during the life of the contract. This work is intended to provide prevention, control and abatement of water pollution/erosion within the limits of the project and to minimize damage to the work, adjacent property and to bodies of water, if any.

E. This work shall comply with the more stringent of the requirements of the WSDOT/APWA or Washington State Department of Ecology. The improvements shown on the plans should be considered as the minimum necessary.

F. The County Inspector or DISTRICT may request additional measures be implemented. Any discrepancies between the construction control and inspection requirements and this specification shall be brought to the attention of the DISTRICT prior to bidding.

1.3 PERMITS

A. DISTRICT-FURNISHED PERMITS

The DISTRICT has made application for the permits listed in the appendix. The Contractor shall be responsible for compliance with all construction stipulations contained therein. Generally, the specifications and drawings contain specific requirements for which the Contractor is responsible for compliance.

1. Building Permit for planned construction
2. Grading Permit for planned construction

B. CONTRACTOR-FURNISHED PERMITS

1. The Contractor shall be responsible for identifying, obtaining and complying with all permits and inspections required for construction activities, including necessary plumbing, electrical or other permits required for permanent construction.
2. The Contractor shall obtain separate permits or revisions of permits for any activities not covered under permits furnished by the DISTRICT.
3. The Contractor shall perform any and all activities required to obtain the Contractor-furnished permits, including contacting respective agencies, filing applications and paying any required application fees.

C. In the event the Contractor's work plan requires work/storage areas beyond the limits of the construction easement provided by the DISTRICT, those areas shall be arranged for by the Contractor at the Contractor's sole expense.

1.4 SUBMITTALS

A. Contractor shall submit for approval manufacturer's data for clear plastic covering, filter fabric, seeding, mulching, quarry spalls or any additional preferred products not identified on the erosion control plans with intended use on the project site.

B. The Contractor shall submit for review all procedures for control of job related activities to protect the environment including dust control measures, handling and disposing of solid wastes, oil and hazardous substances handling, storage, dewatering, stormwater management, spill prevention and clean up.

1.5 REFERENCES

WSDOT/APWA	Standard Specifications for Road, Bridge and Municipal Construction, 2010, or most current update, Washington State Department of Transportation/APWA
SWPPP	Site specific Storm Water Pollution Prevention Plan (SWPPP) and Temporary Erosion Control Plans.

PART 2 PRODUCTS

2.1 CLEAR PLASTIC COVERING

A. Plastic sheeting shall have a minimum thickness of 0.06 millimeters.

2.2 FILTER FABRIC FENCE

A. All geotextile used shall meet the requirements of Section 9-33.2(1) Table 6 of WSDOT/APWA. All geotextile properties listed are minimum average roll values (i.e., the text result for any sampled roll in a lot shall meet or exceed the values shown in the table).

2.3 PERMANENT AND/OR TEMPORARY SEEDING

It is the DISTRICT's preference that the site be allowed to re-vegetate naturally without the need to import seed to the site. The relative flatness of the site reduces potential for erosion hazards typically associated with point discharges of storm runoff during a rainfall event. However, the CONTRACTOR shall be prepared to hydroseed as indicated in the specifications, should an erosion hazard become apparent. In the event

hydroseeding is required, this shall be a change condition and the Contractor shall be compensated via the Contingency Account bid item.

2.4 MULCHING

Mulching per plan notes.

2.5 QUARRY SPALLS

Quarry Spalls shall be in accordance with Section 9-13.6 of WSDOT/APWA.

2.6 WATTLES

Wattles to conform to WSDOT Standard Detail I-30.30-00 and Section 9-14.5(5).

PART 3 EXECUTION

3.1 GENERAL

A. Install Temporary Erosion Sediment Control (TESC) facilities specified on the plans prior to starting any clearing or grubbing operations.

B. Stormwater discharged from the site shall conform to the requirements of WSDOT/APWA, Washington State Department of Ecology or local, whichever is more stringent.

3.2 DRAINAGE OF EXCAVATED AREAS

A. Provide and maintain ditches of adequate size to collect rainfall and groundwater seepage which may enter the excavations. Divert the water into sumps, so that it can be drained or pumped out of the excavations, treated and discharged according to all applicable permits.

3.3 OTHER WASTEWATER

A. All water which has been polluted by materials such as oil, grease, cement and concrete, paints or chemicals used by the Contractor's operation shall be disposed of in an approved manner and in accordance with all applicable local, state, and federal regulations.

3.4 FILTER FABRIC FENCE

A. The filter fabric fence shall prevent soil carried by runoff water from going beneath, through or over the top of the silt fence, but shall allow the water, without soil, to pass through the fence. Installation shall be per plan detail and Section 8-01.3(9)A of WSDOT/APWA.

3.5 HYDROSEEDING & SOIL PREPARATION

A. It is the DISTRICT's preference that the site be allowed to re-vegetate naturally without the need to import seed to the site. The relative flatness of the site reduces potential for erosion hazards typically associated with point discharges of storm runoff during a rainfall event. However, the CONTRACTOR shall be prepared to hydroseed as indicated in the specifications, should an erosion hazard become apparent.

B. The Contractor shall submit to the DISTRICT certificates of inspection of seed by state or federal authorities and copies of delivery invoices or other proof of quantities of mulch and fertilizer.

C. All hydroseeding and soil preparation requirements shall be in accordance with Section 8-01.3(2) of WSDOT/APWA and with BMP C120: Temporary and Permanent Seeding identified in the SWPPP, and/or as directed by WA state and local authorities.

3.6 WATTLES

A. Install as shown on plans and per WSDOT Standard Detail I-30.30-00.

3.7 REMOVAL OF TEMPORARY FACILITIES

A. Upon completion of all work, and when site has been adequately stabilized, remove all facilities constructed for temporary erosion and sediment control.

END OF SECTION

SECTION 02200 - EARTHWORK

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

B. General

Contractor shall include in the base bid the cost of achieving the final grades shown on the Contract Documents beginning with the existing conditions as represented in the site survey and the geotechnical report attached to, and included in, the appendix. All excavation to suitable bearing soil, export, import, placement and compaction required to achieve the final grades and completed structures shall be included in the base bid.

The Contractor shall make a reasonable effort to use the soils on-site as for both structural and non-structural fill. This includes normal or typical efforts of on-site soil management (wetting or drying soils as needed to reach the optimum moisture content, protecting stockpiled soils, controlling surface water near work areas, etc.).

The has not attempted to calculate the required export material required, structural fill volumes or the net imbalance for either of these items. It shall be the Contractor's responsibility to determine those amounts and include them as incidental in the base bid.

C. Section Includes:

1. Preparing subgrades for buried structures, slabs-on-grade, walks, pavements.
2. Excavating and backfilling for buildings and structures.
3. Drainage course for concrete slabs-on-grade.
4. Subbase course for concrete walks and pavements.
5. Subbase course and base course for asphalt paving.
6. Excavating and backfilling trenches for utilities and pits for buried utility structures.

D. Related Sections:

Coordinate related work specified in other parts of the Project Manual, including but not limited to the following:

1. Appendix-F Geotechnical Report (Onshore) – Admiralty Inlet Pilot Tidal Project (February 13, 2013) prepared for Snohomish County PUD No. 1
2. Section 02250 - Trench Safety Systems
3. Section 02110 – Protection of Environment

1.3 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.
   1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
   2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
   1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions only as directed by DISTRICT. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
   2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by The DISTRICT. Unauthorized excavation, as well as remedial work directed by The DISTRICT, shall be without additional compensation.

G. Fill: Soil materials used to raise existing grades.

H. Structures: Buildings, footings, foundations, retaining walls, slabs, vaults, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

I. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

J. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

K. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

L. Unsuitable Soils: Unanticipated unsuitable soil shall be that mineral soil that is not suitable for use as structural fill after a reasonable effort has been made through on-site soil management / soil conditioning to establish a soil moisture content that allows the compaction of the soil to the specified density as verified by the or the ’s geotechnical representative.

1.4 REFERENCES

WSDOT/APWA	Standard Specifications for Road, Bridge and Municipal Construction, 2010, Washington State Department of Transportation/APWA
ICC	Island County Code Chapter 11.

1.5 SUBMITTALS

A. Product Data: For each type of the following manufactured products required:
   1. Each type of plastic warning tape.
   2. Controlled low-strength material, including design mixture.

B. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:
   1. Classification according to ASTM D 2487 of each soil material proposed for fill and backfill.
   2. Laboratory compaction curve according to ASTM D 698, ASTM D 1557 for each soil material proposed for fill and backfill.

1.6 QUALITY ASSURANCE

A. Materials and soils testing services shall be provided by the DISTRICT.

B. Geotechnical Testing Agency Qualifications: An independent testing agency qualified according to ASTM E 329 to conduct soil materials and rock-definition testing, as documented according to ASTM D 3740.

1.7 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by resident or others unless permitted in writing by the DISTRICT and then only after arranging to provide temporary utility services according to requirements indicated.
   1. Notify DISTRICT not less than two days in advance of proposed utility interruptions.
   2. Do not proceed with utility interruptions without the DISTRICT's written permission.
   3. Contact utility-locator service for area where Project is located before excavating.

B. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth moving operations.
   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from DISTRICT and authorities having jurisdiction.
   2. Provide alternate routes around closed or obstructed traffic ways if required by DISTRICT or authorities having jurisdiction.

C. Utility Locator Service: Call Before You Dig 811 before beginning earth moving operations.

D. Do not commence earth moving operations until temporary erosion- and sedimentation-control measures, specified in Division 2 Section “Protection of Environment” are in place.

PART 2 PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: Soil Classification ASTM D 2487 Soil Classification Groups GW, GP, GM, SW, SP, and SM, or a combination of these groups; free of rock or gravel

larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter, or as determined by on-site geotechnical engineer.

C. Unsatisfactory Soils: Soil Classification Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups, or as determined by on-site geotechnical engineer.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

E. Aggregate for Gravel Base per WSDOT 9-03.10. Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inch sieve and not more than 10 percent passing a No. 200 sieve.

F. Crushed Surfacing Top Course (or Crushed Rock Top Course): Naturally or artificially graded mixture of natural or crushed gravel, crushed stone shall be per WSDOT 9-03.9(3).

G. Gravel Backfill for Pipe Zone Bedding per WSDOT 9-03.12(3): Shall be crushed, processed or naturally occurring granular material. Shall be free from various types of wood waste or other extraneous or objectionable material.

H. Drainage Course: Narrowly graded mixture of clean crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

I. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and 0 to 5 percent passing a No. 4 sieve.

J. Sand: ASTM C 33; fine aggregate. (aka fine graded granular)

K. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 ACCESSORIES

A. Warning Tape: Per Section 9-15.18 of WSDOT/APWA consisting of a~~A~~cid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

PART 3 EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.

B. Protect and maintain erosion and sedimentation controls during earth moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

C. The Contractor is solely responsible for providing temporary and permanent control of surface water and subsurface seepage to allow for site access, grading, construction of underground utilities, and paving. The Contractor is solely responsible for protecting disturbed areas and graded areas from inclement weather and surface runoff during construction to provide a suitable working platform for all phases of the construction.

3.3 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

2. Excavation for Underground Vaults, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.

3.4 EXCAVATION FOR INTERIOR BUILDING SLAB

Excavate surfaces under slabs to allow for a layer of fine graded granular material, a vapor barrier, clean compacted drainage course and structural fill (compacted to at least 95 percent of the maximum dry density based on ASTM Test Method D1557) as required, all to the dimensions outlined in the contract plans.

3.5 EXCAVATION FOR WALKS AND PAVEMENTS

Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.6 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.
   1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.
   1. Clearance: 12 inches each side of pipe or conduit.

C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.
   1. For pipes and conduit less than 6 inches in nominal diameter, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
   2. For pipes and conduit 6 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe or conduit circumference. Fill depressions with tamped sand backfill.
   3. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

3.7 SUBGRADE INSPECTION

A. Notify the DISTRICT when excavations have reached required subgrade.

B. If the DISTRICT determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

C. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.

D. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by the DISTRICT, without additional compensation.

3.8 UNAUTHORIZED EXCAVATION

Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by the DISTRICT.

3.9 STORAGE OF SOIL MATERIALS

Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

3.10 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:
   1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
   2. Surveying locations of underground utilities for Record Documents.
   3. Testing and inspecting underground utilities.
   4. Removing concrete formwork.
   5. Removing trash and debris.
   6. Removing temporary shoring and bracing, and sheeting.
   7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.11 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Trenches under Footings: Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings.

D. Backfill voids with satisfactory soil while removing shoring and bracing.

E. Place and compact initial backfill of satisfactory soil, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.

   1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

F. Place and compact final backfill of satisfactory soil to final subgrade elevation.

G. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.12 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:
   1. Under grass and planted areas, use satisfactory soil material.
   2. Under walks and pavements, use satisfactory soil material.
   3. Under steps and ramps, use engineered fill.
   4. Under building slabs, use engineered fill.
   5. Under footings and foundations, use engineered fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.13 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.14 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 1557:

1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.
2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 92 percent.
3. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 85 percent.
4. For utility trenches, compact each layer of initial and final backfill soil material at 90 percent.

D. Conditioning existing soil to reduce/increase moisture content: Condition existing mineral soil material via on-site soil management procedures to within 2 percent of the optimum moisture content for compaction purposes.

3.15 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

1. Turf or Unpaved Areas: Plus or minus 1 inch.
2. Walks: Plus or minus 1 inch.
3. Pavements: Plus or minus 1/2 inch.

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.16 SUBSURFACE DRAINAGE

A. Subdrainage Pipe: Specified in Division 2 Section "Subdrainage."

B. Subsurface Drain: Place subsurface drainage geotextile around perimeter of subdrainage trench. Place a 6-inch course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in a minimum of 12 inches of filter material, placed in compacted layers 6 inches thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least 6 inches.

1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D 698 with a minimum of two passes of a plate-type vibratory compactor.

3.17 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place subbase course and base course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place subbase course and base course under pavements and walks as follows:

1. Place base course material over subbase course under hot-mix asphalt pavement.
2. Shape subbase course and base course to required crown elevations and cross-slope grades.
3. Place subbase course and base course 6 inches or less in compacted thickness in a single layer.
4. Place subbase course and base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches (150 mm) thick or less than 3 inches thick.
5. Compact subbase course and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

C. Pavement Shoulders: Place shoulders along edges of subbase course and base course to prevent lateral movement. Construct shoulders, at least 12 inches wide, of satisfactory soil materials and compact simultaneously with each subbase and base layer to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

3.18 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

A. Place drainage course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:

1. Install subdrainage geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
2. Place drainage course 6 inches or less in compacted thickness in a single layer.

3. Place drainage course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
4. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.19 FIELD QUALITY CONTROL

A. Testing Agency: the DISTRICT will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by the DISTRICT.

D. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:

1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than three tests.
2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet or less of wall length, but no fewer than two tests.
3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length, but no fewer than two tests.

E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.20 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by the DISTRICT; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.21 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Transport surplus satisfactory soil to designated storage areas on the DISTRICT's property. Stockpile or spread soil as directed by the DISTRICT and as indicated on plans and Appendix-F “Geotechnical Report.”

1. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off the DISTRICT's property.
2. The Contractor shall be responsible for measuring the quantity of unanticipated unsuitable material that is removed. The Contractor shall measure in-place bank yards by field measurement that shall be observed, verified, and documented by the DISTRICT or the DISTRICT’s geotechnical representative prior to backfilling with structural fill. The Contractor shall note that measurements by truck tickets will not be accepted.

   Soil integrity will be influenced by the weather conditions and the Contractor’s handling\and protection of the material as it is removed and placed. It is the sole responsibility of the Contractor to protect soils from the elements. Material that is deemed unsuitable due to lack of protection will not be applied to the unit price. The Contractor will be responsible for removing such material and replacing with acceptable material at no additional cost to the DISTRICT.

END OF SECTION

SECTION 02210 – SITE CLEARING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stockpiling material.

B. Related Sections:

1. Division 02 Section “Protection of Environment" for temporary erosion control measures.

1.3 DEFINITIONS

A. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.

D. Plant-Protection Zone: Area within construction easement, but outside the construction limits. A groups of trees, shrubs, or other vegetation to be protected during construction, and indicated on Drawings.

E. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 MATERIAL OWNERSHIP

A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain the DISTRICT's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from the DISTRICT and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by the DISTRICT or authorities having jurisdiction.

B. In the event the Contractor's work plan requires work/storage areas beyond the limits of the construction easement provided by the DISTRICT, those areas shall be arranged for by the Contractor at the Contractor's sole expense.

C. Utility Locator Service: Notify Call Before You Dig 811 for area where Project is located before site clearing.

D. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant protection measures are in place.

E. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

F. Do not direct vehicle or equipment exhaust towards protection zones.

G. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

H. Handling, and Stockpiling: Perform only when the topsoil is dry or slightly moist.

PART 2 PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Division 2 Section "Earthwork."

1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to temporary erosion and sedimentation control Plans and as necessary in order to meet requirements of Department of Ecology and Island County.

B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE AND PLANT PROTECTION

Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by the DISTRICT.

3.4 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.

1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
2. Use only hand methods for grubbing within protection zones.
3. Chip removed tree branches and stockpile in areas shown on plans.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.5 TOPSOIL STRIPPING

A. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects more than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.

B. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

1. Limit height of topsoil stockpiles to 72 inches and as shown on the drawings.
2. Do not stockpile topsoil within protection zones.
3. Dispose of surplus topsoil. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused or can not be stored on site as indiated on drawings.

3.6 DISPOSAL OF SURPLUS AND WASTE MATERIALS

Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off project site.

END OF SECTION

SECTION 02250 – TRENCH SAFETY SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

This section specifies requirements for the safety systems to be used in all excavation activities, including but not limited to trenching Horizontal directional drilling and structure excavation.

1.3 REFERENCES

R.C.W. Chapter 49.17 WISHA.

WAC 296-155 Safety Standards for Construction Work.

R.C.W. Chapter 39.04.180 Public Works/Trench Excavations - Safety Systems Required.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.1 EXCAVATION SAFETY SYSTEMS

A. Protect all excavation in excess of 4 feet in depth with a safety system conforming to the referenced requirements.

B. The Contractor's excavation safety system shall be designed by a qualified person and meet the referenced requirements.

C. All excavation not requiring trench safety systems shall also meet the WISHA safety standards and the requirements of Section 2 Division "Earthwork".

END OF SECTION

SECTION 02275 – CMU RETAINING WALL

PART 1 GENERAL

1.1 SUMMARY

A. Work shall consist of designing, furnishing and construction of a Concrete Masonry Unit Retaining Wall System in accordance with these specifications and in conformity with the lines, grades, design, and dimensions shown on the plans.

B. Work includes preparing foundation soil, furnishing and installing leveling pad, unit drainage fill and backfill to the lines and grades shown on the construction drawings.

C. Furnish all labor, materials, tools, equipment, and services for all work as indicated in accordance with provisions of the Contract Documents.

D. Completely coordinate with work of all other trades.

E. Although not specifically indicated, provide all supplementary or miscellaneous items, appurtenances, and devices incidental to, or necessary for sound, secure, complete installation..

1.2 RELATED SECTIONS

A. SECTION 02200 EARTHWORK

1.3 REFERENCES AND QUALITY ASSURANCE

A. REFERENCES

1. American Society for Testing and Materials (ASTM)
2. Geo-synthetic Research Institute (GRI)
3. National Concrete Masonry Association (NCMA)

1.4 SUBMITTALS

Product data and test reports showing compliance with this specification and project conditions.

1.5 DELIVERY, STORAGE AND HANDLING

A. Contractor shall check all materials upon delivery to assure that the proper type, grade, color, and certification have been received.

B. Contractor shall protect all materials from damage due to jobsite conditions and in accordance with manufacturer's recommendations. Damaged materials shall not be incorporated into the work.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURER

A. Basis of Design: Keystone Century Wall Retaining Wall System as manufactured by Keystone Block and Supply Company, Inc., Scranton PA.

Century Wall Large Unit	8”high x 18”wide x 12”deep
Universal Cap	4”high x 18/12”wide x 13”deep

B. Other Manufacturers and Products: Submit substitution request complying with the requirements of Section 01300.

2.2 DEFINITIONS

A. Concrete Masonry Unit (CMU) - a concrete retaining wall element machine made from Portland cement, water, and aggregates.

B. Reinforced Backfill - compacted soil that is placed within the reinforced soil volume as outlined on the plans.

2.3 CMU RETAINING WALL UNITS

A. Concrete units shall conform to the following architectural requirement:

1. Face color - concrete gray, unless otherwise specified. The DISTRICT may specify standard manufacturers’ color.
2. Face finish - sculptured rock face. Other face finishes will not be allowed without written approval of DISTRICT.
3. Bond configuration - running with bonds nominally located at midpoint vertically adjacent units, in both straight and curved alignments.
4. Exposed surfaces of units shall be free of chips, cracks or other imperfections when viewed from a distance of 10 feet (3 m) under diffused lighting.

B. Concrete materials shall conform to the requirements of ASTM C1372 - Standard Specifications for Segmental Retaining Wall Units.

C. Concrete units shall conform to the following structural and geometric requirements measured in accordance with ASTM C140 Sampling and Testing Concrete Masonry Units:

1. Compressive strength: $\geq$ 3000 psi (21 MPa).
2. Absorption: $\leq$ 8 % (6% in northern states) for standard weight aggregates.
3. Dimensional tolerances: ± 1/8" (3 mm) from nominal unit dimensions not including rough split face, ±1/16" (1.5 mm) unit height - top and bottom planes.

D. Concrete units shall conform to the following performance testing:

1. Inter-unit shear strength in accordance with ASTM D6916 (NCMA SRWU-2): 1200-plf (17 kN/m) minimum at 2-psi (13 kPa) normal pressure.
2. Geogrid/unit peak connection strength in accordance with ASTM D6638 (NCMA SRWU-1): 700-plf (10 kN/m) minimum at 2-psi (13 kPa) normal force.

E. Concrete units shall conform to the following constructability requirements:

1. Setback: 3/8" (10 mm) ± per course.
2. Alignment and grid positioning mechanism - fiberglass pins, two per unit minimum.
3. Maximum horizontal gap between erected units shall be ≤ 1/2 inch (13 mm).

2.4 SHEAR CONNECTORS

A. Shear connectors shall be 1/2-inch (12 mm) diameter thermo-set isopthalic polyester resin-pultruded fiberglass reinforcement rods to provide connection between vertically and horizontally adjacent units with the following requirements:

1. Flexural Strength in accordance with ASTM D4476: 128,000 psi (882 MPa) minimum.
2. Short Beam Shear in accordance with ASTM D4475: 6,400 psi (44 MPa) minimum.

B. Shear connectors shall be capable of holding the geo-grid in the proper design position during grid pre-tensioning and backfilling.

2.5 BASE LEVELING PAD MATERIAL

A. Material shall consist of a compacted crushed stone base or non-reinforced concrete.

2.6 UNIT DRAINAGE FILL

A. Unit drainage fill shall consist of clean 1" (25 mm) minus crushed stone or crushed gravel meeting the following gradation tested in accordance with ASTM D-422:

Sieve Size	Percent Passing
1 inch (25 mm)	100
3/4-inch (19 mm)	75-100
No. 4 (4.75mm)	0 – 10
No. 50 (300um)	0 – 5

B. Drainage fill shall be placed within the cores of, between, and behind the units as indicated on the design drawings. Not less than one cubic foot (0.028 m^3), of drainage fill shall be used for each square foot (0.093 m^2) of wall face unless otherwise specified.

2.7 REINFORCED BACKFILL

A. Reinforced backfill shall be free of debris and meet the following gradation tested in accordance with ASTM D-422:

Sieve Size	Percent Passing
2 inch (50 mm)	100
3/4-inch (19 mm)	100-75
No. 40 (425um)	0-60
No. 200 (75um)	0-35

B. The maximum aggregate size shall be limited to 3/4 inch (19 mm) unless field tests have been performed to evaluate potential strength reductions to the geo-grid design due to damage during construction.

C. Material can be site-excavated soils where the above requirements can be met. Unsuitable soils for backfill (high plastic clays or organic soils) shall not be used in the backfill or in the reinforced soil mass.

D. Contractor shall submit reinforced fill sample and laboratory test results to the DISTRICT for approval prior to the use of any proposed reinforced fill material.

PART 3 EXECUTION

3.1 EXCAVATION

A. Contractor shall excavate to the lines and grades shown on the construction drawings. The DISTRICT's representative shall inspect the excavation and approve prior to placement of leveling material or fill soils. Proof roll foundation area as directed to determine if remedial work is required.

3.2 BASE LEVELING PAD

A Leveling pad material shall be placed to the lines and grades shown on the construction drawings, to a minimum thickness of 6 inches (150 mm) and extend laterally a minimum of 6" (150 mm) in front and behind the CMU wall unit.

B. Soil leveling pad materials shall be compacted to a minimum of 95 % Standard Proctor density per ASTM D-698 or 92% Modified Proctor Density per ASTM D1557.

C. Leveling pad shall be prepared to insure full contact to the base surface of the concrete units.

3.3 MODULAR CONCRETE UNIT INSTALLATION

A. First course of units shall be placed on the leveling pad at the appropriate line and grade. Alignment and level shall be checked in all directions and insure that all units are in full contact with the base and properly seated.

B. Place the front of units side-by-side. Do not leave gaps between adjacent units. Layout of corners and curves shall be in accordance with manufacturer's recommendations.

C. Install shear/connecting devices per manufacturer's recommendations.

D. Place and compact drainage fill within and behind wall units. Place and compact backfill soil behind drainage fill. Follow wall erection and drainage fill closely with structure backfill.

E. Maximum stacked vertical height of wall units, prior to unit drainage fill and backfill placement and compaction, shall not exceed two courses.

END OF SECTION

SECTION 02510 – ASPHALTIC CONCRETE PAVING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Hot-mix asphalt paving.

1.3 REFERENCES

WSDOT	Standard Specifications for Road, Bridge and Municipal Construction, 2010, Washington State Department of Transportation/APWA
MUTCD	Manual on Uniform Traffic Control Devices (MUTCD) Current Edition

APPENDIX-P WSDOT PERMIT CONDITIONS

1.4 DEFINITION

A. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.

1. Job-Mix Designs: For each job mix proposed for the Work.

B. Qualification Data: For qualified manufacturer and installer.

C. Material Test Reports: For each paving material.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated.

B. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of WSDOT/APWA for asphalt paving work.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met (only 1-lift required on this 2” section of HMA – refer to contract plans) :

1. Minimum surface temperature of 60 deg F.

2. Slurry Coat: Comply with weather limitations in ASTM D 3910.

3. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.
4. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.

PART 2 PRODUCTS

2.1 AGGREGATES

A. General: Use materials and gradations that have performed satisfactorily in previous installations.

B. Coarse Aggregate: ASTM D 692, sound; angular crushed stone or crushed gravel.

2.2 ASPHALT MATERIALS

A. Asphalt Binder: AASHTO M 320 or AASHTO MP 1a, PG 64-22.

B. Asphalt Cement: ASTM D 3381 for viscosity-graded material or ASTM D 946 for penetration-graded material.

C. Prime Coat: Asphalt emulsion prime coat complying with WSDOT/APWA requirements.

2.3 MIXES

A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction and complying with the following requirements:

1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to begin paving.

B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
2. Proof roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by the DISTRICT, and replace with compacted backfill or fill as directed.

C. Proceed with paving only after unsatisfactory conditions have been corrected.

3.2 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

B. Prime Coat: Apply uniformly over surface of compacted unbound-aggregate base course at a rate of 0.15 to 0.50 gal./sq. yd.. Apply enough material to penetrate and seal but not flood surface. Allow prime coat to cure.

1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
2. Protect primed substrate from damage until ready to receive paving.

3.3 HOT-MIX ASPHALT PLACING

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
2. Spread mix at minimum temperature of 250 deg F.

B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.

1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete a section of asphalt base course before placing asphalt surface course.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.4 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor greater than 96 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.5 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: Plus or minus 1/2 inch.
2. Surface Course: Plus 1/4 inch, no minus.

B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

1. Base Course: 1/4 inch
2. Surface Course: 1/8 inch

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.

C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

D. Replace and compact hot-mix asphalt where core tests were taken.

E. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.7 DISPOSAL

A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.

1. Do not allow milled materials to accumulate on-site.

END OF SECTION

SECTION 02700 – SITE DRAINAGE

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Pipe and fittings.
   2. Cleanouts.
   3. Roof downspout drainage.

B. This Section includes storm drainage outside the building and connections to the existing utility system. This work shall comply with the more stringent of the requirements of WSDOT/APWA, Island County or the drawings.

1.3 REFERENCES

WSDOT/APWA Standard Specifications for Road, Bridge and Municipal Construction, 2010, Washington State Department of Transportation/APWA

1.4 SUBMITTALS

A. Material submittals shall include a complete list of equipment and product, manufacturer's design information and catalog sheets for each item.

B. Inspection and test reports specified in the Cleaning and Testing section.

1.5 DELIVERY, STORAGE AND HANDLING

A. Do not store pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle precast structures according to manufacturer's written rigging instructions.

PART 2 PRODUCTS

2.1 PVC PIPE AND FITTINGS

A. PVC pipe shall conform to ASTM D3034 and shall be defined as flexible pipe. Joints shall conform to ASTM D3212 using a restrained rubber gasket conforming to ASTM F477.

B. Fittings shall be injection molded tees or factory solvent welded saddle tees. Saddles fastened to pipe with external bands are not acceptable on any new system.

2.3 CLEANOUTS

PVC Cleanouts: Shall be provided at cleanout locations within landscaped areas.

1. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

PART 3 EXECUTION

3.1 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Division 2 Section "Earthwork."

3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

C. Use fittings for branch connections unless direct tap into existing storm sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

F. Install gravity-flow, nonpressure drainage piping according to the following:

1. Install piping pitched down in direction of flow.
2. Install piping with 12-inch minimum cover.

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure drainage piping according to the following:

1. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasketed joints.

3.4 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from storm sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in storm sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in storm sewer pipe.

1. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.

B. Set cleanout frames and covers in earth in cast-in-place concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding earth grade.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.5 STORMWATER INLET AND OUTLET INSTALLATION

A. Install outlets that spill onto grade, anchored with concrete, where indicated.

B. Install outlets that spill onto grade, with flared end sections that match pipe, where indicated.

C. Construct energy dissipaters at outlets, as indicated.

3.6 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318.

3.7 IDENTIFICATION

A. Materials and their installation are specified in Division 2 Section "Earthwork." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.

1. Use warning tape or detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.8 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place or fully backfilled for pipes with less than 24” of cover, and again at completion of Project.

1. Submit separate reports for each system inspection.
2. Defects requiring correction include the following:
    a. Alignment: Less than full diameter of inside of pipe is visible between structures.
    b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
    c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
    d. Infiltration: Water leakage into piping.
    e. Exfiltration: Water leakage from or around piping.
3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours advance notice.
4. Submit separate report for each test.
5. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
    a. Option: Test plastic piping according to ASTM F 1417.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.9 CLEANING AND TESTING

A. Cleaning and testing shall be in conformance with Section 7-17.3(2) of WSDOT/APWA

END OF SECTION

SECTION 02710 - SUBDRAINAGE

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes foundation, subsoil drainage systems.

1.3 REFERENCES

WSDOT/APWA Standard Specifications for Road, Bridge and Municipal Construction, 2010, Washington State Department of Transportation/APWA

1.4 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Material submittals shall include a complete list of equipment and products, manufacturer's design information and catalog sheets for each item.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced Installer who has completed foundation drainage systems similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

1.6 COORDINATION

A. Coordinate foundation drainage system installation with excavating, trenching, and backfilling.

B. Coordinate drainage panel installation with waterproofing of walls below grade.

C. Coordinate piping termination with storm drainage system

PART 2 PRODUCTS

2.1 PIPE AND FITTINGS

A. Solid walled pipe and fittings shall be Polyvinyl Chloride (PVC) Sewer Pipe conforming to ASTM D 3034, SDR 35, bell-and-spigot ends, with gasketed joints meeting ASTM F 477.

B. Perforated PVC Sewer Pipe shall conform to the provisions of ASTM D 2729 and provide two rows of 3/8" perforations at 6 inches on center.

2.2 FILTER FABRIC

A. Filter fabric shall be Mirafi 140N or an approved equal.

2.3 GRAVEL BACKFILL FOR DRAINS

A. Gravel backfill for drains shall conform to Section 9-03.12(4) of the WSDOT/APWA Standard Specifications.

2.3 CLEANOUTS

A. Cleanouts shall be installed in accordance with the plans and details. At a minimum, cleanouts are to be provided at each of the corners of the building where the drain line turns.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine surfaces and areas for suitable conditions where foundation drainage systems are to be installed. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PIPING INSTALLATION

A. Drawing plans and details indicate general location and arrangement of foundation drainage system piping.

B. Foundation drains shall not be connected into roof downspout drainage system.

C. Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing, solidly in filtering material. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions and other requirements indicated.

1. Install piping to provide positive drainage in the direction of flow or lay flat. Sags or rises are not acceptable.
2. Provide recesses in excavation bottom to receive bells of pipe bell ends. Lay pipe with bells facing upslope and with spigot end entered fully into adjacent bell.
3. Apply and compact impervious fill material to raise low areas or where unsatisfactory bearing soil may occur.

D. Extend piping and connect to storm drainage system, of sizes and in locations indicated. Terminate piping as indicated.

3.3 CLEANOUT INSTALLATION

A. Cleanouts shall be installed in accordance with the plans and details or as to comply with local agency requirements and details whichever is more stringent.

3.3 FIELD QUALITY CONTROL

A. Testing: Test drain piping with water or visually check piping to ensure free flow before backfilling. Remove obstructions, replace damaged components, and repeat test until results are satisfactory.

1. Place additional filtering material to depth of 4 inches (100 mm) around sides and top of drains after testing.

END OF SECTION

SECTION 02001 – HORIZONTAL DIRECTIONAL DRILLING

PART 1 GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall furnish all labor, equipment, and materials necessary to install high density polyethylene (HDPE) conduit(s), sized in coordination with the requirements of the marine trunk cable, by horizontal directional drilling (HDD) as indicated on the Project Drawings. The DISTRICT is prepared to accept HDD plans from the CONTRACTOR that includes:

   A. One larger conduit complete with three sub-ducts, or

   B. Two smaller, individually drilled HDD conduits, without sub-ducts.

   In either scenario, it shall be the CONTRACTOR's responsibility to coordinate and verify the sizing with the requirements included in the Marine Operations (Division-18000) specifications included herein.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Installation of Pipelines by Horizontal Directional Drilling, Pipeline Research Committee, American Gas Association, PR-227-9424, April 1995.

B. Horizontal Directional Drilling Good Practices Guidelines, 2008, 2004, 2001, HDD Industry Consortium, 300pp.

C. API Bulletin 13D, 1985. Bulletin on the Rheology of Oil-Well Drilling Fluids, Second Edition, Dallas, Texas, American Petroleum Institute.

D. API Recommended Practice 13B-1, 1990. Standard Procedures for Field Testing Water-Based Drilling Fluids, First Edition, Dallas, Texas, American Petroleum Institute.

E. Installation of Pipelines Beneath Levees Using Horizontal Directional Drilling, US Army Corps of Engineers, Waterways Experiment Station, Final Report, CPAR-GL-98-1, April 1998.

F. API Specification 13A, 1993. Specification for Drilling Fluid Materials, Fifteenth Edition, Dallas, Texas. American Petroleum Institute.

G. IADC Drilling Manual, 1992. Eleventh Edition, Houston, Texas, International Associated of Drilling Contractors.

H. Tables for Hydraulic Design of Pipes and Sewers, American Society for Civil Engineers, 5th ed., 1990.

1.3 SUBMITTALS

A. The Contractor shall submit the following information, providing sufficient detail to allow the DISTRICT to determine whether the proposed equipment, materials, and procedures meet the Contract requirements. Review and acceptance of the CONTRACTOR's Submittals by the DISTRICT shall not be construed in any way as relieving the CONTRACTOR of its responsibilities under this Contract.

B. **Horizontal Directional Drilling Work Plan:** Submit a HDD Work Plan complete with drawings and written description identifying all details of the proposed method of construction and the sequence of operations to be performed during construction.

C. **Qualifications:** Submit written documentation of the HDD Contractor, HDD Superintendent and drill rig operator. Provide evidence of the following qualifications:

1. The HDD Contractor shall have successfully completed at least five (5) HDD projects that include the installation of 6-inch pipe or greater, with a minimum drilling length of 500 LF for each project. At least three (3) of the projects must have been installations with one of the HDD endpoints located in a tidally influenced water body at a water depth of at least 50 feet.

2. The HDD Superintendent shall have successfully completed at least five (5) projects of 6-inch diameter (or greater) with pull lengths of 500 feet (or greater) in the last 5 years. At least two (2) of the projects must have been installations with one of the HDD endpoints located in a tidally influenced water body at a water depth of at least 60 feet.

3. The HDD drill rig operator shall have successfully completed at least three (3) projects of 6-inch diameter (or greater) with pull lengths of 500 feet (or greater) in the last 5 years.

D. **Shop Drawings:** The drawings shall include all equipment, equipment setup areas, pipe layout areas, and any excavations or mud recirculating pits. The CONTRACTOR shall confirm that all operations shall be completely contained within the temporary construction easement shown on the Drawings.

E. **Schedule:** The CONTRACTOR shall submit a detailed schedule showing all major construction activities and durations, with starting and completion dates shown. The schedule shall include:

1. "One call" utility locate requests and visual confirmation of all crossing utilities and all parallel utilities within twenty (20) feet laterally of the bore centerline.

2. Site preparation.

3. Rig mobilization and setup.

4. Pilot bore drilling (including contingency plan for potential problems).

5. Reaming (including contingency plan for potential problems).

a. Layout and fusing of pipe.

b. Final reaming (swab) and pullback of pipe (including contingency plan for potential problems).

c. Annulus grouting after conduit(s) installation.

d. Cleanup, surface restoration, and demobilization.

F. **Description of Methods, Equipment and Materials:** The CONTRACTOR shall submit detailed descriptions of all methods, equipment, and materials to be used for the pipeline installation. Description of drilling fluid shall be accompanied by Materials Safety Data Sheets (MSDS) and manufacturers' descriptions and warranties. Descriptions of equipment shall include manufacturers' specifications, calibrations, appropriate drawings, photographs, and descriptions of any modifications since manufacture.

G. **Surveying, Equipment and Procedures:** The CONTRACTOR shall submit records of equipment calibrations and certifications for all equipment used for downhole surveys and tracking of the drill head. Procedures for operating the downhole survey tools shall be described, including measures to verify the accuracy of the equipment readings.

H. **Drilling and Reaming Rates:** The CONTRACTOR shall submit maximum anticipated drilling and reaming rates for pilot bore and each reaming pass and confirm that pump capacity is adequate for these anticipated drilling rates for the drilling fluid weights anticipated.

I. **Pipe Filling Methods:** The CONTRACTOR shall submit methods and procedures for buoyancy control during pullback.

J. **Calculations for Pullback:** The CONTRACTOR shall submit calculations for pullback loads for the conditions and operating practices anticipated. All assumptions used in the calculations shall be provided. These calculations shall be made and stamped by a licensed Professional Engineer registered in the State of Washington.

K. **Pipe Stress Calculations:** The CONTRACTOR shall submit calculations for pipe stresses expected to result from the pullback, bending, fluid buckling loads, earth loads, groundwater loads, break-over stresses during entry into the bore, and any other installation and service loads expected to be exerted on the pipe. All assumptions used in the calculations shall be provided. Calculations shall include a minimum pipe wall thickness. These calculations shall be made and stamped by a licensed Professional Engineer registered in the State of Washington.

L. **Calculations of Maximum Allowable Drilling Fluid Pressure:** The CONTRACTOR shall submit calculations identifying the critical downhole pressure that would cause hydrofracture (Frac-Out) or inadvertent drilling fluid returns. The calculations shall identify the critical points in the alignment. The calculations shall identify all parameters used and state all assumptions made in the calculations. The calculations shall be sealed and stamped by a licensed Professional registered in the State of Washington.

M. **Frac-Out and Surface Spill Contingency Plan:** The CONTRACTOR shall submit a Frac-Out and Surface Spill Contingency Plan describing procedures for preventing drilling fluid losses or spills into the marine environment and/or fluid returns to the surface. The plan shall address roles and responsibilities of involved parties, monitoring, prevention, containment, cleanup, and documentation procedures, and observations to be made and plans for containment and cleanup, if spills or hydrofracture occur. The plan shall also address changes that may be required to CONTRACTOR's operations to avoid recurrences. CONTRACTOR shall provide waste storage capacity calculations for a onshore frac-out scenario and provide the same capacity in their Contingency Plan and onsite for the duration of the HDD work. Plan shall also include a list of materials and equipment that will be onsite and available should a frac-out occur. Plan shall include diver inspection of the exit point during key points of the initial pilot bore(s) as mitigation for controlling the release of drilling fluids into the marine environment. Plan shall correlate specific drilling activity with diver observation.

N. **Rig Capacity:** The CONTRACTOR shall submit details on the capacity of the drill rig verifying that the pullback capacity is greater than the required pullback calculated and submitted by the CONTRACTOR.

O. **Soil Separation Plant:** The CONTRACTOR shall submit details on the pump and cleaning plant. Include dimensions, manufacturer's specifications, pump capacity and noise rating on the system.

P. **Plans for Disposal of Spoils and Drilling Fluids:** The CONTRACTOR shall submit plans for disposal of waste materials resulting from the pipeline(s) construction, including drilling fluids, cuttings, waste oil, fuel, discharge water, etc. The CONTRACTOR shall identify the disposal site and submit a letter indicating willingness and legal authority to accept the described and anticipated waste products. All onsite storage of waste materials shall be stored in above-grade watertight storage containers. CONTRACTOR shall provide calculations that outline and demonstrate that the storage provided onsite will address the needs of both typical and those identified in the Contingency Plan.

Q. **Contingency Plans for Potential Problems:** The CONTRACTOR shall submit contingency plans for remediation of potential problems that may be encountered during the drilling operations. The contingency plans shall address the observations that would lead to the discovery of the problem and the methods that would be used to mitigate the problem. Potential problems that shall be addressed include:

1. Natural or man-made obstructions encountered (such as buried logs, boulders, etc.).

2. Utility strike.

3. Loss of circulation.

4. Deviation from planned bore path.

5. Inability to advance drill or product pipe.

6. Hydrolock.

7. Drill or product pipe twisted off or broken off in borehole.

8. Pipe collapses or pipe deformations exceed maximum allowable tolerances.

9. Frac-out (both on and off-shore).

R. **Safety Plan:** The CONTRACTOR shall submit a Safety Plan, including the name of the CONTRACTOR'S Site Safety Representative, emergency telephone numbers for medical facilities, and precautions for handling and disposal of any hazardous or flammable materials. The Safety Plan shall include a code of safe practices and an emergency plan in accordance with OSHA and Washington/OSHA requirements.

S. The following shall be submitted as construction progresses and at the completion of construction.

1. Daily Logs and Records: Daily logs and records shall be maintained by the CONTRACTOR and shall include drilling lengths, location of drill head, installation loads, drilling fluid pressures and flow rates, drilling fluid losses, inadvertent returns, drilling times required for each pipe joint, any instances of retraction and re-drilling of the pilot bore or segments thereof, and any other relevant observations, including any hard drilling zones, steering problems, circulation problems, observed settlement, heave, frac-outs, or surface spills. Daily logs and records shall be submitted by noon of the following day to which the records correspond.

2. Variations in Plan and Profile: The CONTRACTOR shall document any variations between the actual plan and profile of the bore path and the location shown on the Drawings and specifications herein. The CONTRACTOR shall notify the DISTRICT immediately upon discovery of any deviations that exceed design tolerances.

3. Mud Weights: The CONTRACTOR shall submit measured drilling fluid viscosity and density at least three (3) times per shift with at least two (2) hours between readings, using calibrated Marsh funnel and mud balance. Measurements shall be made during each stage of the drilling process. These measurements shall be included in daily logs submitted to the DISTRICT. The CONTRACTOR shall document modifications to the drilling fluids, by noting the types and quantities of drilling fluid additives and the dates and times when introduced. The reason for the addition of drilling fluid additives or other modifications shall be documented and reported.

4. Pilot Bore As-Built Profile: The CONTRACTOR shall submit an as-built profile of the pilot bore within 48 hours of completion of the pilot bore.

1.4 MARINE REQUIREMENTS

A. The CONTRACTOR shall comply at all times with the requirements of the United States Coast Guard (USCG) concerning the movement and position of the CONTRACTOR's floating equipment used to complete the installation.

B. In the event of any drilling fluid escape into the marine environment, the CONTRACTOR shall, at his own expense, immediately restore the affected seabed or area to its original profile to the satisfaction of the DISTRICT.

C. The CONTRACTOR shall permit the USCG to inspect operations at any reasonable time.

D. Ordinary business, marine operations and activity will continue during the conduit installation, and the CONTRACTOR's operations shall be carried out in such a way as to avoid interference with marine traffic unless approved in advance in writing by the USCG and other responsible authorities. The CONTRACTOR shall attend meeting with said authorities and the DISTRICT as necessary.

E. The CONTRACTOR shall, during marine operations and at all other times, be particularly careful to keep interference with navigation to a minimum and, if required, shall attach buoys to all anchors of all floating equipment and exhibit proper and necessary lights and signals, and shall obey instructions on these matters issued at any time by the USCG or any other relevant statutory authority.

1.5 DEFINITIONS

A. **Annular Space**: The space between the excavated HDD final reamed bore diameter and the product pipe or the space between product pipe and conductor casing.

B. **Bent Sub:** A bent sub is a section of drill pipe behind the cutting tools that is inclined at an angle from the axis of the bore in the desired direction of steering. The bent sub allows steering while rotating the cutting tools.

C. **Horizontal Directional Drilling:** Horizontal Directional Drilling (HDD) is a guided, steerable drilling system used for the trenchless installation of pipes, conduits, and cables. A pilot bore path is excavated in a shallow arc from a surface-launched drill rig. Excavation takes place with fluid assisted cutting from a drilling tool on the drill string. The pilot bore is directed by the positioning of a bent sub. The bore is filled with drilling mud/fluid for stabilization. The bore path is enlarged with subsequent multiple reaming passes until the desired diameter is achieved. As a final step, the product pipe, conduit, or cable is pulled into the fluid-stabilized bore.

D. **Drilling Fluid/Mud:** A mixture of water and bentonite continuously pumped to the drilling tool or bit cutting head to facilitate the removal of soil cuttings, and stabilization of the bore. These fluids also cool the cutting tools and lubricate the pipe string.

E. **Pilot Bore:** The action of creating the first guided pass of the HDD process which is

then reamed in multiple passes to the size required to allow pullback of the pipe.

F. **Drilling Tool/Bit:** Any tool or system of tools that excavate at the face of a bore.

G. **Pullback:** That part of a horizontal directional drilling process in which the drill string and product pipe are pulled back through the bore to the entry.

H. **Pullback Loads:** The tensile load (force) applied to a drill string and product pipe during the pullback process.

I. **Frac-out**: The fracturing or failure of the soil around the bore hole as a result of excessive drilling fluid pressure generally resulting in drilling mud being released to the surface.

1.6 DESIGN CRITERIA

A. **Equipment:** The CONTRACTOR shall provide all equipment, materials, and personnel necessary for completing the installation as shown on the Drawings and specified herein. The equipment and materials shall include but are not limited to:

1. Directional drilling rig with all ancillary equipment, including drill pipe, drilling fluid, cutting tools, reaming bits, swivels, expanders, motors, generator, pumps, hoses, mixing equipment, drilling fluid processing equipment (cuttings separation equipment), downhole survey equipment, energized surface grid, fluid pressure and flow rate monitoring equipment, spare parts, pipe handling equipment, crane, backhoe, roller, side boom tractors, control cabin, control equipment, waste storage and containment and office equipment.

2. Drilling fluids, water, fuel, lubricant, polymers, or other additives.

3. Any other expendable or reusable materials, supplies, and equipment needed for the installation.

B. The drilling equipment shall be capable of advancing through the geologic conditions to be encountered at the site as depicted in the geotechnical report, included in this specification in Appendix-F, and as anticipated by the CONTRACTOR.

C. The drilling fluid shall be designed for the geologic conditions to be encountered at the site as depicted in the geotechnical report and as anticipated by the CONTRACTOR.

D. The capacity of the directional drilling rig used by the CONTRACTOR shall be adequate to install the specified pipeline.

E. The pump used by the CONTRACTOR shall be adequate to supply the required flow rate and pressures at the anticipated drilling fluid viscosity at all times. Drilling speeds shall not exceed pump capacity.

F. The drilling system shall contain an electronic data logger to track rate of penetration, rotational torque, thrust/pullback, and annular pressure.

G. The drilling system shall include a fluid pump and separation plant that can manage the

rates of drilling fluid pumping, spoil separation, and slurry cleaning required by the CONTRACTOR to achieve planned production rates for the soils anticipated. Shaker screens, hydrocyclones, and centrifuges may be required for efficient separation of spoils.

H. All spoil and slurry must be contained in trucks, tanks, approved recirculation pits, or other containers at all times. Dumping of spoil or slurry on the ground, discharge into sewers, or discharge into water bodies shall not be permitted. All spoils shall be transported and disposed of off-site at an approved disposal facility that meets all State of Washington and local requirements.

I. Perform all work within work areas shown on the Drawings.

J. Any deviation to the radii of curvatures or entry and exit angles shown on the Drawings should be submitted in writing to the DISTRICT for approval.

1.7 Surface settlement or heave, of the ground surface or utilities and/or other features above the HDD centerlines and within the zone influenced by the HDD construction shall be limited to values that avoid damage. The CONTRACTOR shall repair any damage resulting from settlement or heave caused by HDD activities at no additional cost to the DISTRICT. The CONTRACTOR shall grout any voids caused by or encountered during drilling.

A. The CONTRACTOR shall allow access to the DISTRICT and shall furnish necessary assistance and cooperation to aid the DISTRICT in observations and data and sample collection, including, but not limited to the following:

1. The CONTRACTOR shall allow the DISTRICT and/or DISTRICT's Representative full access to the operator control container prior to, during, and following all HDD operations. This shall include, but not be limited to, providing access to the operator console including visual access to real-time operator control screens, gauges, and indicators during all drilling operations.

2. The CONTRACTOR shall allow the DISTRICT and/or DISTRICT's Representative full access to the slurry separation plant prior to, during, and following all HDD operations. This shall include, but not be limited to, full access to shaker screens, hydrocyclones, conveyor belts, and slurry and spoil holding tanks. The CONTRACTOR shall allow the DISTRICT to collect soil samples from the shaker screens and/or spoil holding tanks on the slurry separation plant a minimum of once per drill pipe, and whenever changes in conditions are observed or suspected.

3. Subject to 4 hours notice, the CONTRACTOR shall arrange for the transport of the DISTRICTand/or DISTRICT's Representative and their staff between the shore and any and all marine craft involved in the conduit(s) installation. The CONTRACTOR shall provide all necessary safety and rescue equipment for personnel.

PART 2 PRODUCTS

2.1 MATERIALS

A. **Pipe:** The pipe thickness must conform to the most conservative design with respect to design calculations for the critical combination of internal and external pressure, pullback, and bending as determined by the HDD CONTRACTOR. Minimum pipe wall thickness shall be as shown in calculations submitted in accordance with this specification.

B. **Water:** The CONTRACTOR shall secure a suitable source of water, and shall be responsible for transporting, storing, and disposing of any water required. There is no water source available to the contractor onsite. Water will need to be imported as required.

C. **Drilling Fluids:** The CONTRACTOR shall select the bentonite drilling fluid mixture proportions to ensure continuous circulation, bore stability, reduce drag on the pipe, and completely fill the annular space between the bore and the pipe to control settlement. Management and disposal of drilling fluids shall be the CONTRACTOR's responsibility.

D. **Drill Pipe:** The CONTRACTOR shall provide high quality drill pipe that has been inspected and determined to be adequate for the project requirements. Bent, cracked, or fatigued drill pipes shall not be used. Threads must be in good condition.

PART 3 EXECUTION

3.1 GENERAL

A. The CONTRACTOR shall not initiate HDD until all submittals are received, reviewed, and accepted by the DISTRICT.

B. The CONTRACTOR shall not initiate HDD until all required permits are obtained.

C. The CONTRACTOR shall have the equipment listed in the submitted and approved Frac-Out and Surface Spill Contingency Plan prior to commencing drilling operations.

3.2 WORK STAGING AREA

A. **Work Staging:** The CONTRACTOR shall limit staging and work operations to the areas shown on the Drawings, or as otherwise accepted in writing by the DISTRICT, for storage of equipment and materials, parking, pipe layout, drilling, and other work.

B. **Control of Drilling Fluids:** The CONTRACTOR shall follow all requirements of the Frac-Out and Surface Spill Contingency Plan and control operational pressures, drilling mud weights, drilling speeds, and any other operational factors required to avoid hydrofracture fluid losses into the surrounding formations, and control drilling fluid spillage. This includes any spillages, inadvertent fluid, or slurry returns at entry and exit locations or at any intermediate point. All inadvertent returns or spills shall be promptly contained and cleaned up on the land portion of the bore. For the marine portion of the bore the CONTRACTOR shall, upon notice from divers, immediately modify their drilling practices as necessary such that the amount of drilling fluid released on the sea floor is kept to a minimum, all in accordance with the CONTRACTOR submitted, Frac-Out and Surface Spill Contingency Plan. The CONTRACTOR shall maintain on-site mobile spill containment and removal

equipment on site at all times. The CONTRACTOR shall be capable of quickly containing and removing spills. The CONTRACTOR shall immediately notify the DISTRICT of any inadvertent returns or spills and immediately clean up the inadvertent return or spill.

C. **Combustible Materials:** Combustible materials (fuel, oil, lubricants, etc.) shall be stored off-site or in a well-ventilated storage facility removed from the immediate vicinity of the drilling area by at least twenty (20) feet.

D. **Site Security:** The CONTRACTOR shall install an enclosure fence around the work area. The enclosure fence shall include a lockable gate and should prevent entry of unauthorized persons.

3.3 MOBILIZATION

A. The CONTRACTOR shall mobilize all equipment, materials, and personnel necessary to construct the pipeline using the HDD process at the locations shown on the Drawings.

1. Entry Area: The CONTRACTOR shall set up temporary workspace within the areas delineated on the Drawings. Appropriate precautions and measures shall be employed by the CONTRACTOR to prevent erosion, surface drainage, and spillage of drilling fluids or other materials that could adversely impact the environmental quality of the site. Silt fences, hay wattles, and hay bales shall be used to line the work area to minimize erosion and contain any spillages or runoff.

3.4 HORIZONTAL DIRECTIONAL DRILLING

A. **Bore Tracking and Monitoring:**

1. Downhole Wireline and Surface Grid Tracking System: The CONTRACTOR shall monitor and record x, y, and z coordinates relative to an established surface survey bench mark, from downhole survey data using a downhole wireline system. The grids shall be surveyed to establish horizontal and vertical position to 0.1 feet accuracy. The data shall be continuously monitored and recorded at least once per drill pipe length or at thirty (30) feet or thirty (30) minute intervals during drilling, whichever is most frequent. The completed borehole shall be surveyed with the downhole locating system after all reaming is completed and prior to pullback of the pipe. This information shall be collected and provided to the DISTRICT prior to commencement of pullback.

2. Deviations between the recorded and design bore path shall be calculated and reported on the daily report. If the deviations exceed tolerances shown of the drawings, such occurrences shall be reported immediately to the DISTRICT. The CONTRACTOR shall undertake all necessary measures to correct deviations and return to design line and grade.

3. Drilling Fluid Pressures and Flow Rates: Drilling fluid pressures and flow rates shall be continuously monitored and recorded by the CONTRACTOR. The pressures shall be monitored at the pump, and shall be made during pilot bore drilling, reaming, and pullback operations. Maximum allowable drilling speeds shall be calculated for pilot boring and each reaming pass and shall not be exceeded for pilot boring or reaming passes. Annular pressure measurements shall be

continuous and shall be recorded using a data logging system.

4. Drilling Fluid Viscosity and Density (Mud Weight): The CONTRACTOR shall measure and record drilling fluid viscosity and density at least three (3) times per shift with at least two (2) hours between readings, using calibrated Marsh funnel and mud balance. These measurements shall be included in daily logs submitted to the DISTRICT.

B. **Location of Entry and Exit Points:** Entry and exit points shall be as shown on the Drawings, unless otherwise approved in writing by the DISTRICT. The CONTRACTOR shall employ licensed, experienced surveyors to locate the entry and exit points, and to establish horizontal and vertical datum for the bore and the pipe layout and fabrication areas.

C. **Entry and Exit Angles:** Drill entrance and exit angles shall be as shown on the Drawings, unless otherwise approved in writing by the DISTRICT.

D. **Pilot Bore:** The pilot bore shall follow the design path of the bore shown on the Drawings.

1. Horizontal and Vertical Tolerances: Horizontal and vertical deviations shall be no more than plus or minus five (5) feet from the design path centerline or within the tolerances shown on the drawings, as indicated.

2. Entry and Exit Tolerances**:** The location of the entry and exit points shall be within the tolerances shown on the Drawings. The CONTRACTOR shall be solely responsible for all work necessary to correct excessive deviations from line and grade, including re-drilling, redesigning connections, and acquiring additional easement, at no additional cost to the DISTRICT and without schedule extension.

E. **Reaming:** The pilot bore shall be reamed using equipment and methods submitted by the CONTRACTOR. The CONTRACTOR shall completely ream the bore to the final diameter prior to pullback.

F. **Swab Pass:** The CONTRACTOR shall complete a swab pass of the bore prior to pullback of the pipe.

G. **Pipe Pullback**:

1. The pipe shall be installed by pulling it into the reamed bore hole behind a final reaming tool selected by the CONTRACTOR.

2. The pipe shall be isolated from excessive torsional and axial stresses by a swivel device.

3. The HDPE pipe shall be filled with water in accordance with approved submittal as it enters the bore to reduce pullback loads.

4. The CONTRACTOR shall monitor and record installation loads once per drill pipe or every 30 feet, whichever is more frequent.

5. The CONTRACTOR shall cease operations if the pipe is damaged and shall remove

the pipe from the bore and repair the pipe using the manufacturer's recommended procedure or replace the damaged pipe before resuming installation.

6. Damage to the pipe resulting from installation or grouting of the annulus is the responsibility of the CONTRACTOR, including costs for replacement and labor and materials.

7. The CONTRACTOR shall cap the conduit exit points to prevent silt and debris from entering the conduit.

8. The CONTRACTOR shall leave 18 inches of conduit protruding from the exit point for attachment of the bellmouth assembly by divers used during the cable pull.

9. The CONTRACTOR shall leave a pulling line installed in the HDPE conduit for access by divers during the cable pull. The pulling line shall have adequate tensile strength to allow the trunk cable (TC) to be pulled in.

H. **Site Restoration and Demobilization:** The CONTRACTOR shall remove all equipment, materials, drilling fluids, muck, waste, and debris from the site and restore the site to its original condition upon completion of the installation.

END OF SECTION

SECTION 02110 - PROTECTION OF ENVIRONMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Conforming to the requirements of permits furnished by others and obtaining other permits required to perform the work.
2. Planning, designing, constructing and maintaining of silt barriers, and holding and sedimentation facilities necessary or required to divert, remove, treat and dispose of water from construction areas.
3. Installing and implementing dust control measures.

B. The Contractor shall perform all work necessary to comply with the requirements of permits furnished by others and Contractor-furnished permits governing this work.

C. All work required in this section, including all erosion and sediment control facilities, shall be installed prior to any ground disturbing activity requiring the use of the facilities.

D. This work shall consist of temporary measures that may be shown in the plans, proposed by the Contractor, and approved by the DISTRICT or ordered by the DISTRICT during the life of the contract. This work is intended to provide prevention, control and abatement of water pollution/erosion within the limits of the project and to minimize damage to the work, adjacent property and to bodies of water, if any.

E. This work shall comply with the more stringent of the requirements of the WSDOT/APWA or Washington State Department of Ecology. The improvements shown on the plans should be considered as the minimum necessary.

F. The County Inspector or DISTRICT may request additional measures be implemented. Any discrepancies between the construction control and inspection requirements and this specification shall be brought to the attention of the DISTRICT prior to bidding.

1.3 PERMITS

A. DISTRICT-FURNISHED PERMITS

The DISTRICT has made application for the permits listed in the appendix. The Contractor shall be responsible for compliance with all construction stipulations contained therein. Generally, the specifications and drawings contain specific requirements for which the Contractor is responsible for compliance.

1. Building Permit for planned construction
2. Grading Permit for planned construction

B. CONTRACTOR-FURNISHED PERMITS

1. The Contractor shall be responsible for identifying, obtaining and complying with all permits and inspections required for construction activities, including necessary plumbing, electrical or other permits required for permanent construction.
2. The Contractor shall obtain separate permits or revisions of permits for any activities not covered under permits furnished by the DISTRICT.
3. The Contractor shall perform any and all activities required to obtain the Contractor-furnished permits, including contacting respective agencies, filing applications and paying any required application fees.

C. In the event the Contractor's work plan requires work/storage areas beyond the limits of the construction easement provided by the DISTRICT, those areas shall be arranged for by the Contractor at the Contractor's sole expense.

1.4 SUBMITTALS

A. Contractor shall submit for approval manufacturer's data for clear plastic covering, filter fabric, seeding, mulching, quarry spalls or any additional preferred products not identified on the erosion control plans with intended use on the project site.

B. The Contractor shall submit for review all procedures for control of job related activities to protect the environment including dust control measures, handling and disposing of solid wastes, oil and hazardous substances handling, storage, dewatering, stormwater management, spill prevention and clean up.

1.5 REFERENCES

WSDOT/APWA	Standard Specifications for Road, Bridge and Municipal Construction, 2010, or most current update, Washington State Department of Transportation/APWA
SWPPP	Site specific Storm Water Pollution Prevention Plan (SWPPP) and Temporary Erosion Control Plans.

PART 2 PRODUCTS

2.1 CLEAR PLASTIC COVERING

A. Plastic sheeting shall have a minimum thickness of 0.06 millimeters.

2.2 FILTER FABRIC FENCE

A. All geotextile used shall meet the requirements of Section 9-33.2(1) Table 6 of WSDOT/APWA. All geotextile properties listed are minimum average roll values (i.e., the text result for any sampled roll in a lot shall meet or exceed the values shown in the table).

2.3 PERMANENT AND/OR TEMPORARY SEEDING

It is the DISTRICT's preference that the site be allowed to re-vegetate naturally without the need to import seed to the site. The relative flatness of the site reduces potential for erosion hazards typically associated with point discharges of storm runoff during a rainfall event. However, the CONTRACTOR shall be prepared to hydroseed as indicated in the specifications, should an erosion hazard become apparent. In the event

hydroseeding is required, this shall be a change condition and the Contractor shall be compensated via the Contingency Account bid item.

2.4 MULCHING

Mulching per plan notes.

2.5 QUARRY SPALLS

Quarry Spalls shall be in accordance with Section 9-13.6 of WSDOT/APWA.

2.6 WATTLES

Wattles to conform to WSDOT Standard Detail I-30.30-00 and Section 9-14.5(5).

PART 3 EXECUTION

3.1 GENERAL

A. Install Temporary Erosion Sediment Control (TESC) facilities specified on the plans prior to starting any clearing or grubbing operations.

B. Stormwater discharged from the site shall conform to the requirements of WSDOT/APWA, Washington State Department of Ecology or local, whichever is more stringent.

3.2 DRAINAGE OF EXCAVATED AREAS

A. Provide and maintain ditches of adequate size to collect rainfall and groundwater seepage which may enter the excavations. Divert the water into sumps, so that it can be drained or pumped out of the excavations, treated and discharged according to all applicable permits.

3.3 OTHER WASTEWATER

A. All water which has been polluted by materials such as oil, grease, cement and concrete, paints or chemicals used by the Contractor's operation shall be disposed of in an approved manner and in accordance with all applicable local, state, and federal regulations.

3.4 FILTER FABRIC FENCE

A. The filter fabric fence shall prevent soil carried by runoff water from going beneath, through or over the top of the silt fence, but shall allow the water, without soil, to pass through the fence. Installation shall be per plan detail and Section 8-01.3(9)A of WSDOT/APWA.

3.5 HYDROSEEDING & SOIL PREPARATION

A. It is the DISTRICT's preference that the site be allowed to re-vegetate naturally without the need to import seed to the site. The relative flatness of the site reduces potential for erosion hazards typically associated with point discharges of storm runoff during a rainfall event. However, the CONTRACTOR shall be prepared to hydroseed as indicated in the specifications, should an erosion hazard become apparent.

B. The Contractor shall submit to the DISTRICT certificates of inspection of seed by state or federal authorities and copies of delivery invoices or other proof of quantities of mulch and fertilizer.

C. All hydroseeding and soil preparation requirements shall be in accordance with Section 8-01.3(2) of WSDOT/APWA and with BMP C120: Temporary and Permanent Seeding identified in the SWPPP, and/or as directed by WA state and local authorities.

3.6 WATTLES

A. Install as shown on plans and per WSDOT Standard Detail I-30.30-00.

3.7 REMOVAL OF TEMPORARY FACILITIES

A. Upon completion of all work, and when site has been adequately stabilized, remove all facilities constructed for temporary erosion and sediment control.

END OF SECTION

SECTION 02200 - EARTHWORK

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

B. General

Contractor shall include in the base bid the cost of achieving the final grades shown on the Contract Documents beginning with the existing conditions as represented in the site survey and the geotechnical report attached to, and included in, the appendix. All excavation to suitable bearing soil, export, import, placement and compaction required to achieve the final grades and completed structures shall be included in the base bid.

The Contractor shall make a reasonable effort to use the soils on-site as for both structural and non-structural fill. This includes normal or typical efforts of on-site soil management (wetting or drying soils as needed to reach the optimum moisture content, protecting stockpiled soils, controlling surface water near work areas, etc.).

The has not attempted to calculate the required export material required, structural fill volumes or the net imbalance for either of these items. It shall be the Contractor's responsibility to determine those amounts and include them as incidental in the base bid.

C. Section Includes:

1. Preparing subgrades for buried structures, slabs-on-grade, walks, pavements.
2. Excavating and backfilling for buildings and structures.
3. Drainage course for concrete slabs-on-grade.
4. Subbase course for concrete walks and pavements.
5. Subbase course and base course for asphalt paving.
6. Excavating and backfilling trenches for utilities and pits for buried utility structures.

D. Related Sections:

Coordinate related work specified in other parts of the Project Manual, including but not limited to the following:

1. Appendix-F Geotechnical Report (Onshore) – Admiralty Inlet Pilot Tidal Project (February 13, 2013) prepared for Snohomish County PUD No. 1
2. Section 02250 - Trench Safety Systems
3. Section 02110 – Protection of Environment

1.3 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.
   1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
   2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
   1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions only as directed by DISTRICT. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
   2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by The DISTRICT. Unauthorized excavation, as well as remedial work directed by The DISTRICT, shall be without additional compensation.

G. Fill: Soil materials used to raise existing grades.

H. Structures: Buildings, footings, foundations, retaining walls, slabs, vaults, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

I. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

J. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

K. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

L. Unsuitable Soils: Unanticipated unsuitable soil shall be that mineral soil that is not suitable for use as structural fill after a reasonable effort has been made through on-site soil management / soil conditioning to establish a soil moisture content that allows the compaction of the soil to the specified density as verified by the or the ’s geotechnical representative.

1.4 REFERENCES

WSDOT/APWA	Standard Specifications for Road, Bridge and Municipal Construction, 2010, Washington State Department of Transportation/APWA
ICC	Island County Code Chapter 11.

1.5 SUBMITTALS

A. Product Data: For each type of the following manufactured products required:
   1. Each type of plastic warning tape.
   2. Controlled low-strength material, including design mixture.

B. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:
   1. Classification according to ASTM D 2487 of each soil material proposed for fill and backfill.
   2. Laboratory compaction curve according to ASTM D 698, ASTM D 1557 for each soil material proposed for fill and backfill.

1.6 QUALITY ASSURANCE

A. Materials and soils testing services shall be provided by the DISTRICT.

B. Geotechnical Testing Agency Qualifications: An independent testing agency qualified according to ASTM E 329 to conduct soil materials and rock-definition testing, as documented according to ASTM D 3740.

1.7 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by resident or others unless permitted in writing by the DISTRICT and then only after arranging to provide temporary utility services according to requirements indicated.
   1. Notify DISTRICT not less than two days in advance of proposed utility interruptions.
   2. Do not proceed with utility interruptions without the DISTRICT's written permission.
   3. Contact utility-locator service for area where Project is located before excavating.

B. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth moving operations.
   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from DISTRICT and authorities having jurisdiction.
   2. Provide alternate routes around closed or obstructed traffic ways if required by DISTRICT or authorities having jurisdiction.

C. Utility Locator Service: Call Before You Dig 811 before beginning earth moving operations.

D. Do not commence earth moving operations until temporary erosion- and sedimentation-control measures, specified in Division 2 Section “Protection of Environment” are in place.

PART 2 PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: Soil Classification ASTM D 2487 Soil Classification Groups GW, GP, GM, SW, SP, and SM, or a combination of these groups; free of rock or gravel

larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter, or as determined by on-site geotechnical engineer.

C. Unsatisfactory Soils: Soil Classification Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups, or as determined by on-site geotechnical engineer.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

E. Aggregate for Gravel Base per WSDOT 9-03.10. Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inch sieve and not more than 10 percent passing a No. 200 sieve.

F. Crushed Surfacing Top Course (or Crushed Rock Top Course): Naturally or artificially graded mixture of natural or crushed gravel, crushed stone shall be per WSDOT 9-03.9(3).

G. Gravel Backfill for Pipe Zone Bedding per WSDOT 9-03.12(3): Shall be crushed, processed or naturally occurring granular material. Shall be free from various types of wood waste or other extraneous or objectionable material.

H. Drainage Course: Narrowly graded mixture of clean crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

I. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and 0 to 5 percent passing a No. 4 sieve.

J. Sand: ASTM C 33; fine aggregate. (aka fine graded granular)

K. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 ACCESSORIES

A. Warning Tape: Per Section 9-15.18 of WSDOT/APWA consisting of a~~A~~cid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

PART 3 EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.

B. Protect and maintain erosion and sedimentation controls during earth moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

C. The Contractor is solely responsible for providing temporary and permanent control of surface water and subsurface seepage to allow for site access, grading, construction of underground utilities, and paving. The Contractor is solely responsible for protecting disturbed areas and graded areas from inclement weather and surface runoff during construction to provide a suitable working platform for all phases of the construction.

3.3 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

2. Excavation for Underground Vaults, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.

3.4 EXCAVATION FOR INTERIOR BUILDING SLAB

Excavate surfaces under slabs to allow for a layer of fine graded granular material, a vapor barrier, clean compacted drainage course and structural fill (compacted to at least 95 percent of the maximum dry density based on ASTM Test Method D1557) as required, all to the dimensions outlined in the contract plans.

3.5 EXCAVATION FOR WALKS AND PAVEMENTS

Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.6 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.
   1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.
   1. Clearance: 12 inches each side of pipe or conduit.

C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.
   1. For pipes and conduit less than 6 inches in nominal diameter, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
   2. For pipes and conduit 6 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe or conduit circumference. Fill depressions with tamped sand backfill.
   3. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

3.7 SUBGRADE INSPECTION

A. Notify the DISTRICT when excavations have reached required subgrade.

B. If the DISTRICT determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

C. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.

D. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by the DISTRICT, without additional compensation.

3.8 UNAUTHORIZED EXCAVATION

Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by the DISTRICT.

3.9 STORAGE OF SOIL MATERIALS

Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

3.10 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:
   1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
   2. Surveying locations of underground utilities for Record Documents.
   3. Testing and inspecting underground utilities.
   4. Removing concrete formwork.
   5. Removing trash and debris.
   6. Removing temporary shoring and bracing, and sheeting.
   7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.11 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Trenches under Footings: Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings.

D. Backfill voids with satisfactory soil while removing shoring and bracing.

E. Place and compact initial backfill of satisfactory soil, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.

   1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

F. Place and compact final backfill of satisfactory soil to final subgrade elevation.

G. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.12 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:
   1. Under grass and planted areas, use satisfactory soil material.
   2. Under walks and pavements, use satisfactory soil material.
   3. Under steps and ramps, use engineered fill.
   4. Under building slabs, use engineered fill.
   5. Under footings and foundations, use engineered fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.13 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.14 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 1557:

1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.
2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 92 percent.
3. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 85 percent.
4. For utility trenches, compact each layer of initial and final backfill soil material at 90 percent.

D. Conditioning existing soil to reduce/increase moisture content: Condition existing mineral soil material via on-site soil management procedures to within 2 percent of the optimum moisture content for compaction purposes.

3.15 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

1. Turf or Unpaved Areas: Plus or minus 1 inch.
2. Walks: Plus or minus 1 inch.
3. Pavements: Plus or minus 1/2 inch.

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.16 SUBSURFACE DRAINAGE

A. Subdrainage Pipe: Specified in Division 2 Section "Subdrainage."

B. Subsurface Drain: Place subsurface drainage geotextile around perimeter of subdrainage trench. Place a 6-inch course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in a minimum of 12 inches of filter material, placed in compacted layers 6 inches thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least 6 inches.

1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D 698 with a minimum of two passes of a plate-type vibratory compactor.

3.17 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place subbase course and base course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place subbase course and base course under pavements and walks as follows:

1. Place base course material over subbase course under hot-mix asphalt pavement.
2. Shape subbase course and base course to required crown elevations and cross-slope grades.
3. Place subbase course and base course 6 inches or less in compacted thickness in a single layer.
4. Place subbase course and base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches (150 mm) thick or less than 3 inches thick.
5. Compact subbase course and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

C. Pavement Shoulders: Place shoulders along edges of subbase course and base course to prevent lateral movement. Construct shoulders, at least 12 inches wide, of satisfactory soil materials and compact simultaneously with each subbase and base layer to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

3.18 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

A. Place drainage course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:

1. Install subdrainage geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
2. Place drainage course 6 inches or less in compacted thickness in a single layer.

3. Place drainage course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
4. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.19 FIELD QUALITY CONTROL

A. Testing Agency: the DISTRICT will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by the DISTRICT.

D. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:

1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than three tests.
2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet or less of wall length, but no fewer than two tests.
3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length, but no fewer than two tests.

E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.20 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by the DISTRICT; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.21 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Transport surplus satisfactory soil to designated storage areas on the DISTRICT's property. Stockpile or spread soil as directed by the DISTRICT and as indicated on plans and Appendix-F “Geotechnical Report.”

1. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off the DISTRICT's property.
2. The Contractor shall be responsible for measuring the quantity of unanticipated unsuitable material that is removed. The Contractor shall measure in-place bank yards by field measurement that shall be observed, verified, and documented by the DISTRICT or the DISTRICT’s geotechnical representative prior to backfilling with structural fill. The Contractor shall note that measurements by truck tickets will not be accepted.

   Soil integrity will be influenced by the weather conditions and the Contractor’s handling\and protection of the material as it is removed and placed. It is the sole responsibility of the Contractor to protect soils from the elements. Material that is deemed unsuitable due to lack of protection will not be applied to the unit price. The Contractor will be responsible for removing such material and replacing with acceptable material at no additional cost to the DISTRICT.

END OF SECTION

SECTION 02210 – SITE CLEARING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stockpiling material.

B. Related Sections:

1. Division 02 Section “Protection of Environment" for temporary erosion control measures.

1.3 DEFINITIONS

A. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.

D. Plant-Protection Zone: Area within construction easement, but outside the construction limits. A groups of trees, shrubs, or other vegetation to be protected during construction, and indicated on Drawings.

E. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 MATERIAL OWNERSHIP

A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain the DISTRICT's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from the DISTRICT and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by the DISTRICT or authorities having jurisdiction.

B. In the event the Contractor's work plan requires work/storage areas beyond the limits of the construction easement provided by the DISTRICT, those areas shall be arranged for by the Contractor at the Contractor's sole expense.

C. Utility Locator Service: Notify Call Before You Dig 811 for area where Project is located before site clearing.

D. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant protection measures are in place.

E. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

F. Do not direct vehicle or equipment exhaust towards protection zones.

G. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

H. Handling, and Stockpiling: Perform only when the topsoil is dry or slightly moist.

PART 2 PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Division 2 Section "Earthwork."

1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to temporary erosion and sedimentation control Plans and as necessary in order to meet requirements of Department of Ecology and Island County.

B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE AND PLANT PROTECTION

Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by the DISTRICT.

3.4 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.

1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
2. Use only hand methods for grubbing within protection zones.
3. Chip removed tree branches and stockpile in areas shown on plans.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.5 TOPSOIL STRIPPING

A. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects more than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.

B. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

1. Limit height of topsoil stockpiles to 72 inches and as shown on the drawings.
2. Do not stockpile topsoil within protection zones.
3. Dispose of surplus topsoil. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused or can not be stored on site as indiated on drawings.

3.6 DISPOSAL OF SURPLUS AND WASTE MATERIALS

Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off project site.

END OF SECTION

SECTION 02250 – TRENCH SAFETY SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

This section specifies requirements for the safety systems to be used in all excavation activities, including but not limited to trenching Horizontal directional drilling and structure excavation.

1.3 REFERENCES

R.C.W. Chapter 49.17 WISHA.

WAC 296-155 Safety Standards for Construction Work.

R.C.W. Chapter 39.04.180 Public Works/Trench Excavations - Safety Systems Required.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.1 EXCAVATION SAFETY SYSTEMS

A. Protect all excavation in excess of 4 feet in depth with a safety system conforming to the referenced requirements.

B. The Contractor's excavation safety system shall be designed by a qualified person and meet the referenced requirements.

C. All excavation not requiring trench safety systems shall also meet the WISHA safety standards and the requirements of Section 2 Division "Earthwork".

END OF SECTION

SECTION 02275 – CMU RETAINING WALL

PART 1 GENERAL

1.1 SUMMARY

A. Work shall consist of designing, furnishing and construction of a Concrete Masonry Unit Retaining Wall System in accordance with these specifications and in conformity with the lines, grades, design, and dimensions shown on the plans.

B. Work includes preparing foundation soil, furnishing and installing leveling pad, unit drainage fill and backfill to the lines and grades shown on the construction drawings.

C. Furnish all labor, materials, tools, equipment, and services for all work as indicated in accordance with provisions of the Contract Documents.

D. Completely coordinate with work of all other trades.

E. Although not specifically indicated, provide all supplementary or miscellaneous items, appurtenances, and devices incidental to, or necessary for sound, secure, complete installation..

1.2 RELATED SECTIONS

A. SECTION 02200 EARTHWORK

1.3 REFERENCES AND QUALITY ASSURANCE

A. REFERENCES

1. American Society for Testing and Materials (ASTM)
2. Geo-synthetic Research Institute (GRI)
3. National Concrete Masonry Association (NCMA)

1.4 SUBMITTALS

Product data and test reports showing compliance with this specification and project conditions.

1.5 DELIVERY, STORAGE AND HANDLING

A. Contractor shall check all materials upon delivery to assure that the proper type, grade, color, and certification have been received.

B. Contractor shall protect all materials from damage due to jobsite conditions and in accordance with manufacturer's recommendations. Damaged materials shall not be incorporated into the work.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURER

A. Basis of Design: Keystone Century Wall Retaining Wall System as manufactured by Keystone Block and Supply Company, Inc., Scranton PA.

Century Wall Large Unit	8”high x 18”wide x 12”deep
Universal Cap	4”high x 18/12”wide x 13”deep

B. Other Manufacturers and Products: Submit substitution request complying with the requirements of Section 01300.

2.2 DEFINITIONS

A. Concrete Masonry Unit (CMU) - a concrete retaining wall element machine made from Portland cement, water, and aggregates.

B. Reinforced Backfill - compacted soil that is placed within the reinforced soil volume as outlined on the plans.

2.3 CMU RETAINING WALL UNITS

A. Concrete units shall conform to the following architectural requirement:

1. Face color - concrete gray, unless otherwise specified. The DISTRICT may specify standard manufacturers’ color.
2. Face finish - sculptured rock face. Other face finishes will not be allowed without written approval of DISTRICT.
3. Bond configuration - running with bonds nominally located at midpoint vertically adjacent units, in both straight and curved alignments.
4. Exposed surfaces of units shall be free of chips, cracks or other imperfections when viewed from a distance of 10 feet (3 m) under diffused lighting.

B. Concrete materials shall conform to the requirements of ASTM C1372 - Standard Specifications for Segmental Retaining Wall Units.

C. Concrete units shall conform to the following structural and geometric requirements measured in accordance with ASTM C140 Sampling and Testing Concrete Masonry Units:

1. Compressive strength: $\geq$ 3000 psi (21 MPa).
2. Absorption: $\leq$ 8 % (6% in northern states) for standard weight aggregates.
3. Dimensional tolerances: ± 1/8" (3 mm) from nominal unit dimensions not including rough split face, ±1/16" (1.5 mm) unit height - top and bottom planes.

D. Concrete units shall conform to the following performance testing:

1. Inter-unit shear strength in accordance with ASTM D6916 (NCMA SRWU-2): 1200-plf (17 kN/m) minimum at 2-psi (13 kPa) normal pressure.
2. Geogrid/unit peak connection strength in accordance with ASTM D6638 (NCMA SRWU-1): 700-plf (10 kN/m) minimum at 2-psi (13 kPa) normal force.

E. Concrete units shall conform to the following constructability requirements:

1. Setback: 3/8" (10 mm) ± per course.
2. Alignment and grid positioning mechanism - fiberglass pins, two per unit minimum.
3. Maximum horizontal gap between erected units shall be ≤ 1/2 inch (13 mm).

2.4 SHEAR CONNECTORS

A. Shear connectors shall be 1/2-inch (12 mm) diameter thermo-set isopthalic polyester resin-pultruded fiberglass reinforcement rods to provide connection between vertically and horizontally adjacent units with the following requirements:

1. Flexural Strength in accordance with ASTM D4476: 128,000 psi (882 MPa) minimum.
2. Short Beam Shear in accordance with ASTM D4475: 6,400 psi (44 MPa) minimum.

B. Shear connectors shall be capable of holding the geo-grid in the proper design position during grid pre-tensioning and backfilling.

2.5 BASE LEVELING PAD MATERIAL

A. Material shall consist of a compacted crushed stone base or non-reinforced concrete.

2.6 UNIT DRAINAGE FILL

A. Unit drainage fill shall consist of clean 1" (25 mm) minus crushed stone or crushed gravel meeting the following gradation tested in accordance with ASTM D-422:

Sieve Size	Percent Passing
1 inch (25 mm)	100
3/4-inch (19 mm)	75-100
No. 4 (4.75mm)	0 – 10
No. 50 (300um)	0 – 5

B. Drainage fill shall be placed within the cores of, between, and behind the units as indicated on the design drawings. Not less than one cubic foot (0.028 m^3), of drainage fill shall be used for each square foot (0.093 m^2) of wall face unless otherwise specified.

2.7 REINFORCED BACKFILL

A. Reinforced backfill shall be free of debris and meet the following gradation tested in accordance with ASTM D-422:

Sieve Size	Percent Passing
2 inch (50 mm)	100
3/4-inch (19 mm)	100-75
No. 40 (425um)	0-60
No. 200 (75um)	0-35

B. The maximum aggregate size shall be limited to 3/4 inch (19 mm) unless field tests have been performed to evaluate potential strength reductions to the geo-grid design due to damage during construction.

C. Material can be site-excavated soils where the above requirements can be met. Unsuitable soils for backfill (high plastic clays or organic soils) shall not be used in the backfill or in the reinforced soil mass.

D. Contractor shall submit reinforced fill sample and laboratory test results to the DISTRICT for approval prior to the use of any proposed reinforced fill material.

PART 3 EXECUTION

3.1 EXCAVATION

A. Contractor shall excavate to the lines and grades shown on the construction drawings. The DISTRICT's representative shall inspect the excavation and approve prior to placement of leveling material or fill soils. Proof roll foundation area as directed to determine if remedial work is required.

3.2 BASE LEVELING PAD

A Leveling pad material shall be placed to the lines and grades shown on the construction drawings, to a minimum thickness of 6 inches (150 mm) and extend laterally a minimum of 6" (150 mm) in front and behind the CMU wall unit.

B. Soil leveling pad materials shall be compacted to a minimum of 95 % Standard Proctor density per ASTM D-698 or 92% Modified Proctor Density per ASTM D1557.

C. Leveling pad shall be prepared to insure full contact to the base surface of the concrete units.

3.3 MODULAR CONCRETE UNIT INSTALLATION

A. First course of units shall be placed on the leveling pad at the appropriate line and grade. Alignment and level shall be checked in all directions and insure that all units are in full contact with the base and properly seated.

B. Place the front of units side-by-side. Do not leave gaps between adjacent units. Layout of corners and curves shall be in accordance with manufacturer's recommendations.

C. Install shear/connecting devices per manufacturer's recommendations.

D. Place and compact drainage fill within and behind wall units. Place and compact backfill soil behind drainage fill. Follow wall erection and drainage fill closely with structure backfill.

E. Maximum stacked vertical height of wall units, prior to unit drainage fill and backfill placement and compaction, shall not exceed two courses.

END OF SECTION

SECTION 02510 – ASPHALTIC CONCRETE PAVING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Hot-mix asphalt paving.

1.3 REFERENCES

WSDOT	Standard Specifications for Road, Bridge and Municipal Construction, 2010, Washington State Department of Transportation/APWA
MUTCD	Manual on Uniform Traffic Control Devices (MUTCD) Current Edition

APPENDIX-P WSDOT PERMIT CONDITIONS

1.4 DEFINITION

A. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.

1. Job-Mix Designs: For each job mix proposed for the Work.

B. Qualification Data: For qualified manufacturer and installer.

C. Material Test Reports: For each paving material.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated.

B. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of WSDOT/APWA for asphalt paving work.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met (only 1-lift required on this 2” section of HMA – refer to contract plans) :

1. Minimum surface temperature of 60 deg F.

2. Slurry Coat: Comply with weather limitations in ASTM D 3910.

3. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.
4. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.

PART 2 PRODUCTS

2.1 AGGREGATES

A. General: Use materials and gradations that have performed satisfactorily in previous installations.

B. Coarse Aggregate: ASTM D 692, sound; angular crushed stone or crushed gravel.

2.2 ASPHALT MATERIALS

A. Asphalt Binder: AASHTO M 320 or AASHTO MP 1a, PG 64-22.

B. Asphalt Cement: ASTM D 3381 for viscosity-graded material or ASTM D 946 for penetration-graded material.

C. Prime Coat: Asphalt emulsion prime coat complying with WSDOT/APWA requirements.

2.3 MIXES

A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction and complying with the following requirements:

1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to begin paving.

B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
2. Proof roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by the DISTRICT, and replace with compacted backfill or fill as directed.

C. Proceed with paving only after unsatisfactory conditions have been corrected.

3.2 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

B. Prime Coat: Apply uniformly over surface of compacted unbound-aggregate base course at a rate of 0.15 to 0.50 gal./sq. yd.. Apply enough material to penetrate and seal but not flood surface. Allow prime coat to cure.

1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
2. Protect primed substrate from damage until ready to receive paving.

3.3 HOT-MIX ASPHALT PLACING

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
2. Spread mix at minimum temperature of 250 deg F.

B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.

1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete a section of asphalt base course before placing asphalt surface course.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.4 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor greater than 96 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.5 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: Plus or minus 1/2 inch.
2. Surface Course: Plus 1/4 inch, no minus.

B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

1. Base Course: 1/4 inch
2. Surface Course: 1/8 inch

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.

C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

D. Replace and compact hot-mix asphalt where core tests were taken.

E. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.7 DISPOSAL

A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.

1. Do not allow milled materials to accumulate on-site.

END OF SECTION

SECTION 02700 – SITE DRAINAGE

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Pipe and fittings.
   2. Cleanouts.
   3. Roof downspout drainage.

B. This Section includes storm drainage outside the building and connections to the existing utility system. This work shall comply with the more stringent of the requirements of WSDOT/APWA, Island County or the drawings.

1.3 REFERENCES

WSDOT/APWA Standard Specifications for Road, Bridge and Municipal Construction, 2010, Washington State Department of Transportation/APWA

1.4 SUBMITTALS

A. Material submittals shall include a complete list of equipment and product, manufacturer's design information and catalog sheets for each item.

B. Inspection and test reports specified in the Cleaning and Testing section.

1.5 DELIVERY, STORAGE AND HANDLING

A. Do not store pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle precast structures according to manufacturer's written rigging instructions.

PART 2 PRODUCTS

2.1 PVC PIPE AND FITTINGS

A. PVC pipe shall conform to ASTM D3034 and shall be defined as flexible pipe. Joints shall conform to ASTM D3212 using a restrained rubber gasket conforming to ASTM F477.

B. Fittings shall be injection molded tees or factory solvent welded saddle tees. Saddles fastened to pipe with external bands are not acceptable on any new system.

2.3 CLEANOUTS

PVC Cleanouts: Shall be provided at cleanout locations within landscaped areas.

1. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

PART 3 EXECUTION

3.1 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Division 2 Section "Earthwork."

3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

C. Use fittings for branch connections unless direct tap into existing storm sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

F. Install gravity-flow, nonpressure drainage piping according to the following:

1. Install piping pitched down in direction of flow.
2. Install piping with 12-inch minimum cover.

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure drainage piping according to the following:

1. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasketed joints.

3.4 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from storm sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in storm sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in storm sewer pipe.

1. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.

B. Set cleanout frames and covers in earth in cast-in-place concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding earth grade.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.5 STORMWATER INLET AND OUTLET INSTALLATION

A. Install outlets that spill onto grade, anchored with concrete, where indicated.

B. Install outlets that spill onto grade, with flared end sections that match pipe, where indicated.

C. Construct energy dissipaters at outlets, as indicated.

3.6 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318.

3.7 IDENTIFICATION

A. Materials and their installation are specified in Division 2 Section "Earthwork." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.

1. Use warning tape or detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.8 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place or fully backfilled for pipes with less than 24” of cover, and again at completion of Project.

1. Submit separate reports for each system inspection.
2. Defects requiring correction include the following:
    a. Alignment: Less than full diameter of inside of pipe is visible between structures.
    b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
    c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
    d. Infiltration: Water leakage into piping.
    e. Exfiltration: Water leakage from or around piping.
3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours advance notice.
4. Submit separate report for each test.
5. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
    a. Option: Test plastic piping according to ASTM F 1417.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.9 CLEANING AND TESTING

A. Cleaning and testing shall be in conformance with Section 7-17.3(2) of WSDOT/APWA

END OF SECTION

SECTION 02710 - SUBDRAINAGE

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes foundation, subsoil drainage systems.

1.3 REFERENCES

WSDOT/APWA Standard Specifications for Road, Bridge and Municipal Construction, 2010, Washington State Department of Transportation/APWA

1.4 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Material submittals shall include a complete list of equipment and products, manufacturer's design information and catalog sheets for each item.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced Installer who has completed foundation drainage systems similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

1.6 COORDINATION

A. Coordinate foundation drainage system installation with excavating, trenching, and backfilling.

B. Coordinate drainage panel installation with waterproofing of walls below grade.

C. Coordinate piping termination with storm drainage system

PART 2 PRODUCTS

2.1 PIPE AND FITTINGS

A. Solid walled pipe and fittings shall be Polyvinyl Chloride (PVC) Sewer Pipe conforming to ASTM D 3034, SDR 35, bell-and-spigot ends, with gasketed joints meeting ASTM F 477.

B. Perforated PVC Sewer Pipe shall conform to the provisions of ASTM D 2729 and provide two rows of 3/8" perforations at 6 inches on center.

2.2 FILTER FABRIC

A. Filter fabric shall be Mirafi 140N or an approved equal.

2.3 GRAVEL BACKFILL FOR DRAINS

A. Gravel backfill for drains shall conform to Section 9-03.12(4) of the WSDOT/APWA Standard Specifications.

2.3 CLEANOUTS

A. Cleanouts shall be installed in accordance with the plans and details. At a minimum, cleanouts are to be provided at each of the corners of the building where the drain line turns.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine surfaces and areas for suitable conditions where foundation drainage systems are to be installed. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PIPING INSTALLATION

A. Drawing plans and details indicate general location and arrangement of foundation drainage system piping.

B. Foundation drains shall not be connected into roof downspout drainage system.

C. Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing, solidly in filtering material. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions and other requirements indicated.

1. Install piping to provide positive drainage in the direction of flow or lay flat. Sags or rises are not acceptable.
2. Provide recesses in excavation bottom to receive bells of pipe bell ends. Lay pipe with bells facing upslope and with spigot end entered fully into adjacent bell.
3. Apply and compact impervious fill material to raise low areas or where unsatisfactory bearing soil may occur.

D. Extend piping and connect to storm drainage system, of sizes and in locations indicated. Terminate piping as indicated.

3.3 CLEANOUT INSTALLATION

A. Cleanouts shall be installed in accordance with the plans and details or as to comply with local agency requirements and details whichever is more stringent.

3.3 FIELD QUALITY CONTROL

A. Testing: Test drain piping with water or visually check piping to ensure free flow before backfilling. Remove obstructions, replace damaged components, and repeat test until results are satisfactory.

1. Place additional filtering material to depth of 4 inches (100 mm) around sides and top of drains after testing.

END OF SECTION

SECTION 03300 - CAST IN PLACE CONCRETE

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Formwork

B. Reinforcing

C. Placing

D. Finishing

E. Curing

All materials and workmanship shall be in accordance with ACI 301, ACI 318, and ASTM C94 and as noted on General Notes in Structural Drawings.

1.2 SUBMITTALS

A. PRODUCT DATA

Submit manufacturer's product data with application and installation instructions for proprietary materials and items, including reinforcement and forming accessories, admixtures, patching compounds, water stops, joint systems, curing compounds, dry-shake finish materials, and others as requested by the DISTRICT.

B. SHOP DRAWINGS; REINFORCEMENT

1. Submit shop drawings for fabrication, bending, and placement of concrete reinforcement.
2. Comply with ACI 315 Manual of Standard Practice for Detailing Reinforced Concrete Structures showing bar schedules, stirrup spacing, diagrams of bent bars, and arrangement of concrete reinforcement.
3. Include special reinforcement required and openings through concrete structures.

C. MIX REPORTS

Submit mix reports for concrete materials and mix design as specified. See General Notes Structural Drawings.

PART 2 PRODUCTS

2.1 FORM MATERIALS

1. The contractor may use plywood, lumber, or steel forms. Wood forms shall be of dressed material, free from loose knots, knot holes, cracks, or wanes, making it unsuitable for form work.

2. Forms shall conform to the shapes and dimensions shown on the drawings and be braced to be unyielding and made reasonably tight to prevent excess leakage.
3. Aluminum forms shall not be used.

2.2 REINFORCEMENT

1. Reinforcing steel shall be ASTM A615 Grade 60 deformed bars fabricated in accordance with applicable ACI and CRSI codes.
2. Tie wire shall be heavy annealed black wire.
3. Anchor bolts, heavy hex nuts, and washers shall be ASTM F-1554, Grade 36, Class 2A unless noted otherwise on the Structural Drawings.
4. Welded wire fabric shall be ASTM A185 - 65.

2.3 CONCRETE MATERIALS

Cast-in-place concrete mixes, specifications and standards shall be per General Notes Structural Drawings S1.1 and S1.2.

2.4 COMPOUND - HARDENER AND SEALER

Concrete floor sealant/hardener shall be as specified in Section 03366.

PART 3 EXECUTION

3.1 FORMWORK

A. ERECT FORMS

1. All forms shall be set true to the lines designated, and the interior shape and dimension shall be such that the finished concrete shall coincide exactly as shown on the plans.
2. Provide bracing to ensure stability of form work. Shore or strengthen form work subject to over stressing by construction loads. Forms shall be constructed to permit proper cleaning, and removal of chips, sawdust, and extraneous matter.
3. In no case shall any concrete be placed in any form until the form has been checked by the DISTRICT. Form ties shall be so arranged as to allow the removal of all metal to a depth of not less than 1/2-inch below the concrete surface. Wire tie or clamping devices will not be allowed.
4. Standing water will not be permitted in the forms during the placing of concrete.
5. All forms are to be removed.
6. Fill all holes with dry pack cement mortar. Built-in items shall be placed exactly where shown. Form design is the responsibility of the contractor.

7. Coat all forms with approved form release compound for type of forms used.
8. Remove all dirt, dust, oil, release agents, stains, and other foreign matter forms from concrete floors prior to final finish.
9. All exposed corners shall have a 3/4-inch chamfer.

B. APPLICATION - FORM RELEASE AGENT

1. Forms shall be oiled with a non-staining form oil acceptable to the DISTRICT.
2. The oil shall be applied several days before the concrete is placed and shall be in such quantity that it will be fully absorbed by the wood and will not discolor the surface of the concrete.
3. Apply form release agent on form work in accordance with manufacturer's recommendations and prior to placement of reinforcing steel, anchoring devices, and embedded items.

C. INSERTS, EMBEDDED PARTS, AND OPENINGS

1. Provide formed openings where required for items to be embedded in passing through concrete work.
2. Locate and set in place pipe sleeves, floor drains, sewer lines, conduit, etc. that will be cast directly into concrete.
3. Penetrations are not allowed in footings (see structural drawings).

D. FORM CLEANING

1. The contractor shall clean form work to remove all foreign matter adhering to the forms.
2. The forms shall be cleaned with water or use compressed air to remove remaining foreign matter. Ensure that water and debris drain to exterior through clean-out ports.

E. FORM REMOVAL

1. In general, forms shall not be removed until ample time has elapsed after placement of the concrete to permit the development of the proper set. This period shall not be less than four (4) days for slabs or foundations unless otherwise directed by the DISTRICT.
2. In removing forms, care shall be taken to avoid damaging of concrete surfaces and especially to avoid damage to the tops of slabs exposed above ground. Methods of removal tending to produce shocks or jars or fractures of concrete will not be permitted.

3. Forms shall be completely removed unless in the discretion of the DISTRICT the ground conditions or other considerations at a particular structure warrant leaving them in place.
4. In any case, removal of forms may not be done without the approval of the DISTRICT, and the contractor shall arrange his stripping operations so that concrete surfaces will be exposed for inspection and any repairing of defects which may be necessary while the excavations are free from water and before the concrete surfaces become covered with soil.

3.2 REINFORCEMENT PLACEMENT

1. All reinforcing steel shall be placed in such a condition that it is free from rust, dirt, and scale and shall be unpainted.
2. Steel reinforcement to be placed in the work shall be stored under cover to prevent rusting and shall be placed on blocks such that no steel touches the ground surface.
3. Embedded steel shall be placed as indicated on the contract drawings such that no movement is present during the placement of concrete. Care should be taken not to chip, mark, or otherwise destroy the galvanizing finish during construction. Do not displace or damage vapor barrier.
4. All anchor bolts shall be set plumb and accurate and held securely during the placing of the concrete.
5. All anchor bolt settings shall be checked and approved by the DISTRICT prior to pouring the concrete.
6. All anchor bolts and nuts are to be hot dip galvanized, and the contractor shall take special care not to damage this coating.
7. Damaged materials shall be replaced at the contractor's expense.
8. Threads of anchor bolts shall be protected by wrapping in tape or other technique for protection during concrete placement.
9. Setting anchor bolts after placement of concrete will NOT be allowed.
10. Anchor bolts shall be installed in accordance with latest ACI code.

3.3 CONCRETE PLACEMENT

A. PLACING CONCRETE

Notify field inspector at least 24-hours before an intended pour (see General Notes Structural Drawings for codes, specifications, and standards).

B. PIPE SLEEVES

PVC sleeves or approved equal shall be placed around all water piping 1/2-inch larger in diameter than water pipe and caulked upon completion.

C. EXPANSION JOINT

Submit Control Joint Plan to DISTRICT at a minimum of fourteen (14) days prior to pour. Joints shall be saw cut within 4 to 12-hours of pour.

3.4 FINISHING

A. FLOOR FINISHING

1. Concrete shall be protected from freezing, direct rays of sun, and drying effects of wind. Protect all concrete against rain spatter; pitted floors will not be accepted. Floors shall be protected with reinforced kraft paper before any work or traffic is permitted.
2. Slabs shall be screeded to true level or sloped with a tolerance of 1/8-inch in 10-feet and finished monolithically.
3. Building floor shall be sloped 3/16-inch per foot or as shown to floor drains as detailed on the plans.
4. Do not absorb water with neat cement.
5. Final intended interior/exterior floors, sidewalks and slabs to receive steel troweling and sidewalks a medium broom.

Steel troweling shall be used on all slabs except as indicated otherwise. Trowel by hand or machine to hard, dense surfaces; free from trowel marks. Wait until surfaces are dry enough for proper troweling. Chemical dryers are not permitted. Trowel must make a ringing sound when drawn over surface of concrete.

Sidewalks shall be sloped from edge of building to edge of sidewalk as shown on plans and be finished with 1/2-inch troweled radius on edges and at expansion joints. Crack control joints shall be 1/4-inch tool at 5-feet 0-inches on center as shown on the drawings. Tool 1/4-inch joints after broom finish is applied.
Utility pads, exterior foundations, and other exterior flat work shall have 1/2-inch troweled radius on all edges and as directed by the DISTRICT.

Concrete shall be placed monolithically and deposited as close to final position as practicable and vibrated to obtain thorough compaction, embedment of reinforcing, and complete filling of forms.
Prior to finishing any concrete work, the contractor shall broom samples for approval.

B. FLOOR SURFACE TREATMENT

1. Remove all dirt, dust, oil, release agents, stains and other foreign matter from all concrete floors prior to final finish.
2. All concrete surfaces exposed above grade shall be treated with the approved sealer/hardener in accordance with the manufacturer's directions. Refer to specification Section 03366.

C. SIDEWALK FINISH

Sidewalk finish shall be light broom to all exterior platforms. Cure and seal compound shall be applied per the manufacturer's directions.

3.5 CURING AND PROTECTION

Coordinate with specification Section 03366 and concrete sealer/hardener manufacturer for acceptable curing compounds compatible with specified finish products.

Keep exterior surfaces of new concrete continually wet with fog or continuous water spray equipment for six (6) hours then cover with two (2) layers of wet burlap or other DISTRICT approved equal during a minimum curing period of seven (7) days.

All areas must be kept saturated during this time period. Allow no shrinkage cracking to occur in slabs or sidewalks. Apply approved liquid applied curing compound on day 7.

After concrete has cured and work building construction has commenced the contractor shall cover interior concrete with Kraft paper. Lap joints 3-inches and seal with waterproof cement. Maintain protection until building is complete.

Take special care to protect interior/exterior concrete from stains. All stains shall be removed to the satisfaction of the DISTRICT at the completion of the building construction.

See General Notes Structural Drawings for additional requirements.

END OF SECTION

SECTION 03366 – CONCRETE SEALER/HARDENER

PART 1 GENERAL

1.1 SUMMARY

A. Provide concrete sealer/hardener at all areas calling for concrete seal as indicated in the finish schedule.

B. Furnish all labor, materials, tools, equipment, and services for all concrete sealer/densifier/hardener application as indicated in accordance with provisions of the Contract Documents.

C. Completely coordinate with work of all other trades.

D. Although not specifically indicated, provide all supplementary or miscellaneous items, appurtenances, and devices incidental to, or necessary for sound, secure, complete installation.

1.2 SYSTEM

A. DESCRIPTION

1. A sealer/densifier/hardener that will react with concrete surfaces to produce a dense, hydrophobic, insoluble, moisture barrier to seal out contaminants, while hardening and densifying the surface.

1.3 REFERENCES AND QUALITY ASSURANCE

A. REFERENCES

1. Corps of Engineers Spec.: CEGS 03300 4-79
2. USDA approved
3. Dept. of Navy, GSA, VA approved

B. DESIGN CRITERIA

1. ACI 302 Class 1 through 4 concrete floors.
2. Complies with all Federal and State VOC requirements.

C. APPLICATOR QUALIFICATIONS:

1. Applicator shall be trained and certified by the manufacturer. Provide certification in writing by the manufacturer or manufacturer's representative.

1.4 SUBMITTALS

A. Product data, test reports, certification of rate of application.

B. Project closeout data: Warranty.

C. Applicator's proof of certification.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver to job site in sealed labeled containers.

B. Store and handle to prevent damage to product and environment.

1.6 JOB CONDITIONS

A. Existing Conditions

1. Assure concrete has been cured a minimum of three days.
2. Assure that concrete is clean and free of film forming curing compounds and/or other sealers; and free of laitance, grease, oil, and contaminants.

B. Environmental Requirements

1. Comply with all VOC and EPA requirements.

C. Protection

1. Protect adjacent surfaces/areas from damage due to overspray.

1.7 WARRANTY

A. Provide written warranty signed jointly by applicator, manufacturer, and contractor.

B. Warrant installation for a period of five (5) years from date of Substantial Completion against dusting from abrasion.

PART 2 PRODUCTS

2.1 CONCRETE SEALER/DENSIFIER/HARDENER

A. Acceptable Manufacturers

L & M Construction Chemicals, Inc., 14851 Calhoun Road, Omaha, NE. or approved equal.

Contact local representative for list of certified applicators:
Bill Pavitt, CSI Phone:425-562-6076 Fax:425-562-6149

1. Product:

   Base: "Seal Hard" or approved equal.

   A solution of 100% active ingredient chemicals which penetrate concrete to seal, densify, dustproof, and harden to resist water and oil penetration, and contamination.

   Active Ingredients: 100 %

   Type: Siliconates

   Flash Point: None

   Specific Gravity: 1.155

   VOC gm/L: 0

   Solids Minimum: 30%

PART 3 EXECUTION

3.1 INSPECTION

A. Assure surfaces are clean and free of all contaminants, dirt, debris, and any film forming curing compounds or sealers. Scrub clean with a heavy duty cleaner/degreaser.

B. Assure concrete has been cured a minimum of 3 days.

C. Inserts, embedded parts, and openings

3.2 APPLICATION

A Apply in strict accordance with manufacturer's instructions.

1. Apply directly from sealer container onto prepared surfaces undiluted.
2. Application equipment: Mechanical "walk-behind" or riding scrubber.
3. Apply at minimum rate of 1 gallon per 150 to 200 sq. ft.
4. Aggressively scrub into surfaces with a mechanical scrubber or bristle broom.
5. Allow surfaces to remain wet with sealer for 30 to 60 minutes. Continue scrubbing and/or brooming.
6. Remove excess sealer at end of application procedure by thoroughly flushing with clean water and then remove all solution by squeegee and wet vacuum.
7. Apply in 1 coat.

3.3 FIELD QUALITY CONTROL

A. Have applicator certify rate of application.

3.4 CLEANING

A. Leave area broom clean. Remove all containers and packages; dispose of legally off site.

B. Protect finished surface from damage and soiling following application.

C. Conduct final cleaning and buffing just prior to substantial completion.

END OF SECTION

SECTION 03600 - GROUTING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. This section covers materials and procedures for grouting equipment, dowels, rebar, and structural base plates.

B. All grouting shall be done with non-shrinking grout.

PART 2 MATERIALS

2.1 GENERAL

Materials shall be in accordance with these requirements:

A. Non-shrinking grout; Master Builders "Masterflow 555" or acceptable equal. See General Notes Structural Drawings.

B. Epoxy grout; Hilti Hit-Hy 150 MAX-SD 2-part low sag epoxy or acceptable equal. See General Notes Structural Drawings.

C. Water - Clean and free from mud, oil, organic matter, and other deleterious substances.

PART 3 EXECUTION

3.1 GROUTING OF BASES FOR EQUIPMENT AND STRUCTURES

A. All equipment and structural base plates shall be firmly and solidly grouted in place, utilizing non-shrink grout by methods that will ensure complete, uniform, and permanent filling of all space beneath the base without disturbing or displacing the alignment or level of the base in its correct position.

B. Should the installation of any equipment be done under the supervision and direction of a manufacturer's erection superintendent, or other accredited supervisor provided by the manufacturer of the equipment, then the grouting procedure shall follow his direction. Otherwise, these specifications shall govern.

C. SURFACE PREPARATION

1. The surfaces of hardened concrete upon which grout will be placed shall be chipped to remove laitance and surface mortar and to expose the aggregate.

2. The surface of the hardened concrete shall be cleaned of all oil, grease, laitance, curing compound, and other foreign loose materials and shall be saturated with water for not less than 24 hours immediately before the grout is placed.

3. All excess water shall be removed.

B. ALIGNMENT AND LEVELING

1. Each base shall be set in place over its anchor bolts and shall be carefully aligned in proper position and then brought to accurate level.
2. Small structural bases may be leveled by means of an extra nut below the base on each anchor bolt.

C. MIXING

1. Non-shrinking grout shall be furnished factory premixed so only water is added at the job site.
2. Grout shall be mixed in a mechanical mixer for a minimum of three (3) minutes.
3. No more water shall be used than is recommended by the manufacturer.

D. PLACEMENT

1. Non-shrinking grout shall be placed immediately after mixing and before stiffening sets in.
2. Grout shall be placed in strict accordance with the directions of the manufacturer so that all grout space is completely filled without voids.
3. Non-shrinking grout shall be finished smooth in all locations where the grout will be exposed to view after it has reached its initial set.

E. FINISHING OF EDGES

1. When the placing of the grout has been completed, it shall be allowed to stand undisturbed until set stiff.
2. Then immediately the form or dam, if any, shall be taken off, and the portions of the grout which extend beyond the edges of the base shall be cut off flush and removed, except where a sloping surface is indicated on the drawings.
3. Sloping surfaces shall be finished to a one-to-one slope.
4. All grouting shall be completed in a proper and workmanlike manner with the exposed edges of the foundation and the surfaces adjacent thereto left clean and free from cement and grout.

3.2 CURING

A. All grout shall be protected against rapid loss of water by covering with wet rags and polyethylene sheets.

B. After edge finishing is completed, the grout shall be wet cured for at least seven (7) days.

C. When air temperatures of 90° F or above may be expected during curing, special procedures shall be adopted by the contractor to keep the grout as cool as possible.

D. When air temperatures of 45° F or below may be expected during curing, special procedures shall be adopted by the contractor for maintaining the grout at temperatures of not less than 50° F for five (5) days or 70° F for three (3) days after the grout is placed.

E. Grout and adjacent form surfaces shall be kept moist at all times.

F. Sudden cooling of grout shall not be permitted.

3.3 DOWELS

A. Dowels shall be provided in those places as shown on the drawings.

B. Dowels shall be ASTM A706 grade 60 bar.

C. Grout shall be placed to the full depth of hole.

END OF SECTION

SECTION 06100 – ROUGH CARPENTRY

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Wood framing, engineered wood products, and related work as shown on the drawings.

B. Refer to General Notes in Structural Drawings

1.2 SUBMITTALS

Submit the following certifications, which will not be returned unless an error is observed:

1. Pressure Treated Wood: State chemicals and process used, net amount of salts retained and conformance with applicable standards.

2. Preservative Treated Wood: Moisture content was reduced to 19% maximum, after treatment.

3. See General Notes Structural Drawings.

1.3 QUALITY ASSURANCE

A. Grade Marks: Identify all wood materials by official grade mark.

   1. Lumber: Grade stamp to contain symbol of grading agency, mill number or name, grade of lumber, species grouping designation, and condition of seasoning at time of manufacture.

   2. Softwood Plywood: Show Type, Grade, Class and Identification Index; and Inspection and Testing Agency Mark.

B. Requirements of regulatory agencies:

   1. Fire retardant treat all concealed wood "rough carpentry" materials except as specifically indicated.

   2. Preservative Treated Lumber and Plywood: American Wood Preservers Bureau, Quality Mark.

3. Pressure Treated Material: American Wood Preservers Bureau Standards.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Immediately upon delivery to jobsite, place materials in area protected from weather.

B. Store materials at least 6 inches above ground on framework of blocking and cover with protective waterproof covering providing for adequate air circulation or ventilation.

C. Do not store seasoned materials in wet or damp portions of building.

D. Protect sheet materials from corners breaking and damaging surfaces while unloading.

PART 2 PRODUCTS

2.1 MATERIALS

A. Lumber: WCLIB or WWPA Rules, Coast Region Douglas Fir.

1. Dimensions: Specified lumber dimensions are nominal. Provide lumber of same nominal dimension with the same actual dimension, after surfacing.

2. Moisture Content: Kiln dried or 19% maximum at time of permanent closing in of building or structure, for lumber 2 inch or less nominal thickness; S-GRN may be used.

3. Surfacing: Surface four sides (S4S), unless specified otherwise.

B. Plywood: Comply with Product Standard 1. Provide exterior graded plywood where preservative treated materials are required or where edge or surface is permanently exposed to weather.

Provide exterior grade plywood at roof and exterior walls.

Provide AC grade with exterior glue at interior locations.

C. Preservative Treated Wood Products:

1. Where cast into concrete, provide AWPB LP-22 waterborne salt preservative Chemonite or Wolman Process or approved equal, for ground contact use.

2. At all exposed fencing and framing, and where resting on concrete, masonry or roofing, provide either:

   a. AWPB LP-2 treated (waterborne preservative), for above ground application, Wolmanized Process pressure treated non-incised where exposed to view, incised where concealed.

   b. Or Heartwood Grade Western Red Cedar or Redwood.

3. Apply two brush coats of zinc or copper azole to sawed or cut surfaces of preservative treated lumber, as approved.

4. Comply with General Notes Structural Drawings S1-3.

D. Shims and Spacers:

1. Shims: Tapered, matching pairs of hardwood or cedar blocks.

2. Spacers: Tempered hardboard or C-C plywood.

3. Minimum Width: 2 inch.

4. Dip in zinc or copper azole ("Cuprinol" or "Wolman") before installation.

E. Fasteners, Anchorages, and Accessories:

1. Manufacturer: Simpson or approved equal.

2. Provide size, type, material, and finish suited to application shown. Provide metal hangers and framing anchors of size and type recommended for intended use by manufacturer. Hot-dip galvanize fasteners, anchorages, and accessories.

F. Building Paper / Weather-resistant Barrier:

Refer to Section 07260 Air/Weather Barrier

G. Engineered Wood Products:
Refer to Structural Drawings and Structural Notes.

Provide engineered wood products acceptable to authorities having jurisdiction and for which current model code research or evaluation reports exist that show compliance with building code in effect for Project.

Allowable Design Stresses: Provide engineered wood products with allowable design stresses, as published by manufacturer that meet or exceed those indicated. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that surfaces to receive rough carpentry materials are prepared to exact grades and dimensions.

B. Provide uniform and even bearing on supports under load-bearing members.

3.2 INSTALLATION

A. Use preservative treated wood products for wood materials for permanent construction as indicated or as required.

B. Fit members closely and set accurately to required lines and levels, secure rigidly in place.

C. Secure with sufficient and appropriate fasteners to insure rigidity.

D. Blocking: Locate as required for installation of finishing materials, fixtures, specialty items and trim. Locations of solid blocking include, but are not limited to, at grab bars, toilet partitions, toilet accessories, and surface mounted equipment.

E. Fireblocking: Provide fireblocking and draftstopping in all locations as required by the current edition of the International Building Code and all other applicable Codes.

F. Building Paper: Apply building paper horizontally shingle fashion. Refer to Section 07260. Paper shall be continuous around corners and angles and behind siding joints and control joints.

Install in accordance with Manufacturer's instruction over exterior sheathing. Seal joints and penetrations through weather resistant barrier with specified tape and fasteners prior to installation of finish material. Air infiltration barrier shall be air-tight and free from holes, tears, and punctures.

G Install rough carpentry work to comply with International Building Code, "Manual of House Framing" by National Forest Products Assoc,. (N.F.P.A.) and recommendations of American Plywood Association.(APA), unless otherwise indicated. For sheathing, underlayment and other products not covered in the above standards, comply with recommendations of

manufacturer of product involved for use intended. Set carpentry work to required levels and lines, with members plumb and true and cut to fit.

END OF SECTION

SECTION 06190 – WOOD TRUSSES

PART 1 GENERAL

1.1 SECTION INCLUDES

Section includes planar structural units consisting of metal plate connected members which are fabricated from dimension lumber and which have been cut and assembled prior to delivery to the job site.

Section includes all necessary bridging, bracing, blocking, hangers, connection clips, and all other accessories necessary for installation and performance of the structural units.

Refer to General Notes Structural Drawings.

1.2 SUBMITTALS

1. Product Data: Submit fabricator's technical data covering lumber, hardware, fabrication process, handling and erection. Include copy of current ICBO Evaluation Report.

2. Shop Drawings: Submit for approval: show details of fabrication and erection, indicate dimensions, shapes and connections.

3. Design Calculations: Submit complete engineering calculations for approval.

4. Shop Drawing and Design Calculations shall be stamped and signed by a professional engineer registered in the state of Washington.

5. Refer to General Notes Structural Drawings.

1.3 QUALITY ASSURANCE

A. TPI Standards; comply with applicable requirements and recommendations of the following Truss Plate Institute (TPI) publications:

1. "Design Specification for Metal Plate Connected Wood Trusses".

1.4 DELIVERY, STORAGE, AND HANDLING

A. Handle and store trusses with care and in accordance with manufacturer's instructions and TPI recommendations to avoid damage from bending, over-turning or other cause for which truss is not designed to resist or endure.

B. Time delivery and erection of trusses to avoid extended on-site storage and to avoid delaying work of other trades whose work must follow erection of trusses.

PART 2 PRODUCTS

2.1 MATERIALS

A. Lumber:

1. Factory mark each piece of lumber with type, grade, mill and grading agency..

2. Nominal sizes are indicated, except as shown by detail dimensions. Provide actual sizes as required by PS 20, for dressed lumber, S4S, unless otherwise indicated.

3. Lumber Grade and Species: As shown on Structural Drawings.

B. Fasteners and Anchorages:

1. Fasteners and Anchorages: Provide size, type, material and finish indicated, complying applicable Federal specifications for nails, screws, bolts, nuts and washers and anchoring devices.

C. Pre-Fabricated Wood Trusses

1. Prefabricated Wood Trusses with solid or structural composite lumber chords, and bearing hardware/attachments of material and size as required by manufacturer. Provide units complying with material requirements of and with structural capacities established and monitored according to an approved IEE-ES Evaluation Report.

2. Provide trusses manufactured without urea formaldehyde. Chord Material shall have a minimum specific gravity of 0.5. Web Material shall be cold-formed steel tubes conforming to ASTM A500, Grade B, with exceptions approved by applicable ICC-ES Evaluation Report. Structural Properties with depths designated in Structural Drawings and designed to support all loads indicated in the Drawings.

2.2 WOOD TREATMENT:

A. Kiln-dry lumber after treatment to a moisture content of 19% or less.

B. Inspect each piece of treated lumber after drying and discard damaged or defective pieces.

PART 3 EXECUTION

3.1 FABRICATION:

A. Cut truss members to accurate lengths, angles and sizes to produce close fitting joints with wood-to-wood bearing in assembled units.

B. Assemble truss members in design configuration indicated using jigs or other means to ensure uniformity and accuracy of assembly with close fitting joints. Position members to produce design camber indicated.

3.2 INSTALLATION

A. General: Erect and brace trusses to comply with recommendations of manufacturer.

B. Erect trusses with plate of truss webs vertical (plumb) and parallel to each other, located accurately at design spacing indicated.

C. Hoist units in place by means of lifting equipment suited to sizes and types of trusses required, applied at designated lift points as recommended by fabricator, exercising care not to damage truss members or joints by out-of-plate bending or other causes.

D. Provide temporary bracing as required to maintain trusses plumb, parallel and in location indicated, until permanent bracing is installed.

E. Anchor trusses securely at all bearing points to comply with methods and details indicated.

F. Install permanent bracing and related components to enable trusses to maintain design spacing, withstand live and dead loads including lateral loads, and to comply with other indicated requirements.

G. Do not cut or remove truss members.

END OF SECTION

SECTION 06200 – EXTERIOR FINISH CARPENTRY

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Exterior Finish Carpentry Items other than Shop Fabricated work.

B. Installation of doors and finish hardware in accordance with requirements of those sections and as specified in this section.

C. "Exterior Finish Carpentry" is defined to include all exterior carpentry work exposed to view, is non-structural, and which is not specified as part of other sections. Types of finish carpentry work in this section include:

Cedar fascia and standing and running trim.

Cedar fence, trim, and hardware.

1.2 REFERENCES

ASTM E84-91a	Test Method for Surface Burning Characteristics of Building Materials
APA	United States Product Standard (with American Plywood Association's Grade Trademarks): PS 1-83 for Construction and Industrial Plywood with Typical APA Trademarks
AWI	Architectural Woodwork Quality Standards, Guide Specifications and Quality Certification Program, Latest Edition
WCLIB No. 16	Standard Grading Rules for West Coast Lumber, Latest Edition
WWPA	Standard Grading Rules for Western Lumber, Latest Edition
UL 723	Underwriters Laboratories, Inc., for Surface Burning Characteristics

1.3 SUBMITTALS

A. Submit the following in accordance with Division 1.

1. Samples: Submit three samples each of wood material for verification of match to specified materials.

   a. Cedar fence materials.

   b. Exposed framing and standing and running trim.

2. Finish specified in Section 09900 - Painting on wood lumber and veneer on specified species, grade and cut in accordance with Color Schedule.

1.4 QUALITY ASSURANCE

A. Installer: Work of this section shall be done by an experienced finish carpenter. Submit certification that the personnel:

1. Regularly and presently construct Finish Carpentry as one of their principal services.

2. Has technical qualifications, experience, training and facilities to properly construct architectural woodwork.

1.5 DELIVERY, STORAGE AND HANDING

A. Time deliveries in accordance with requirements of construction progress schedule.

Do not deliver woodwork, until painting, wet work, grinding and similar operations which would damage, soil or deteriorate woodwork have been completed in installation areas.

B. Store materials in ventilated, interior locations under constant humidity and temperature conditions with minimum temperatures of 55º F and relative humidity of 50-percent to 55-percent. Store plywood products flat. Allow to stabilize prior to use.

C. Furnish room under lock and key for storing finish hardware in accordance with Section 08710 until installed

D. Protect from damage at all times. Cover to protect against dirt and dust.

1.6 PROJECT SITE CONDITIONS

Environmental requirements: Verify conditions suitable for installation of finish woodwork

A. Advise Contractor of requirements for woodwork installation areas. Do not install woodwork until the conditions are acceptable in installation areas.

B. Maintain temperature and relative humidity as required for a tolerance of ± 1% of the specified optimum moisture content until woodwork receives specified finishes. Maintain temperature and humidity conditions until acceptance of the Work by the DISTRICT.

1.7 COLORS AND FINISHES OF MATERIALS

Provide approved colors, textures, patterns, and other finish treatments as selected by the DISTRICT.

PART 2 PRODUCTS

2.1 MATERIALS

A. General: Materials shall be selected to match specified materials, details, and conditions.

1. Nominal sizes are indicated where possible but custom material sizes are required to match detail dimensions and custom conditions.
2. Moisture content of lumber: Provide kiln-dried (KD) lumber having a moisture content from time of manufacture until time of installation not greater than values required by the applicable grading rules for the species and product indicated.

a. Cedar framing and standing & running trim: 19% maximum.

B. Softwood Lumber:

1. Comply with PS 20-10 and applicable grading rules of respective grading and inspecting agency for species and product indicated. Manufacture to sizes and patterns using seasoned lumber. Use pieces made from solid lumber for transparent finished work, and for painted work.

C. Exterior Cedar Materials:

Manufacture to sizes and patterns using seasoned lumber. Use pieces made from solid lumber for finished work.

Boards and worked lumber products complying with requirements indicated below including those of grading agency listed with species:

Species: WRCLA Western Red Cedar; WWPA or WCLIB.

Grade: 2x and larger – Kiln-dried; Select Tight Knot or better.

1x - Clear VG.

Texture: Smooth surface all sides; S4S.

D. Cedar Fence Materials: Boards and lumber products complying with requirements indicated below including those of grading agency listed with species.

1. Cedar Boards: 5/4 x 6 Cedar Decking

Species: WRCLA Western Red Cedar;.

Grade: Kiln-dried; Architect Knotty; S4S. NLGA or WCLIB

Texture: Smooth Textured; S4S

2. Pressure Treated Cap and Trim: Non-incised AWPB LP-2 treated (waterborne preservative). Refer to Section 06100.

   Member sizes as indicated. Cut from standard lumber size as needed.

3. Pressure Treated Fence Posts: Incised AWPB LP-2 treated (waterborne preservative). Refer to Section 06100.

4. Apply two brush coats of zinc or copper azole to sawed or cut surfaces of preservative treated lumber.

E. Fasteners and Anchorages:

1. Provide nails, screws and other anchoring devices of type, size, material and finish suitable for intended use and required to provide secure attachment, concealed where possible. Provide corrosion-resistant hot-dipped galvanized fasteners and anchorages as per ASTM A 153, aluminum, and stainless steel fasteners for work exposed to exterior.

2. Select fasteners to avoid splitting members. Select nail length to penetrate solid wood supports a minimum of 1-1/4 inch.

F. Fence Gate Hardware

1. Provide gate hardware as needed for complete and secure operation of the gates shown. Provide corrosion-resistant stainless steel devices and fasteners unless noted otherwise.

   Continuous Hinges – Full-length stainless steel hinges at each gate leaf.

   Cane Bolt – Minimum 20 inch length bolt and matching handle rest at inactive leaf of double gate. Provide recessed strike in concrete slab.

   Latch – Heavy duty swivel hasp and staple suitable for padlock.

   Gate Stop – Surface mounted gate stop on inactive leaf of double gate.

   Metal brace – 1-1/2-inch square galvanized steel diagonal brace at each gate. Recess on inside face of gate frame.

2.2 PRE-FINISHING

A. General: Materials shall be shop pre-primed on all sides prior to construction.

1. Provide an alkyd oil base and stain blocking primer compatible with final coating specified in Section 09900.

2. Brush apply or back-brush spray-applied primer.

2.3 FABRICATION

A. Workmanship

1. Finish exposed surfaces to be smooth, free from tool and machine marks

2. Use concealed fastenings wherever possible

3. Joints: Make tight and form to conceal or reduce exposed shrinkage.

PART 3 EXECUTION

3.1 PREPARATION

A. Field measurements: Take all dimensions necessary prior to fabrication and installation.

B. Back prime any work scheduled to be painted prior to installation

C. Protect surrounding areas or surfaces to preclude damage during installation

3.2 INSTALLATION / FINISH CARPENTRY

A. General: Install materials in accordance with WRCLA recommendations.

1. Install exterior finish carpentry work plumb, level, true and straight with no distortions. Shim as required using concealed shims. Scribe and cut finish carpentry items to fit adjoining work. Anchor finish carpentry work securely to supports and substrates, using concealed galvanized fasteners and blind nailing where possible. Use fine finishing nails for exposed nailing except as indicated, countersunk and filled flush with finished surface.

B. Priming: Apply an alkyd oil base and stain-blocking prime coating to all surfaces prior to installation.

1. Back prime all surfaces of all exterior finish materials with an oil/alkyd primer compatible with finish material specified in Section 09900.

2. Prime all field cuts prior to installation. Coat surface with oil/alkyd wood primer to cover end grain.

C. Standing and Running Trim:

1. Install with minimum number of joints possible, using full-length pieces from maximum length of lumber available. Stagger joints in adjacent and related members. Cope at returns, miter at corners to produce tight fitting joints with full surface contact throughout length of joint. Use scarf joints for end-to-end joints.

2. Prior to installing exterior finish carpentry make certain that all flashing is in place and ready to receive finish work.

3. Stagger butt joints to meet on studs or other framing support. Fit siding to trim in accordance with siding manufacturer's recommendations. Cut butt splices at 30 degree angles
4. Follow WRCLA recommendations for fastener placement and spacing.
5. Set nails and screws for putting. Countersink fastenings. Putty recesses.
6. Where screw attachment required, space screws at equal intervals.
7. Select and cut material to exclude damaged, marked, or defective areas.

3.3 INSTALLATION OF WORK FROM OTHER SECTIONS

A. Install finished installations and items provided in other sections, but not normally installed under those sections. Conform strictly to manufacturer's templates and instructions, IBC and UL requirements, references, and industry standards of workmanship and requirements of contract documents.

3.4 ADJUSTMENT, CLEANING, AND PROTECTION

A. Repair damaged and defective work wherever possible to eliminate defects functionally and visually; where not possible to repair properly, replace woodwork. Adjust joinery for uniform appearance.

B. Clean exposed and semi-exposed surfaces. Touch-up finishes to restore damaged or soiled areas.

C. Protection: Installer of finish carpentry work shall advise Contractor of final protection and maintained conditions necessary to ensure that work will be without damage or deterioration at time of finishing and acceptance.

D. Leave work clean, premises free of residue of work of this section and ready for work of Section 09900 - Painting.

END OF SECTION

SECTION 07210 - BUILDING INSULATION

PART 1 GENERAL

1.1 SECTION INCLUDES

This section includes batt insulation and vapor barrier facing for exterior walls to achieve thermal values, and rigid foundation insulation at exterior walls.

1.2 SUBMITTALS

Submit under provisions of Section 01300 - Submittals and Shop Drawings product data in the form of manufacturer's fully descriptive published literature

1.3 QUALITY ASSURANCE

See drawings including wall and partition type schedule, wall sections, and details for complete wall assemblies

1.4 DELIVERY, STORAGE AND HANDLING

A. Deliver in original labeled packages

1. State manufacturer, material, "R" value, thickness, density and other pertinent information

B. Store in clean, dry place

C. Handle carefully to prevent tearing material

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

Insulation manufacturers: Owens-Corning, U. S. Gypsum, Manville, Certainteed, Knauf, or approved.

2.2 MATERIALS

A. Thermal Batt And Blanket Insulation:

Commercial glass fiber or mineral wool batt and blanket insulation where indicated.

1. Unfaced Blanket Insulation

   Installations in concealed spaces of wall assemblies protected from fire exposure and concealed from view by gypsum board finish attached to structural framing systems. Installations at stud walls and furring systems.

   a. Provide supplementary support to hold insulation in place until interior finish is applied when installed in heights over 8-feet or when recommended by manufacturer.

   b. Thermal insulation installations: Provide full stud thickness unless indicated otherwise.

   c. Flame spread 25 or less, smoke developed 50 or less, UL labeled. Provide tape recommended by manufacturer for sealing joints.

2. Exterior Blanket Insulation:

   Insulation for exterior walls shall be unfaced fiber glass or mineral wool batt insulation and conform to ASTM C665, Type 1, as manufactured by Owens-Corning, Johns-Manville, Certainteed or other engineer approved equal.

   Thickness: 6 inches and 4 inches, or as needed to completely fill cavity.

3. Vapor Retarders

   a. Vapor barrier where separate from insulation: Multi-ply reinforced polyethylene sheet, ASTM E 1745, Class C, not less than 7.8 mils thick; or polyethylene sheet, ASTM D 4397, not less than 10 mils thick.

   b. Tape for Vapor Retarder: Pressure sensitive tape of type recommended by vapor retarder manufacturer for sealing joints and penetrations in vapor retarder.

   c. Products: Subject to compliance with requirements.

B. Board Insulation Materials:

1. Rigid Foundation Insulation: Extruded Polystyrene Board Insulation, ASTM C 578, Type IV; extruded cellular type polystyrene board with either natural skin or cut cell surfaces; 4.0% maximum water absorption; thermal conductivity (k-value at 40 degrees F.) of 0.25.

   a. Number of layers: Insulation shall be applied in 1 layer. R-value or thickness as indicated on drawings.
   b. Panels Size: Largest size practical for installation to yield fewest joints.

c. Board Edges: Tongue and groove
d. Compressive Resistance: 25 psi
e. Surface Burning Characteristics: Flame spread of 5; smoke developed of 165 in accordance with ASTM E 84.

2. Available Manufactures: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to the following: Dow Chemical Co.: Styrofoam SM, SB,TG

B. Rigid Insulation for use at Roof:

See roofing specification.

C. Miscellaneous Materials:

Provide miscellaneous and accessory materials, methods, tools and equipment required for completion of insulation work.

1. Sealing tape: Ideal, No. 375 or as approved.
2. Adhesive for Bonding Insulation: As recommended by the insulation manufacturer, and complying with fire-resistance requirements.

PART 3 EXECUTION

3.1 EXAMINATION

Examine substrates and conditions with contractor present, for compliance with requirements of the sections in which substrates and related work are specified and to determine if other conditions affecting performance of insulation are satisfactory. Do not proceed with installation of insulation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

Clean substrates of substances harmful to insulations or vapor barriers including removal of projections that might puncture vapor barriers.

3.3 GENERAL INSTALLATION

A. Comply with insulation manufacturer's instructions applicable to products and application indicated. If printed instructions are not available or do not apply to project conditions, consult manufacturer's technical representative for specific recommendations before proceeding with installation of insulation.

B. Extend insulation full thickness as indicated to envelop entire area to be insulated. Cut and fit tightly around obstructions, and fill voids with insulation. Remove projections that interfere with placement.

C. Apply a single layer of insulation of required thickness, unless otherwise shown or required to make up total thickness.

3.4 INSTALLATION OF GENERAL BUILDING INSULATION

A. Apply insulation units to substrate by method indicated, complying with manufacturer's recommendations. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.

B. Seal joints between closed-cell (nonbreathing) insulation units by applying adhesive, mastic, or sealant to edges of each unit to form a tight seal as units are shoved into place. Fill voids in completed installation with adhesive, mastic, or sealant as recommended by insulation manufacturer.

C. Set vapor barrier to warm side of construction, except as otherwise indicated. Do not obstruct ventilation spaces, except for firestopping.

    1. Tape joints and ruptures in vapor retarder, and seal each continuous area of insulation to surrounding construction to ensure airtight installation.

D. Perimeter Insulation Below Grade: Protect insulation outside foundation wall by application of metal flashing as indicated in drawings. Set insulation in adhesive in accordance with the recommendations of the manufacturer of the insulation.

3.5 PROTECTION

A. General

Protect installed insulation and vapor barriers from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation will be subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

3.6 CLEAN UP

Leave premises clean and free of residue of work of this section

END OF SECTION

SECTION 07260 – AIR/WEATHER BARRIER

PART 1 GENERAL

1.1 SECTION INCLUDES

Furnish and install air barrier/weather resistant barrier over exterior of wall sheathing at all locations regardless of whether or not indicated on drawings to protect exterior sheathing and interior walls.

1.2 RELATED SECTIONS

Section 06100 – Rough Carpentry

Section 07462 – Fiber Cement Siding

Section 07620 – Sheet Metal Flashing and Trim

1.3 SYSTEM DESCRIPTION

A. The airtight components and secondary moisture protection of the building enclosure and the joints, junctures and transitions between materials, products, and assemblies forming the air-tightness and moisture barrier of the building enclosure are called "the air/moisture barrier system". Services include coordination between the trades, the proper scheduling and sequencing of the work, preconstruction meetings, inspections, tests, and related actions.

B. Air Barrier Penetrations: All penetrations of the air/moisture barrier and paths of air infiltration / exfiltration through the air/moisture barrier system shall be made air-tight.

C. Moisture Barrier Penetrations: All penetrations of the air/moisture barrier and paths of water migration through the air/moisture barrier system shall be made water shedding.

1.4 SUBMITTALS

A. General: Submit each item in this Article according to the conditions of the Contract and Division I Specifications Sections.

B. Product Data: Submit product specifications, technical data and installation instructions of manufacturer equaling or exceeding those specified, including:

1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Installation methods

1.5 QUALITY ASSURANCE

A. Qualifications:

1. Installer with a minimum of 2 years successful experience in the installation of air barrier/secondary weather resistant barriers.

B. Install job mock-up using specified air barrier/secondary weather resistant barrier with system of fastening and taping seams as per manufacturer's instructions.

Obtain architect's approval of system for appearance and workmanship standard.

1.6 DELIVERY, STORAGE AND HANDLING

A. Immediately upon delivery to jobsite, place materials in area protected from weather.

B. Store materials in manufacturer's unopened packaging at least 6 inches above ground on framework of blocking and cover with protective waterproof covering providing for adequate air circulation or ventilation.

C. Do not store seasoned materials in wet or damp portions of building.

D. Do not store in direct sunlight. Weather barrier shall be stored in a covered area. Do not expose to building site chemicals.

1.7 PROJECT CONDITIONS

A. Anticipate environmental conditions and schedule installation when conditions are within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.8 WARRANTY

A. Product Warranty: Limited product warranty against manufacturing defects.

1. HardieWrap Weather Barrier and related products for 10 years.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Acceptable Manufacturer: James Hardie Building Products, Inc., located at: 26300 La Alameda Suite 400 ; Mission Viejo, CA 92691; Toll Free Tel: 866-274-3464; Tel: 949-367-4980; Web: www.jameshardiecommercial.com

B. Other Manufacturers: Submit Substitution Request, conforming to requirements of Section 01300, 1.4 “Or Equal” Clause or Substitutions.

2.2 AIR / WEATHER BARRIER SYSTEM

A. Moisture Air Barrier Sheet:

1. Product: HardieWrap Weather Barrier as manufactured by James Hardie Building Systems.
2. Composition: Non-woven, non-perforated polyolefin.
3. Film: MicroTech Coating with micropores to balance water holdout and breathability.
4. Thickness: 11 mil (0.28 mm).
5. UV Stability: Up to 180 days.
6. Water Holdout (AATCC127): 128 inches (3250 mm).
7. Breathability/Water Vapor Permeance (ASTM E-96A): 15 perms.
8. Air Resistance (TAPPI T-460): >1800 sec/100 cc.
9. Tear Strength (ASTM D1117): 15 to 18 lb (6.8 to 8.2 kg).
10. Basis Weight: 19.4 lbs/1000 sf (9.5 kgs/100 sm).

B. Self-Adhering Flashing: Designed For Peel And Stick Application.

1. Product: HardieWrap Flashing as manufactured by James Hardie Building Systems.
2. Composition: Butyl rubber adhesive non-woven polyolefin backing; coated Kraft paper release.
3. Total Thickness: 25 mil (0.64 mm).
4. UV Stability: Up to 180 days.
5. Application Temperature: 30 degree F to 180 degree F (-1 degree C to 82 degrees C).
6. Operating Temperature: -30 degree F to 200 degree F (-34 degree C to 93 degrees C).
7. Packaging: Individually shrink-wrapped.
8. Roll Weight: 4 inch (102 mm) = 4.6 lb (2 kg)/roll, 6 inches (152 mm) = 6.9 lb (3 kg) /roll, 9 inches (229 mm) = 9.9 lb (4.5 kg)/roll.
9. Provide Width for Application Required: 4 inches by 100 feet (102 mm by 30.5 m) (2x4 construction), 6 inches by 100 feet (152 mm by 30.5 m) (2x4 construction), 9 inches by 100 feet (229 mm by 30.5) (2x6 construction).

C. Flexible Flashing:

1. Product: HardieWrap Flex Flashing as manufactured by James Hardie Building Systems.

2. Composition: Butyl rubber adhesive; creped cross-laminated polyolefin backing; polyethylene film release.
3. Total Thickness: 60 mil (1.5 mm).
4. Tensile Strength (ASTM D3759): 18 lb/inch (3.2kg/cm).
5. UV Stability: Up to 180 days.
6. Water Vapor Transfer Rate (ASTM E96-94): <.2g/100 square inches/24hrs.
7. Application Temperature: 30 degrees F to 180 degrees F (-1 degrees C to 82 degrees C).
8. Operating Temperature: -30 degrees F to 200 degrees F (-34 degrees C to 93 degrees C).
9. Packaging: Each roll is packed in a convenient dispenser box
10. Roll Weight: 6 inches (152 mm) = 22.2 lb (10kg)/roll, 9 inches (229 mm) = 33.3 lb (15 kg)/roll.
11. Provide Width for Application Required: 6 inches by 75 feet (152 mm by 23.9 m) (2x4 construction), 9 inches by 75 feet (229 mm by 23.9) (2x6 construction).

D. Seam Tape:

1. HardieWrap Seam Tape as manufactured by James Hardie Building Systems.
2. Composition: Polypropylene film coated with acrylic adhesive Total Thickness: 3.0 mil (.08 mm).
3. Adhesion Peel to HardieWrap (PSTC-1): 22 oz/inch (25 N/100 mm).
4. Tensile Strength (ASTM D3759): 32 lb/in (.58 kg/mm).
5. Elongation: 136 percent.
6. UV Stability: Up to 90 days.
7. Application Temperature: 30 degrees F to 180 degrees F (-1 degrees C to 82 degrees C).
8. Operating Temperature: -30 degrees F to 200 degrees F (-34 degrees C to 93 degrees C).
10. Packaging: Individually shrink-wrapped.
11. Roll Weight: 1 lb(0.5 kg)/roll.
12. Roll Size: 1-7/8 inches (43 mm) by 165 feet (50 m).

PART 3 EXECUTION

3.1 INSTALLATION

A. Install Air/Weather Barrier over exterior side of exterior wall sheathing.

1. Install Air/Weather Barrier after sheathing is installed and before windows and doors are installed. Install lower level barrier prior to upper layers to ensure proper shingling of layers.
2. Overlap upper layers of air/weather barrier (in shingle lap fashion) by a minimum of 6 inches below the horizontal edge, and tape the horizontal seam line.
3. Assure that the bottom edge of the air/weather barrier extends over the sill plate and foundation interface by at least 1 inch (25 mm
4. Overlap Air/Weather Barrier at corners of building by a minimum of 12 inches.
5. Overlap Air/Weather Barrier vertical seams by a minimum of 6 inches and the vertical seam shall be taped.
6. Attach weather barrier so that it is taut and flat.
7. Ensure barrier is plum and level with foundation, and unroll extending Air/Weather Barrier over window and door openings.
8. Attach Air/Weather Barrier to wood, insulated sheathing board or exterior gypsum with plastic cap nails every 12” to 18” on vertical stud line with wood stud framing, and screws with washers to metal stud framing.
9. Prepare window and door rough openings as follows:

    a. Prepare each window rough opening by cutting a modified “I” pattern in the Air Barrier.

        1. Horizontally cut Air Barrier along bottom of header.
        2. Vertically cut Air Barrier down the center of window openings from the top of the window opening down to 2/3 of the way to the bottom of the window openings.
        3. Diagonally cut Air Barrier from the bottom of the vertical cut to the left and right corners of opening.
        4. Fold side and bottom flaps into window opening and fasten every 6 inches. Trim off excess.

    b. Prepare each rough door opening by cutting a standard “I” pattern in the Air Barrier.

1. Horizontally cut Air/Weather Barrier along bottom of door frame header and along top of sill.
2. Vertically cut Air/Weather Barrier down the center of door openings from the top of the door opening (header) down to the bottom of the door opening (sill).
3. Fold side flaps inside around door openings and fasten every 6 inches. Trim off excess.
4. Tape all horizontal and vertical seam of Air/Weather Barrier with HardieWrap Seam Tape.
5. Seal all tears and cuts in Air/Weather Barrier with HardieWrap Seam Tape.

B. Flexible Flashing:

1. Windows and Doors: Air/Weather barrier is not designed nor guaranteed as a flashing material to prevent moisture or air from intruding behind weather barrier. Verify that flashing has previously been installed around all windows and door openings. Install flexible flashing per manufacturer's instructions.
   a. Use the inverted "Y" cut method at rough window and door openings. Do not place fasteners within 9 inches (229 mm) of the rough opening, door or window heads. This area shall not be fastened to allow for proper head flashing installation. At the top corners of the rough opening, cut the weather barrier at 45 degree to extend 9 inches (229 mm) past the joint.
   b. Fold the top flap up and out of the way and fasten temporarily
   c. Fold the remaining three flaps in through the opening fastening them inside the opening with staples.
2. Rough Electrical and Plumbing Penetrations: Seal with a double layer of flashing. Install the top flashing piece over the bottom flashing piece overlapping flashing layers to cover flashing cut-out necessary for placement around penetration.

C. Repairs:

1. For minor punctures or tears, less than 3 inches (76 mm), cover and completely seal with seam tape. For larger holes, greater than 3 inches (76 mm), use slit flashing technique.
   a. Slit flashing requires making a horizontal slit above the damaged area and placing a cut piece of Air/Weather barrier into the slit, covering the damaged area. Tape the perimeter of the patched area.

END OF SECTION

SECTION 07410 – METAL ROOF PANELS

PART 1 GENERAL

1.1 SUMMARY

This work includes the following:

A. Preformed standing seam metal roof panels, installed over solid substrate.

Provide all labor, materials, and equipment necessary to install the roof systems for a complete weather-tight system.

The complete metal roofing, including all associated flashings, closures, and sheet metal accessories, shall be provided by a single manufacturer. Refer to Section 07620 for Sheet Metal Flashing and Trim.

1.2 DEFINITIONS

Metal Roof Panel Assemblies:

Metal roof, attachment system components, miscellaneous metal framing, and accessories necessary for a complete weather-tight roofing system.

1.3 PERFORMANCE REQUIRMENTS

A. Testing And Certification

1. Air Infiltration: Panel (without insulation) to meet the following standard when tested in accordance with ASTM E-1680-95

    a. With Sidelap Sealant: 0.006 CFM/lineal ft. of panel seam at 1.57 psf positive pressure

    b. 0.02 CFM/lineal ft. of panel seam at 1.57 psf negative pressure.

2. Water Penetration: Panel to meet the following standard when tested in accordance with ASTM E1646-95

    a. With Sidelap Sealant: No leakage at 6.24 psf.

3. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580- for wind-uplift class as indicated.

4. Thermal Movements: Provide metal roof panel assemblies that allow for thermal movements resulting from the following maximum change in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections and other detrimental effects.

   Base engineering calculation on surface temperatures of materials due to both solar heat gains and nighttime-sky heat loss.

   a. Temperature Change (Range): 120 deg F, ambient, 180 deg F, material surfaces.

1.4 DESIGN CRITERIA

1. The metal roof system and attachment method shall resist the following design loads:

Live Load	25 psf
Dead Load	15 psf
Basic Wind Speed	85 mph
Wind Exposure Category	Exposure ‘D’
Deflection	L/240

   Refer to Structural Notes.

2. Wind Uplift: The roof system manufacturer shall provide a wind pressure map based on design wind speeds that comply with the IBC and local codes. Attachment calculations, stamped by a Professional Engineer licensed in the State of Washington, shall be provided for design wind uplift conditions for the entire roof including roof perimeter and roof corners.

3. Drag Loading: The roof panel manufacturer shall provide calculations stamped by a Professional Engineer indicating compliance of panels and fasteners to resist down drag load requirements at the "pin" location.

1.5 SUBMITTALS

A. Product Data

Submit Manufacturer’s technical product data, installation instructions and recommendations for each type of roofing and wall panels required. Include data substantiating that materials comply with requirements.

Samples: Provide a minimum of four (4) 6-inch square samples of each color and texture for preliminary review and color selection.

B. Shop Drawings

1. Show panel layout, trim installation, and panel attachment.

2. Show fabrication and installation layouts of panels; details of edge conditions, joints, panel profiles, corners, anchorages, trim, flashings, closures and accessories. Distinguish between factory and field-assembled work.

   a. Accessories: Include details of flashing and trim at a scale of not less than 1-1/2 inches per 12-inches.

C. Field quality-control inspection reports

D. Maintenance data

E. Warranties

Submit Manufacturer's warranties and contractors' warranties.
Refer to Section 1.7 Warranty.

1.6 QUALITY ASSURANCE

A. Installer's Qualifications

1. Only installers approved by the metal roofing manufacturer and having a minimum of five (5) years experience in installations of this type and size are approved for this project.

2. Provide manufacturer's certification of installer and a list of installer's recent projects for review and approval.

B. Source Limitations

Obtain each type of metal panels through one source from a single manufacturer.

C. Product Options

Drawings indicate size, profiles and dimensional requirements of metal roof panels and are based on specific systems indicated.

D. Standards:

Conform to applicable standards of the following:

1. National Association of Architectural Metal Mfgrs.(NAANM)
   Metal finishes manual, sections AMP 500-501

2. National Roof Manufacturers' Association Roofing and Waterproofing Manual
3. Sheet Metal and Air Conditioning Contractor's National Association (SMACNA) Architectural Sheet Metal Manual
4. ASTM A792-83-AZ50: Specifications for sheet steel, aluminum-zinc alloy coated (galvanized) by the hot dip process, general requirements. (Zincalume)
5. AISI: "Cold Form Steel Design Manual", American Iron Steel Institute.

1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver components, panels and other manufactured items so as not to be damaged or deformed. Package metal roof panels for protection during transportation and handling.

B. Stack metal panels on platforms or pallets, covered with weather-tight and ventilated covering. Store metal panels to ensure dryness and to avoid contact with other materials. Do not bend panels.

C. Protect strippable protective coating prior on panels from exposure to sunlight and high humidity, except to extent necessary for period of installation.

1.8 WARRANTY

A. Manufacturer’s Product Warranty

1. Manufacturer's Product Warranty: Furnish Manufacturer's standard 20-year warranty of finish durability.

   Manufacturer's Standard Warranty for each roofing type specified; minimum 10 years for factory-produced panels, seams, fasteners, etc..

B. Contractor’s Warranty

Warrant panels, flashings, sealants, fasteners and accessories against defective materials and/or workmanship, to remain watertight and weatherproof with normal usage for five (5) years following Project Substantial Completion date.

1.9 PRODUCT DELIVERY, STORAGE, HANDLING

A. Protect against damage and discoloration.

B. Handle panels with non-marring slings.

C. Do not bend panels.

D. Store panels above ground, with one end elevated for drainage.

E. Protect panels against standing water and condensation between adjacent surfaces.

F. If panels become wet, immediately separate sheets, wipe dry with clean cloth, and allow to air dry.

G. Ship panels with plastic sheeting or strippable film coating between all panels. Remove any strippable film coating prior to installation and, in any case, do not allow the strippable film coating to remain on the panels in extreme heat, cold, or direct sunlight or other UV source.

1.10 PROJECT CONDITIONS

A. Examine the conditions and the substrates in which metal roofing and siding work is to be installed. Substrate shall be installed level, flat, and true to avoid panel stresses.

B. Field measurements shall be taken prior to fabrication of panels.

C. Proceed with installation only after satisfactory conditions are met.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design:

AEP Span – Washington, 2141 Milwaukee Way, Tacoma WA. 98421, 253-383-4955 800-733-4955 or approved equal.Approved Manufacturer: Shall submit substitution request.

Metal Sales Mfg. Corporation

Manufacturers submitting substitutions shall comply with Division 1.

B. PANEL DESIGNATION

Panel Designation – AEP –Span manufactured products basis of Design

1. Standing seam metal roof panels: Design Span hp

Standing Seam: Panels shall consist of integral self-locking standing seams 1 3/4" high, spaced 17" on center. Panel shall be factory tension-leveled.

Thickness: 24 gauge

Provide continuous one-piece full-length panels throughout unless shown otherwise on drawings.

Roofing panels shall be factory formed. Field formed panels are not acceptable.

2.2 MATERIALS

A. Panels

1. General: Metal coil shapes to be manufactured of recycled steel content.
2. Base Metal:

   a. Material: Steel conforming to ASTM A-924/ASTM A-792 (formerly ASTM A792) Zincalume®, minimum yield 40,000 psi.
   b. Protective Coating: Conform to ASTM A924 / ASTM A-792 (formerly ASTM A792) AZ50 Zincalume®.

3. Exterior Finish:

   a. At Standing Seam Metal Roof Panels: DuraTechTM 5000 exterior finish includes a 0.2 mil thick corrosion-resistant primer and a 0.8 mil thick finish coat of polyvinylidene fluoride (PVF2), full 70% Kynar/Hylar 5000 for a total for a total 1.0 mil dry film thickness.

   b. Colors as selected from manufacturer's standard selection of not less than 12 colors.

   c. Fabricate from new materials, free of pits, rust, dents, and warps, non-uniform zinc coatings, or "White Rust".

4. Interior Finish:

   a. Primer Coat Material: Corrosion-resistant primer; primer coat dry film thickness: 0.15 mils; finish coat material: polyester paint, finish coat dry film thickness: 0.35 mils.

   b. Total Interior Dry Film Thickness: 0.50 mils.

B. Fabrication

1. Unless otherwise shown on drawings or specified herein, panels shall be full length. Fabricate flashings and accessories in longest practical lengths.

2. Roofing panels shall be factory formed. Field formed panels are not acceptable.

C. Roof Accessories

1. Fastener Clips:
   Roof - UL-90 rated clip; 18 gauge Zincalume steel; 40 ksi yield strength; 3 1/2" long triple-fastener type.

2. Fasteners: Per manufacturer's recommendations.

   Provide stainless steel screws with neoprene washers in accordance with manufacturer's recommendations for plywood decking. Lengths to provide 1/2" maximum penetration through plywood decking.

3. End Closures:
   Roof - Weatherproof , laminated, semi-rigid, cross-linked polyethylene foam, tightly fit to panel configurations.

4. Sealant:
   a. Gunnable Grade Caulking - Single component polyurethane caulk.
   b. Tape Sealant - Butyl

5. Factory Applied Seam Sealant: Norton Plastics Granlon 800 hot melt foamable mastic, injected with nitrogen gas, applied inside panel seam at a temperature between 240 and 350 degrees Fahrenheit.

6. Bearing Plate: 22 gauge 4"x6" Zincalume-coated steel bearing plate.

D. Flashing

1. Material - Gauge and finish to match panels. Do not use lead or copper.

2. Fabricate flashing, closures, and related trim at perimeter of roofing from prefinished galvanized steel to profiles indicated; full-lengths in runs under 20 feet.

E. Roofing Felt and Cold-Applied Membrane

1. Cold-Applied Membrane: Grace Ice & Water Shield by Grace Construction Products.

2. Roofing Felt: Minimum 30 lb. roofing felt underlayment.

F. Rigid Insulation for use with roof system:

1. Rigid high thermal polyisocyanurate foam insulation for use with single-ply roof systems; closed cell polyisocyanurate foam core with fibrous glass facers. U.S. Intec Inc. USIso Roof Insulation or approved equal.

   Thickness: 6 inches minimum or as indicated on drawings.

2. Acceptable Manufacturers:

   Johns Manville ENERGY 3 25 PSI

   U.S. Intec Inc. USIso Roof Insulation

   or approved equal.

3. Other Manufacturers: Submit Substitution Request, complying with requirements of Division 1.

2.3. ARCHITECTURAL LOUVERS

A. Fixed, weather-tight units for constant air flow.

B. Drainable blade

1. Model A6097
2. Manufacturer: Construction Specialties, Inc., San Marcos, CA or approved.

C. Heads, sills, jambs and mullions to be one (1) piece structural members of galvanized steel. Jamb and mullion shall have integral internal drains. One (1) piece blades formed with gutters designed to catch and direct water to jamb and mullion drains.

D. All fasteners to be stainless steel.

E. Furnish with 1/2-inch bird screen secured within a frame.

F. Shall carry a standard wind load of not less than 20 psf.

G. Minimum free area of 50-percent.

H. Finish: Kynar 500® finish, minimum 1 mil thick full strength, 70-percent resin fluoropolymer coating. All material shall have a clean galvanealed heat treated surface prior to application of inhibitive primer.

   Colors shall match adjacent siding color.

PART 3 EXECUTION

3.1 EXAMINATION

A. Existing Conditions

1. Inspect installed work of other trades and verify that such work is complete to a point where this work may continue.

2. Verify that installation may be made in accordance with approved shop drawings and manufacturer's instructions.

3.2 PREPARATION

A. Field Measurements

1. Verify prior to fabrication.

2. If field measurements differ from drawing dimensions, notify the DISTRICT prior to fabrication.

B. Protection

1. Treat, or isolate with protective material, and contacting surfaces of dissimilar materials to prevent electrolytic corrosion.

2. Require workmen who will be walking on Roofing Panels to wear clean, soft-soled work shoes that will not pick up stones or other abrasive material, which could cause damage or discoloration.

3. Protect work of other trades against damage and discoloration.

C. Surface Preparation

1. Clean and dry surfaces prior to applying sealant.

3.3 INSTALLATION

A. Panels

1. Follow roof panel manufacturer's directions.

2. Install panel seams (choose one) vertically or horizontally.

3. Lap panels away from prevailing wind direction.

4. Do not stretch or compress panel side-laps.

5. Secure panels without warp or deflection. Fully engage interlocking seams.

6. Provide metal roofing systems neat, square, and true.

7. Extend roof panels to overlap gutter openings 2 inches, but do not restrict opportunity to clean gutters.

B. Allowable Erection Tolerance

1. Maximum Alignment Variation: 1/4 inch in 40 feet.

C. Flashing

1. Follow manufacturer’s directions and approved Shop Drawings.

2. Overlap roof panels at least 6 inches.

3. Install flashings to allow for thermal movement.

4. Remove strippable protective film, if used, immediately preceding flashing installation.

5. Secure flashings and closures in accordance with manufacturer's recommendations not over 12 inches o.c. Place closures in all voids of panels. Provide other related closures and clips as indicated and as required.

D. Cutting And Fitting

1. Neat, square and true. Torch cutting is prohibited where cut is exposed to final view.

2. Openings 6 inches and larger in any direction: Shop-fabricate and reinforce to maintain original load capacity.

3. Where necessary to saw-cut panels, deburr cut edges and treat with galvanic paint. Small brush application only - do not spray apply.

E. Roofing Felt and Cold-Applied Membrane

1. Install according to manufacturer's instructions and recommendations.

2. Prior to installation verify that substrate is completely sealed. Prevent infiltration of product odor into occupied space; install additional vapor barrier as needed.

3. At eaves provide ice and water shield membrane. Extend membrane four feet up from edge of eaves. Lap roofing felt over the membrane.

3.4 CLEANING AND PROTECTION

A. Damaged Units: Replace panels and other components of the work which have been damaged or have deteriorated beyond successful repair by means of finish touch-up or similar minor repair procedures. Replace as directed by Architect or Owner's representative.

B. Cleaning: Remove protective coverings and strippable films (if any) at time in project construction sequence which will afford greatest protection of work. Clean finished surfaces as recommended by panel manufacturer, and maintain in a clean condition during construction.

C. Protection: Installer shall advise Contractor of protection and surveillance procedures, as required to ensure that work of this section will be without damage or deterioration at time of substantial completion.
Protect adjacent surfaces from damage or marring.

3.5 CLEAN UP AND CLOSE OUT

A. Panel Damage And Finish Scratches

1. Do not apply touch-up paint to damaged paint areas with minor scratches.

2. Panels or flashings that have severe paint and/or substrate damage shall be replaced as directed by Architect.

B. Cleaning And Repairing

1. At completion of each day's work and at work completion, sweep panels, flashings and gutters clean. Do not allow fasteners, cuttings, filings or scraps to accumulate.

2. Remove debris from project site upon work completion or sooner, if directed.

END OF SECTION

SECTION 07462 – FIBER CEMENT SIDING

PART 1 GENERAL

1.1 SUMMARY

This work includes the following:

A. Horizontal lap siding, individual shingle siding, and shingle panel siding.
B. Fiber-cement trim and mounting blocks.

Provide all labor, materials, and equipment necessary to install the fiber cement siding systems for a complete weathertight system.

The complete fiber cement siding system, including all associated flashings, closures, and accessories, shall be provided by a single manufacturer.

1.2 RELATED SECTIONS

A. Section 06100 Rough Carpentry
B. Section 06200 Exterior Finish Carpentry
C. Section 07210 Building Insulation
D. Section 07260 Air-Weather Barrier
E. Section 07620 Sheet Metal Flashing and Trim

1.3 SUBMITTALS

A. Submit the following in accordance with Section 01300 - Submittals.
   1. Samples: Submit three samples each of siding profile for verification of match to specified materials. Minimum size: 12” length.
   2. Product Data: Manufacturer's data sheets on each product to be used, including:
      a. Preparation instructions and recommendations.
      b. Storage and handling requirements and recommendations.
      c. Installation methods and instructions for each siding and trim type.
   3. Shop Drawings: Provide detailed drawings of atypical non-standard applications of fiber-cement siding materials that are outside the scope of the standard details and specifications provided by the manufacturer

B. Maintenance data

C. Warranties

1.4 QUALITY ASSURANCE

A. Installer's Qualifications

1. Installer Qualifications: Minimum of 2 years experience with installation of similar products.

B. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.

1. Finish areas designated by Architect.
2. Do not proceed with remaining work until workmanship is approved by the DISTRICT.
3. Refinish mock-up area as required to produce acceptable work.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Protect materials during transit, delivery, storage and handling to prevent damage, soiling and deterioration.

B. Store products in manufacturer's unopened packaging until ready for installation.

C. Store siding on edge or lay flat on a smooth level surface. Protect edges and corners from chipping. Store sheets under cover and keep dry prior to installing.

D. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.6 PROJECT CONDITIONS

A. Advise Contractor of temperature and humidity requirements for materials storage and installation areas.

B. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

C. Examine the conditions and the substrates in which siding work is to be installed. Substrate shall be installed level, flat, and true.

D. Proceed with installation only after satisfactory conditions are met.

1.7 WARRANTY

A. Product Warranty: Limited, non-pro-rated product warranty.

1. HardiePlank HZ10 lap siding for 30 years.
2. HardiShingle HZ10 shingle siding for 30 years.

B. Workmanship Warranty: Application limited warranty for 2 years.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:

Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work may include, but are not limited to:

1. Basis of Design:

   James Hardie Building Products, Inc., which is located at: 26300 La Alameda Suite 400 ; Mission Viejo, CA 92691; Toll Free Tel: 866-274-3464; Tel: 949-367-4980; www.jameshardiecommercial.com

2. CertainTeed Corporation, P.O> Box 860, Valley Forge PA, 19482; Toll Free Tel: 800-233-8990; www.certainteed.com

2.2 MATERIALS

A. General: Materials shall be selected to match specified materials, details, and conditions.

1. Nominal sizes are indicated where possible but custom material sizes are required to match detail dimensions and custom conditions.

B. Siding - Basis of Design:

1. Horizontal Siding #1: HardiePlank HZ10 Lap as manufactured by James Hardie Building Products, Inc.

   Type: Select Cedarmill 5-1/4 inches (133 mm) with 4 inches (102 mm) exposure.

   Thickness: 5/16 inch.

   Weight: 2.3 lbs./ sq. ft.

2. Hardie Shingle Siding: HardieShingle HZ10 siding as manufactured by James Hardie Building Products, 1nc.

Type: Straight Edge Notched Panel

Thickness: 1/4 inch.

Weight: 1.9 lbs./sq. ft.

Size: 48” x 16” planks

Exposure: 7 inches

3. Hardie Individual Shingle Siding: HardieShingle HZ10 Individual Shingles as manufactured by James Hardie Building Products, 1nc.

Type: Straight Edge Shingles

Thickness: 1/4 inch.

Weight: 1.9 lbs./sq. ft.

Size: 15-1/4” length x various standard widths from 4-3/16” to 10”

Exposure: 7 inches

C. Fasteners and Anchorages:

1. Provide nails, screws and other anchoring devices of type, size, material and finish as recommended by James Hardie Building Products, Inc., and as suitable for intended use and required to provide secure attachment, concealed where possible. Provide corrosion-resistant hot-dipped galvanized fasteners and anchorages as per ASTM A 153, and stainless steel fasteners for work exposed to exterior. Do not use aluminum fasteners, staples, or clipped head nails.

2. Select fasteners to avoid splitting members. Select nail length to penetrate solid wood supports as recommended by the siding manufacturer.

3. Place fasteners in strict accordance with manufacturer’s recommendations and as recommended by local building code requirements for high wind areas.

D. Fiber-Cement Mounting Blocks:

1. Provide StrudiMount pre-manufactured fiber-cement mounting blocks manufactured by Mid-America using James Hardie XLD trim.

2. Select from Split Mount, Universal Mount, Receptacle Mount, and Oversize Mount to suit installation requirements.

Furnish with factory-primed finish suitable for field painting.

E. Joint Flashing Behind Butt Joints:

1. Aluminum sheet pre-finished with paint coating compatible with cement-based products. Width: 6" minimum.

   Acceptable Product: Xtrene Trim Plank Flashing by R.H. Tamlyn & DSons LP, Stafford, Texas.

2. Other Manufacturers and Products: Submit Substitution Request conforming to requirements of Section 01300.

2.3. PRE-FINISHING

A. General: Materials shall be shop pre-primed on all sides prior to construction.

1. Primer: Factory primed by James Hardie.

2. Topcoat: Refer to Section 09900 and Exterior Finish Schedule. Verify primer and topcoat compatibility.

3. Provide factory primer products for touchup of cut ends.

PART 3 EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If framing preparation is the responsibility of another installer, notify the DISTRICT of unsatisfactory preparation before proceeding.

C. Provide nominal 2 inch by 4 inch (51 m by 102 mm) wood framing selected for minimal shrinkage and complying with local building codes, including the use of water-resistive barriers or vapor barriers where required. Minimum 1-1/2 inches (38 mm) face and straight, true, of uniform dimensions and properly aligned.

D. Install water-resistive barriers and claddings to dry surfaces.

E. Repair any punctures or tears in the water-resistive barrier prior to the installation of the siding.

F. Protect siding from other trades.

3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

C. Install a water-resistive barrier as required in accordance with local building code requirements.

D. The water-resistive barrier must be appropriately installed with penetration and junction flashing in accordance with local building code requirements.

E. Install Engineered for ClimateTM HardieWrap™ weather barrier in accordance with local building code requirements.

F. Use HardieWrap™ Seam Tape at joints and laps

G. Install HardieWrap™ flashing and HardieWrap™ Flex Flashing.

3.3 INSTALLATION - HARDIEPLANK HZ10 LAP SIDING

A. Install materials in strict accordance with manufacturer's installation instructions.

B. Starting: Install a minimum 1/4 inch (6 mm) thick lath starter strip at the bottom course of the wall. Apply planks horizontally with minimum 1-1/4 inches (32 mm) wide laps at the top. The bottom edge of the first plank overlaps the starter strip.

C. Allow minimum vertical clearance between the edge of siding and any other material in strict accordance with the manufacturer's installation instructions.

D. Align vertical joints of the planks over framing members.

E. Maintain clearance between siding and adjacent finished grade.

F. Locate splices at least one stud cavity away from window and door openings.

G. Use off-stud metal joiner in strict accordance with manufacturer's installation instructions.

H. Wind Resistance: Where a specified level of wind resistance is required Hardieplank lap siding is installed to framing members and secured with fasteners described in Table No. 2 in National Evaluation Service Report No. NER-405.

I. Face nail to sheathing.

J. Provide joint flashing behind all field butt joints in accordance with manufacturer’s recommendations.

K. Caulk joints in strict accordance with manufacturer’s recommendations.

3.4 INSTALLATION - HARDIESHINGLE HZ10 SIDING

A. Install materials in strict accordance with manufacturer's installation instructions.

B. Starting: Install a minimum 1/4 inch (6 mm) thick lath starter strip at the bottom course of the wall.

C. Apply starter course of 10 inches (254 mm) shingles or 9-1/2 inches (241 mm) lap siding overlapping the starter strip.

D. Apply subsequent courses horizontally with a minimum 8-1/4 inch overlap at the top and a minimum 2 inch (51 mm) side lap. The bottom edge of the first two courses overlaps the starter strip.

E. Fasten between 1/2 inch (13 mm) and 1 inch (25 mm) in from the side edge and between 8-1/2 inches (216 mm) and 9 inches (229 mm) up from the shingle bottom edge.

F. Allow minimum vertical clearance between the edge of siding and any other material in strict accordance with the manufacturer's installation instructions.

G. Ensure vertical joints of overlapping shingle course do not align.

H. Maintain clearance between siding and adjacent finished grade.

I. Locate splices at least one stud cavity away from window and door openings.

J. Wind Resistance: Where a specified level of wind resistance is required, Hardie Shingle siding is installed to substrate and secured with a minimum two fasteners described in Table No. 6, 7 and 8 in National Evaluation Service Report No. NER-405.

K. Face nail on designated line to sheathing.

L. Caulk joints in strict accordance with manufacturer’s recommendations.

3.5 FINISHING

A. Finish factory primed siding with a minimum of two coats high quality alkali resistant 100 percent acrylic exterior grade topcoat within 90 days of installation. Follow paint manufacturer's written product recommendation and written application instructions.

B. Do not paint when wet.

C. Back-roll finish surface if paint is spray applied.

3.6 ADJUSTMENT, CLEANING, AND PROTECTION

A. Repair damaged and defective work wherever possible to eliminate defects functionally and visually; where not possible to repair properly, replace work. Adjust joinery for uniform appearance.

B. Clean exposed and semi-exposed surfaces. Touch-up finishes to restore damaged or soiled areas.

C. Protection: Installer of finish carpentry work shall advise Contractor of final protection and maintained conditions necessary to ensure that work will be without damage or deterioration at time of finishing and acceptance.

D. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

SECTION 07620 – SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Complete systems using proven details to exclude water from the building at copings, base flashings, parapet wall liners, gutters, and other locations commonly closed by "sheet metal" and all other miscellaneous “sheet metal” work on the project.

1. Formed Roof Flashing and Trim
2. Formed Wall Flashing, Trim, and Counterflashing
3. Gutters and Downspouts

B. The requirements shown by the details are intended to establish basic dimensions, profiles and sight lines. Within these limitations, the Contractor will be responsible for the design of the flashing and sheet metal assemblies and may make whatever modifications of and additions to the details as may be required to prevent water and air penetration. Maintain the visual design concept as shown, including member sizes, profiles and alignment of components.

1.2 REFERENCES

A. ANSI/ASTM B32: Solder Metal, 2000
B. ASTM A 653/A 653M: Standard Specification for Steel Sheets, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process; 2000
C. ASTM B 209: Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
D. NRCA (National Roofing Contractors Association), current edition
E. SMACNA (Sheet Metal and Air Conditioning Contractors' National Association) Architectural Sheet Metal Manual, Fifth Edition, 1993.

1.3 SUBMITTALS

A. Product Data: Submit metal manufacturer's specifications, installation instructions and general recommendations for flashing and trim applications, with complete list of materials proposed for use.

B. Shop Drawings

Submit shop drawings for review prior to fabrication, include the following:

1. Identify material, thickness, weight, and finish for each item and location in project. Details for forming sheet metal flashing and trim, including profiles, shapes, seams, and dimensions. Roof details showing each condition keyed to the roof plan.
2. Details for fastening, joining, supporting, and anchoring sheet metal flashing and trim, including fasteners, clips, cleats, and attachments to adjoining work.
3. Profile and dimensions of each sheet metal item, gauge, type/finish of sheet metal, fastener type, location and spacing.
4. Corner and end details for each different flashing type.
5. Downspouts section and details of bends, hangars and connections to gutter outlet tube and to storm drainage system.
6. Fastener material, type and size for each condition.
7. Sealant details showing joint configuration, sealant types and location for each condition.

C. Fastener Samples

Submit samples of each different type of fastener proposed for use, key the fasteners to the fasteners noted in the shop drawings.

D. Guarantee

1. The Contractor shall guaranty the sheet metal installation for a period of five (5) years against defects in installed materials and workmanship including a five (5) year watertight guaranty.

2. Correct any flashing or sheet metal item that is defective, improperly installed or leaking for a period of five (5) years at no cost to the DISTRICT.

1.4 PERFORMANCE REQUIREMENTS

A. General

Install sheet metal flashing and trim to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failing, rattling, leaking, and fastener disengagement.

B. Thermal Movements

1. Provide sheet metal flashing and trim that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects.

2. Provide clips that resist rotation and avoid shear stress as a result of sheet metal and trim thermal movements.

C. Water Infiltration

Provide sheet metal flashing and trim that do not allow water infiltration to building interior.

1.5 QUALITY ASSURANCE

A. Sheet Metal Flashing And Trim Standard

Comply with SMACNA's Architectural Sheet Metal Manual. Conform to dimensions and profiles shown unless more stringent requirements are indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver sheet metal flashing materials and fabrications undamaged. Protect sheet metal flashing and trim materials and fabrications during transportation and handling.

B. Unload, store, and install sheet metal flashing materials and fabrications in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack materials on platforms or pallets, covered with suitable weather-tight and ventilated covering. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage.

1.7 COORDINATION

Coordinate instillation of sheet metal flashing and trim with interfacing and adjoining construction to provide a leak proof, secure, and non-corrosive installation.

PART 2 PRODUCTS

2.1 MATERIALS

A. Galvanized Steel: Galvanized steel sheet, A-60, 24 Gauge min. or as needed to provide units without bends or deformation.

1. Galvanized steel complying with ASTM A792-83-AZ50, aluminum-zinc alloy coated by hot dip process.
2. Provide hot dip galvanized fasteners for installation.
3. For painted surfaces, shop prime with a modified epoxy polyester factory primer after cleaning as recommended by paint manufacturer.
4. Finishes:

    a. Paint all flashing and sheet metal including gutters and downspouts. Provide factory pre-finished material using Kynar resin finish. Total dry film thickness 1.0 mil minimum.

    Colors to be selected by Architect. Provide standard colors available from at least three sources. Provide up to four colors as selected by the Architect.

    b. General: Apply coatings either before or after forming and fabricating panels, as required by coating process and as required for maximum coating performance capability.

    c. Protect coating promptly after application and cure, by application of strippable film or removable adhesive cover, and retain until installation has been completed.

    d. Durability: Provide coating which has been field tested under normal range of weathering conditions for minimum of 20 years without significant peel, blister, flake, chip, crack or check in finish, and without chalking in excess of 8 (ASTM D 659), and without fading in excess of 5 NBS units.

B. Fasteners:

1. Nails: No nail fasteners to be used.
2. Screws: Atlas "Neo-Bond", Type 305 stainless steel screws with neoprene washers at least 3/4 inch diameter, 20 gage minimum or approved equal. Screw sizes and lengths as needed for weather tight installation.
3. At concrete, provide suitable stainless steel fasteners.
4. Provide fasteners for compliance with minimum requirements for FM approved perimeter flashing systems. Refer to FM Data Sheets 1-49 Perimeter Flashing and Sheets 1-28 Wind Design.

C. Gutters and Downspouts

1. Galvanized steel complying with ASTM A792-83-AZ50, aluminum-zinc alloy coated by hot dip process.
2. Gutters: 5" gutter with end caps and downspout connections, formed as required to provide rigid installation. Profile as shown in drawings
3. Downspouts: 3" x 3" downspouts.

2.2 FABRICATION

A. GENERAL

1. Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's Architectural Sheet Metal Manual that apply to design, dimensions, metal, and other characteristics of item indicated.
2. Shop fabricate coping, flashing and sheet metal.
3. Obtain field measurements for accurate fit before shop fabrication.

B. SHEET METAL FLASHING AND TRIM

1. Fabricate in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
2. Fabricate without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.
3. Fabricate non-moving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.

C. SEALED JOINTS

Form non-expansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA recommendations.

D. EXPANSION PROVISIONS

Where lapped or bayonet-type expansion provisions in the work cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1-inch (25 mm) deep, filled with elastomeric sealant concealed within joints.

E. CONCEALMENT

Conceal fasteners and expansion provisions where possible on exposed-to-view sheet metal flashing and trim, unless otherwise indicated.

F. CLEATS AND ATTACHMENT DEVICES

Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, non-corrosive metal.

1. Thickness: As recommended by SMACNA's Architectural Sheet Metal Manual for application but not less than thickness of metal being secured.

G. CONTINUOUS GUTTER

Fabricate to match configuration shown on the Drawings from pre-finished galvanized steel sheet; minimum 20 gauge.

1. Fabricate into a continuous gutter from minimum 10-foot long sections as required for each roof eave condition.
2. Provide watertight end closures, fabricate to fit gutter profile; seal watertight.
3. Provide watertight drain outlet tube at each downspout location similar to SMACNA Figure 1-33D; seal lap joint watertight and attach securely to gutter with minimum of 6 solid head rivets.
4. Gutter Expansion: Leave expansion space at gutter ends to allow for unrestrained movement of gutter due to thermal expansion and contraction.
5. Fabricate gutter support brackets and spacers per SMACNA Fig 1-16. Weld to continuous steel angle at back edge of gutter at time of installation.
6. Hot-dip galvanize support brackets and spacers after fabrication.
7. Paint all flashing and sheet metal including gutters and downspouts. Provide factory pre-finished material using Kynar resin finish. Total dry film thickness 1.0 mil minimum.
8. Provide Leaf Screens at each downspout outlet similar to SMACNA Figure 1-24D fabricated from 0.063-inch diameter stainless steel wire.
9. Fabricate to cross-section indicated, complete with end pieces, expansion joints, outlet tubes, and other accessories as required.

H. DOWNSPOUTS

1. Fabricate rectangular downspouts, as indicated on drawings, complete with mitered elbows. Size: 3" x 3".
2. Furnish with metal hangers, from the same material as downspouts, and anchors, except at carport attach to joists with clamps and pipe clevis hangers as indicated on drawings.
3. Fabricate downspouts from the following material:
   a. Galvanized Steel, 0.0217-inch (0.55 mm)
   b. Pre-painted, Metallic-Coated Steel, 0.0217-inch (0.55 mm)

I. RAKE EDGE FLASHING

Fabricate to match configuration shown on the drawings from 24 gauge pre-finished galvanized steel sheet.

1. Provide continuous 22 gauge cleat to lock into hem on exposed outside face.

J. EAVE FLASHING

Fabricate to match configuration shown on the drawings from pre-finished galvanized steel sheet, 24 gauge or as shown on drawings.

1. Lay out and fabricate for 6 inch lap joints.
2. Shop fabricate outside corners for neat appearance.
3. Provide continuous 22 gauge cleat to lock into hem on exposed outside face.

K. COPINGS

Fabrication to match configuration shown on the Drawings and SMACNA Figure 3-4 from pre-finished galvanized steel sheet.

1. Provide continuous 22 gauge cleat to lock into hem on exposed outside face.
2. Fabricate joint plates of same thickness as copings.
3. Fasten concealed inside face with screw fasteners.
4. Drill elongated holes for fasteners on interior leg, fasten with screw fasteners
5. Outside Corners: Bend outside vertical face to form corner, overlap top and seal watertight.
6. Inside Corners: Overlap top and seal watertight; bend and lap inside vertical corner and seal.
7. Joint Style: Butt with 12-inch (300 mm) wide concealed back-up plate.

L. BASE FLASHING

Fabricate base flashing from the following material:

1. Galvanized Steel, 0.0276-inch (0.7 mm)
2. Pre-painted, Metallic-Coated Steel, 0.0276-inch (0.7 mm)

M. COUNTERFLASHING

Fabricate counterflashing from the following material:

1. Galvanized Steel, 0.0217-inch (0.55 mm)
2. Pre-painted, Metallic-Coated Steel, 0.0217-inch (0.55 mm)

N. FLASHING RECEIVERS

Fabricate flashing receivers from the following material:

1. Galvanized Steel, 0.0217-inch (0.55 mm)
2. Pre-painted, Metallic-Coated Steel, 0.0217-inch (0.55 mm)

O. ROOF PENETRATION FLASHING

Fabricate roof penetration flashing from the following material:

1. Galvanized Steel, 0.0276-inch (0.7 mm)
2. Pre-painted, Metallic-Coated Steel, 0.0276-inch (0.7 mm)

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with installer present to verify actual locations, dimensions and other conditions affecting performance of work.

B. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 GENERAL INSTALLATION

A. GENERAL

1. All flashing and sheet metal products shall be shop fabricated. Coordinate fabrication and installation requirements with roofing and siding manufacturers.
2. Use fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
3. SMACNA Details: Except as otherwise shown or specified, comply with applicable recommendations and details of the "Architectural Sheet Metal Manual" by Sheet Metal and Air-Conditioning Contractors National Association, Inc.4.Separate dissimilar metals as required to prevent electrolysis.

4. Provide for thermal expansion of running trim, flashing, and other items exposed for more than 15'-0" continuous length.
5. Install work with lines and corners of exposed units true and accurate, free of waves, warps, buckles, fastening stresses or distortion, allowing for expansion and contraction. Provide uniform, neat seams with minimum exposure of solder. Fold back the sheet metal to form a hem on the concealed side of exposed edges.
6. Conceal fasteners and expansion provisions wherever possible in exposed work, and locate so as to minimize the possibility of leakage. Cover and seal work as required for a watertight installation. Provide cleat-type anchorages for metal flashing and trim wherever practical, arrange to relieve stresses from building movement and thermal expansion.

B. METAL PROTECTION

Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by fabricator or manufacturers of dissimilar metals.

1. Coating: Coat side of lead sheet metal flashing and trim with bituminous coating where flashing and trim will contact wood, ferrous metal, or cementitious construction.
2. Underlayment: Where installing metal flashing directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet or install a course of polyethylene underlayment.
3. Waterproof Flanges: Bed flanges in thick coat of asphalt roofing cement where required for waterproof performance.

C. FLASHING AND TRIM

1. Install exposed sheet metal flashing and trim without excessive oil canning, buckling, and tool marks.
2. Install sheet metal flashing and trim true to line and levels indicated. Provide uniform, neat seams with minimum exposure of solder, welds, and elastomeric sealant.
3. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
    a. Space cleats not more than 12-inches (30 mm) apart. Anchor each cleat with two 92) fasteners. Bend tabs over fasteners.

D. EXPANSION PROVISIONS

Provide for thermal expansion of exposed flashing and trim.

1. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24-inches (600 mm) of corner or intersection.
2. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently watertight, form expansion joints of intermeshing hooked flanges, not less than 1-inch (25 mm) deep, filled with elastomeric sealant concealed within joints.

E. FASTENERS

1. Use fasteners of sizes that will penetrate substrate not less than 1-1/4 inches (32 mm) for nails and not less than ¾-inch (19 mm) for wood screws.
2. Galvanized or Pre-painted, Metallic Coated Steel use stainless steel fasteners.

F. JOINT SEALANT

Seal joints with elastomeric sealant as required for watertight construction.

1. Where sealant-filled joints are used, embed hooked flanges of joint members not less than 1-inch (25 mm) into sealant.
2. Form joints to completely conceal sealant.
3. When ambient temperature at time of installation is moderate, between 40°F and 70°F (4°C and 21°C), set joint members for 50-percent movement either way. Adjust setting proportionately for installation at higher ambient temperatures.
4. Do not install sealant-type joints at temperatures below 40°F (4°C).
5. Prepare joints and apply sealants to comply with requirements in Section 07900 – Joint Sealers.

3.3 ROOF DRAINAGE SYSTEM INSTALLATION

A. GENERAL

Install sheet metal roof drainage items to produce complete roof drainage system according to SMACNA recommendations and as indicated.
Coordinate installation of roof perimeter flashing with installation of roof drainage system.

B. HANGING GUTTERS

Join sections with lapped joints sealed with elastomeric sealant.
Provide for thermal expansion.

Attach gutters at eave or fascia to firmly anchored gutter brackets or straps spaced not more than 36-inches (900 mm) apart.
Provide end closures and seal watertight with sealant.
Slope to downspouts.

1. Fasten gutter spacers to front and back of gutter.
2. Loosely lock straps to front gutter bead and anchor to roof deck.
3. Anchor and loosely lock back edge of gutter to continuous cleat, eave or apron flashing.
4. Anchor back of gutter that extends onto roof deck with cleats spaced not more than 24-inches (600 mm) apart.
5. Anchor gutter with spikes and ferrules spaced not more than 24-inches (600 mm) apart.
6. Install gutter with expansion joints at locations indicated but not exceeding 50-feet (15.24 m) apart. Install expansion joint caps.

C. DOWNSPOUTS

Join sections with 1-1/2 inch (38 mm) telescoping joints.
Provide fasteners designed to hold downspouts securely 1-inch (25 mm) away from walls; locate fasteners at top and bottom and at approximately 60-inches (1500 mm) o.c. in between.

1. Provide elbows at base of downspout to direct water away from building.
2. Connect downspouts to underground drainage system indicated.

3.4 ROOF FLASHING INSTALLATION

A. GENERAL

Install sheet metal roof flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and SMACNA's Architectural Sheet Metal Manual.

Provide concealed fasteners where possible, set units true to line, and level as indicated.

Install work with laps, joints, and steams that will permanently watertight.

B. ROOF EDGE FLASHING

Anchor to resist uplift and outward forces according to recommendations in FMG Loss Prevention Data Sheet 1-49 for specified wind zone and as indicated.

1. Interlock bottom edge of roof edge flashing with continuous cleats anchored to substrate at 16-inch (400 mm) centers.

C. COUNTERFLASHING

Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers as needed and fit tightly to base flashing.

Extend counterflashing 4-inches (100 mm) over base flashing.

Lap counterflashing joints a minimum of 4-inches (100 mm) and bed with elastomeric sealant.

1. Secure in a waterproof manner by means of interlocking folded seam or blind rivets and sealant.

D. ROOF PENETRATION FLASHING

Coordinate installation of roof penetration flashing with installation of roofing and other items penetrating roof. Install flashing as follows:

1. Turn lead flashing down inside vent piping, being careful not to block vent piping with flashing.
2. Seal with elastomeric sealant and clamp flashing to pipes penetrating roof except for lead flashing on vent piping.

3.5 CLEANING AND PROTECTION

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Clean and neutralize flux materials. Clean off excess solder and sealants.

C. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed.

On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain in a clean condition during construction.

D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION

SECTION 07900 – JOINT SEALERS

PART 1 GENERAL

1.1 SUMMARY

Work of this section includes sealant and caulking systems necessary to exclude water from the building at existing door frames, joints, and openings, and at new windows, grilles, and other locations, using proven detail and installation.

1.2 REFERENCES

ASTM C 790-90	Recommended Practices for Use of Latex Sealing Compounds
ASTM C 834-91	Specification for Latex Sealing Compounds
ASTM C 920-87	Specification for Elastomeric Joint Sealants

1.3 SYSTEM DESCRIPTION

A. Sealant systems installed with pressure gun. Include sealing of vertical and horizontal joints as required to make airtight

B. Regardless of terminology used on drawings, where "caulking" or "sealant" is called for, use specified sealant continuously to seal entire area and assembly.

C. All sealants used as a filter must meet or exceed standard regulations, with the following limits of VOC contents:

1. Sealants	VOC/Limit (grams/liter)
Architectural	250
Roofing Material Installation	450
PVC Welding	480
Other	420

2. Sealant Primers	VOC/Limit (grams/liter)
Architectural – Nonporous	250
Architectural – Porous	775
Other	750

1.4 SUBMITTALS

A. Submit under provisions of Section 01300.

1. Product data: Indicate type of sealant, chemical characteristics, performance criteria, limitations and color availability. Include manufacturer standard Material Data Safety Sheet (MSDS) for each sealant used, highlighting VOC limits. Obtain approval from THE DISTRICT before proceeding.

2. Samples
   a. Backer rods for vertical and horizontal applications
   b. Color samples of sealant proposed for work

B. Submit test reports in accordance with Section 01300.
   1. Test sealant bond used at joints between adjacent assemblies or construction as required by the DISTRICT. Submit results of testing in the form of a written report to the DISTRICT prior to sealant work being performed.

1.5 DELIVERY, STORAGE AND HANDLING

Deliver sealant products to job in manufacturer's original, unopened dated containers.

1.6 PROJECT/SITE CONDITIONS

A. Temperature: Minimum 40º F and rising

   Do not proceed with installation of sealants under adverse weather conditions, or when temperatures are below or above manufacturer's recommended limitations for installation.

B. Moisture: Do no work when moisture is present or when surfaces to be sealed are wet.

C. Solvent curing sealants: Do not install in enclosed building spaces

D. The installer must examine the joint surfaces, backing, and anchorage of units forming sealant rabbet, and the conditions under which the sealant work is to be performed, and notify the Contractor of conditions detrimental to the proper and timely completion of the work and performance of the sealants.

   Do not proceed with the sealant work until unsatisfactory conditions have been corrected in a manner acceptable to the installer.

1.7 WARRANTY

Provide manufacturer's five (5) year warranty as specified herein

Repair or replace sealants which fail to perform as air-tight and water-tight joints; or fail in joint adhesion, cohesion or abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, or general durability; or appear to deteriorate in another manner not clearly specified by submitted manufacturer's data as an inherent quality of the material for the exposure indicated.

1.8 COLOR SCHEDULE

Provide approved colors, textures, patterns and other finish treatments as selected under provisions of Section 01300.

PART 2 PRODUCTS

2.1 GENERAL

A. Comply with contract documents and manufacturer's data. Where these may be in conflict, the more stringent requirements govern.

B. Color: Match approximate color adjacent surfaces, except as otherwise approved from the DISTRICT's samples.

C. Verify compatibility with back-up material before beginning work

Before purchase of each required material, confirm its compatibility with each other material it will be exposed to in the joint system.

D. Size and Shape: As shown or, if not shown, as recommended by the manufacturer for the type and condition of joint, and for the indicated joint performance or movement.

E. Grade of Sealant: For each application, provide the grade of sealant (non-sag, self-leveling, no-track, knife grade, preformed, etc.) as recommended by the manufacturer for the particular condition of installation (locations, joint shape, ambient temperature, and similar conditions), to achieve the best possible overall performance. Grades specified herein are for normal conditions for installation.

2.2 MANUFACTURERS/PRODUCTS

A. INTERIOR SEALANTS

1. General sealant: Paintable, siliconized acrylic latex sealant, complying with ASTM C 834 or approved. Color as selected in accordance to individual sections.

Provide one-part, non-sag, mildew-resistant, sealant complying with ASTM C 834, formulated to be paintable and recommended for exposed interior applications involving joint movement of not more than 7.5 percent from installed dimension.

2. Available Manufacturers

a. Sonneborn; Sonolac

b. Bostik; Chem-Calk 600

c. Tremco; Tremco Acrylic Latex Caulk

Other Manufacturers and Products: Submit Substitution Request, complying with requirements of Section 01300 for Product Substitutions.

B. TAPE SEALANTS FOR INTERIOR USE

1. Provide black materials where exposed at completion.
2. Multiply nominal joint dimension by 1.25 to find minimum thickness of sealant required.

3. Acceptable Manufacturers and Products: Norton "Bear" brand vinyl, Williams NN1 neoprene.
4. Other Manufacturers and Products: Submit substitution request, complying with requirements of Division 1.

C. ELASTOMERIC SEALANTS

Provide at joints in the exterior of the Building.

1. Where one of the joint surfaces is glass, provide silicone rubber based, one-part, non-sag, elastomeric sealant, complying with FS TT-S-001543, Class A and ASTM C 920 Type S, Grade NS Class 40, uses T, NT, M, G, A and O; recommended by manufacturer (also tested for compatibility and materials warranted for 20 years by manufacturer) for exterior joint surfaces shown.

   Acceptable Manufacturers and Products:

   a. Silicone Building Sealant 790/795; Dow Corning Corp.
   b. Silglaze Construction 1200 Sealant; General Electric Co.
   c. Proglaze Construction Sealant; Tremco, Inc.

   Other Manufacturers and Products: Submit Substitution Request, complying with requirements of Division 1.
2. At other locations, provide manufacturer's standard multi-part chemically curing non-sag sealant which complies with ASTM C 920 Type M, Grade NS, Class 25, Uses NT, M, G, A and, as applicable to joint surfaces encountered, O.

   Acceptable Manufacturers and Products:

   a. Tremco "Dymeric".
   b. Sonneborn, "Sonolastic NP2".
   c. Mameco "Vulkem" 922.

   Other Manufacturers and Products: Submit Substitution Request, complying with requirements of Division 1.

D. EXPANDING FOAM SEALANT

1. Provide a multi-purpose polyurethane or latex polymer foam sealant suitable for filling and sealing around doors and windows, at cracks and gaps at the exterior envelope, and at attics and crawlspaces.
   a. Products shall be flexible and moldable after application and shall be paintable.
   b. Products shall resist pest and rodent infiltration.
2. Acceptable Manufacturers and Products: DAP Products, DAPtex Latex Sealant; Convenience Products, Touch 'n Foam latex Formula; Dow Chemical Co., Great Stuff Pro; or approved equal
3. Other Manufacturers: Submit Substitution Request, complying with requirements of Division 1.

E. CAULKING AT JAMES HARDIE SIDING AND TRIM PRODUCTS

1. Use an Elastomeric Joint Sealant complying with ASTM C920 Grade NS, Class 25 or higher or a Latex Joint Sealant complying with ASTM C834.
2. Caulking/Sealant must be applied in accordance with the caulking/sealant manufacturer's written instructions.

F. MISCELLANEOUS MATERIALS

1. Joint cleaner: As recommended by sealant or caulking manufacturer for joint surfaces.
2. Joint primers: Non-corrosive and non-staining type, as recommended by sealant manufacturer for joint surface conditions encountered.
3. Bond breaker tape: Polyethylene tape/plastic tape recommended by sealant manufacturer, applied to sealant contact surfaces where bond to substrate or backer rod must be avoided for proper performance of sealant. Provide self-adhesive tape where applicable.
4. Backer rods: Compressible rod stock of polyethylene foam, polyethylene jacketed polyurethane foam, butyl rubber foam, neoprene foam or other flexible, permanent, durable non-absorptive material as recommended for compatibility with sealant by the sealant manufacturer.
   a. Provide size and shape of rod which will control the joint depth for sealant placement, break bond of sealant at bottom of joint, form optimum shape of sealant bead on back side, and provide a highly compressible backing to minimize the possibility of sealant extrusion when joint is compressed.
   b. Horizontal joints: Closed cell polyethylene foam rod, except where joint filler is specified at paving.
   c. Vertical joints: Closed cell polyethylene foam or "soft rod" (skinned open cell) polyethylene foam
   d. Diameter: 1/3 greater than width of joint where it is to be installed.
   e. Polystyrene foam and open cell rods are not acceptable.

PART 3 EXECUTION

3.1 EXAMINATION

Be sure that surfaces are clean and dry before proceeding. Remove lacquers and protective films from metal surfaces.

3.2 PREPARATION

A. Clean joint surfaces as recommended by sealant manufacturer. Provide bond-breaker or separator between sealant and joint filler, wherever recommended by manufacturer and wherever sealant is not compatible with joint filler.

B. Remove loose materials and foreign matter which might impair adhesion of sealant

C. Prime or seal the joint surfaces wherever shown or recommended by the sealant manufacturer. Do not allow primer/sealer to spill or migrate onto adjoining surfaces.

D. Perform preparation in accordance with referenced ASTM C 790 for latex base sealant. No solvent-release type materials permitted except as approved.

E. Install sealant backer rod for elastomeric sealants, except where shown to be omitted or recommended to be omitted by sealant manufacturer for the application shown.

3.3 PROTECTION

Completely protect surfaces adjacent to joints. Apply masking around joints to protect adjacent surfaces from defacement and staining during sealing operations.

3.4 INSTALLATION, APPLICATION, PERFORMANCE

A. Install in accordance with contract documents and manufacturer's directions. Where these may be in conflict, the more stringent requirements govern. Seal joints at the following locations:

1. Joints of dissimilar materials
2. Horizontal joints
3. Other locations as detailed or required to make airtight. See requirements of individual sections.

B. BACKING FOR SURFACES

1. Where more than 3/4-inch wide pack with foam rod back-up material to within 1/2-inch of surface.
2. Where less than 1/2-inch wide, install foam rod back-up material to within 1/4-inch of surface.
3. Where less than 1/2-inch deep, apply bond breaker tape to bottom of joints to prevent adhesion of sealant to bottom of joint.
4. Provide backing materials in as long lengths as practicable; install with proper tools. Force backing into joint to proper depth for sealant.
   a. Do not insert with sharp objects. Backer rods must not be punctured.

C. SEALING

1. Apply sealant in accordance with manufacturer's directions and the following:
   a. Install elastomeric sealants in joints to size and shape indicated with slight concave surface and depth equal to 50-percent of normal joint width, but not more than 1/2-inch and not less than 1/4-inch (dimension requirements may vary slightly between manufacturers).
   b. Install non-elastomeric sealants to size and shape indicated or with slightly concave surface and depth from 75-percent to 125-percent of normal joint width
2. Examine installation carefully. Repair any areas where sealant is not properly adhered due to bubbles, foreign matter or other defects.
3. Seal joints before final coat of finish is applied to adjacent surfaces.
4. Provide positive contact to surfaces.
5. Where exposed to view, install caulking and sealants with finish surface uniformly smooth and free of wrinkles.

3.5 CLEAN UP

A. Remove excess material. Remove and dispose of masking materials. Leave surfaces neat, clean and smooth.

B. Remove excess and spillage of compounds promptly as work progresses. Clean the adjoining surfaces by whatever means may be necessary to eliminate evidence of spillage.

C. PROTECTION

1. Protect from dust, moisture and other harmful substances during installation
2. Protect all sealed joints for at least twelve (12) hours

END OF SECTION

SECTION 08100 - METAL DOORS AND FRAMES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Hollow Metal Door Frames
B. Hollow Metal Doors
C. Accessories for Complete and Finished Installations

1.2 REFERENCES

ANSI A 115	Specifications for Door and Frame Preparation
ASTM A 366-85	Standard Specification for Steel, Sheet, Carbon, Cold-Rolled, Commercial Grade
ASTM A 525-90	Standard Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process
ASTM A 568-90b	Standard Specification for Steel, Sheet, Carbon and High-Strength Low Alloy, Hot-Rolled Sheet and Cold-Rolled
ASTM A 569-85	Standard Specification for Steel, Carbon (0.15 Maximum, Percent), Hot-Rolled Sheet and Strip Commercial Quality
ASTM E 152-81a	Standard Methods of Fire Tests of Door Assemblies
NFPA 80-90	Standard for Fire Doors and Windows
SDI-100-91	Recommended Specifications for Standard Steel Doors and Frames
SDI-105-91	Recommended Erection Instructions for Steel Frames
SDI-119-90	Performance Test Procedures for Steel Door Frames and Frame Anchors

1.3 SUBMITTALS

Submit under provisions of Division 1.

A. SHOP DRAWINGS

1. Details of each frame type and accessories
2. Elevations of door design type
3. Conditions at openings. Show condition at floor/threshold and required clearance at door bottom to clear flooring material on swing side
4. Details of construction
5. Location and installation requirements of finish hardware and reinforcements
6. Details of joints and connections

7. Anchorage and accessory items
8. Schedule of doors and frames. Use same reference numbers for details and openings as those on drawings.

B. PRODUCT DATA

1. Manufacturer's fully descriptive product literature including fabrication and installation instructions. Transmit one (1) copy of instructions to installer
2. Manufacturer's standard water-based epoxy primer for approval.

C. CERTIFICATES

Manufacturer's written certification attesting that:

1. Hollow metal doors and frames delivered to project conform to or exceed requirements of these specifications.
   a. Manufacturer agrees to replace, at no additional cost to the DISTRICT, doors and frames not meeting provisions of these specifications.

2. Specified priming procedures, methods and products have been followed.

1.5 REGULATORY REQUIREMENTS

A. Comply with the IBC current edition, local codes, ordinances, and other applicable regulatory requirements.
B. Fabrication and installation of frame assemblies: NFPA Standard No. 80

1.6 DELIVERY, STORAGE AND HANDLING

A. Store under cover in building in protected, upright position. Set on wood sills.

B. Protection prior to installation:
   1. Protect at all times to prevent damage to doors, frames and finish
   2. Prevent rust and damage
   3. Clean abraded, scarred and rusty areas
   4. Touch up with paint used for shop painting
   5. Replace units if repair is unsatisfactory or impractical

1.7 WARRANTY

Provide manufacturer's standard one (1) year warranty

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Curries, 1-206-298-4770 (Contract Hardware), 1-253-471-9150 (Washington Architectural Hardware)
B. Steelcraft, 1-206-623-1048 (Cascade Steel Door and Hardware), 1-206-883-1243 (Krause and Scheelar, Inc.), 1-253-474-5356 (Benson Industries)
C. Republic Builders Products, 1-800-726-9242 (Washington Architectural Hardware)
D. Ceco Door Products, 1-800-999-5158 (Builders Hardware and Supply), 425-881-9400 (Island Building Products), 253-288-8455 (Evergreen Construction Specialties)
E. Fleming, 1-206-623-1048 (Cascade Steel Door and Hardware)

2.2 MATERIALS

A. Hot-rolled steel sheets and strips: Commercial quality carbon steel, pickled and oiled, complying with ASTM A569 and ASTM A568.
B. Cold-rolled steel sheets: Commercial quality carbon steel, complying with ASTM A366 and ASTM A568.
C. Support and anchors: Fabricate of not less than 16 gauge galvanized sheet steel
D. Inserts, bolts and fasteners: Manufacturer's standard units.
E. Internal construction: Interior doors of polystyrene core laminated to both face sheets with adhesive.

2.3 FABRICATION

A. GENERAL

1. Fabricate units to be rigid, neat in appearance, free from defects, warp or buckle.
2. Wherever practicable, fit and assemble units in manufacturer's plant. Clearly identify work that cannot be permanently factory-assembled at project site.
3. Fabricate exposed faces of doors and panels from only cold-rolled steel.
4. Fabricate frames, concealed stiffeners, reinforcement, edge channels and moldings from either cold-rolled or hot-rolled steel (at fabricator's option).
5. Weld exposed joints continuously, grind, dress, and make smooth, flush and invisible.
6. Allow clearance for flooring as required.

B. STANDARD STEEL DOORS

1. Provide metal doors of types and styles indicated on drawings and schedules and complying with manufacturer's specifications and SDI-100 for minimum materials and construction requirements

   Maximum allowable U-value: U=0.60

2. Flush panel type: SDI, Grade II, Model 2 or 3, seamless 16 gauge minimum thickness for face sheets
3. Close edges of all doors, including tops. Submit detail for approval. Edges shall be finished smooth.

C. STEEL FRAMES

1. Provide 14 gauge metal door, sidelight and relight frames of types and styles indicated on drawings or schedules and complying with manufacturers. specifications and SDI-100 for minimum materials and construction requirements.
2. Conceal fastenings: Dap frames and body putty flush with frame to make fastenings invisible as applicable.
3. Pressed steel frames with 2-inch face, 1/2-inch returns, double rabbet with 5/8-inch stop.
4. Fabricate frames of welded construction as required for rated and non-rated assemblies, all corners mitered. Knock-down frames not permitted.
5. Plaster guards: Provide 26 gauge steel plaster guards or mortar boxes, welded to frame, at back of finish hardware cutouts where finish materials might obstruct hardware operation.

2.4 PROVISION FOR HARDWARE

A. Hardware reinforcing: Factory reinforce, drill and tap doors and frames to receive mortised hinges, locks, latches, flush bolts and concealed door closers as indicated or required for installations. Comply with applicable requirements of ANSI A115.

   1. Provide minimum gauge hardware reinforcing as follows:

      a. Hinges: 10 gauge at doors or equivalent number of threads and 7 gauge at frames.
      b. Locks: 12 gauge or equivalent number of threads
      c. Surface closers: 12 gauge x 5-inch wide minimum
      d. Hold open arms: 12 gauge
      e. Panic devices: 12 gauge
      f. Floor check hinges and pivots: 7 gauge

2. Work to templates for all hardware.
3. Drill for door silencers.
4. Provide plaster guards at silencers and strike pockets.
5. Conform to standards of hardware manufacturer except as modified in this section.
6. Locate finish hardware as specified in Section 08710 – Door Hardware.

B. Provide field tapping and drilling and installation of surface applied hardware not applicable for factory installation.
C. Anchors: Provide sufficient wall anchorage for wall attachment, tested in accordance with SDI 119, Level A of one (1) million cycles, except where anchorage is otherwise detailed on drawings.

2.5 FINISH

Interior doors and frames: Provide water-based epoxy shop primer in accordance with SDI for work of Section 09900 – Painting.

2.6 GALVANIC PROTECTION/CONTACTING DISSIMILAR METALS

Coat or otherwise isolate to prohibit galvanic action

PART 3 EXECUTION

3.1 EXAMINATION

Verify frame dimensions, hardware, and clearance requirements for flooring material or threshold. Adjust dimensions as necessary to make all parts come together as indicated.

3.2 INSTALLATION

A. Install in accordance with contract documents, references, codes and manufacturer's instructions. Where in conflict, follow more stringent requirements.

B. GENERAL

1. Regardless of tolerances specified or required for individual components forming portions of working assemblies, the contractor shall be responsible for final fitting and adjustments to individual components to provide a complete workable and usable assembly.

2. If components forming an assembly do not function properly to provide a complete usable system, it shall be the contractor's responsibility to provide corrective measures. Door shall clear floor for full swing.

C. FRAMES

1. Place frames per SDI-105.
2. Set frames accurately in place/plumb/align and securely brace.
3. Install fire-rated frames in accordance with NFPA Standard No. 80.
4. Jamb Anchors: Install a minimum of three (3) wall anchors per jamb at hinge and strike levels.
5. Install sealant between door frames and wall in accordance with Section 07900 – Joint Sealers.

D. DOOR INSTALLATION

1. Fit hollow metal doors accurately in their respective frames, within clearance specified in SDI-100 and NFPA 80 for labeled doors
2. Finish hardware is specified in Section 08710 – Door Hardware.

3.3 ADJUSTMENT AND CLEAN UP

Adjust all moving parts, touch up after installation, and thoroughly clean surfaces.

END OF SECTION

SECTION 08360 – SECTIONAL OVERHEAD DOORS

PART 1 GENERAL

1.1 SECTION INCLUDES

Section includes sectional vinyl overhead doors furnished as a complete unit produced by one manufacturer, including frames, sections, brackets, guides, tracks, counterbalance mechanisms, hardware, and installation accessories, to suit openings and head room allowable.

1.2 SUBMITTALS

A. Submit under provisions of Section 01300 - Submittals and Shop Drawings.

1. Shop Drawings: Show special components and installations that are not fully dimensioned or detailed in manufacturer's data.
2. Product data: Include manufacturer's complete definitive brochures. Include roughing-in diagrams, and installation instructions for each type and size of overhead door.
3. Maintenance data: Submit in accordance with Section 01300 procedures for protection of installed doors during remainder of construction.
4. Submit manufacturer's Operating and Maintenance Data in accordance with Section 01700.

1.4 QUALITY ASSURANCE

A. Provide each sectional overhead door as a complete unit produced by one manufacturer, including frames, sections, brackets, guides, tracks, counterbalance mechanisms, hardware, operators and installation accessories, to suit openings and head room allowable.

1.5 DELIVERY, STORAGE AND HANDLING

Comply with manufacturer's instructions and provisions

A. DELIVERY

1. Deliver in manufacturer's original unopened protective material or container.
2. Clearly mark covering with manufacturer's name, brand name, size, and identifying symbol.
3. Package each door individually; completely sealed on faces and all edges.
4. Inspect for damage before accepting.

B. STORAGE

1. Stack package flat on 2' x 4' lumber, lay 1'-0" from ends and across center.
2. Under bottom and over top of package, provide protection as needed to prevent damage to door units. Maintain packaging closed and free from damage until ready for installation.
3. Store doors in area where there will be no great variation of heat, dryness and humidity.

C. HANDLING

1. Lift doors in accordance with manufacturer's recommendations. Do not drag doors across one another

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

1. Provide sectional vinyl overhead doors from the following or approved equal.

   A. Wayne-Dalton Corp.;
   B. Overhead Door Co.,

2. Other Manufacturers: Submit Substitution Request, conforming to requirements of Section 01300, 1.4 "Or Equal" Clause or Substitutions.

2.2 MATERIALS AND FABRICATION

A. OPERATION AND EQUIPMENT:

Provide as standard with manufacturer for model indicated.

B. RESIDENTIAL VINYL GARAGE DOORS:

Model 8700 Insulated Vinyl Sectional door as manufactured by Wayne-Dalton or approved equal.

1. Twin 20-gauge steel C-channels full length of each panel and anchored to interior steel stiles for strength.

2. Exterior face: Raised vinyl panel of UV-Resin; Factory prefinished with full PVC color construction.
   Color to be selected by the DISTRICT.

3. Reinforce sections with continuous horizontal and diagonal reinforcing as required by door width and design wind loading.

4. Insulate inner core of door sections with manufacturer's standard polyurethane insulation, R10 min.; permanently bonded to the vinyl skin for energy efficiency, durability and added rigidity.

C. TRACKS, SUPPORTS AND ACCESSORIES:

1. Tracks: Provide manufacturer's standard galvanized steel track system, sized for door size and weight, and designed for clearances shown.

2. Provide complete track assembly including brackets, bracing and reinforcing for rigid support of ball bearing roller guides for required door type and size.

3. Support and attach tracks at opening jambs with adjustable brackets. Ensure tight closure at jambs when door unit is closed.

4. Provide additional seismic bracing as needed to maintain track alignment.

D. WEATHER SEALS:

1. Provide continuous rubber, neoprene, or flexible vinyl adjustable weatherstrip gasket at tops and compressible astragal on bottoms of each overhead door. Provide continuous flexible seals at door jamb edges for a fully weather-tight installation.

E. HARDWARE:

1. Provide rust-resistant hardware with galvanized or stainless steel fasteners, for standard application as recommended by manufacturer.
2. Provide manufacturer’s standard lift handle and lock assembly.

F. ROLLERS

1. Provide rollers with steel ball bearings in steel races. Provide steel roller tires to suit size of tracks.

G. COUNTERBALANCING MECHANISM:

1. Torsion Spring: Hang door assembly for operation by torsion spring counterbalance mechanism.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install door, track, and operating equipment complete with necessary hardware, jamb and head mold stops, anchors, inserts, hangers and equipment supports in accordance with final shop drawings, manufacturer's instructions, and as specified herein.

B. Fasten vertical track assembly to framing at not less than 24 inches o.c. Hang horizontal track from structural overhead framing with angle or channel hangars, welded and bolt-fastened in place. Provide sway bracing, diagonal bracing, and reinforcing as required for rigid installation of track and door operating equipment. Provide all additional framing, blocking, and accessories for complete installation.

C. Upon completion of installation, including work by other trades, lubricate, test and adjust doors to operate easily, free from warp, twist, or distortion and fitting weather-tight for entire perimeter.

END OF SECTION

SECTION 08710 - DOOR HARDWARE

PART 1 GENERAL

1.1 SECTION INCLUDES

Door finish hardware.

1.2 QUALITY ASSURANCE

Comply with the latest edition of the International Building Code (IBC), Washington State Code for Accessibility, and UL requirements for fire rated openings. Comply with UL 294, Access Control System Units.

Provide only hardware that has been tested by UL for types and sizes of doors specified. Complies with the requirements of the door and frame labels.

A. SUPPLIER

1. Finish hardware shall be supplied by a factory-authorized builder's hardware distributor for products as specified, or approved and who has been furnishing hardware in the same area as the project for a period of not less than five (5) years.

2. The supplier's organization shall include a member of the American Society of Architectural Hardware Consultants who is available at all reasonable times during the course of work to meet with the District, Architect, and/or contractor for project hardware consultation.

B. INSTALLER

1. Finish hardware shall be installed only by experienced tradesmen.

2. Contractor shall submit to DISTRICT prior to installation certification from the hardware vendor that he/she is qualified to install all door hardware specified.

C. CODES

1. All finish hardware shall comply with applicable local and/or current building codes.
2. Hardware for fire-rated openings shall also be in compliance with all fire building codes applicable to the district in which the building is located. Provide only hardware which has been tested and listed by UL for the types and sizes of doors required and which complies with the requirements of the door and door frame labels.

1.4 SUBMITTALS

Submit in accordance with Section 01300 - Submittals and Shop Drawings.

A. HARDWARE SCHEDULE

Submit hardware schedule including room number, door number, hand of door swing, door size, and door and door frame material.

1. Submit within thirty (30) days after award of contract, six (6) copies of completely detailed hardware schedules. List hardware for each door separately in the vertical format.

2. Review and acceptance by the DISTRICT does not relieve the contractor of exclusive responsibility to fulfill the requirements as shown and specified.

3. Acceptance of the hardware schedule does not relieve supplier of responsibility for errors or omissions.

4. Promptly incorporate corrections and changes in the first submittal and return a minimum of two (2) copies of the revised schedule to the contractor, one (1) to the District, and one (1) to the Architect.

B. Product Data: Provide product data sheets or catalog information for each item along with each hardware schedule.

C. Templates: Provide one (1) copy of complete template information for each item along with one (1) copy of the approved hardware schedule to hollow metal, wood and aluminum door and frame supplies.

D. Wiring Diagrams: Provide complete wiring diagram and information for each electromechanical or electromagnetic device.

E. Keying
The DISTRICT will provide all final cores and keying.

1.5 PRODUCT AND HANDLING AND STORAGE

A. Packaging: Each item or package is to be separately tagged with identification related to the final hardware schedule. Basic installation instructions shall be included in the packages.

B. Storage: The general contractor shall provide a locked room at the job site for the storage of hardware.

C. The Hardware Supplier shall inventory the hardware jointly with the contractor at the jobsite, until both parties are satisfied that the quantity is correct.

1.6 GUARANTEE

Finish hardware shall be guaranteed against defects in workmanship and operation for a period of at least one (1) year, backed by a factory warranty of the hardware manufacturer. The following products shall be guaranteed for periods beyond one (1) year:

A. Locks - Two (2) years
B. Door closers - Ten (10) years

PART 2 PRODUCTS

2.1 GENERAL

All hardware shall be full mortise.

2.2 HARDWARE FINISHES

Provide hardware items in the following finishes unless specified otherwise in the hardware groups.

Hinges (EXTERIOR)	US32D
Hinges (INTERIOR)	US26D
Locks	US26D
Cylinders	US26D
Stops	US32D

2.3 MATERIALS

A. HINGES

Out-swing exterior doors shall have non-removable (NRP) pin. All hinge open widths shall be minimum, but of sufficient size to permit door swing to 180°. Furnish hinges with five (5) knuckles and flush bearing.

1. Furnish three (3) hinges per leaf to 7'-6" height. Add one (1) hinge for each additional 30-inches in height or fraction thereof.

2. Furnish 4-1/2-inch hinges for doors up to 36-inches wide. Furnish 5-inch hinges for door 36-inches wide and greater.

3. Adjust hinge size as applicable for size of door regardless of sizes called out in hardware schedule.

4. Acceptable Manufacturers:
   a. McKinney
   b. Stanley
   c. Lawrence Brothers
   d. Hager

B. MORTISE LOCKSETS

1. Extra heavy duty mortise locksets with Best removable 7-pin cores.

2. Manufacturer: BEST;
   Series: 40H SERIES
   Trim Design: Lever – 14
   Cylinders: By Owner

C. ELECTROMECHANICAL MORTISE LOCKSETS

1. Manufacturer: BEST;
   Series: W SERIES
   Trim Design: Lever – 14
   Cylinders: By Owner

D. THRESHOLDS, WEATHERSTRIPPING AND SWEEPS

1. Manufacturers: Pemko, Reese, Zero or approved equal, mill finish aluminum
2. Threshold: Pemko
3. Weather-stripping: Pemko
   a. Where weather-stripping is required, it shall be applied to both sides of a mullion
4. Sweeps: Pemko

E. STOPS

1. Manufacturer: Trimco No. 1234, finish US32D satin stainless steel (Glynn Johnson /Builders Brass Works) or approved equal
2. All doors are to have a Floor Stop 1234 unless otherwise specified. If Floor Stop cannot be used, advise the Architect of the specific door during submittal process. Contractor shall provide solid backing for all wall-mounted stops.

F. KEYING

1. All locks shall be keyed to the District's existing "Best" master key system.
2. Provide all locks with construction cylinders for use during construction phase.
3. The District will supply all permanent cores, keys and keying. It shall be the contractor’s responsibility to return construction cores to the supplier.
4. Keys: Construction keys: - Four (4) total provided to District for distribution.

G. DOOR SILENCERS

1. Manufacturers: Glynn Johnson, Trimco/Builders Brass Works
2. Quantity: Furnish three (3) for each single door frame and four (4) for each pair of doors.
3. Type: 64 for metal frames

2.3 HARDWARE GROUPS

The following schedule of hardware groups is considered to be a guide only. It is the hardware supplier's responsibility to furnish all required hardware.

Quantities listed are for the contractors' convenience only and are not guaranteed. Provide the quantity of items needed for a complete installation.

Items not specifically mentioned but necessary to complete the work shall be furnished, matching in quality and finish the items specified.

PART 3 EXECUTION

3.1 INSTALLATION

A. Receive, store and be responsible for all finish hardware. All keys shall be properly marked immediately upon receipt and turned over to the District at the completion of the project.

B. Carefully install hardware, using skilled finish carpenters. Fit before painter's finish is applied, remove and install after finish is complete. Install hardware so that all operating parts function smoothly, close tightly, and do not rattle. Install proper screws at all screw holes, install hardware firmly anchored.

C. Hang all doors so that they will stand in any open position.

D. Metal Thresholds

1. Set metal thresholds in full bed of sealant, forming tight seal between threshold and mounting surface.

2. Secure permanent anchor thresholds using countersunk non-ferrous screws to match color of threshold (stainless steel screws at aluminum thresholds).

E. Weather-stripping and Bumpers: Install all weather-stripping and bumpers before painting, then remove, store and reinstall after painting is approved by the DISTRICT.

F. Hardware Mounting Heights: Comply with WAC 51-20 and IBC for accessibility

G. Inspection:

1. After installation has been complete, the hardware supplier shall, in the presence of the DISTRICTs Representative, check the job for proper installation and operation.

H. Protection:

1. The General Contractor is responsible for the proper protection of all items of hardware until the DISTRICT accepts the project as complete.

3.2 KEYING

Coordinate with District and assist with final keying as needed.

3.3 SCHEDULE OF FINISH HARDWARE

A. LEGEND OF LISTED MANUFACTURERS

BE	Best	BW	BBW
MC	McKinney	GJ	Glynn Johnson
RX	Rixson	ST	Stanley
TR	Trimco	PE	Pemco

B. The items listed in the following Schedule of Finish Hardware shall conform throughout the requirements of the foregoing specification. The last column of letters in the hardware schedule refers to the manufacturer abbreviation listed above.

C. The door schedule on the drawings indicates which hardware set is used with each door.

D. DOOR HARDWARE SETS

SET #1

2	Hinges	TA2314 NRP	32D	MC
1	Electric Hinge	TA2314-CC8	32D	MC
1	Electric Lock	45HW-7DEU14H	630	BE
		NOTE: DISTRICT to provide permanent core.		
1	Stop	1234 SERIES (VERIFY SIZE)	32D	TR
1	Latch Protector	LP01	US32D	MC
1	Gasket	S88D (HEAD & JAMBS)		PE
1	Door Bottom	315CN		PE
1	Threshold	171A-FHSL25 (VERIFY SIZE)		PE
1	Transformer/Rectifier	8W599 / 8WCON		BE

SET #2

3	Hinges	T2714	26D	MC
1	Lockset	45H-7A14H STD	630	BE
		NOTE: DISTRICT to provide permanent core.		
1	Stop	1234 SERIES (VERIFY SIZE)	32D	TR
3	Door Silencers	64		GJ

END OF SECTION

SECTION 09120 - ACOUSTICAL SUSPENSION SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

Exposed suspended tee grid for lay-in acoustical ceiling panels, including provisions for mechanical and electrical penetrations and installations

1.2 REFERENCES

ASTM A153-82	Specifications for Zinc-Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A641-91	Specifications for Zinc-Coated (Galvanized) Steel Wire
ASTM C635-91	Specification for Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings
ASTM C636-91	Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels
ASTM E580-74(1984)	Application of Ceiling Suspension Systems for Acoustical Tiles and Lay-in Panels in Areas Requiring Seismic Restraint
CISCA	Acoustical Ceilings: "Use and Practice"
UBC-97	Section 2504 and Table 25-A
NWWCB	Wall and Ceiling Manual and Recommendations of Northwest Wall and Ceiling Bureau

1.3 SYSTEM DESCRIPTION

A. Pre-finished metal grid modular system to accommodate acoustical lay-in ceiling panels, light fixtures, air diffusers, and as indicated or required for completed assembly.

1. Finished installation is required to conceal plenum, yet allow access to its services.
2. Make provisions for vertical as well as horizontal suspension systems.

B. The complete suspension system is required to lock together in a positive manner providing pull out tension values of 300 lbs. or greater on cross tee connections and 200 lbs. or greater on main tee splices.

1. See Mechanical Division 15 for size and weight of air supply and return units.

2. See Electrical Division 16 for size and weight of light fixtures.

1.4 SUBMITTALS

Submit in accordance with the requirements of Division 1.

A. Shop drawings: Indicate grid lay-out based on actual field conditions, junctions with other work, ceiling finishes, and interrelation of mechanical and electrical items, including ducts.
B. Product data: Submit copies of manufacturer's recommendations for suspension system installation.
C. Samples: Submit samples of grid system units
D. Design data: Submit complete details showing compliance with seismic bracing requirements of IBC. Design will be reviewed by structural engineer licensed in Washington State on contract to the District.

1. Completed installations are required to support finished acoustical ceiling assemblies including mechanical and electrical lay-in units with maximum deflection of 1/360th of the span in accordance with referenced ASTM C365 - "Intermediate Duty Classification"
2. Acoustical system shall be designed for and provide support at electrical fixtures, mechanical diffusers, and the like in accordance with IBC Chapter 8.
   Coordinate with mechanical/electrical work; Seismic Design Category D.
3. Lateral sway bracing and seismic uplift bracing shall comply with Section 1613 of the current edition of the IBC and as required by the local authorities.

1.5 QUALITY ASSURANCE

A. INSTALLER QUALIFICATIONS

1. Shall have at least five (5) years experience in furnishing and installing ceiling systems of greater or equal magnitude to work of this section.

B. Perform work of Sections 09120 and 09510 under direct supervision of one (1) installer.

C. Special requirements of regulatory agencies: Comply with local codes, ordinances, and other applicable regulatory requirements.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver products in original, unopened, protective packaging. Attach legible manufacturer's labels indicating brand name, pattern, size and thickness.
B. Acceptance at site: Verify undamaged condition.
C. Store products in original protective packaging in safe, protected location.
D. Do not begin installation until sufficient materials are received to complete space.
E. Handle at all times to prevent soiling and physical damage.

1.7 PROJECT CONDITIONS

Comply with recommendations of CISCA handbook and Northwest Wall and Ceiling Bureau for job site conditions.

PART 2 PRODUCTS

2.1 MATERIALS/GENERAL

Comply with contract documents, references, codes and manufacturer's instructions. Where these may be in conflict, the more stringent requirements govern.

2.2 MANUFACTURERS/PRODUCTS - GRID SYSTEM

A. Basis of Design: Armstrong World Industries.
   1. Non-rated: Armstrong "Prelude XL"

2.3 MATERIALS

A. Grid suspension systems: ASTM C636, intermediate duty, interlocking main runners and override cross tees, narrow faced continuous rolled steel-capped double web system, direct hung, suspended ceiling system, exposed grid, for lay-in acoustical panel ceilings.

   1. Main runners, cross tees, wall moldings materials: Double-wed, cold-rolled electro-galvanized steel.
      a. Main-tee and cross-tee, double web design with rectangular or round bulb.

b. Cross-tee with extended web forming positive interlock; lower flange extended and offset.
c. Hanger holes as required for system.
d. Exposed flanges: 15/16-inch wide
e. Main-tees and cross-tees: 1-1/2-inch deep
f. Grid size: As indicated on plans.

2. Wall moldings: Prelude XL, 2-inch wall leg molding by 2-inch horizontal support leg.
3. Surface finish: Baked polyester paint.
4. Seismic performance: Comply with Seismic Design Category D for components and design system.

B. HANGER WIRE

1. Minimum 12 gauge galvanized carbon steel conforming to ASTM A 641, soft-annealed, mild steel, pre-stretched, yield stress load of at least three (3) times design load and as required by UBC Table 25-A.
2. Suspension wires for light fixtures: Intermediate or heavy duty.

C. Accessories: Provide support, trim and necessary devices to complete system.

D. Sway and seismic bracing: In accordance with Section 1613 of IBC.

E. Furnish components from single manufacturer.

2.4 FABRICATION

Manufacturer's standard fabrication: Design suspension system components to support ceiling assembly with maximum deflection of 1/360 of the span, including appropriate load carrying capacity for acoustical panels, light fixtures, and HVAC elements.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine for unevenness and irregularities.

B. Coordinate all work including mechanical and electrical work in space above ceiling with work in this section. NOTE: Upon completion of communications cable tray systems, contractor must allow District communication personnel seven (7) working days to pull in cable prior to installation of grid system.

3.2 PREPARATION

A. Field measurements: Measure on job prior to installation.
B. Coordinate ceiling areas with mechanical and electrical installations including penetrations and inserts. Verify exact locations shown on drawings.

3.3 INSTALLATION

A. Install in accordance with contract documents, references, codes and manufacturer's instructions. Where these may be in conflict, the more stringent requirements govern.
B. Provide hangers, channels, connectors, clips, and as required for installation of ceiling related accessories.

C. ALLOWABLE TOLERANCES

1. Level main runners and cross tees to within 1/8-inch in 12-feet.
2. Maximum deflection for suspension system, including components, hangers, fastening devices, lighting fixtures, ceiling grilles and acoustical panels is not to exceed 1/360 of span.

D. HANGER WIRES

1. Space in accordance with referenced ASTM C636.
2. Install hangers within 6-inches of each corner of light fixtures, if dead load of fixture exceeds deflection capability of ceiling suspension system.
3. Install hangers within 6-inches from vertical surfaces.
4. Do not splay hangers more than 5-inches in vertical drop.
5. Locate anchors such that hangers do not interfere with mechanical or electrical work.
6. Do not support from duct work or piping.
7. Reinforce vertical support systems with metal angles pop riveted into horizontal and vertical main tees at 24-inches on center, or as approved, for rigid system.

E. Sway and seismic bracing: Install in accordance with ASTM E580 and in accordance.

F. Carrying channels and hangers: Provide as required at locations for mechanical equipment above ceiling in dimensions to clear the equipment.

G. WALL MOLDINGS AND EDGE TRIMS

1. Install wall moldings at intersection with vertical surfaces including columns.
2. Include outside corner caps.
3. Attach to vertical surfaces with mechanical fasteners.
4. Install required trim for finished and complete installation.

3.4 CLEAN UP

A. Clean soiled or discolored surfaces after installation.
B. Remove and replace damaged or improperly installed units.
C. Remove all debris resulting from work of this section.

END OF SECTION

SECTION 09250 - GYPSUM BOARD

PART 1 GENERAL

1.1 SECTION INCLUDES

Section includes gypsum wallboard finish systems over wood framing.

1.2 REFERENCES

Including, but not limited to, the following:

ASTM C 1396:	Standard Specification for Gypsum Board
ASTM C 1002:	Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs.
GA 201	Gypsum Board for Walls and Ceilings
GA 216-2010	Application and Finishing of Gypsum Panel Products.
GA 214-10	Recommended Levels of Gypsum Board Finish

Northwest Wall and Ceiling Bureau's Recommendations and Specifications

1.3 SUBMITTALS

A. Before submission of shop drawings or product data, submit a complete list of products, manufacturers and fabricators for all materials used in the work of this Section; specifically identifying joint compounds.

B. Submit Product Data in accordance with Division 1.

1.4 QUALITY ASSURANCE

A. STANDARDS

Comply with ANSI/ASTM C 840 Application and Finishing of Gypsum Board requirements of the manufacturer, The Gypsum Association's Recommendations and Specifications, or other standards indicated, except where more stringent requirements are shown or specified. Refer to Gypsum Association GA-216.

B. TOLERANCE OF SURFACE FLATNESS:

Within 1/8 inch in 10 feet and 1/8 inch maximum hollow in 14 inches from corners. In addition, where studs of this Section support other work, perform this work in a manner allowing tolerances specified for other work to be met.

C. INSTALLER QUALIFICATIONS

1. Installer: Able to show similar installations in good condition after five (5) years service.
2. Perform work of Section 09250 by or under direct supervision of one (1) installer.

D. REGULATORY REQUIREMENTS:

Comply with requirements of local ordinances and other applicable regulatory requirements, including the following:

1. Materials, accessories and application procedures: UL listed for type of construction shown.

E. LEVEL OF FINISH:

In accordance with "Recommended Specification: Levels of Gypsum Board Finish".

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in original packages, containers or bundles bearing brand name and identification of manufacturer or supplier.
B. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic and other causes. Neatly stack gypsum boards flat to prevent sagging.
C. Handle gypsum boards to prevent damage to edges, ends and surfaces. Do not bend or otherwise damage metal corner beads and trim.

1.6 BUILDING INTERIOR CONDITIONS

Environmental requirements; Temperature and ventilation:

A. Provide adequate, properly regulated heating and ventilating
B. Conform to requirements of product manufacturer

PART 2 PRODUCTS

2.1 GENERAL

Comply with contract documents, references, codes, and manufacturer's instructions. Where these may be in conflict, the more stringent requirements govern.

2.2 ACCEPTABLE MANUFACTURERS

Manufacturers will be accepted or rejected based upon the acceptability of the required submittals.

2.3 PRODUCTS

A. Gypsum Wallboard: Comply with ASTM C36

1. Ends square cut and edges tapered.
2. Non-rated assemblies: 5/8-inch thick.
3. Exposed Gypsum Board Surfaces: Provide gypsum wallboard complying with ASTM C 36 with paper-face surface suitable to receive decorated finish and with long edges tapered to receive manufacturer's standard joint treatment, unless otherwise shown.

B. Metal Trim Accessories:

Provide manufacturer's standard hot-dipped galvanized (ASTM C840, A525) steel beaded units with flanges for concealment in joint compound. Provide standard or specifically fabricated comparable items:

1. 90º corner beads
2. L-type edge trim beads
3. Special L-kerf type edge trim beads
4. Other special shapes as required to complete installation

C. Fasteners:

1. Wood framing - as applicable: Type "W" in required lengths for attachment to wood framing.
2. Screws, U. S. Gypsum, or approved, conforming to ASTM C1002

D. Joint Materials: As recommended by gypsum board manufacturer for intended purposes.

1. Conform to referenced GA 201 and GA 216 for reinforcing tape, joint compound, adhesive (if any), and water.

2. Joint Treatment Materials for Gypsum Wallboard Construction: ASTM C 475 and as recommended in writing by wallboard manufacturer and included on Product Data submitted.

E. Trim Accessories: Provide accessories of sizes required for the applications shown and specified, fabricated from galvanized steel or as indicated for the following applications:

1. At external corners, provide metal corner bead with smooth rigid nose and perforated and knurled flanges.
2. For protection of exposed edges around openings, and where wallboard abuts dissimilar construction, provide beaded nose metal casing bead with exposed flange knurled for joint treatment.

PART 3 EXECUTION

3.1 PREPARATION

A. Examine substrates to which gypsum panel construction attaches or abuts, including preset metal door frames, cast-in-anchors, and structural framing, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of construction. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Protect surrounding areas and surfaces to preclude damage. Exercise care to avoid soiling, spatter, and damage to work of other trades.

C. Use cover cloths or other means of protection. Remove, clean, and repair any soiled or damaged work, as required.

D. Protect from damage at all times.

3.2 INSTALLATION

A. Install in accordance with contract documents, references, codes, and manufacturer's instructions.

1. Where these may be in conflict, the more stringent requirements govern.
2. Locate exposed end-butt joints as far from center of walls and ceilings as possible, and stagger not less than 24 inches in alternate courses of board.
3. Install wall/partition boards in the manner that minimizes the number of end-butt joints or avoids them entirely where possible.
4. Install exposed gypsum board with face side out. Do not install imperfect, damaged or damp boards.
5. Cover both faces of walls with gypsum board in concealed spaces (above ceilings, etc.) full height to floor or roof structure above.
6. Fit gypsum board tightly around ducts, pipes, and conduits.

B. Allowable Tolerances:

1. Butt boards together for a light contact at edges and ends with not more than 1/16-inch open space between boards.
2. Shim panels as necessary to comply with tolerances. Do not force into place.

C. Corner Trim: Reinforce external vertical corners with specified 3/4-inch radius corner beads and horizontal external corners with 90º corner beads unless otherwise indicated or directed.

D. Edge Trim: Install square edged metal trim bead at exposed edges and boundaries of areas and where abutting dissimilar materials.

E. Other Trim: Install where required for complete and finished installation.

F. Mechanical and Electrical: Provide for penetrations.

G. Single Layer Systems: Install in accordance with ASTM C840

H. Space fasteners in gypsum boards in accordance with ASTM C 840 and manufacturer's recommendations, except where more stringent requirements

3.3 FINISHING

A. LEVEL 2 FINISH

As defined by the Gypsum Association GA 216-2010 .

1. Joints and interior angles: Tape embedded in joint compound with separate coats of joint compound applied over joints, angles, fastener heads and accessories. Tool joint compound smooth and free of tool marks and rides.
   a. Center reinforcing tape over joint and coat into compound leaving approximately
      1/64-inch to 1/3-inch under tape to provide proper bond
   b. Follow with skim coat to embed tape, but not to function as second coat
   c. Allow embedding coat to thoroughly dry prior to sanding.
2. After final sanding, wipe all drywall surfaces with damp sponge to remove dust and particles.
3. Leave areas finished uniformly smooth for subsequent smooth finish (paint, wall covering, or as indicated). No wall texturing is to be applied.

B. BEADS, TRIM, FASTENER AND JOINT DEPRESSIONS

1. Cover with one (1) coats of taping and joint compound to make true and level with adjacent surfaces.
2. Allow sufficient drying time.
3. Leave depressions flush with surface plane.

3.4 FIELD QUALITY CONTROL

A. Installer to be present at engineer's inspection of work.

B. Touch up as required and directed subsequent to finish application.

3.5 CLEAN UP

A. Clean beads, screeds, metal base, metal trim, mechanical and electrical items, and other work.

1. Wipe clean, leaving work ready for finish specified under other sections
2. As work is completed in each space, clean all rubbish, utensils, and surplus materials from the space. Leave floors broom-clean.

B. Leave installation clean and ready for work of Section 09900 – Painting

END OF SECTION

SECTION 09510 - ACOUSTICAL LAY-IN PANEL CEILINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

Section includes bevel edged lay-in acoustical ceiling panels installed in suspended exposed tee grid systems specified in Section 09120 – Acoustical Suspension Systems.

1.2 REFERENCES

ASTM C423	Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
ASTM E84	Test Method for Surface Burning Characteristics of Building Materials
ASTM E119	Method for Fire Tests of Building Construction and Materials
ASTM E413	Classification for Rating Sound Insulation
ASTM E1264	Classification for Acoustical Ceiling Products
CISCA	Acoustical Ceiling/Use and Practice (Published by Ceiling and Interior Systems Contractors Association - CISCA)
UL	Fire Resistance Directory and Building Material Directory
UL	Uniform Building Code (UBC) - 1997 Edition

1.3 SUBMITTALS

Submit in accordance with Section 09120, Paragraph 1.4 and Division 1.

1.4 QUALITY ASSURANCE

A. INSTALLER'S QUALIFICATIONS

1. Approved by manufacturer as qualified installer.
2. Able to show three (3) installations of similar type, size and scope.

1.5 REGULATORY REQUIREMENTS

Comply with local codes, ordinances, and other applicable regulatory requirements.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in original, unopened, protective packaging. Manufacturer's labels indicating brand name, pattern, size, and thickness must be attached and legible.

B. Store cartons and bundles at required temperature and humidity.

C. Do not begin installation until sufficient materials are received to complete the space.

1.7 PROJECT SITE CONDITIONS

A. Do not begin installation until gypsum board, concrete and other wet work is completely dry.

B. Install under standard occupancy conditions from 60º F to 85º F, at not more than 80-percent relative humidity in an enclosed building.

1.8 EXTRA STOCK

Acoustical ceiling panels: Furnish one case for each type, size and color installed. Deliver full case to project site, packaged for storage at project closeout.

1.9 WARRANTY

Manufacturer: Ten (10) year warranty against sag in spaces with relative humidity of up to 70-percent relative humidity and temperature from 65º F to 85ºF.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Armstrong World Industries
B. USG Interiors, Inc.

2.2 PRODUCTS

A. Basis of Design: Armstrong, Cortega, Item 769, panel size 24-inch by 24-inch by 5/8-inch

2.3 MATERIALS

A. ACOUSTICAL PANELS FOR NON-FIRE RATED ASSEMBLIES

1. Square edge regular lay-in acoustical panels for 9/16-inch exposed tee ceiling suspension system.
2. Basic compliance standard: ASTM E1264
   a. Type III - mineral base with paint finish.
   b. Form 2.
   c. Pattern designation C D - textured pattern.
   d. Wet-formed mineral fiber panels.
3. Panel edge detail: Square edge
4. Exposed surface color: White
5. Exposed surface finish: Factory-applied latex paint.
6. Flame spread: 0-25 (ASTM E 84), Class A rated (ASTM E 12640
7. NRC range: 0.55(ASTM C 423)
8. CAC range: 30-35 (ASTM E 413);
9. Accessories: As required to complete installation in accordance with manufacturer's instructions and as indicated.

PART 3 EXECUTION

3.1 EXAMINATION

A. Provide coordination prior to execution of work. Examine surfaces of evenness and regularity.
B. Note layout on reflected ceiling plan. Verify actual layout with the DISTRICT before proceeding with installation of acoustical panels into grid.

3.2 INSTALLATION OF LAY-IN ACOUSTIC PANELS

A. Install acoustical ceiling panels in accordance with contract documents, references, codes, and manufacturer's instructions. Where in conflict, follow more stringent requirements.
B. Provide continuously at entire ceiling areas designated for acoustical ceiling panels except for mechanical/electrical penetrations, or where other finishes or treatments are specifically indicated.
C. Fit units in place, free from damaged edges, soiled surfaces, and other defects to appearance and function.
D. Fit border units neatly against abutting surfaces.
E. Install level, in uniform plane, free from twist warp, and dents.
F. Cut in alarm heads, mechanical supply ducts and return grills and other ceiling appurtenances for neat, clean and finished appearance.

3.3 ADJUSTING AND REPLACEMENT

Damaged or improperly installed work: remove and replace.

3.4 CLEAN UP

A. Soiled, discolored materials: Clean or remove and replace.
B. Leave installation clean and premises free from residue and work of this section.

END OF SECTION

SECTION 09900 - PAINTING

PART 1 GENERAL

1.1 SECTION INCLUDES

The work under this section includes:

A. Section includes painting and finishing of exterior and interior exposed items and surfaces, unless otherwise indicated.

B. Preparation and painting of specific exterior building elements as indicated.

C. Preparation and painting of structural, mechanical, and electrical work in rooms and spaces, scheduled for painting.

See individual sections for requirements for shop and factory primed materials.

1.2 REFERENCES

Washington Council, P.D.C.A. Specification, Latest Edition.

Architectural Painting Specifications Manual (APSM), latest edition, published by MPI

SSPC Steel Structures Painting Council

ASTM: American Society for Testing and Materials

1.3 SUBMITTALS

A. Submit in accordance with Division 1.

B. PRODUCT DATA

Submit complete product data list.

1. Arrange in same format as scheduled in this section
2. Include manufacturer's publications, performance criteria, recommendations, and limitations.
3. Show conformance to specifications including ASM and SSPC requirements.
4. Include additional information requested by the DISTRICT.

C. SAMPLES

1. Color chips: Manufacturer's complete selection
2. Color samples: Size not less than 8-inches x 10-inches on heavy card stock.
   a. Show colors, selected by the DISTRICT, and gloss level specified in this section
   b. Furnish additional samples as required until colors, finishes, and textures are approved.
   c. Retain approved samples for reference.

D. Subcontractor's written qualifications: Furnish written qualifications attesting to past satisfactory experience. List last three (3) jobs. Include following information:
   1. Start and completion dates
   2. Project manager, telephone number

E. Moisture test results: Submit substrate-moisture content test results for approval prior to paint application.

1.4 FIELD CONTROL "SAMPLES":

1. Request review of first finished room, space, or item of each color scheme required as a sample of selected colors, finish, texture and workmanship; under illumination equal to that expected at occupancy.

2. For spray or roller application, paint surface of at least 100 sq.ft.

3. Consider approved "Samples" as the project standard.

1.5 QUALIFICATIONS

A. APPLICATOR

   1. Employ only qualified journeymen. Apprentices may be employed to work under direction of qualified journeymen, in accordance with trade regulations.
   2. Maintain full competent crew

B. Manufacturers and materials: Listed by ASM, except as otherwise scheduled. Use approved product numbers and finish system codes specified and listed by ASM for each manufacturer. Do not substitute without the DISTRICT's written approval.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver in unopened containers, bearing manufacturer's original labels. Show Product Name on label of containers identical with that used in Product Data list submitted as specified above.

B. Store in accordance with manufacturer's instructions and as required by governing codes and ordinances
   1. Store and mix material outside building

C. Toxic and explosive materials: Take appropriate safety precautions conforming to manufacturer's instructions, codes and ordinances, ASM, and other applicable industry standards.
   1. To prevent fire hazards and spontaneous combustion, place cotton waste, cloths, and other hazardous materials in containers.
   2. Daily remove from site.

1.7 PROJECT SITE CONDITIONS

A. Environmental requirements: Do no work under this section when surface or air temperatures are below 50º F or below manufacturer's recommended temperatures for conditions of installation.
Do not apply exterior paint in rainy weather.
Do not apply finish in areas where dust is being generated.

B. Ventilation: Verify adequate continuous ventilation as recommended/required by the manufacturer

C. Illumination: Temporary lighting to attain lighting level of 80 foot candles measured at mid-height at substrate surfaces.

D. Protect work of other trades. Correct painting related damage by cleaning, repairing or replacing and refinishing, as directed by the DISTRICT.

1.8 WARRANTY

Guarantee work of this section against ordinary wear and usage for two (2) years from date of substantial completion of the work

A. Warrant work to be in accordance with specifications, standards, and requirements incorporated in referenced ASM.

1.9 EXTRA STOCK

Leave a minimum of one (1) unused gallon of each type and color of paint and other coating products for maintenance purposes.

A. Label for positive identification with minimum 1/2-inch press type, tape over with clear tape, and include color number and name.

B. Store where directed.

C. Turn over to District at job site and obtain signed receipt.

D. Include MSDS (material safety data sheets) with each container of product to District.

1.10 COLOR SCHEDULE

Coordinate with the DISTRICT for color schedule of approved colors, textures, patterns, and other finishes for specified materials.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. AVAILABLE PRODUCTS

Subject to compliance with requirements, products that may be incorporated into the work include, but are not limited to, products listed in other Part 3 sections.

B. MANUFACTURER'S NAMES

Provide products from manufacturers included in the Architectural Painting Specification Manual and products as indicated in the Painting Schedule in Part 3.

2.2 PAINT MATERIALS – GENERAL

A. MATERIAL COMPATIBILITY

Provide primers and finish-coat materials that are compatible with one another and with the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

B. MATERIAL QUALITY

Provide manufacturer's best quality paint material of the various coating types specified that are factory formulated and recommended by manufacturer for application indicated. Paint material containers not displaying manufacturer's product identification will not be acceptable.

C. PERFORMANCE REQUIREMENTS

All paints used shall comply with Green Seal product standard with VOC limits as follows:

Paints	VOC Limit (Grams/Liter)
Interior Coatings:	
Non-Flat	150
Flat	50
Anti-corrosive and anti-rust paints applied to interior ferrous metal substrates:	250
Exterior Coatings:	
Non-Flat	200
Flat	100

D. PAINT COLORS:

1. A complete schedule of colors will be furnished by the DISTRICT.
2. Paint area of each color for observation, review and revisions before batch mixing of colors, or shipping large quantities of that color to job. Allow revisions to "Approved" colors and textures after review of initial area of each color.
3. Vary top coats in shade from preceding coat without affecting finish color.

PART 3 EXECUTION

3.1 EXAMINATION

A. Arrange for required lighting, temporary heat, and ventilation.

B. Conduct substrate-moisture content test using an approved electronic moisture meter. Assure that moisture content does not exceed limits indicated by ASM, Article 3.4, including the following;

1. Wood including boards, lumber and timber: 19-percent
2. Gypsum wallboard: 17-percent

3. Follow recommendations of paint manufacturer for allowable moisture for specific type surfaces. Submit results to the DISTRICT for approval prior to beginning work.

C. Examine surfaces scheduled to receive paint and finishes for conditions that will adversely affect execution, permanence or quality of work and which cannot be put into an acceptable condition through preparatory work as specified. Report unsatisfactory conditions to General Contractor for correction.

3.2 MATERIALS TO BE FINISHED

Finish all materials, except as specifically excluded or specified in other sections. See finish schedule for any rooms not required to be painted.

A. Mechanical and electrical items: Paint out conduit and other such items to match color of adjacent surfaces

3.3 PATCHING / TOUCH-UP

As work is completed in room areas, repair surfaces damaged by other trades and requiring touch-up or refinishing.

3.4 SURFACE PREPARATION:

A. Do not apply finishes until surfaces are dry and clean and in proper condition to receive finish.

B. In addition to painting specified, sand and patch prime coats specified under other Sections.

C. Perform preparation and cleaning procedures in accordance with coating manufacturer's instructions for each substrate condition.

D. Remove hardware and accessories, machined surfaces, plates, lighting fixtures and similar items in place and not to be finish-painted, or provide surface-applied protection. Reinstall removed items.

E. Seal wood required to be job finished. Prime edges, ends, face, undersides and backsides of counters, cases, cabinets, etc. Use spar varnish for backpriming where transparent finish is required.

1. Backprime interior paneling only where masonry, plaster, or other wet wall construction occurs on backside.
2. Seal tops, bottoms of wood doors with heavy coat of varnish type finish compatible with final finish immediately upon delivery to job.

3. Sand to smooth and even surface, then remove dust residue. Clean soiled surfaces, using alcohol wash where required.

4. Putty: Fill nail holes, cracks, open joints and other blemishes with putty compatible with finish system after priming coat has dried. Color putty to match finish.

F. Wallboard Materials:

1. Test plaster with one percent solution of phenolphthalein in alcohol for dryness and excess acid. Treat excess lime with zinc sulfate solution after observation.
2. Rake cracks, scratches and abrasions. Fill with thin layers of patching plaster or joint cement as appropriate.
3. Sand smooth; do not raise "nap" of paper on wallboard.

G. Ferrous Metal Surfaces:

1. Remove dirt and grease with mineral spirits.
2. Remove dust, mill scale, and defective paint down to sound surface using scraper, sandpaper or wire brush as necessary. Clean rusted surfaces down to bare metal.
3. Feather edges of sound paint by grinding.
4. Where large areas of bare metal are exposed prime with primer specified.

H. Galvanized Steel Surfaces:

1. Clean surface in accordance with ASTM D6386 to remove oily residue and provide surface profile. Dry with clean cloth.
2. Prime with Tnemec primer system recommended for this exposure.

I. For surface preparation of other materials not specifically noted, provide appropriate primers and cleaning agents recommended by paint manufacturer.

3.5 APPLICATION (EXTERIOR / INTERIOR)

A. Paint materials may be applied to fields of walls, ceilings and painted doors with rollers or airless spray equipment. Brush-paint other work except as specifically indicated. Lay off painted doors with roller of acceptable texture after application of paint.

1. Apply each coat evenly, without brush marks, skipped or missed areas; and without sags, runs or other blemish.

2. Where spray application is permitted, spray each coat without streaking, lapping or pile up of paint, and lay off with roller for light stippled surface.
3. Back-roll finish surface of fiber cement siding and trim if paint is spray applied.
4. Back-brush finish surface of exterior wood surfaces if paint or stain is spray applied.

B. Omit first coat (primer) on metal surfaces that have been shop-primed and touch-up painted. Apply prime coat to material which is required to be painted or finished, and which has not been prime coated by others.

C. Apply each material at not less than the manufacturer's recommended spreading rate, to provide a total dry film thickness of not less than 3.0 mils for the coating systems applied under this section.

D. Completed Work: Match approved samples for color, texture and coverage. Remove, refinish or repaint work not in compliance with specified requirements.

E. Observation of Surfaces:

1. Do not apply additional coats until completed coat has been reviewed by the DISTRICT.
2. Only observed coats of paint will be considered in determining number of coats applied.

F. Sand lightly between succeeding coats.

G. Finish door edges, tops and bottoms to match faces.

H. Refinish whole wall where portion of finish has been damaged or is not acceptable.

I. Make edges of paint adjoining other materials or colors clean and sharp without overlapping. Exercise care that paint does not lap or splatter onto surfaces scheduled to receive other finishes or which are not to be painted.

3.6 APPLICATION - SURFACE PRIMER

A. All areas shall receive an application of a surface primer.

B. Surface primers used shall be recommended by the topcoat manufacturer for exterior use.

C. Primers will be applied at the recommended wet film/dry film thickness, and at the appropriate time to observe the recoat window of minimum and maximum drying times before top coating. Do not apply the primer if rain is forecast within four (4) hours.

3.7 CONTINUOUS CLEAN UP

A. As work proceeds, and on completion of work promptly remove all spilled, splashed, or splattered products so as not to damage surfaces. Produce a satisfactory finish by painting or repainting as directed, surfaces from which paint spatters cannot satisfactorily be removed.

B. Keep premises free from any unnecessary accumulation of tools, equipment, surplus materials, and debris.

3.8 FIELD QUALITY CONTROL

Conform to referenced ASM standards for "Premium" material and work, unless otherwise indicated.

3.9 CLEAN UP

A. At conclusion of project, thoroughly clean paint and splatters from surfaces including adjacent surfaces. Take care not to scratch or otherwise damage surfaces. Verify chemical compatibility of cleaners to be applied to materials to be cleaned.

B. Leave premises net and clean; free from debris and residue from work of this section.

3.10 PAINTING SCHEDULE

A. Exterior Ferrous Metal Scheduled for Field Painting:

Surface Preparation:

Unprimed Steel: SSPC SP11 Power Tool Cleaning to Level SP-6

Primed Steel: Step One – SSPC-SP1 Solvent Cleaning

Step Two – SSPC SP3 Power Tool Cleaning of welds.

Galvanized Steel: Step One – SSPC SP1 Solvent Cleaning

Step Two – Abrade using 3M brown metal finish pad

1. Prime Coat: Tnemec Series 394

   One Coat at 2.5 to 3.5 mils dry film thickness.

2. First Coat: Tnemec Series 27 F.C. Typoxy, at 2.0 to 6.0 mils dry.

   Tinted half tone of finish coat

3. Second Coat: Tnemec Series 750 UVX, at 2.5 to 5.0 mils dry.

   Semi-Gloss Finish

   Colors: To Be Selected By the DISTRICT. Minimum two (2) colors.

4. Apply to:

   a. Bollards, framing and mounting hardware, and other miscellaneous metal work .

   b. Metal doors, frames and other Work of Section 08100.

   c. Paint all other exterior metalwork items as indicated.

   d. Work of this Article is not limited to the items listed above.

B. Gypsum Wall Board Surfaces:

   1. First coat: White pigmented Primer/Sealer compatible with finish products.

   2. Second & Third Coats: 100% acrylic paint, min. 12 lbs. acrylic/gal.; 43% solids; Tnemec Series 1029 or approved equal.

      Apply at 250 SF/gal. Semi-Gloss

      Colors: To Be Selected by the DISTRICT.

      Minimum (2) colors.

C. Interior Woodwork - Painted: Includes plywood wainscot, and other wood surfaces designated for paint.

   1. First Coat: Latex enamel undercoater.

   2. Second and Third Coats: Interior Latex Enamel; Semi-Gloss

      Colors: To Be Selected by the DISTRICT.

      Minimum (2) colors.

D. Interior Woodwork – Dry Fall Painted: Includes exposed wood trusses, decking.

   1. First Coat: Tnemec Series 115 Uni-Bond DF

   2. Second Coat: Tnemec Series 115 Uni-Bond DF

   3. Colors: To Be Selected by the DISTRICT.

      Minimum (1) color.

E. Interior Ferrous Metal:

   Surface Preparation:

   Unprimed Steel: SSPC SP11 Power Tool Cleaning to Level SP-6

   Primed Steel: Step One – SSPC-SP1 Solvent Cleaning

   Step Two – SSPC SP3 Power Tool Cleaning of welds.

   Galvanized Steel: Step One – SSPC SP1 Solvent Cleaning

   Step Two – Abrade using 3M brown metal finish pad

Prime Coat: Tnemec Series 394

One coat at 2.5 to 3.5 mils dry film thickness.

1. First Coat: Tnemec Series 115 Uni-Bond, at 2.0 to 4.0 mils dry.

   Tinted half tone of finish coat

2. Second Coat: Tnemec Series 1029 Enduratone, at 2.0 to 3.0 mils dry. Advanced acrylic finish coat; HDP acrylic polymer. Semi-Gloss Finish

   Colors: To Be Selected. Minimum two (2) colors

3. Work includes, but is not limited to the following:
   a. Interior metal doors and frames.
   c. Exposed wall grilles of Division15000.
   d. Exposed piping of Division 15000.
   e. Panels and other Work of Division16000.
   f. Apply also to other interior metal surfaces not scheduled for other finishes; work of this Article is not limited to the items listed above.

F. Fiber Cement Siding

All material shall be primed on all surfaces prior to installation.

1. Prime Coat: Fiber cement products shall be factory pre-primed with manufacturer's standard high quality primer.
2. First Coat: 100% Acrylic Flat Exterior Paint. Tinted half tone of finish coat.
3. Second Coat: 100% Acrylic Flat Exterior Paint.
4. Colors: To Be Selected by the DISTRICT. Minimum (2) colors.
5. Provide products from manufacturers included in the Architectural Painting Specification Manual (APSM) as recommended for materials being coated.

G. Exterior Wood Designated for Paint:

All material shall be primed on all surfaces prior to installation.

1. Prime Coat: Solvent based oil or oil/alkyd type primer. One Coat; dry film thickness per product manufacturer.
2. First Coat: 100% Acrylic Flat Exterior Paint. Tinted half tone of finish coat.
3. Second Coat: 100% Acrylic Flat Exterior Paint.
4. Colors: To Be Selected by the DISTRICT. Minimum (2) colors.

5. Provide products from manufacturers included in the Architectural Painting Specification Manual (APSM) as recommended for materials being coated.
6. Work includes, but is not limited to the following:
    a. Standing and running trim.
    b. Fascia and soffits.

END OF SECTION

SECTION 10200 – LOUVERS AND VENTS

PART 1 GENERAL

1.1 SUMMARY

A. Work of this Section includes exterior louvers and vents as indicated in drawings with related items for their support. Provide all accessories as needed for complete installation.

B. Refer to mechanical drawings and specifications for additional information and coordination.

1.2 SUBMITTALS

A. Submit Product Data in accordance with Division 1, including anchor details and installation instructions. Show fabrication methods and identify finishing products.

B. Submit Shop Drawings in accordance with Division 1 for assemblies that are not completely shown by Product Data.

1.3 QUALITY ASSURANCE

A. Comply with SMACNA (Sheet Metal and Air Conditioning Contractor's National Association) "Architectural Sheet Metal" recommendations for fabrication, construction details, and installation procedures, except where more stringent requirements are indicated.

B. Verify size, location, and placement of louver units prior to fabrication, wherever possible. Coordinate field measurements and shop drawings with fabrication and shop assembly to minimize field adjustments and splicing.

C. Minimum free area: 50 percent.

Provide solid "blank" panel backing at units where indicated.

PART 2 PRODUCTS

2.1 MATERIALS

A. Extruded Aluminum: Alloy 6063-T5.

B. Fastenings: Use same material as items fabricated, or stainless steel. Provide types, gages, and lengths to suit installation conditions. Use socket flathead machine screws for exposed fasteners, not pop rivets.

C. Anchors and Inserts: Use non-ferrous metal anchors and inserts for exterior installations and elsewhere as required for corrosion resistance.

2.2 FORMED SHEET METAL LOUVERS:

A. Acceptable Manufacturers;

Basis of Design: Ruskin ELF-15J Thin Line Stationary Louver; Extruded Aluminum; Standard Construction.

Subject to compliance with requirements, products of one of the following manufacturers may be used: AiroLite, Construction Specialties, Carnes, Potorff, or Cesco

B. Other Manufacturers: Submit Substitution Request, conforming to requirements of Division 1.

C. Fabrication: Provide louvers and accessories of design, materials, sizes, depths, arrangements and metal thicknesses indicated, or thicker metal as required for performance and use intended.

1. Fabricate frames, including sills, to suit adjacent construction and to provide continuous uninterrupted horizontal lines. Where needed, provide concealed mullions at spacing recommended by manufacturer.
2. Factory assembly louver components. Join frame members to one another and to blades by all welded construction.

D. Stationary Wall Louvers: Provide horizontal blade louvers; maximum spacing 2-inch; slope 45 degrees; with 6063T5 extruded aluminum not less than 0.063 inches wall thickness. Louver depth: 1.5” minimum.

E. Performance Data: Minimum 50 percent free area based on 48 inch x 48 inch size unit in accordance with AMCA 500.

2.3. FACTORY FINISH

A. Provide Kynar 500 Fluoropolymer Coating. Conform to AAMA 605.2.

B. Apply coating following cleaning and pretreatment.
Cleaning: AA-C12C42R1X. Dry louvers before final finish application.
Total Dry Film Thickness: Approximately 1.2 mils (0.03mm) when baked at 450 degrees F for 10 minutes.

C. Color to be selected from manufacturer's standard colors. Meet or exceed AAMA2605-02. Provide manufacturer's 20-year warranty on colors.

2.4. LOUVER SCREENS

A. Provide removable screens for all exterior louvers; 5/8"x.040 (16x1) expanded, flattened aluminum wire in removable frame.

B. Fabricate screen frames of the same metal type, gage, and finish as the louver units to which secured. Provide frames consisting of U-shaped metal for permanently securing screen mesh.

C. Locate screens on inside face of louvers. Secure screens to louver frames with machine screws, spaced at each corner, and 12 inch o.c. between.

PART 3 EXECUTION

3.1 INSTALLATION

A. Locate and place louver units plumb, level and in proper alignment with adjacent work in accordance with manufacturer's instructions.

B. Use concealed anchorages wherever possible. Provide washers fitted to screws where required to protect metal surfaces and to make a weather-tight connection.

C. Form tight joints with exposed connections accurately fit together. Provide reveals and openings for sealants and joint fillers, as shown.

D. Repair finishes damaged by cutting, welding, soldering, and grinding operations required for fitting and jointing. Restore finishes so that there is no evidence of corrective work. Return items that cannot be refinished in the field to the shop, make the required alterations, and refinish the entire unit.

E. Provide concealed gaskets, flashing and joint fillers. Install as the work progresses to make the installations weather-tight.

F. Isolate dissimilar materials to prevent the possibility of corrosive or electrolytic action.

G. Coordinate installation with mechanical systems and provide for connections to ducts, dampers, and associated hardware as needed for complete installation.

3.2 CLEANING

A. Clean louver surfaces in accordance with manufacturer's instructions.

B. Repair minor damage to surfaces as directed by the DISTRICT. Replace units that cannot be repaired and replaced to original factory condition.

END OF SECTION

SECTION 10522 - FIRE EXTINGUISHERS

PART 1 GENERAL

1.1 SECTION INCLUDES

This section includes fire extinguishers and mounting brackets as indicated in drawings and as required by local fire authorities.

1.2 SUBMITTALS

Submit Product Data in accordance with Division 1.

A. Product data for fire extinguishers.
B. Details showing mounting methods

1.3 QUALITY ASSURANCE

A. UL Listed Products: Provide portable fire extinguishers which are UL Listed and bear UL "Listing Mark" for type, rating, and classification of extinguishers indicated.
B. Coordination: Verify type and capacity of extinguishers indicated.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include, but are not limited to, the following:

1. J.L Industries
2. Larson's Manufacturing Co.
3. Amerex

or approved equal.

2.2 FIRE EXTINGUISHERS

A. GENERAL

Provide fire extinguishers for locations, to be determined, that comply with authorities having jurisdiction.

B. MULTIPURPOSE DRY CHEMICAL FIRE EXTINGUISHERS

1. Multi-Purpose dry chemical type, UL rated, in enameled steel container with pressure-indicating gage, for Classes A, B, and C fires.

   J.L. Cosmic 5E 3A:40BC

   Quantity: Two (2)

2. Plastic and aluminum valve bodies are not acceptable.

3. Provide manufacturer's standard mounting brackets where needed for secure mounting.

   Quantity mounting brackets: Two (2)

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine walls for thickness and framing for proper mounting prior to cabinet installation.
B. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Follow manufacturer’s printed instructions for installation.

B. Install in locations and at mounting heights indicated or, if not indicated, at heights to comply with applicable regulations of governing authorities.

   1. Prepare walls for mounting with blocking as needed by type and size of bracket to comply with manufacturer’s instructions.
   2. Fasten mounting brackets, square and plumb.

END OF SECTION

SECTION 10719 – FLOOD BARRIERS

PART 1 GENERAL

1.1 SECTION INCLUDES

This section includes flood barriers factory assembled with frames and hardware in accordance with the contract documents.

1.2 STANDARDS

A. Comply with the provisions of the following, as applicable:

1. AWS Structural Welding Code.
2. ASME Structural Welding Code Section IX.
3. Presray Corporation QA Program

1.3 SUBMITTALS

A. Manufacturers Data: Submit installation and maintenance instructions for flood barriers.

B. Shop Drawings: Submit shop drawings for flood barriers including dimensioned plans and elevations, sections, connections and anchorage, and parts list.

C. Calculations: Submit calculations, approved by a qualified engineer, to verify the barrier's ability to withstand the design pressure loading.

1.4 WARRANTY

A. 1-year limited against defects and workmanship from date of shipment

PART 2 PRODUCTS

2.1 MANUFACTURER

A. Presray Corporation Critical Containment Solutions, P.O. Box 200, Wassiac, NY 12592 Phone 845-373-3900 www.presray.com
Email: technicalsupport@presray.com

2.2 FLOOD BARRIER

Flood barrier shall be Model CG11FS as manufactured by Presray Corporation

2.3 MATERIALS

A. Panel: 6061 –T6 aluminum plate.

B. Conversion Frame: Low carbon steel.

C. Finish: Panel, bright aluminum finish. Conversion frame, brush-off blast clean per SSPC-SP7, primed with one coat rust inhibitive, lead free, red primer.

D. Gasket: Presray type 25 durometer neoprene molded rather than extruded, with fully molded corners, no mitered joints allowed.

E. Hardware:

Attachment bolts: Presray type FS

Grab Handles: Welded lift attachments on top edge and/or face or panel for ease handling.

2.4 DESIGN

A. Flood barriers shall be designed with a minimum 2:1 factor of safety based on material yield strength, and shall provide an effective seal against the design flood level.

B. Frame shall have mounting holes for expansion anchors and bolts.

2.5 INSPECTION AND TEST

A. All welds on steel assemblies that may be potential “leak path” shall be liquid penetrant inspected in accordance with ASME section VIII Div. of Appendix 8.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install flood barriers in accordance with manufacturer’s instructions and approved shop drawings.

END OF SECTION

Section No.	Section Name	No. of Pages
15010	Common Work Results for Mechanical	18
15090	Hangers and Supports	7
15250	Insulation	6
15421	Condensate Piping	5
15509	Clean-Agent Fire-Extinguishing Systems	8
15810	Split-System Heat Pumps	7
15811	Split-System Heat Pumps Wall Mount	5
15840	HVAC Ducts and Casings	7
15860	Duct Accessories	7
15870	Air Outlets And Inlets	3
15900	Electric and Electronic Control System	7
15905	Sequence of Operation	3
15950	Testing, Adjusting, Balancing	5
15995	Commissioning	2

SECTION 15010 – COMMON WORK RESULTS FOR MECHANICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 0 and Division 1 Specification Sections, apply to this Section.

1.2 WORK INCLUDED

A. General Mechanical HVAC Requirements.

B. Mechanical HVAC Submittals.

C. Equipment Identification.

1.3 GENERAL REQUIREMENTS

A. Scope: Furnish all labor, materials, tools, equipment, and services for all mechanical work as specified in Division 15 and as shown on the drawings. This section applies to all Division 15 specifications and to all project mechanical work. All mechanical equipment and devices furnished or installed under other Divisions of this specification (or by the DISTRICT) which require connection to any mechanical systems (i.e. hydronic systems, duct systems, etc.) shall be connected under this division of the Specifications.

B. General: All work shall conform with the General Conditions, Supplementary Conditions, and all other provisions of the Contract Documents.

C. Complete Systems: Furnish and install all materials, appurtenances, devices, and miscellaneous items not specifically mentioned herein or noted on the drawings, but which are necessary to make a complete working installation of all mechanical systems. Not all accessories or devices are shown or specified that are necessary to form complete and functional systems.

D. Review and Coordination: To eliminate all possible errors and interferences, thoroughly examine all the Drawings and Specifications before work is started, and consult and coordinate with each of the various trades regarding the work. Such coordination shall begin prior to any work starting, and continue throughout the project.

E. Conflicts: Where conflicts occur, the most expensive and stringent requirement (as judged by the Architect/Engineer) shall prevail. Notify the DISTRICT of any discrepancies or conflicts before proceeding with any work or the purchasing of any materials for the area(s) of conflict until requesting and obtaining written instructions from the DISTRICT on how

to proceed. Any work done after discovery of such discrepancies or conflicts and prior to obtaining the DISTRICT's instructions on how to proceed, shall be done at the Contractor's expense, including any necessary work to comply with the resolution determined by the DISTRICT.

F. Field Conditions:

1. Check field conditions and verify all measurements and relationships indicated on the drawings before proceeding with any work.

2. In verifying existing conditions, the Contractor shall verify by direct physical inspection, complete tracing out of systems, by applying test pressures, by excavation and inspection, use of pipeline cameras, and other suitable absolute certain methods to confirm the actual physical conditions that exist.

G. Drawings and Specifications: Drawings and specifications are complementary and what is called for in either is binding as if called for in both.

H. Offsets/Fittings: The drawings are diagrammatic and show the general arrangement of the construction and therefore do not show all offsets, fittings and accessories which are required to form a complete and operating installation. Include in bid all necessary fittings, offsets, and transitions to completely connect all systems, maintain clear access paths, and comply with all project requirements. Contractor is responsible to determine the quantity of offsets and fittings required, and the labor involved. No added payments or "extras" will be granted for the Contractor's failure to correctly estimate number of offsets, fittings, transitions and labor required. Contractor is advised that transitions are required at connections to all equipment, to all air inlets/outlets, crossing of beam lines, at crossing with piping, and similar locations.

I. Locations: Unless dimensioned locations for mechanical items are shown, select the precise location of the item in accordance with the Contract Documents and subject to the DISTRICT's review. No allowances will be granted for failure to obtain the DISTRICT's review.

J. Design: The level of design presented in the documents represents the extent of the design being furnished to the Contractor; any additional design needed shall be provided by the Contractor. All design by the Contractor shall be performed by individuals skilled and experienced in such work, and where required by local code (or elsewhere in the documents) shall be performed by engineers licensed in the State where the project is located. The Contractor shall include in his bid the costs of all such added design including engineering, drafting, coordination, and all related activities and work. Such designs services are required for many building systems; including but not limited to fire sprinkler systems, control systems, hanger/support systems, temporary duct/piping systems, system offset/adjustments to suit structure, and for methods/means of accomplishing the work.

K. Experience: All work shall be performed by individuals experienced and knowledgeable in the work they are performing, and experienced with the same type of systems and building type as this project. By virtue of submitting a bid, the Contractor is acknowledging that workers to be utilized on this project have such experience and knowledge. Upon request of the Engineer, the Contractor shall submit resumes showing the work history, training, and types of projects worked on, for all individuals assigned to this project.

L. Standards and References: Shall be latest edition unless a specific edition, year, or version is cited.

M. Permits and Fees:

1. The Contractor shall obtain and pay for all permits, licenses, fees and inspections as required by the Code and as specified herein (unless noted otherwise in the Contract Documents).

2. Fees which this Contractor shall pay include all charges made by any utility company or municipality for material, labor or services incident to the connection of service (unless noted otherwise in the Contract Documents).

1.4 DEFINITIONS

A. "Provide," except to the extent further defined, means to "furnish and install, complete and ready for the intended use."

B. "Governing Codes" and “Code” means "the applicable provisions of all codes, ordinances, and standards including but not limited to:

Washington State Energy Code

Uniform Plumbing Code
International Mechanical Code
International Fire Code
International Building Code
NFPA Codes and Standards
Washington State Electrical Code
National Electric Code
State Public Health Department Regulations
ASME Code for Pressure Piping
ASME Pressure Vessel Code
ASME Unfired Pressure Vessel Code
Safety Code for Mechanical Refrigeration
Washington State General Safety and Health Standards
Washington State Boiler Code
and all local amendments to these."
The edition as adapted by the authority having jurisdiction shall prevail. In case of conflict the most stringent edition and code shall prevail.

C. "Finished Areas" means "areas receiving a finish coat of paint on one or more wall surface."

D. "As indicated" means "as shown on the drawings and described in the specifications."

E. "Concealed" means "hidden from view" as determined when areas are in their final finished condition, from the point of view of a person located in the finished area. Items located in areas above suspended ceilings, in plumbing chases, and in similar areas are considered "concealed." Items located in cabinet spaces (e.g. below sinks) are not considered concealed.

F. "As required" means "as necessary to form a safe, neat, and complete working installation (or product), fulfilling all the requirements of the specifications and drawings and in compliance with all governing codes."

G. "Furnish," except as otherwise defined in greater detail, means "supply and deliver to the project site, ready for unpacking, assembly and installation."

H. "Approved" and "or approved," as used in reference to a product or manufacturer, means "as judged satisfactory and acceptable by the Architect/Engineer within the limitations of the Architect/Engineer's responsibilities." Where used in conjunction with the Architect/Engineer's response to submittals, requests, applications, inquiries, reports, and claims by the Contractor, the meaning of the term will be held to the limitations of the Architect/Engineer's responsibilities and duties as specified in the General Conditions. In no case will "approval" by the Architect/Engineer be interpreted as an assurance to the Contractor that the requirements of the Contract Documents have been fulfilled.

I. "Approved equal" means "or approved."

J. "Equal" means "or approved."

K. The term "work included" (as used at the beginning of each specification section), and the items listed with it, is only an indication of some of the items specified in that section and is in no way limiting the work of that Section. See complete drawings and specifications for all required work.

L. "Verify" means "Contractor shall obtain, by a means independent of the the DISTRICT, the information noted and the information needed to properly perform the work". Where used as "verify existing" in reference to existing piping or duct systems, the "verify" definition shall include "Confirm by positive means independent of any actual field labeling on the existing piping systems and independent of the Architect/ Engineer and The DISTRICT what the existing piping (or duct) system contains, what the flow direction is, what normal pressures/temperatures are and what other systems and areas the piping (or duct) is interconnected to, all to insure that proper connections are made (and other work performed) on the system." Such independent means shall include methods such as: the use of exterior pressurized sources to pressurize piping system lines, use of flow tests with dyes, physical tracing of piping and all connections to, electronic detection methods, electronic/electric line tracing, physical

disassembling of system, excavation or uncovering of concealed systems, use of insertion cameras and similar efforts.

M. "Coordinate" means "to accomplish the work with all others that are involved in the work by: directly discussing the work with them, arranging and participating in special meetings with them to discuss and plan the work being done by each, obtaining and completing any necessary forms and documentation required, reaching agreement on how parts of the work performed by each trade will be installed relative to each other both in physical location and in time sequence, exchanging all necessary information so as to allow the work to be accomplished with a united effort in accordance with the project requirements".

N. Abbreviations: See Division 1 and the drawings.

1.5 QUALITY ASSURANCE:

A. Code: All work shall be done in accordance with all applicable codes and ordinances. Throughout the Project Documents, items are shown or specified in excess of code requirements; in all such cases, the work shall be done so that code requirements are exceeded as indicated.

B. Code Knowledge: Contractor and workers assigned to this project shall be familiar and knowledgeable of all applicable codes and ordinances. By submitting a bid, the Contractor is acknowledging he and the workers to be utilized on this project have such knowledge.

C. Proof of Code Compliance: On completion of the work, satisfactory evidence shall be furnished to show that all work has been installed in accordance with all codes and that all inspections required have been successfully passed. Satisfactory evidence includes signed inspections by the local code authority, test lab results, qualified and witnessed field tests, and related acceptance certificates by local code authorities, and field notes by the Contractor as to when all inspections and tests occurred.

D. ASME: All pressure vessels, safety devices, and appurtenances shall comply with the standards of, and bear the stamp of ASME.

E. Electrical: All electrical devices and wiring and equipment shall comply with standards of NEC and Division 26 specifications. All electrical devices shall be UL (or other approved agency) listed and so identified.

F. Quality Assurance Checks: Prior to ordering items or materials, confirm the following for each:

1. General: Item is suitable for the intended purpose and complies with the Contract Documents.
2. Manufacturer: Item’s manufacturer is listed as an acceptable manufacturer in the Contract Document’s or a substitution request (where allowed) has been submitted and the manufacturer has been listed as acceptable.
3. Electrical (for items requiring electrical power):

a. Item is for use with the voltage/phase as indicated on the electrical plans (or for the electrical circuit the item will be connected to).

b. Item's ampacity requirements (MCA) do not exceed that indicated on the electrical plans (or for the electrical circuit the item will be connected to).

4. Weight: Item's weight is no greater than that indicated on the plans.

5. Adequate Space: Item will fit in the space available, and along the path available to install the item.

6. Installation: A suitable method for installing the items has been selected which meets the project schedule and other requirements.

7. Lead Time: The item's fabrication, shipping, and delivery period meets the project schedule requirements.

1.6 SUBMITTALS

A. Submittals shall comply with the Division 1 Specification Section entitled "Submittals."

B. Prior Approval-Product Information: All products to be used in this project must first have their product information submitted to the Architect/Engineer for review and approval before they may be ordered. The purpose of the submittal process is to allow the DISTRICT an opportunity to make revisions in products. Any item that the Contractor orders or installs, prior to making a proper submittal and having it approved, violates the Contract requirements, and is done at the Contractor's own risk.

C. Variations: Only variations that are specifically noted on submittals will be considered. Variations shall be noted by being submitted on 8-1/2" x 11" paper, with 1/4" high lettering clearly describing what the proposed variation is, who is proposing it, why it is being proposed, any cost changes associated with the variation, the date, and related data to clearly identify the project and to which item(s) the variation pertains. Failure to submit information on the variation in this way will result in the review being conducted without considering the variation.

D. By submitting an item for review, the Contractor is claiming that all "Quality Assurance Checks" have been performed and satisfactorily passed.

E. Product Information Required: The following information is required for each item and is defined as making up the product submittal for that item. Failure to submit the required information may result in the rejection of the submittals and submitted item.

1. Manufacturer's catalog information, containing product description, model number, and illustrations. Mark clearly to identify pertinent information and exact model and configuration being submitted.

2. List of accessories and options provided with product.
3. Product dimensions and clearances required.
4. Product weight.
5. Product name and symbol as shown on the drawings or written in the specifications.
6. Performance Data: Provide performance capacity and characteristics showing compliance with the capacity listed in the equipment schedules and specified.
7. Manufacturer's and nearest sales representatives names, 7addresses, and phone numbers.
8. For equipment requiring piping or plumbing connections:
   (1) Type of connections required.
   (2) Size and locations of connections.
9. For electrically operated equipment:
   (1) Number and locations of electrical service connections required.
   (2) Voltage required.
   (3) Fuse or circuit breaker protection requirements.
   (4) Motor starter requirements; if motor starter is furnished with the equipment, submit product information on motor starter.
10. Manufacturer's installation instructions and recommendations. Installation of the item will not be allowed to proceed until this information is received. Failure to furnish this information is cause for rejection of the material.
11. See each specification section for other submittal requirements.

F. Shop drawings shall be provided for the following systems:
   a. HVAC Controls.
   b. For any parts of any system which are to be installed differently than as shown on the drawings.
   c. Other areas/work as noted in documents.

G. See individual specification section for any specific submittal requirements.

1.7 RECORD DATA

A. Field Record Drawings: The Contractor shall maintain a set of full size contract plans at the project site upon which all changes from the as-bid plans are noted. These plans shall also include actual locations (with dimensions) of all underground and concealed mechanical systems.

Connection points to outside utilities shall be located by field measurements and so noted on these record drawings. All addenda, change order, field orders, design clarifications, request for information, and all other clarifications and revisions to the plans shall also be made a part of these record drawings. Plans shall be available for weekly review by the Architect/Engineer. Label drawing “As-Builts” with date, name of Contractor, and name of individual overseeing the work.

B. Final Record Drawings Submittals: Deliver to the Architect/Engineer the original “Field Record” drawings at project substantial completion.

1.9 SPECIAL TOOLS

A. At completion of project this Contractor shall furnish to the DISTRICT one complete set of any and all special tools such as odd size wrenches, keys, etc. (allen wrenches are considered odd), which are necessary to gain access to, service, or adjust any piece of equipment installed under this contract. Each tool shall be marked or tagged to identify its use.

1.10 PROJECT CLOSEOUT

A. Closeout Submittals: The following items must be presented to the DISTRICT prior to final acceptance of the building. Final payment of the Contract will be contingent upon receiving these documents. See Division 1 requirements also.

1. Balancing Report.
2. Field record drawings.
3. Operation & Maintenance Manuals.
4. Guarantees (including one-year)
5. Special Tools.
6. Spare Parts (see individual specification sections).
7. Proof of compliance with governing codes (copy of signed off permits or letter).
8. Extra sets of filters.
9. Equipment Start-up Reports (see equipment specification sections).

B. Completion Reviews and Punchlists: The Architect/Engineer responsible for review of the Division 15 work will provide one substantial completion review to determine whether the work (or designated portion thereof) is substantially complete, and develop a list (punchlist) of those items that are not done. After completing these punchlist items, the Contractor shall submit to the DISTRICT a copy of the punchlist, with each item initialed by the General Contractor and by the Foreman (or Superintendent) of the trade responsible for the work. Every item shall be addressed as corrected, or as being otherwise resolved with the DISTRICT. After receipt and agreement with this initialed list, the DISTRICT will make one

final completion review to determine if the work (or designated portion thereof) is fully complete.

1.11 PRODUCT HANDLING AND PROTECTION

A. Protection:

1. Protect all material, equipment and apparatus provided under this section from damage, water, corrosion, freezing and dust, both in storage and when installed, until final project acceptance.
2. Protect premises and work of other divisions from damage arising out of installation of work of this division.
3. Completely cover motors, control panels, equipment, machinery and similar items to protect from dirt and water during construction.

B. Provide temporary heated and sheltered storage facilities for material and equipment.

C. Condensation: Provide adequate venting arrangements for all protected items to avoid condensation damage.

D. Openings: Cap all openings in pipe and ductwork to protect against entry of foreign matter until all work that has dust or fumes associated with it is complete. Caps shall be of sufficient strength and seal integrity to prevent entry of water if sprayed direct with a hose, and to prevent entry of general fumes.

E. Equipment Storage Maintenance: Equipment requiring rotation, lubrication, or other maintenance or inspection during storage shall have records maintained and witnessed on a monthly basis and forwarded to the Architect/Engineer prior to acceptance.

F. Improper Storage/Protection: Material, equipment, or apparatus damaged because of improper storage or protection will be rejected.

G. Paint Finishes: Painting finishes that are damaged by handling, storage, etc. shall be corrected by the Contractor, at no additional cost to the DISTRICT. Painting shall comply with Division 09 and manufacturer's requirements.

1.12 JOB CONDITIONS

A. Special Requirements:

1. Maintain emergency and service entrance usable to pedestrian and vehicle traffic at all times. Where trenches are cut, provide adequate bridging for traffic.
2. Coordinate startup and shutdown of water, waste, heating systems, and other utilities with all other trades and the DISTRICT's representative.
3. The Contractor shall coordinate all construction activities with the DISTRICT's Representative and cooperate fully so as to minimize conflicts and to facilitate the DISTRICT usage of the premises during construction.
4. Provide temporary utility services to occupied areas to accommodate t's use during construction. All temporary work shall comply with same specifications as for new work and be of same quality.

B. Downtime Restrictions:

1. Contractor shall notify the the DISTRICT at least 72 hours in advance of any intended shut-down of electric power, domestic hot water, or heating services.
2. Electrical power to the building shall not be interrupted at any one time for more than 15 minutes.

C. Schedule of Work: Arrange work to comply with schedule of construction, and so as not to violate the downtime restrictions, and to accommodate the The DISTRICT's schedule use of the premises during construction.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Any reference in the Specifications or on the Drawings to any article, device, product, material, fixture, form or type of construction by manufacturer, name, make, model number, or catalog number shall be interpreted as establishing a standard of quality and shall not be construed as limiting competition.

B. The manufacturers listed as Acceptable Manufacturers are approved to bid the project for the items indicated without obtaining prior approval.

C. Other manufacturers desiring to bid the project require prior approval. See Paragraph entitled “Substitutions” this specification section for requirements.

D. The listing of a manufacturer as an Acceptable Manufacturer does not necessarily mean that the products of that manufacturer are equal to those specified. The listing is only an indication of those manufacturers which may be capable of manufacturing, or have in the past

manufactured, items equal to those specified. The Architect/Engineer shall be the final judge as to whether an item is equal to that specified.

E. Products provided by Acceptable Manufacturers shall be equal to or superior to the specified manufacturer's item in function, appearance, and quality, and shall fulfill all requirements of the plans and specifications. The DISTRICT shall be the final judge as to whether an item meets these requirements or not. If a manufacturer is not certain that his product meets these requirements or not then the manufacturer shall submit data as required in Paragraph entitled “Substitutions” this specification section, to obtain the Architect/Engineer’s approval prior to bid opening.

F. The approval of a manufacturer applies to the Manufacturer only and does not relieve the Contractor from the responsibility of meeting all applicable requirements of the plans and specifications.

G. Contractor shall be responsible for all costs to other trades and all revisions required to accommodate any products which are different than those specified or shown.

H. In reviewing a manufacturer for acceptance, factors considered include the following: engineering data showing item's performance, proper local representation of manufacturer, likelihood of future manufacturer's local support of product, service availability, previous installation, previous use by The DISTRICT/Engineer/Architect, product quality, availability/quality of maintenance and operation data, capacity/performance compared to specified items, acoustics, items geometry and access, utility needs, and similar concerns.

2.2 PRODUCTS--GENERAL

A. Standard Products: Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacture of such products which are of a similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for two years prior to bid opening. The two year use shall include applications of equipment and materials under similar circumstances and of similar size. The two years’ experience must be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures. Except that equipment changes made solely to satisfy code requirements or to improve unit efficiency are not required to have two year prior operation.

B. Service Support: Qualified permanent service organizations for support of the equipment shall be located reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

C. Manufacturer's Nameplate: For each item of equipment, provide a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place. The nameplate of the distributing agent will not be acceptable. Nameplates

for equipment, and other items listed in IMC shall provide added information as required by the IMC.

D. Compatibility: All components and materials used shall be compatible to the conditions and materials the items will be exposed to. All items exposed to the weather shall be galvanized, or be of stainless steel or similar corrosion resistant material.

E. Nameplates/Labels/Legends: Where nameplates or labels are required, these shall have minimum of 1/8-inch high (unless indicated otherwise) lettering, engraved on laminated plastic. Laminated plastic shall have black surface layer and white (unless other color indicated) sub-layer, with engraving through to expose white sub-layer. Prior to making a list and applying labels, the Contractor shall submit a list of all proposed labels.

F. Non-Specified Items: Materials shown on the drawings but not specified shall be provided as shown and as required to suit the application illustrated and intended and shall be of commercial quality, consistent with the quality of similar type items provided on the project. Not all items shown on the drawings necessarily have a corresponding specification; such items shall be provided per this paragraph and so as to provide complete, finished, fully functioning mechanical systems.

G. Warranty: Equipment shall be warranted by the manufacturer to be free from all manufacturing defects and capable of providing satisfactory operation for a period of one year (or longer, where indicated so) after the date of project acceptance. The Contractor shall include in his bid all costs associated with this warranty to insure that the warranty extends to one year after the date of project acceptance. Possible project delays and failure by others to complete their work may cause the date of project acceptance to be substantially delayed. The Contractor shall be responsible for increasing the warranty dates by corresponding amounts to still provide one year warranties.

H. Weights: Unit weights shall not exceed the weights shown unless the Contractor provides added structural supports as required by the Engineer. The Contractor shall bear all costs for all redesign and added supports to accommodate heavier equipment. The Contractor shall reimburse the Engineer for all time associated with all review and analyses regarding the use of equipment heavier than that indicated.

I. Temperature/Pressure Rating: All materials and components furnished shall be suitable for the temperature and pressures they will be exposed to. Contractor shall consider possible operating modes to insure proper material ratings. Consideration shall include such factors as high temperatures caused by heat transfer from piping, coils, etc. when fans are shut down (e.g., motors, control devices, etc. installed within air handling units or mechanical rooms shall be rated for high temperatures due to such heat gain).

J. Standardization: All like products shall be by the same manufacturer and have the same characteristics and features to allow for The DISTRICT's standardization.

K. Model Numbers: Any reference to a manufacturer's "model number" is a reference to a manufacturer's series number or type of product, and it not a complete "model number", and does not indicate all features, accessories, and options that are required. These series numbers are only meant to convey a type of product that may meet the project requirements. Where conflicts of discrepancies occur regarding current manufacturer's series numbers versus series numbers specified in these documents, the features/accessories/options as shown in current catalogs in the Engineers office corresponding to the specified series number shall prevail. Such catalogs are available for review. Where conflicts or discrepancies occur regarding a listed manufacturer's series or "model" and a specified capacity or feature, the more stringent and expensive shall prevail.

L. Special Products: Numerous products specified for this project are custom products, or require special and unique construction, and special and unique features. Such special items may include: Finishes, controls, UL (or other independent testing lab) listing specialized for the custom one of a kind equipment specified, construction, configuration, capacities, accessories, spare parts, warranty, testing, flow rates, application, installation, delivery date, cleaning, etc. Include in bid all costs to provide items meeting all project requirements. Products may reference a manufacturer's series number, but are still special and custom, with the series number identifying only a reference point for the unit manufacturer. The series number is not to be construed as limiting the features or capabilities of the item. Contractor shall review all requirements and all vender quotes to ensure all requirements are being met and to include all costs in bid. No added cost will be paid for failure to include in bid all costs necessary to provide the special, unique, and custom items required.

M. Substitutions: All substitutions shall have the approval of the Architect/Engineer prior to being used. Provide information required by the applicable Division 1 Specification Sections.

2.3 ELECTRICAL

A. All electrical work, conduit, boxes and devices in connection with control wiring as required to install the control equipment as specified herein or shown on the drawings shall be furnished and installed complete by the Division 15 Contractor.

B. All electrical work performed under this section of the Specifications shall conform to all applicable portions of the Division 16 specifications and shall conform to all governing codes.

C. All starting switches and disconnect switches provided by this Contractor shall be labeled to identify the equipment served and usage. Such labeling shall match that specified in Division 16.

D. All equipment shall be factory wired to a junction box for connection of electrical service.

2.4 PRODUCT LISTINGS

A. General: Any piece of equipment used in this project and hereinafter specified which requires electrical hook-up, such as fans, pumps, hot water tanks, boosters, air handling equipment, etc. shall be provided with an approved label from an agency acceptable to the authority having jurisdiction. Such listing is not required where the authority having jurisdiction does not require it.

B. Complete Assembly: Approval of agency shall be for the complete assembly (approval of individual components not acceptable) and all labels must be located outside of equipment and shall be visible to inspector.

C. Responsibility: It shall be the responsibility of the mechanical contractor or the equipment supplier to meet the requirements of this Section. All agency costs to provide appropriate label for a piece of equipment shall be included in the bid.

2.5 EQUIPMENT IDENTIFICATION

A. General: All mechanical equipment shall be marked. All markings in concealed accessible spaces shall be reviewed and verified by Architect/Engineer prior to being concealed.

B. All mechanical equipment which was scheduled on the Contract Drawings shall be marked with the name of the item; i.e., Heating Ventilating Unit No. 1, Exhaust Fan No. 2, Boiler No. 1 etc. The identification shall be the same as shown on the Contract Drawings. The marking shall be located on a side of the equipment so as to be easily read, with the marking visible to a person standing at floor level near the unit (assuming any necessary access to a concealed unit has been made). Lettering shall be a minimum 2" high, with color contrasting sharply with the color of unit. Marking shall be with phenolic engraved labels, white lettering on a black background, drilled for fastening with two screws. Equipment marking is not required for; air outlets and inlets, plumbing fixtures. Submit list of labels prior to fabricating.

PART 3 - EXECUTION

3.1 GENERAL

A. Workmanship: This Contractor shall furnish and install all equipment included in the Contract to provide complete and functioning systems with a neat and finished appearance. If, in the judgment of the

Architect/Engineer, any portion of the work has not been installed in accordance with the specifications and in a neat workmanlike manner, or has been left in a rough, unfinished manner, the Contractor shall be required to revise the work so that it complies with the specifications and is acceptable to the Architect/Engineer, at no increase in cost to the The DISTRICT.

3.2 INSTALLATION

A. Space Verification: Prior to ordering materials verify that adequate space exists to accept the items to be installed, and along the path used to install the item. Such verification shall be by direct field measurement of the actual space available and use of manufacturer's final submittal dimensions. Where the project involves new construction and long lead equipment items and a time schedule not allowing for such direct field measurements, confirm in writing with all trades associated with building the space that adequate room is available. No submittals shall be made until such space verification work has been performed, and confirmed that adequate space is available.

B. Replacement and Maintenance: Install mechanical equipment to permit easy access for normal maintenance, and so that parts requiring periodic replacement or maintenance (e.g., coils, heat exchanger bundles, sheaves, filters, meters, bearings, etc.) can be removed. Relocate items which interfere with access or revise item installation location, orientation, or means of access.

C. Access Doors: Provide access doors in building, equipment, and ducts as required to allow for inspection, service, and proper maintenance to all items.

D. Manually Operated Components: Valves, damper operators, and other devices which are manually adjusted or operated shall be located so as to be easily accessible by a person standing on the floor. Any such items which are not in the open shall be made accessible through access doors in the building construction.

E. Monitoring Components: Gauges, thermometers, instrumentation and other components which are installed to monitor equipment performance, operating conditions, etc., shall be oriented so as to be easily read by a person standing on the floor. Provide necessary brackets and hangers as needed.

F. Accessible Installation: If circumstances at a particular location make the accessible installation of an item difficult or inconvenient, the situation shall be discussed with the Architect/Engineer before installing the item in a location that will result in poor access.

G. Rotating Parts: Belts, pulleys, couplings, projecting setscrews, keys and other rotating parts which may pose a danger to personnel shall be fully enclosed or guarded in accordance with applicable codes, and so as not to present a safety hazard.

H. Equipment Pads: All ground and slab mounted mechanical equipment shall be installed on a minimum 4 inch thick concrete pad, (unless indicated otherwise). Where the largest dimension for any pad exceeds 6 feet provide a 6 x 6 - 10 Ga. x 10 Ga. welded wire fabric reinforcement in the pad (unless noted otherwise).

I. Dissimilar Metals: Provide separations between all dissimilar metals. Where not specified in another way, use 10 mil plastic tape wrapped at point of contact or plastic centering inserts.

J. Electrical Offsets: Provide offsets around all electrical panels (and similar electrical equipment) to maintain space clear above and below electrical panels to structure, and clearance of 3.5 feet directly in front of panel, except where indicated otherwise or required by code to be more. Such required offsets are typically not shown on the plans but are to be provided per this paragraph. Include in bid offsets for all systems near electrical panels.

K. Piping Through Framing: Piping through framing shall be installed in the approximate center of the member. Where located such that nails or screws are likely to damage the pipe, a steel plate at least 1/16-inch thick shall be installed to provide protection. At metal framing, wrap piping to prevent contact of dissimilar metals. At metal and wood framing, provide plastic pipe insulators at piping penetrations through framing nearest each fixture and on at least 32-inch centers.

L. Safety Protection: All ductwork and related items installed by this Contractor that present a safety hazard (i.e., items installed at/near head height, items projecting into maintenance access paths, etc.) shall be covered (at hazardous area) with 3/4" thick elastomeric insulation and reflective red/white self-sticking safety tape. All sharp corners on supports and other installed items shall be ground smooth.

M. Equipment Access: Access to equipment is of utmost importance. Contractor shall apply extra attention to the laying out of pipe and duct routings and in coordinating all work so that equipment access and a clear maintenance pathway to equipment is maintained. Poor maintenance access will not be accepted. Contractor shall note that in essentially all areas piping and ducts routed in attic areas need to run with slopes parallel to the roof, necessitating elbows/fittings/transitions at crosses of ducts/pipes and at all connections to mains and branches; and requiring added fittings to maintain a clear walking height over attic walkways.

N. Manufacturer’s Instructions: Installation shall comply with manufacturer’s written installation instructions and recommendations. Submit such instructions for Engineers review prior to beginning installation.

3.3 WATERPROOFING

A. General: Where any work pierces construction intended to be watertight or weatherproof, including waterproof concrete, the method of installation shall be as approved by the Architect-Engineer before work is done.

Contractor shall furnish all necessary caulking and flashing required to make such penetrations absolutely watertight. Where not detailed or indicated how to install, the Contractor shall submit shop drawings of his proposed methods.

B. Equipment: All equipment or material located outdoors shall be watertight and shall be designed and intended by the manufacturer to be used outdoors in the conditions of the climate of the installation.

3.5 FINAL INSPECTION AND INSTRUCTION

A. Instruction:

1. The Operation and Maintenance (O&M) Manuals shall be submitted and approved by the Engineer and The DISTRICT prior to conducting the instruction periods.
2. Instruction shall include a minimum of 4 hours time, discussion on the system's operation and presentation of information from maintenance manuals with appropriate references to drawings, followed by tours of equipment spaces explaining maintenance requirements, access methods, servicing, and maintenance schedules, procedures, temperature settings and available system and equipment adjustments.
3. Field instructions and demonstrations of maintenance procedures for all items covered in the O&M manual shall be provided.
4. The Contractor's Representatives who conduct these instructions and demonstrations shall be qualified foremen or superintendents acquainted with this project and the trades involved. Manufacturer's authorized service representative or direct employee shall provide instruction for all major equipment and systems and where specified.
5. Notice of the contractor's readiness to conduct the instruction and demonstrations shall be given to the DISTRICT and Architect/Engineer at least two weeks prior to proposed instruction periods and mutually agreed upon times arranged.

B. Final Inspection and Field Instruction:

1. Prior to acceptance of the Mechanical work, the Contractor shall put all Mechanical systems into operation for a period of not less than 5 working days so that they may be inspected by the Architect/Engineer and the DISTRICT's representatives.
2. The time of the final inspection shall be mutually agreed to by the DISTRICT and Contractor.
3. The Contractor shall furnish adequate staff to operate the mechanical systems during inspection.
4. During the final inspection period, the Contractor shall demonstrate to the DISTRICT's representatives the operation of all equipment, showing that it operates and is controlled properly.

END OF SECTION

SECTION 15090 – HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 0 and Division 1 Specification Sections, apply to this Section.

1.2 WORK INCLUDED

A. Pipe Hangers and Supports.

B. Duct Hangers and Supports.

C. Mechanical Equipment Anchors and Supports.

1.3 QUALITY ASSURANCE

A. Pipe Hanger Standards: Manufacturers Standardization Society Standards SP-58, SP-89, SP-69, and SP-90.

B. All methods, materials and workmanship shall conform to the International Building Code (IBC), International Mechanical Code (IMC), Uniform Plumbing Code (UPC), ASME standards, and Governing Codes.

1.4 SUBMITTALS

A. Submittals shall comply with Section 15010.

B. Submit product data for all hangers, supports, and anchors. Data to include finish, load rating, dimensions, and applicable agency listings. Indicate application for all items by system type, size, and other criteria as appropriate to project.

C. Shop drawings are required for all trapeze hangers, equipment supports, and any fabricated supports or assemblies.

D. Shop drawings are required for any attachment methods and any support arrangements to be used that are not shown on the plans.

1.5 REFERENCES

A. ASME B 31.9: Building Services Piping.

B. ASTM A 36: Standard Specification for Carbon Structural Steel.

C. ASTM A 108: Standard Specification for Steel Bar, Carbon and Alloy, Cold - Finished.

D. ASTM A 123: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

E. ASTM A 153: Standard specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

F. ASTM A 653: Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc Iron Alloy-Coated (Galvannealed) by the Hot Dip Process.

G. ASTM A 907: Standard Specification for Steel, Wire, Epoxy - Coated.

H. ASTM A 924: Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot Dip Process.

I. IBC: International Building Code.

J. IMC: International Mechanical Code.

K. Mason: Mason Industries Seismic Restraint Guidelines for Suspended Piping, Ductwork, Electrical Systems and Floor Mounted Equipment, 6th Edition.

L. MSS SP-58: Pipe and Hangers and Supports - Materials, Design and Manufacture.

M. MSS SP-69: Pipe and Hangers and Supports - Selection and Application.

N. MSS SP-89: Pipe Hangers and Supports - Fabrication and Installation Practices.

O. MSS SP-90: Guidelines on Terminology for Pipe Hangers and Supports.

P. SMACNA: HVAC Duct Construction Standards Metal and Flexible, 3rd Edition.

Q. SMACNA SRM: Seismic Restraint Manual Guidelines for Mechanical Systems, 2nd Edition.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Products shall comply with Section 15010, Paragraph 2.1, Acceptable Manufacturers.

B. Hangers and Supports: Grinnell, B-Line Systems, Unistrut, Erico, PHD, Basic Engineering.

C. Anchors: Rawplug, Phillips, Hilti, Michigan, Simpson, Fastenal, Grinnell, B-Line Systems, Unistrut, PHD, Basic Engineering.

2.2 GENERAL

A. Finish:

1. Indoor Applications: Electro-plated zinc in accordance with ASTM B 633, or hot-dip galvanized after fabrication in accordance with ASTM A 123; except that hanger straps may be formed from pre-galvanized steel.

2. Outdoor Applications: Hot-dip galvanized after fabrication in accordance with ASTM A 123, ASTM A 153, or ASTM A 653 (as applicable to item). Any field cut pieces shall be hot-dip galvanized

after cutting; or be solvent and wire brushed clean and receive cold galvanizing treatment. Cold galvanizing treatment shall consist of a premixed ready to apply liquid organic zinc compound, with 95% metallic zinc content by weight in dry film; ZRC worldwide “ZRC Cold Galvanizing Compound”.

B. Identification: Steel pipe hangers and supports shall be stamped with the manufacturer’s name, part number, and size.

C. Hanger Rods: Threaded hot rolled steel. Hanger rods shall be sized so that the total load (including pipe or duct, insulation, hangers, and fluid) does not exceed the following:

Nominal Rod Diameter	Maximum Load
1/4 Inch	240 Pounds
5/16 Inch	440 Pounds
3/8 Inch	610 Pounds
1/2 Inch	1130 Pounds
5/8 Inch	1810 Pounds
3/4 Inch	2710 Pounds
7/8 Inch	3770 Pounds
1 Inch	4960 Pounds

D. Hanger Straps: Galvanized steel, minimum 1" x 18" gauge, of lock-forming grade conforming to ASTM A924, G60 (minimum) galvanized coating conforming to ASTM A 653. Minimum yield strength of 30,000 psi. Straps shall be sized so that the total load does not exceed the following:

Strap Size	Maximum Load
1" x 18 Gauge	380 Pounds
1" x 16 Gauge	630 Pounds
1-1/2" x 16 Gauge	990 Pounds

E. Beam Attachments: Constructed of malleable iron or steel, MSS standard types designed for clamping to building structural support beam. “C” clamp type shall have cup point set screws with locknuts and retaining straps. Center loaded type beam clamps shall have horizontally adjustable clamping bolt (or rod with nuts).

F. Concrete Anchors: Wedge type expansion anchors, with hex nut and washer, and stainless steel split expansion rings. Tested to ASTM E 488 criteria, UL listed, with exposed anchor head stamped with code to identify anchor length.

G. General Anchor Bolts/Nuts/Screws/Fasteners: ASTM A307, SAE J429, or ASTM A 563, with unified inch screw threads (course, UNC).

H. Manufactured "Strut" Systems:

1. Channels: Minimum 12 gauge, 1-5/8 x 1-5/8" (unless noted otherwise), with slots/holes to suit application.

2. Accessories: Channel nuts press formed, machined and hardened with gripping slot, fabricated from steel conforming to ASTM A 108 or ASTM A 36. Fittings fabricated from steel in accordance with

ASTM A 907.

I. Steel: Structural steel per ASTM A 36.

J. Wood: Only allowed to be used where building structural elements are of wood construction; shall be of same material as used for building structural purposes.

K. Cold Galvanizing: Cold galvanizing treatment shall consist of a premixed ready to apply liquid organic zinc compound, with 95% metallic zinc content by weight in dry film; 2RC worldwide “ZRC Cold Galvanizing Compound”.

2.3 PIPE HANGERS AND SUPPORTS

A. Copper Pipe: All hangers used directly on copper pipe shall be copper plated or have a factory applied 1/16-inch thick (minimum) plastic coating on all contact surfaces.

B. Fire Suppression: Fire sprinkler supports shall comply with applicable NFPA standards.

C. Type: Shall be MSS type selected in accordance with MSS-69; except that MSS type 24, 26, and 34 shall not be used.

D. Trapeze Hangers: Shall be constructed of carbon steel angles, channels or other structural shapes with flat surface for point of support. Trapeze hangers shall be supported with hanger rods suspended from concrete inserts, beam clamps, or other approved method. Provide a steel washer where hanger rod nuts bear on trapeze hanger.

E. Refrigeration: Supports on refrigeration piping shall have cushion type clamps to minimize vibration transfer.

2.4 DUCT HANGERS AND SUPPORTS

A. Hangers: As shown in SMACNA except that wire shall not be used and all materials used shall comply with these specifications.

B. Vertical Duct Supports at Floor: 1-1/2" x 1-1/2" x 1/8" (minimum) galvanized steel angle and to support ducts, maximum 12 foot on center, and as shown in SMACNA. For ducts over 30 inches wide provide riser reinforcing with hanger rods between the riser support and riser reinforcing.

C. Vertical Duct Supports at Wall: 1-1/2" x 1/8" (minimum) strap or 1-1/2" x 1-1/2" x 1/8" (minimum) angle bracket and as shown in SMACNA.

D. Hanger Attachments to Structure: As shown in SMACNA to suit building construction and as allowed on structural drawings. Provide washers at all fasteners through hanger straps (regardless of SMACNA allowances). Where C-clamps are provided, retainer clips shall be used. Friction beam clamps shall not be used.

E. Hanger Attachments to Ducts: As shown in SMACNA except that wire shall not be used as any form of support or attachment for ducts.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

A. General: Provide all necessary bolts, nuts, washers, turnbuckles, hanger rods, rod connectors, stanchions, wall/roof/floor backing and attachments, bridging between structural members, and any other miscellaneous accessories required for the support and anchoring of all pipes, ducts, and mechanical equipment. All supports, whether from floor, walls, or hung from structure, are Contractor's responsibility. Any field cut pieces shall be hot-dip galvanized after cutting; or be solvent and wire brushed clean and receive cold galvanizing treatment.

B. Backing: Install steel or wood backing in walls (anchored to studs) and in ceiling (anchored to joists or trusses), as required to provide support for items.

C. Installation: Install all inserts, anchors, and supports in accordance with manufacturer's instructions, code requirements, and best professional practices. The most restrictive criteria governs.

D. Welded Assembly Finish: All welded steel support assemblies shall have a power wire brush and primer paint finish.

E. Attachments: Contractor shall design and submit shop drawings of proposed attachment methods to the Engineer for review and approval.

3.2 INSTALLATION OF PIPE HANGERS AND SUPPORTS

A. General: Pipe which is not run underground shall be adequately anchored to the structure to prevent sagging and to keep pipe in alignment, except that piping below structural slabs shall be supported same as for aboveground piping. See structural drawings for extent of structural slab areas.

B. Adjustment: All pipe supports shall be provided with a means of adjustment for the aligning and leveling of the pipe after installation.

C. Applications: Selection, sizing, and installation of pipe supports and accessories shall be in accordance with the manufacturers recommendations, standards MSS SP-89 and MSS SP-69, NFPA 13 for fire protection piping, UPC, and IMC.

D. Support Spacing: Provided piping support spacing according to the most restrictive of the following: UPC, IMC, ASME B31.1, B31.9, local codes, manufacturers recommendations or Contract Documents specific requirements. Provide supports at each change in direction of piping and at each side of concentrated loads.

E. Trapeze Hangers: Four or more pipes running parallel may be supported on trapeze hangers provided the slopes of such pipes allow use of common trapeze. Where trapeze width exceeds 28 inches, provide three (3) hanger rod supports.

F. Vertical Piping Supports: Support piping at each floor line with pipe clamps and at intermediate points as required so that hanger spacing does not exceed allowable spacing and as required to prevent excessive pipe movement and so as to comply with the maximum spacings cited above. Support all pipe stacks at their bases with a concrete pier or suitable support. For vertical pipe drops which occur away from a wall or similar anchoring surface, provide angled bracing from nearest structure on two sides of drop to provide rigid anchoring of pipe drop.

G. Expansion/Contraction: At piping subject to expansion and contraction of 1/2-inch lengthwise or more, provide system support features to accommodate piping movement. Pipe shall be supported on roll type or anti-friction plate type supports to allow movement of piping toward (and away from) expansion devices. At all expansion devices and provide alignment guides on each side of expansion devices and at intermediate points to maintain pipe alignment. Provide anchors to ensure pipe expansion into expansion devices. Anchors shall consist of riser clamp and welded pipe or steel angle anchored to structure, or similar arrangement (unless indicated otherwise).

3.3 INSTALLATION OF DUCT HANGERS AND SUPPORTS

A. General: Provide anchors and supports for all ductwork. Supports and hangers shall comply with SMACNA, except that hanger spacing and hanger maximum loads shall be governed by whichever is more restrictive between these specifications or SMACNA.

B. Hanger Spacing -- Rectangular Duct:

Duct Area	Maximum Spacing
Up to 4 Square Feet	8 Feet
4.1 to 10 Square Feet	6 Feet
10 Square Feet and Up	4 Feet

C. Hanger Spacing -- Round Duct:

Duct Area	Maximum Spacing
Up to 24 Inch Diameter	8 Feet
25 Inch to 48 Inch Diameter	6 Feet
49 Inch Diameter and Up	4 Feet

D. Vertical Ducts: Support at each floor level, but in no case less than on 12 foot intervals.

E. Fittings: Provide supports at each change in direction of duct for ducts with 4 square foot area or more, or for ducts larger than 24 inch diameter. Locate hangers at inside and outside corners of elbows, or at each end of fitting on each side.

F. Concentrated Loads: Provide additional supports at each side concentrated loads such as modulating dampers (24" x 24" and larger), duct heaters (18" x 18" and larger), sound attenuators (all sizes), and similar items.

G. Exterior Duct: Provide supports for exterior ductwork as shown in SMACNA HVAC Duct Construction Standards; spacing as specified herein.

H. End of Duct: At end of duct run, hangar shall be located no more than 1/2 the allowed hangar spacing from the end of the run.

3.4 CEILING AIR INLETS/OUTLETS

A. Ceiling mounted air inlets, outlets or accessories weighing less than 20 pounds shall be positively attached to the ceiling suspension main runners (or ceiling support members) or to cross runners with the same carrying capacity as the main runners (or support members).

B. Terminals or services weighing 20 pounds but not more than 56 pounds, in addition to the above, shall have two No. 12 gauge wire hangers connected from the terminal or service to the ceiling system hangers or to the structure above. These wires may be slack.

C. Terminals or services weighing more than 56 pounds shall be supported directly from the structure above by approved hangers.

3.5 INSTALLATION OF MECHANICAL EQUIPMENT ANCHORS AND SUPPORTS

A. Provide anchoring and supports for all mechanical equipment. All equipment shall be anchored. Anchors shall be adequate to serve as seismic restraints.

B. HVAC and exhaust equipment where suspended from the structure shall be supported using the methods shown in SMACNA and as shown on the drawings.

END OF SECTION

SECTION 15250 - INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 0 and Division 1 Specification Sections, apply to this Section.

1.2 WORK INCLUDED

A. Duct Insulation.

B. Pipe Insulation.

1.3 DEFINITIONS

A. R: Thermal resistance of insulation, in units of hr-sf-deg F/Btu.

B. Subject to Damage: Items installed exposed less than 8 feet above the walking surface (i.e. floor, platform, roof, grade, etc.) adjacent to the item.

1.4 QUALITY ASSURANCE

A. All insulation and materials shall have a fire hazard rating not to exceed 25 for flame spread and 50 for smoke development, as tested by ASTM E 84, NFPA 255, and UL 723.

1.5 SUBMITTALS

A. All submittals shall comply with Section 15010.

B. Provide product data on all insulation materials to be used. Indicate thicknesses to be used.

1.6 GENERAL REQUIREMENTS

A. Code Compliance: Contractor shall insulate all systems with the materials and thicknesses as required by code, but in no case shall the insulation be less than that specified herein. In some cases the specified insulation exceeds code, and shall be provided as specified. Not all systems requiring insulation by code are specified, but shall be provided with insulation where required by code.

B. All adhesives, sealants, mastics and similar materials shall be low-VOC type, and comply with USGBC LEED requirements.

1.7 REFERENCES

A. ASTM A 653: Standard Specification For Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot Dip Process.

B. ASTM B 209: Standard Specification for Aluminum and Aluminum-Alloy

Sheet and Plate.

C. ASTM C 547: Standard Specification for Mineral Fiber Pipe Insulation.

D. ASTM C 1136: Standard Specifications for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.

E. ASTM C 1290: Standard Specification For Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.

F. ASTM E 84: Standard Test Method for Surface Burning Characteristics of Building Materials.

G. NCIIS: National Commercial & Industrial Insulation Standards, published by Midwest Insulation Contractors Association, 5th Edition.

H. NFPA 255: Standard Method of Test of Surface Burning Characteristics of Building Materials.

I. UL 723: Tests For Surface Burning of Building Materials.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Products shall comply with Section 15010, Paragraph Part 2.1, Acceptable Manufacturers.

B. Insulation: Johns Manville, Armacell, Owens-Corning, Knauf, Rubatex, Pittsburgh Corning, GLT, Halstead, Gilsulate.

C. Accessories: Johns Manville, Armacell, Owens-Corning, Knauf, Rubatex, Pittsburgh Corning, GLT, Halstead, Duro Dyne, Gustin Bacon, Childers, RPR, Tee Cee, JPS, Buckaroos.

2.2 DUCT INSULATION

A. Type: Flexible blanket type, constructed of inorganic glass fibers bonded by a thermosetting resin, complying with ASTM C 1290, Type III. Johns Manville “Microlite” (or approved).

B. Jacket: FSK type, vapor proof, consisting of an aluminum foil cover reinforced with glass fiber mesh, and laminated to kraft. Water vapor permeance shall not exceed 0.05 perms. Provide with joint sealing tape, minimum 2 inches wide, constructed of jacket material with adhesive to seal all joints.

C. Thermal Conductivity: Shall not exceed 0.27 Btu-in/hr-sq ft-deg F at 75 degrees F.

D. Operating Limits: 40 degrees F to 250 degrees F.

E. Duct Insulation Thickness:

1 General: Provide insulation densities and thicknesses to achieve the following R values. R values are for the insulation only, in their installed thickness, considering installed duct wrap stretch

and in accordance with code.

2. Lining: Where ducts have internal lining, the insulating properties of the lining may be credited toward meeting the required insulation R value; use R-4 per inch of installed liner.

3. Supply Air Ductwork:

   a. Inside Building and Within Building's Thermal Envelope: R-3.3 (except where ran exposed in conditioned spaces, no insulation is required).

   b. Inside Building But Not Within Building's Thermal Envelope: R-7.

4. Return Air Ductwork:

   a. Inside Building and Within Building's Thermal Envelope: No insulation required; except where duct contains air that may vary by 10 deg F or more from the space the duct passes through, R-3.3 insulation shall be provided.

5. Outside Air Ductwork: Shall be insulated same as required for the building envelope; except where allowed by code to be insulated less than the building envelope, shall be R-7.

6. Exhaust and Relief Ductwork:

   a. Inside Building and Within Building's Thermal Envelope: No insulation required except ductwork from the system's backdraft damper (or motorized damper) to outside the building shall be insulated same as required for the building envelope.

   b. Inside Building But Not Within Building's Thermal Envelope: R-7.

2.3 PIPE INSULATION

A. Type: Flexible cellular elastomeric insulation, factory formed to match pipe sizes applied to, complying with ASTM C 534, Type 1. Armacell "AP/Armaflex SS" (or approved).

B. Thermal Conductivity: Shall not exceed 0.27 Btu-in/ hr-sq ft-deg F at 75 degrees F.

C. Water Vapor Transmission: Water vapor permeance shall not exceed 0.08 perms.

D. Operating Temperature Limits: -20 degrees F to 180 degrees F.

E. Weather Protection: Where installed outdoors provide with manufacturer's weather proof coating to protect from UV and weather exposure.

F. Pipe Fittings: Shall be covered using prefabricated segments of pipe insulation of same materials and thickness as the adjoining pipe insulation, formed to match pipe fitting.

G. Pipe Insulation Thickness: Refrigerant piping (RG or RS piping) returning from an evaporator (i.e. cooling coil) to a compressor shall be considered to operate at 40 deg F. Refrigerant piping (RL piping) from a condenser to an evaporator does not require insulation (unless noted otherwise).

2.4 ACCESSORIES

A. Adhesive, Caulks, Mastics, and Coatings: As recommended by insulation material manufacturer and suited for the application.

B. Bands: 1/2-inch wide, of stainless steel, galvanized steel, or aluminum construction, to match with materials used with.

C. Weld-Attached Anchor Pins and Washers: Copper-coated steel pin for capacitor-discharge welding and galvanized speed washer. Pin length shall be as required for insulation thickness used with. Welded pin holding capacity 100 lb, for direct pull perpendicular to the attached surface. Style and type to suit application.

D. Adhesive-Attached Anchor Pins and Speed Washers: Galvanized steel plate, pin, and washer manufactured for attachment to duct and plenum with adhesive. Pin length sufficient for insulation thickness used with. Adhesive as recommended by the anchor pin manufacturer as appropriate for surface temperatures and materials used with, and to achieve a holding capacity of 100 lb for direct pull perpendicular to the adhered surface. Style and type to suit application.

PART 3 - EXECUTION

3.1 GENERAL

A. Pre-Insulation Review: No covering materials shall be applied until systems to be covered have had all tests satisfactorily completed, have had all required inspections, and have been satisfactorily reviewed by the Architect-Engineer. All systems shall be examined by the Contractor to confirm cleanliness and other conditions are appropriate to allow for insulation installation.

B. Insulation Work Review: No insulated items shall be concealed in the building structure or buried until the insulation work has been satisfactorily reviewed by the Architect-Engineer, and has had all required inspections.

C. Standards: Materials shall be installed in accordance with manufacturers written instructions, NCIIS, and shall comply with materials and methods specified herein. The more stringent requirements govern.

D. Joints/Seams: Joints shall be staggered on multi-layer insulation. Locate seams and joints in least visible location.

E. Insulation Protection: Insulation shall be kept clean and dry and shall be protected from dirt, damage, and moisture. Insulation that becomes dirty, damaged, or wet and cannot be restored to like new condition will be rejected, and shall immediately be removed from the jobsite.

F. Insulation Interruptions: Insulation shall be neatly finished at all supports, protrusions and interruptions. Provide adhesive and tape seal to maintain vapor barrier integrity.

G. Equipment and Floor Protection: Cover existing equipment and finished floors to protect such items from insulation fiber and dust. Keep all such existing areas in a "broom clean" condition at the end of each day. Take precautions in these areas to prevent glass fiber and insulation dust from entering ventilation systems or areas adjacent to the work.

H. Glass Fiber Insulation - General:

1. Finish all insulation ends with joint sealing tape or vapor barrier mastic, no raw edges allowed.

2. Joints: Tightly butt adjacent insulation sections together without any voids. Provide overlap of jacket material over all joints.

I. Items To Be Insulated: Provide insulation on all ductwork, all piping, all items installed in these duct and piping systems, all air and liquid energy conveying systems and components, all air and liquid energy storage, all equipment, and all energy consuming devices specified as part of Division 15, except where such insulation has been specifically excluded.

J. Items Excluded From Being Insulated:

1. Factory insulated or factory lined HVAC, and AC units.

2. Fire suppression piping.

3.2 DUCT INSULATION INSTALLATION

A. Types and Thickness: Insulate all ducts with insulation type and thickness (to provide the required R value) as specified in “Part 2 - Products”.

B. General: Insulation shall be firmly butted at all joints. All longitudinal seams for flexible insulation shall overlap a minimum of 2 inches. All joints and seams shall be finished with appropriate joint sealing tape.

C. Attachment: For rectangular ducts over 24 inches wide, duct insulation shall be additionally secured to the bottom of the ductwork with mechanical fasteners on 18 inch centers to reduce sagging. Washers shall be applied without compressing the insulation. Protruding ends or fasteners shall be cut off flush after washers are installed. All seams, joints, penetrations, and damage to the facing shall be sealed with joint sealing tape or vapor retardant mastic or appropriate joint sealing tape.

3.3 PIPE INSULATION INSTALLATION

A. Types and Thickness: Insulate all piping with insulation type and thickness as specified in “Part 2 - Products”. All piping shall be insulated except where specifically excluded.

B. Elastomeric Pipe Insulation: Flexible elastomeric cellular insulation shall be installed with seams and joints sealed with rubberized contact

adhesive. Insulation with pre-applied adhesive is not permitted. Insulation exposed to weather and not shown to have jacketing shall be protected with two coats of UV resistant finish or PVC or metal jacketing as recommended by the manufacturer after the adhesive is dry and cured. A brush coating of adhesive shall be applied to both butt ends to be joined and to both split surfaces to be sealed. The adhesive shall be allowed to set until dry to touch but tacky under slight pressure before joining the surfaces. Insulation seals at seams and joints shall not be capable of being pulled apart one hour after application. Insulation that can be pulled apart one hour after installation shall be replaced.

C. Pipe Hangers: Provide insulation tight up to pre-insulated pipe supports at pipe hangers, seal all joints with joint sealing tape.

END OF SECTION

SECTION 15421 – CONDENSATE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 0 and Division 1 Specification Sections, apply to this Section.

1.2 WORK INCLUDED

A. Condensate, Overflow, Miscellaneous Drains.

B. Drain Pans.

C. Fabricated P-traps.

D. Testing and Inspection.

1.3 SUBMITTALS

A. Submittals shall comply with Section 22 05 00.

B. Submit product information on all items to be used.

1.04 REFERENCES

A. ASME B 16.15: Cast Bronze Threaded Fitting Classes 125 and 250.

B. ASME B 16.18: Cast Copper Alloy Solder Joint Pressure Fittings.

C. ASME B 16.22: Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

D. ASME B 16.23: Cast Copper Alloy Solder Drainage Fittings.

E. ASME B 16.29: Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings (DWV).

F. ASTM B 32: Solder Metal.

G. ASTM B 88: Seamless Copper Water Tube.

H. ASTM B 306: Copper Drainage Tube (DWV).

I. ASTM D 1785: Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

J. ASTM D 2466: Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.

K. ASTM D 2564: Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.

L. ASTM D 2665: Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Products shall comply with Section 15010, 2.1, Acceptable Manufacturers.

B. Pipe and Fittings: Domestic Manufacturers only; Mueller, Cerro, Tyler, US Pipe, Charlotte Pipe and Foundry, Pacific States Pipe, Atlantic States.

2.2 PIPE AND FITTINGS - MATERIALS

A. Copper DWV Pipe and Fittings: Copper drainage tube per ASTM B 306. Wrought copper and wrought copper alloy solder joint fittings per ASME B 16.29; or cast copper alloy solder joint fittings per ASME B 16.23.

B. Copper Pipe and Fittings: Seamless copper water tube, tube L or M, per ASTM B 88. Solder joint wrought copper and bronze fittings per ASME B 16.22 cast copper alloy fittings per ASME B 16.18, and cast bronze threaded fittings per ASME B 16.15 with 95/5 tin-antimony solder per ASTM B 32.

C. PVC DWV Pipe and Fittings: Polyvinyl chloride drain waste and vent pipe and fittings per ASTM D 2665, with solvent cement joints. Solvent cement shall comply with ASTM D 2564.

D. PVC Pipe and Fittings: Polyvinyl chloride pipe, schedule 40, per ASTM D 1785. Solvent cement socket type fittings per ASTM D 2466. Solvent cement shall comply with ASTM D 2564.

2.3 PIPE AND FITTINGS - APPLICATION

A. Condensate Drains: Copper DWV, copper, PVC DWV, or PVC.

B. Miscellaneous Drains: Copper DWV, copper, PVC DWV, or PVC.

2.4 DRAIN PANS

A. Fabricate of G90 galvanized steel complying with Section 15840; minimum 22 gauge.. Pans shall be welded, with welds power wire brush cleaned and cold-galvanizing compound applied at areas where galvanized coating has been disturbed area. Seal liquid tight all seams. Provide with watertight drain connection, located low in pan; 3/4-inch or sized to match drain line indicated on plans (whichever is larger).

2.5 FABRICATED P-TRAPS

A. Type: Factory fabricated p-trap with dual cleanouts and clear trap, for cooling coil condensate.

B. Construction: Fabricated of schedule 40 PVC, with transparent plastic trap portion. Portion connection to HVAC unit (or coil) drain shall consist of a PVC cross, with top and side cleanouts having caps with integral retaining strap and ring. Outlet portion shall consist of PVC tee fitting, with top portion able to serve as vent.

C. Size: 3/4-inch unless indicated otherwise. Trap heights shall be sized to suit HVAC unit static pressures, unit configuration (i.e. blow through or draw through), and be consistent with HVAC unit manufacturers installation recommendations.

D. Cleaning Brush: Provide with bristled flexible shaft cleaning brush, sized for cleaning of p-trap.

PART 3 - EXECUTION

3.1 GENERAL

A. Installation of all items shall comply with code, best professional practices, and manufacturers written installation instructions.

B. Provide all piping as indicated and as required for condensate and miscellaneous drains and vent connections to all items requiring such drains (i.e. HVAC units, furnaces, AC units, etc.).

C. Coordinate installation of items with all trades that are affected by the work to avoid conflicts.

D. Consult manufacturers data and drawings for information on equipment beginning drain rough-in.

E. Verify points of connection, elevations, and grade requirements before beginning installation or ordering materials.

F. Trap all equipment items as required by governing code; provide proper venting for each trap.

G. Provide drain piping for all drip pans, unit condensate drains, unit P-traps, etc. Run piping to nearest point of drainage, or as shown on drawings. Where routing is not shown, route to nearest point of proper drainage.

3.2 PIPE AND FITTINGS

A. All piping in finished areas shall be installed concealed unless specifically noted otherwise.

B. Install piping so as not to obstruct access to any items requiring routine service, maintenance, or inspection. Offset or reroute piping as required to clear any interferences which may occur. Prior to running any piping, confirm with Architect/Engineer (unless is clearly noted to be ran exposed). Install exposed piping so as not to obstruct any portion of windows, doors, doorways, passageways, or items requiring service or access.

C. Consult all drawings for location or pipe spaces, ducts, electrical equipment, structural elements, ceiling heights, door items requiring access, openings, window openings, and other details and report discrepancies or possible conflicts to Architect/Engineer before installing pipe.

D. Install all drain lines with a slope of 1/4-inch per foot unless noted

otherwise. Coordinate with AHJ if written approval is required for exceptions to 1/4-inch per foot slope.

E. Provide escutcheons where exposed pipe passes through walls, floors, or ceilings.

F. Install all piping parallel to the closest wall and in a neat, workmanlike manner. Horizontal straight runs of piping shall not deviate from straight by more than 1/4-inch in ten feet. Vertical piping shall not deviate from plumb by more than 1/8-inch in ten feet.

G. Do not run any piping above electrical panels (and similar electrical equipment). Provide offsets around such panels as necessary. Such offsets are typically not shown on the plans, but are required per this paragraph.

H. Prior to the joining of any section of pipe to a pipe run, the section shall be thoroughly cleaned inside and out, the ends shall be reamed to remove any cutting burrs and piping prepared as recommended by piping and fitting manufacturer.

I. Threaded Connections: Cut piping carefully, ream, thread and work into place without springing. Use TFE tape or lead and graphite lubricant (on male threads only).

J. Soldered Connections: Polish contact surfaces of fittings and pipes with emery cloth before fluxing male and female surfaces of joints. Steel wool and sandpaper not permitted for polishing.

K. PVC Pipe:

1. Solvent Joints: The outside of the PVC pipe shall be chamfered to a minimum of 1/16 inch at approximately 22 degrees. Chemicals used must penetrate the surface of both pipe and fitting which will result in complete fusion at the joint. Use solvent and cement only as recommended by the pipe manufacturer.

2. Plastic to Metal Connections: Work the metal connection first. Use a non-hardening compound on threaded connections. Use only light wrench pressure. Connections between metal and plastic are to be threaded utilizing female threaded adapters only, not male adapters.

3.3 TESTING AND INSPECTION

A. All piping shall be inspected and approved prior to being concealed or covered.

B. Provide testing as required by code. Testing shall be by water and shall comply with governing code. Testing shall be witnessed by the plumbing inspector and the Engineer's representative (at his option).

C. All leaks shall be eliminated and the system re-tested before proceeding with work or concealing pipe.

D. All repairs to piping shall be with new material and no caulking of screwed joints or holes is allowed.

END OF SECTION

SECTION 15509 – CLEAN-AGENT FIRE-EXTINGUISHING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 0 and Division 1 Specification Sections, apply to this Section.

1.2 WORK INCLUDED

A. System Design.

B. Piping.

C. Discharge Nozzles.

D. Valves.

E. Control System Panels, and Alarms.

F. Manual Discharge/Abort Stations.

G. Fire Extinguishing Agent and Storage Containers.

H. Accessories.

I. Owner Instruction.

1.3 QUALITY ASSURANCE

A. All materials and equipment shall be listed as approved by the Underwriters' Laboratories "List of Inspected Fire Protection Equipment and Materials", or the Factory Mutual Laboratories, "List of Inspected Fire Protection Equipment and Materials", or the Factory Mutual Laboratories, "List of Approved Equipment, Fire Protection Devices and Devices Involving Fire Hazard"; and shall be of the Manufacturer's latest design.

B. Equipment and installation to meet requirements of NFPA 2001, NFPA 70, NFPA 72, NFPA 75, the authority having jurisdiction and all other governing codes (see Section 21 05 00) and these specifications. Throughout the Project Documents items are shown or specified in excess of code requirements; in all such cases the work shall be done so that code requirements are exceeded as indicated.

1.4 SUBMITTALS

A. All submittals shall comply with Section 15010.

B. Submit shop drawings of entire system for approval by the local Fire Marshal. Submit these same drawings to the Architect/Engineer; label these as “Information – Subject to Code Approval – Not For A/E Review”. Submit Fire Marshal approved drawings to Architect/Engineer as the submittal for review.

C. Submit product information on all products to be used.

D. Submit all system calculations showing compliance with NFPA.

1.5 GENERAL REQUIREMENTS

A. System design shall be performed by a Contractor thoroughly familiar with and knowledgeable of NFPA 2001, NFPA 13, NFPA 70, NFPA 72, NFPA 75 and clean agent fire extinguishing systems design and installation. Contractor must be certified by the Fire Extinguishing System Manufacturer. By virtue of submitting a bid, the Contractor is acknowledging that he does in fact have such knowledge and certification; and all work provided will fully comply with all the requirements of these specifications. The fire extinguishing Contractor shall be qualified, as required by local authorities to design and install all parts of the fire extinguishing system.

B. System shall be Contractor designed and approved by both the Fire Marshal and Architect/Engineer.

C. System Description: Provide complete clean agent fire extinguishing system. System shall provide complete coverage of the Control Room and Communication Room. System shall cover the volume of the room.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. All products shall comply with Section 15010, Paragraph 2.1, Acceptable Manufacturers.

B. Extinguishing System Components: Chemetron, Pyrotronics, Fenwall, Kidde.

C. Valves: As recommended by fire extinguishing system manufacturer and complying with applicable requirements..

D. Piping: Domestic manufacturer only.

E. Clean Agent: Great Lakes Chemical, Kidde

2.2 PIPE AND PIPE FITTINGS

A. Piping:

1. A-53, Grade A ERW, threaded end
2. A-52, Grade A ERW, welded connections
3. A-53, Grade A&B seamless, welded or threaded connections
4. A-106 Grade A, B & C, welded or threaded connections

B. Fittings: All fittings shall be Class 300 lb. malleable or ductile iron or 1000-lb. ductile iron forged steel fittings are acceptable. Flange joints should be Class 300lb. Grooved fittings with companion gasketed couplings must be UL listed or FM approved for application intended.

C. Pipe Hangers and Supports: See Section 15090; and in accordance with NFPA Standards.

D. Joint Compound: Only Teflon tape shall be used to aid in making pipe into fittings and sealing of joints.

2.3 CLEAN AGENT

A. Gaseous fire extinguishing agent as defined in NFPA 2001.

B. FM-200 (or approved equal).

2.4 DISCHARGE NOZZLES

A. Discharge nozzles shall be fabricated of corrosion resistant materials (stainless steel or brass). The nozzles shall be designed so that the orifice piece is connected directly to the supply pipe. The size of pipe and nozzles shall be determined from the calculated flow and terminal pressures in accordance with established, recognized test date contained in the manufacturer's listed design manual.

2.5 STORAGE CYLINDERS

A. Storage cylinders shall be constructed of high strength alloy steel, conforming to all applicable specifications of the Department of Transportation. The cylinder shall be designed to permit on-site refilling when required. Valves, manifolds, pressure gauges, and pressure switches shall be provided.

2.6 FIRE SUPPRESSION CONTROL SYSTEM

A. General

1. All equipment and components shall be new, and the manufacturer's current model.
2. All equipment and components shall be installed in strict compliance with manufacturer's recommendations.
3. All equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place. (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.

B. Conduit and Wire

1. Conduit shall be in accordance with The National Electrical Code (NEC), local and state requirements.
2. Conduit shall not exceed 40 percent of interior cross sectional area where three or more cables are contained within a single conduit.
3. Cable must be separated from any open conductors of Power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, as per NEC Article 760-29.
4. All fire alarm system wiring shall be new.
5. Wiring shall be in accordance with local, state and national codes (e.g., NEC Article 760). Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than

18 AWG (1.02 mm) for initiating device circuits and 14 AWG (1.63mm) for indicating device circuits.

6. All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signaling (fire alarm) system.

7. Terminal Boxes, Junction Boxes and Cabinets: All boxes and cabinets shall be UL listed for their use and purpose.

C. Control Panel

1. The Control panel shall be a Chemetron Fire Systems Micro 1002 or approved equal and shall communicate with and control the following types of equipment used to make up the system: smoke detectors, manual release/abort stations, alarm indicating appliances, releasing component and other system controlled devices. The Control Panel shall be connected to a separate dedicated branch circuit, maximum 20 amperes. This circuit shall be labeled at the Main Power Distribution Panel as Fire Releasing Control. Control panel Primary Power wiring shall be 12 AWG. The Control Panel Cabinet shall be grounded securely to either a cold water pipe or grounding rod.

2. System Capacity: The Control panel shall include a 2 Style Y/Z Indicating Circuits, 2 Releasing Circuits, 1 Form C Alarm Contracts, 1 Form C Trouble Contacts, 2 Style B.D Initiating Zones, 1 Style B/D Manual Release Circuit, and 1 Style B/D Abort Circuit.

3. System Display: The system Display shall indicated the status of the following system parameters:

AC POWER	Green LED
SYSTEM ALARM	Red LED
RELEASE	Red LED
SUPERVISORY	Yellow LED
SYSTEM TROUBLE	Yellow LED
CIRCUIT TROUBLE	Yellow LED
ALARM SILENCED	Yellow LED
POWER TROUBLE	Yellow LED

4. System Control Switch Operation

a. Tone Silence Switch: Activation of the control panel Tone Silence switch in response to Alarms Troubles and Supervisory conditions shall silence the local panel piezo electric signal and change the System Alarm or Trouble LED from flashing mode to steady ON mode. Occurrence of any new Alarm or Trouble conditions in the system shall cause the Control Panel to re-sound the Local Piezo sounder and repeat the Alarm or Trouble sequence.

b. Alarm Silence Switch: Activation of the Alarm Signal Switch shall cause all Alarm Indicating Appliances to return to the normal condition after an alarm condition.

c. System Reset Switch: Activation of the System Reset Switch shall cause all electronically-latched initiating devices, appliances as well as all associated output devices and circuits, to return to their normal condition. Holding System Reset down shall perform a LAMP TEST function and will activate the piezo sounder.

d. Alarm Activate Switch: Activation of the Alarm Activate Switch shall activate both indicating circuits and the alarm relay. Alarm Activate shall be a latching function.

5. System Operation

a. Zone Status LEDs: The alarm, supervisory or trouble LED(s) shall flash until event(s) have been acknowledged. Any subsequent new alarm, supervisory or trouble condition will re-sound all indications, and flash new events.

b. Supervisory: A short circuit on this zone shall cause the supervisory LED to flash. The Tone Silence switch shall silence the piezo causing the supervisory LED to illuminate steady. An open circuit shall report as a zone trouble.

c. Zone Disable: Disable/Enable of any initiating circuit shall be accomplished using a special sequence of operation of the 4 control switches. If a zone has been disabled, an alarm shall activate the red zone LED, but not the piezo or any output circuit.

d. Last Event Recall: Last Event Recall shall allow the user to display the previous panel status. Las Event Recall may be used to diagnose the intermittent trouble conditions.

6. Accessories:

a. Module for four zone/function relays

b. Volt and amp meters

7. The Control Panel shall also include the following functions:

a. Output circuits shall be protected against false activations by using a 2-step electronic activation circuit.

b. Battery/Earth fault supervision.

c. Adjustable delay timer shall be available, zero to thirty seconds.

d. Cross zone option shall be selectable (two zones in alarm before release).

e. 3 Abort Function options shall be selectable: (1) Standard UL method; (2) IRI method; and (3) local AHJ method.

f. A second release circuit may be selected in place of the supervisory circuit.

g. A supervised manual release circuit shall be provided, which when activated shall override the Abort.

h. 7 AH to 12 AH battery options shall be available, providing up to 90 hours standby.

i. Watchdog timer to supervise microprocessor.

j. Slide-in zone identification labels.

8. Power Supply

a. The Power Supply for the Control Panel shall be integral to the Control Panel itself, and shall provide all control panels and peripheral device power needs.

b. Input power shall be 120 VAC, 60 HZ. The power supply shall provide and integral battery charger for use with batteries up to 15 Ah.

c. It shall also provide 2.25 ampere of regulated 24 VDC power for release circuits and alarm indicating devices. Resettable Power 24 VDC up to 200 ma. Non Resettable Power 24 VDC up to 200 ma.

d. The Power Supply shall be designed to meet UL and NFPA requirements for power limited operation on all indicating and initiating circuits.

e. Positive-temperature-coefficient thermistors, circuit breakers, fuses, or other over-current protection shall be provided on all power outputs.

9. Mechanical Design: The control panel shall be housed in a cabinet designed for mounting directly to a wall or vertical surface. The back box and door shall be constructed of .060 steel with provisions for electrical conduit connections into the sides and top. The door shall provide a key lock and shall include a glass or other transparent opening for viewing of all indicators. The cabinet shall be approximately 5 inches deep and 14.5 inches wide. Height shall be approximately 16 inches. An optional trim ring shall be used for flush mounting of cabinet. Space shall be provided in the cabinet for 7 AH or 12 AH batteries.

10. Batteries:

a. Shall be 12 volt, Gell-Cell type (2 required).

b. Battery shall have sufficient capacity to power the fire alarm system for not less than ninety hours plus 5 minutes of alarm upon a normal AC power failure.

c. The batteries are to be completely maintenance free. No liquids are required. Fluid level checks, refilling, spills and leakage shall not be required.

D. System Components:

1. Electronic Sounders: Electronic sounders shall operate on 24 VDC nominal. Electronic sounders shall provide continuous or uninterrupted tones with an output sound level of at least 90 dBA measured at 10 feet from the device.

2. Manual Discharge Station: The manual discharge station shall be a Chemetron stock number (see ordering information). The faceplate shall

include the type of agent to be discharged, and operating instructions. All faceplate information shall be in raised letters, stamped into the faceplate material. The letters shall be silk-screened in contrasting color. The switch shall be protected by a red Phenol cover to minimize false operation. A seal shall hold the protective cover in place, and shall serve as positive identification when the station has been operated.

3. Abort Switch Station: The fire suppression system shall include an abort switch to help guard against accidental discharge of the agent. It shall be Chemetron stock number (see ordering information), which operates with a two-pole switch mounted to steel plate. Operating instructions shall be in raised letters, stamped into the faceplate material. The raised letters shall be silk-screened in contrasting color. The abort switch shall have a red Phenol plastic cover to help prevent accidental operation. The switch cover shall have a seal that breaks when lifted to provide positive identification that the unit has been operated. To avoid confusion, the unit shall appear distinctly different from a fire alarm manual station.
4. Smoke Detectors: Smoke detectors shall be a 24 VDC photoelectric type. Each detector shall contain a visual status and alarm indicator, remote LED output and a built-in test switch. Each detector screen and cover assembly shall be easily removable for field cleaning of the detector chamber.
5. Supervisory Switches: Shall be provided and connected under this section and installed by the extinguishing system contractor.
6. Signage: Provide as required by code, NFPA standards, and as noted on plans. Signs shall be metal, with silk-screened lettering, minimum 1” high, in contrasting colors.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be in accordance with the NEC, NFPA 2001, NFPA 72, local and state codes, as shown on the drawings, and as recommended by the equipment manufacturers.

B. All conduit, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detectors shall not be installed prior to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage.

C. All fire detection and alarm system devices, control panels and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas.

D. At the final inspection a factory trained representative of the manufacturer of the major equipment shall perform the tests listed below.

E. Conceal all piping. Provide fitting for changes in direction of piping and for all connections. Make changes in pipe sizes with standard reducing fittings; the

use of bushings is not permitted. All pipes shall be cleaned free of cutting oil and threading debris with solvent approved by Manufacturer.

F. Room Leak Test: Provide room leak test as required by Code and the AHJ. Coordinate with GC regarding level of room sealing required prior to completing system design. Check level of room sealing prior to conducting tests.

3.2 TESTING AND ACCEPTANCE

A. Upon completion of installation, the system shall be thoroughly tested for correct operation and function. Tests shall include actual operation of all mechanical and electrical equipment.

B. Provide the service of a competent, factory-trained engineer or technician authorized by the manufacturer of the alarm equipment to technically supervise and participate during all of the adjustments and tests for the system.

1. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.
2. Close each supervisory contact and verify proper supervisory alarm at the FACP.
3. Open initiating device circuits and verify that the trouble signal actuates.
4. Open and short indicating appliance circuits and verify that trouble signal actuates.
5. Ground device circuits and verify response of trouble signals.
6. Check presence and audibility of tone at all alarm notification devices.
7. Check installation, supervision, and operation of smoke detectors.
8. When any defects are detected, make repairs or install replacement components, and repeat the tests as required.
9. Each initiating device circuit shall be tested for its alarm reporting capability by operating all of the connected initiating devices.
10. Conduct tests from the FACP to verify trouble indications for common mode failures, such as alternating current power failure.

3.3 FINAL INSPECTION AND INSTRUCTION

A. At the final inspection a factory trained representative of the manufacturer of the major equipment shall demonstrate to the Owner the operation of the system.

B. Provide instruction to the Owner. "Hands-on" demonstrations of the operation of all system components and the entire system shall be provided. Instruction shall be for no less than two hours.

END OF SECTION

SECTION 15810- SPLIT SYSTEM HEAT PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 0 and Division 1 Specification Sections, apply to this Section.

1.2 WORK INCLUDED

A. Split System Heat Pumps.

B. Refrigeration Piping and Accessories

C. System Leak Testing and Charging.

D. Start-Up.

1.3 SUBMITTALS

A. Shall comply with Section 15010.

B. Provide complete product information submittals on all units; include performance capacities as a function of indoor and outdoor coil db/wb temperatures and indoor coil air flow rates; supplementary heater capacity; fan performance (cfm vs. esp); and information on all filters and accessories.

1.4 QUALITY ASSURANCE

A. Units shall be UL listed and labeled.

B. Units cooling and heating performance shall be rated in accordance with AHRI standards.

C. Unit construction shall be designed to conform to applicable codes and standards. Unit performance and efficiency shall comply with code.

D. Unit and all components shall be able to withstand ambient temperatures from 0 deg F to 125 deg F, plus direct exposure to sun and weather elements without adverse affects.

E. Unit shall be able to operate and produce cooled air between ambient temperatures of 45 deg F and 115 deg F. Unit shall be able to operate and produce heated air between ambient conditions of 0 deg F and 80 deg F. Unit shall be able to operate with supply air temperatures between 50 deg F and 125 deg F; and with room temperature setpoints between 65 deg F to 85 deg F.

F. Refrigerant Pipe Sizing: Due to the use of proprietary selection criteria by unit manufacturers, the supplier shall size all refrigerant piping between the indoor and outdoor units and provide such sizes to the installing Contractors prior to the bid date. The unit supplier shall also determine the need for any additional accumulators, solenoid valves, and similar accessories and size/select such devices and inform potential installing contractors to allow proper bids. The unit

supplier is obligated to furnish complete air conditioning units, with properly calculated pipe sizes and accessories so as to allow the unit performances as scheduled.

1.5 WARRANTY

A. Entire unit shall be warranted to be free of all manufacturing defects and meeting all Contract Document requirements for a period of one year after Owner project acceptance.

B. Unit compressors shall be warranted by the manufacturer for five years after Owner project acceptance. All labor and materials associated with compressor replacement or repair shall be warranted.

1.6 REFERENCES

A. AHRI 210/240: Unitary Air Conditioning and Air-Source Heat Pump Equipment

B. AHRI 270: Sound Performance Rating of Outdoor Unitary Equipment.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Products shall comply with Section 15010, Acceptable Manufacturers.

B. Heat Pumps: Trane, Carrier, York/JCI.

2.2 SPLIT SYSTEM HEAT PUMP - OUTDOOR UNIT

A. Type: Split system air-to-air heat pump; outdoor section.

B. Capacity: Units shall have minimum cooling and heating capacities as scheduled on the drawings at the conditions shown and with the indoor unit (i.e., air handler) indicated; and shall be rated in accordance with ARI standards.

C. General: Unit shall be fully factory assembled and shall be complete with casing, coils, fans, compressor(s), piping, wiring, controls, and all other accessories required to be ready for field connections and operation. Units shall be UL listed and labeled. Units control wiring shall be 24 volt, and units shall be capable of operating in the cooling mode from 40 to 115 degrees F ambient, and in heating mode from -20 to 65 degrees F ambient.

D. Factory Test: Units shall be factory run-tested to verify proper heating, cooling, defrost, control, and fan operation.

E. Refrigerant: Units shall be for use with refrigerant R-410A and shall be fully charged at the factory.

F. Unit Casing: Shall be constructed of minimum 18 gauge zinc coated steel, with zinc phosphate coating and baked-on polyester powder coating. Access panels shall provide access to unit controls and all major components. All screws or holding devices shall be of cadmium plated construction to resist corrosion. Unit shall have knockouts for piping, electrical and control connections with rubber grommets to insure water-proof connections.

G. Compressor(s): Hermetically sealed or serviceable hermetic reciprocating type compressor, specifically designed for heat pump service. Compressor shall have internal line break overcurrent and overtemperature protection, low pressure protection (via low pressure switch), high pressure protection (via internal relief valve or pressure switch), and crankcase heaters. Motor shall be suction gas cooled and have a voltage utilization range of plus or minus 10% of nameplate voltage. Compressor(s) shall have internal spring isolation mounting and discharge gas sound muffler to reduce vibration transmission and noise.

H. Refrigerant Circuit: Shall be fully factory piped and shall include a refrigerant line filter/drier, liquid line and gas line service valves (brass, back seating type) with service ports, reversing valve, accumulator, and thermostatic expansion valve for both heating and cooling operation.

I. Coils: Shall be constructed of seamless copper tubing with aluminum fins mechanically bonded to tubes.

J. Fan(s): Shall be statically and dynamically balanced at factory. Shall be propeller type, used in draw-through configuration, direct drive type, with permanently lubricated, totally enclosed weather-proof ball bearing type motor(s) having built-in overload protection.

K. Defrost: Unit shall have defrost cycle to remove build-up of frost on outdoor coil. Defrost cycle shall be an on-demand time and temperature initiated; i.e., after 90 minutes (adjustable to lower time periods) elapsed run time; if temperature is low enough, defrost cycle shall be activated. Defrost cycle shall be time or temperature terminated; i.e., defrost cycle shall stop after 10 minutes or when refrigerant temperature is high enough indicating defrost is completed. When in defrost mode, unit shall provide an output (normally open dry contacts) to building control system to allow Section 15900 controls to activate supplementary electric heaters as needed. Unit shall also have defrost control in case of low evaporator coil temperatures at the indoor coil; unit shall prevent compressor slugging by temporarily interrupting compressor operation.

L. Electrical Power: Units shall be for use with power of voltage and phase as scheduled on the drawings.

M. Accessories:

1. Anti-Short-Cycle-Timer: Solid state 24 volt timing device to prevent rapid on-off compressor cycling; providing an approximate 5 minute delay between compressor starts.

2. Low Ambient Accessories: Provide unit with accessories as needed to allow operation to temperatures specified in Paragraph C above. Accessories shall include heat pressure control device(s), evaporator freeze thermostat, low ambient isolation relay.

3. Compressor Start Assist: Provide capacitor(s) and relay(s) to allow improved compressor starts.

4. Mounting Legs: Provide with minimum 4" high non-corroding mounting legs (or base), to allow for proper drainage of unit and base and minimize corrosion.

2.3 SPLIT SYSTEM HEAT PUMP - INDOOR UNIT

A. Type: Split system heat pump, indoor section (i.e. air handler). Vertical air flow configuration.

B. Capacity: Units shall have minimum cooling and heating capacities as scheduled on the drawings at the conditions shown and with the outdoor unit indicated, and shall be rated in accordance with ARI standards.

C. General: Units shall be fully factory assembled and shall be complete with casing, coils, fans, piping, wiring, controls, supplementary electrical heaters and all other accessories required to be ready for field connections and operation. Units shall be UL listed and labeled. Unit shall be compatible with outdoor section as specified so as to provide performance over the temperature range indicated.

D. Factory Test: Units shall be factory run-tested to verify proper heating, cooling, defrost, control, and fan operation.

E. Refrigerant Circuit: Shall be fully factory piped and shall include factory installed thermostatic expansion valve (or dual flow metering device) to allow for both heating and cooling operation.

F. Unit Casing: Shall be constructed of zinc coated steel, with baked-on enamel finish. Access panels shall provide access to unit controls, indoor coil, supply air fan, and filters. Unit shall be completely insulated with minimum 1" thick 1-1/2 lb. per cubic foot neoprene coated fiberglass insulation. Condensate drain pan shall be provided with external connections on either side of unit.

G. Refrigerant Circuit: Shall be fully factory piped and shall include factory installed thermostatic expansion valve (or dual flow metering device) to allow for both heating and cooling operation.

H. Coils: Shall be constructed of seamless copper tubing with aluminum fins mechanically bonded to tubes.

I. Fans: Shall be statically and dynamically balanced at factory. Shall be double width, double inlet, forward curved centrifugal type, with adjustable belt drive or multi-speed direct drive type, as follows:

Fan Scheduled CFM	Drive
0-1899	Direct
1900-2200	Direct or Belt
2201 and up	Belt

Direct drive fans shall have minimum of three speeds, field changeable by switching wiring connections at unit terminal strip. Belt drive units shall have adjustable sheaves. Fan and motor bearings shall be permanently lubricated type with built-in overload protection.

J. Filters: Unit shall be provided with filter racks for accommodating filter sizes as scheduled on the plans.

K. Defrost: In conjunction with outdoor unit, unit shall have defrost control to prevent compressor slugging by temporarily interrupting compressor operation in case of low evaporator coil temperatures.

L. Supplementary Electric Heaters: Shall be provided with capacity and stages as scheduled on the drawings at the voltage and phase indicated. Heaters shall have open wire nickel-chrome elements, mercury contactors, stages as indicated, safety overcurrent protection, and secondary and primary overtemperature protection. Heaters shall have airflow switch (or be interlocked to fan starting device) to only allowing heater operation when airflow is proven. Heaters shall be UL listed.

M. Electrical Power: Units shall be for use with power of voltage and phase as scheduled on the drawings. Units shall have single power entry unless indicated otherwise. Units with single source power entry shall require only one field connection and power source. All necessary terminal block, fuse blocks, fuses, wiring, junction boxes and accessories shall be factory installed within the unit cabinet to provide power to all devices (including the supplementary heater for single source power entry units.)

N. Vibration Isolators: Neoprene-in-shear (or spring suspension) type. All isolators shall be sized by manufacturer for unit weights and so as to provide 95% vibration isolation efficiency.

2.4 REFRIGERANT PIPING

A. Piping: Hard drawn ACR copper tubing per ASTM B280, Type L, with silver brazed joints and wrought copper fittings per ASME B16.22. Use only long radius elbows. Flared fittings (at equipment connections only) shall comply with ASME B16.26. Soft copper tubing may only be used on runs less than 50-feet or where necessary (i.e. when routing through sleeves, or similar door access areas).

B. Sight Glass: Sight glass shall allow visual inspection of refrigerant flow and indicate refrigerant moisture content. Shall be double port type, solder end connections, for use with type of refrigerant of system being installed in, same size as tubing installed in. Henry type 3103 or equal.

C. Isolation Valves: Brass ball valve, full port, rated for 700 psig and -40 deg F to 300 deg F. Compatible with refrigerant used with, UL listed, with rupture proof encapsulated stem, extended copper connections for ease in brazing. Provide in configuration (i.e. angle, straight, with access port) as required to suit application.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Set units in locations as shown on the drawings and in accordance with manufacturer's instructions. Install so as to allow maximum access to units. All indoor units shall be hung from the building structure using vibration isolators. Provide custom fabricated supporting steel frame as necessary to hold units (unless specifically noted or shown otherwise).

B. Refrigerant Piping: Piping joints shall be brazed. Circulate dry nitrogen thru piping being brazed to prevent formation of copper oxide. Provide piping connecting per manufacturers recommendations.

C. Unit Protection: Units shall be protected during construction to prevent mud, dirt, paint overspray, plaster materials, and similar debris from depositing on the unit. Units shall be clean and in new condition prior to Owner acceptance.

D. Unit casing shall be sealed to eliminate all leakage.

E. Unit shall be thoroughly cleaned of all debris prior to operation.

F. Units shall not be operated until all construction activities that generate dust, dirt, fumes, or odors are complete; and the Engineer has reviewed the system and granted approval.

3.2 REFRIGERANT LEAK TESTING AND EVACUATION

A. Notification/Witnessing: Prior to beginning any testing, notify the Architect/Engineer when the testing will occur. The Architect/Engineer will witness (at his discretion) various parts of the test. Failure to notify the Architect/Engineer will be cause to re-test all piping in the presence of a representative of the Architect/Engineer.

B. Disconnect and isolate from the system any components that may be damaged by the test pressure.

C. Connect oil-pumped, dry nitrogen to the system through a pressure reducing gauge manifold. Charge enough nitrogen into the system to raise the pressure to 50 psig. Let stand for 2 hours and check for signs of leakage. If no leakage is noted, slowly increase pressure to 300 psig (or as required by local code, whichever is higher). Tap all brazed connections with a rubber or rawhide mallet sufficiently hard to start any leak that might subsequently open from thermal expansion/contraction or vibration. Check the manifold gauge for any drop in pressure. Let the system stand pressurized for 24 hours. Re-check the manifold gauge. If no change in pressure is noted (after adjusting for temperature) the system may be considered free of leaks.

D. If leakage is suspected or apparent, check joints with a glycerin soap solution or other means to locate the leaks. Repair any leaks found by completely disassembling the connection, cleaning the fitting and remaking the connection. Re-test the system after repairs are made both with pressure (300 psi for 24 hours) and at the leak location with a glycerin soap solution or other means of determining leaks.

E. When the system has been proven free of leaks with the above methods, the system shall be completely evacuated of all air and moisture. Connect a vacuum pump to the system and pump the system down to 500 microns and let stand for a minimum of 2 hours. If the vacuum reading remains unchanged, the system may be charged with refrigerant.

F. After satisfactory pressure testing and vacuum evacuation, fully charge the system with refrigerant. Any final connections that were not subject to the full test pressure (e.g. connections at unit, etc.) shall be carefully checked with a halide or electronic leak detector after the system has been charged.

3.3 START-UP/TESTING & ADJUSTMENT

A. Initial Checks: Prior to operating units, checks shall be made to insure that adequate voltage, air flow, duct connections, electrical connections, control connections, crankcase heaters (where applicable), and other items as listed by the manufacturer are properly provided/connected and operating to insure safe and proper unit operation.

B. Testing and Adjustment: Operate unit in various modes of operating to test for proper operation, including fan rotation, proper damper travel (where applicable), proper cooling/heating, correct interface to other controls (time clock, fans, etc.), etc. Make necessary adjustments.

C. Prior to air balancing and testing, check fans for correct rotation, tighten belts to proper tension, adjust fan rpm to value shown on drawings, and lubricate bearings per manufacturer's recommendations.

D. Subsequent to installation, and prior to air balancing, the installing Contractor shall perform functional tests and start-up for a minimum period of 3 days with various thermostat settings to assure proper operation over the full design range. Provide start-up report, listing all checks performed.

3.4 OWNER INSTRUCTION

A. After all testing and adjustments have been satisfactorily completed, the heat pump owner shall be provided with operator instructions (including start-up, shut-down, emergency, maintenance, and repair instructions) by the manufacturer's authorized service representative.

B. Time Period: Instruction period shall be for a minimum of two (2) hours.

C. Instruction and notification shall comply with Section 15010.

END OF SECTION

SECTION 15811 – SPLIT-SYSTEM HEAT PUMPS WALL MOUNT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 0 and Division 1 Specification Sections, apply to this Section.

1.2 WORK INCLUDED

A. Small Split-System Heat Pumps, Wall Mount

B. Refrigeration Piping and Accessories.

C. System Leak Testing and Charging.

D. Start-Up.

1.3 SUBMITTALS

A. Shall comply with Section 15010.

B. Submit information on all products.

C. Provide complete product information on all units; include cooling performance capacities as a function of indoor and outdoor coil db/wb temperatures and indoor coil air flow rates, fan performance (cfm vs. esp), unit efficiencies, dimensions and information on all filters and accessories. Provide information showing dimensions and location of refrigerant, power, and control connections.

D. Submit air conditioning unit inspection and start-up report.

1.4 QUALITY ASSURANCE

A. Listing: Units shall be listed by an approved testing laboratory for the use and application intended.

B. Rating and Certification: Cooling performances shall be tested and rated in accordance with AHRI 210/240.

C. Applications: Units shall be intended for commercial use and shall include all manufacturers recommended accessories for proper operation for the application intended.

D. Code Compliance: Units shall be rated in accordance with recognized standards and meet code requirements for energy efficiencies. Units shall be constructed and designed to conform to applicable codes and standards.

E. Standardization: In interests of Owner's standardization, all equipment of the same type shall be the product of the same manufacturer.

F. Operating Conditions: Unless more extreme temperatures are noted elsewhere, or required by local conditions or the specific application, unit shall comply with the following:

1. Unit and all components exposed to ambient conditions shall be able to withstand ambient temperatures from -10 deg F to 125 deg F, plus direct exposure to sun and weather elements without adverse affects.
2. Unit shall be able to operate and produce cooled air between ambient temperatures of 0 deg F and 125 deg F.

1.5 WARRANTY

A. General: Entire unit shall be warranted to be free of all manufacturing defects and meeting all Contract Document requirements for a period of one year after Owner project acceptance.

B. Compressors: Unit compressors shall be warranted by the manufacturer for five years after Owner project acceptance. All labor and materials associated with compressor replacement and repair shall be warranted.

1.6 REFERENCES

A. AHRI 210/240: Performance Rating of Unitary Air-Conditioning & Air-Source Heat Pump Equipment

B. ASME B16.22: Standard for Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

C. ASME B16.26: Standard for Cast Copper Alloy Fittings for Flared Copper Tubes.

D. ASTM B280: Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. All products shall comply with Section 15010, Paragraph 2.1; Acceptable Manufacturers.

B. Heat Pump Units: Mitsubishi.

C. Refrigerant Pipe and Fittings: Domestic manufacturers only.

2.2 AIR CONDITIONING UNIT

A. Type: Split system ductless air conditioner.

B. Indoor Unit: Wall (or ceiling) suspended unit (configuration as indicated on plans), with fan, adjustable discharge outlet, air filter, evaporator coil, refrigerant metering device, heavy gauge steel chassis, white plastic enclosure, controls, condensate pan and drain connection, and related accessories to operate properly with outdoor unit.

C. Outdoor Unit: Outdoor condenser and compressor unit, with high efficiency rotary compressor, condenser coil, condenser fan, accumulator, refrigerant piping, wind baffle accessory, heavy gauge steel chassis, baked enamel finish steel cabinet, controls, coil guard, mounting legs, and related accessories to provide capacity indicated.

D. Capacity: As scheduled on drawings at the conditions indicated. Unit shall provide cooling down to 0 deg F ambient. Unit shall be able to operate with refrigerant runs up to 164 feet long. Shall be rated in accordance with AHRI standards.

E. Refrigerant: Units shall be for use with refrigerant R-410A or R-407C.

F. Electrical and Controls: Indoor and outdoor units shall be provided with all contactors, relays, wiring terminals, safety controls, microprocessor devices, and accessories to allow for complete unit operation requiring only connection of room controller, power, and interconnection between indoor and outdoor units. Room controller shall be the electronic type, with liquid crystal display, room temperature sensor, on/off/auto functions, temperature setpoint, fan speed indicator, and self diagnostic display.

G. Condensate Pump: Provide unit with condensate pump. Where not available internal to unit, provide external type, with holding tank, controls, and gpm capacity at least 4 times unit condensate rate, at 10 feet of head. Provide mounting assembly and accessories for completely connected and functioning unit.

2.3 REFRIGERANT PIPING AND ACCESSORIES

A. Piping: Hard drawn ACR copper tubing per ASTM B280, Type L, with silver brazed joints and wrought copper fittings per ASME B16.22. Use only long radius elbows. Flared fittings (at equipment connections only) shall comply with ASME B16.26. Soft copper tubing may only be used on runs less than 50-feet or where necessary (i.e. when routing through sleeves, or similar door access areas).

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install in strict accordance with manufacturer's written instructions and code.

B. Location and Arrangement: Install all equipment at locations and as shown on the drawings. Install so as to allow maximum access to unit. Prior to selecting unit final location, confirm that: proper unit clearances and access will be provided; no adverse airflow conditions are present; confirm location and installation details with other trades. Units shall be level and aligned with building walls. Set outdoor unit on concrete pad (or roof sleepers); anchor to pad (or sleepers).

C. Complete Connections: Connect and install all items shipped loose with units; provide and connect all utilities and accessories as required for

proper unit operation. See Section 23 21 28 for cooling coil condensate drain piping.

D. Refrigerant Piping: Shall be silver brazed. Bleed dry nitrogen through piping during brazing to minimize oxidation. Keep all open ends of piping capped when not being worked. Soft copper shall have long radius bends; install without kinks or excess bends. Piping shall be routed concealed, except where routed outdoors and where noted. Piping shall be ran plumb and square to building walls, and in a neat professional manner. Provide sight glass in refrigerant liquid piping at outdoor unit.

E. Refrigerant Charge: Units shall be checked for proper refrigerant charge and oil level and charged to proper levels after all leak testing and evacuation work has been completed. Refrigerant to be added to the system shall be delivered to the site in factory charged containers and charged into the system through a filter/drier.

F. Cleaning: Units shall be thoroughly cleaned of all debris prior to operation. Units shall be clean and in new condition prior to Owner acceptance.

G. Operation: Units shall not be operated until all construction activities that generate dust, dirt, fumes, or odors are complete; system checkout has occurred; and the Engineer has reviewed the system and granted approval.

3.2 LEAK TESTING AND EVACUATION

A. Disconnect and isolate from the system any controls, relief valves, or other components that may be damaged by the test pressure.

B. Connect oil-pumped, dry nitrogen to the system through a pressure reducing gauge manifold. Charge enough nitrogen into the system to raise the pressure to 140 psig (or as required by the local Code authority).

C. Test all joints for leaks with a glycerin soap solution. Check the manifold gauge for any drop in pressure. Tap all solder/brazed connections with a rubber or rawhide mallet sufficiently hard to start any leak that might subsequently open from thermal expansion/contraction or vibration.

D. Repair any leaks found by completely disassembling the connection, cleaning the fitting and remaking the connection. Re-test the system after repairs are made.

E. When the above tests are successfully completed, allow the system to remain under test pressure (140 psig or as required by the local code authority) for 24 hours. Note the initial pressure and temperature. If the system pressure has not changed (when corrected to account for any change in temperature) the system may be considered free of leaks.

F. When all testing is completed the system shall be completely evacuated of all air and moisture. Connect a vacuum pump to the system and evacuate the system to 500 microns, and let stand for a minimum of 12 hours. If the vacuum reading remains unchanged, the system may be charged with refrigerant.

3.3 START-UP

A. Initial Checks: Prior to unit operation, the system shall be inspected to insure all equipment and controls are properly connected and ready to operate. As a minimum, the following items shall be checked.

1. Adequate refrigerant charge.
2. Gauges installed to read suction and discharge pressure.
3. Proper voltage at outdoor unit.
4. Proper voltage at indoor unit.
5. Unit safeties properly set and connected.
6. Fan motors lubricated and ready to operate.
7. Temperature controls connected.
8. Pipe leak testing completed.
9. Condensate drain installed.
10. System service valves in proper position.
11. Controls properly connected and powered.

B. Initial Operation: After start-up, check unit for proper unit operation including: proper fan rotation, no excessive vibration, no unusual noises, proper unit cycling in response to room temperature, no excessive room temperature swings, no safeties or electrical devices tripping out.

C. Written Report: Submit written report detailing all inspection procedures and findings leak test results, amount refrigerant charge installed, and final start-up/operation results.

3.4 COMMISSIONING

A. The Products referenced in this section are to be commissioned per Division 01 Section 23 08 00. The Contractor has specific responsibilities for scheduling, coordination, startup, test, development, testing and documentation. At a minimum, the Contractor shall provide a documented and signed record to verify that all equipment and systems installed under this contract have been inspected and functionally tested to verify full compliance with the contract specifications. In many cases, this shall require the Contractor to create or otherwise provide procedures and checklists for approval by the Commissioning Consultant prior to the start of functional testing. Reference Division 01 Section 23 08 00 and coordinate all commissioning activities with the Commissioning Consultant.

END OF SECTION

SECTION 15840 – HVAC DUCTS AND CASINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 0 and Division 1 Specification Sections, apply to this Section.

1.2 WORK INCLUDED

A. Ductwork Systems.

B. Flexible Duct.

C. Acoustical Duct Lining.

D. Preparation of Duct for Service.

E. Duct Pressure Testing.

1.3 DEFINITIONS

A. Duct Sizes: All duct dimensions shown are inside clear dimensions. Where inside duct lining is specified or indicated, duct dimensions are to the inside face of lining.

1.4 QUALITY ASSURANCE

A. All work and materials shall comply with HVAC-DCS, NAIMA-DLS, ASHRAE-F, IBC, IMC, NFPA-90A, NFPA-90B, and code. The most restrictive criteria governs.

B. Leakage Criteria: Duct system shall be constructed and sealed so that leakage does not exceed 5%.

C. Drawing Review: Prior to beginning any work review all drawings, duct routing, duct connections, and other duct work details to discover any possible conflicts between duct connections (e.g. supply connected into returns, ducts crossed in shafts, air outlets/inlets not connected to ducts; louver locations not matching architectural plans, etc.) with building structure unit locations, unit arrangements, or with other systems. Submit resolutions of such possible conflicts as submittals with shop drawings of proposed solutions.

1.5 SUBMITTALS

A. Submittals shall comply with Section 15010.

B. Submit shop drawings for all HVAC ductwork which is to be installed differently than as shown on the drawings.

C. Submit shop drawings showing proposed resolution of conflicts after review of documents and again after review of actual field conditions.

1.6 DUCT PRESSURE CLASS

A. Constant Volume Systems: Ductwork shall be constructed to the pressure class corresponding to the static pressure indicated for the fan which serves the ductwork, or to 1-inch pressure class standards (plus or minus as appropriate), whichever is higher; unless noted otherwise.

1.7 REFERENCES

A. ADC-FLEX: Air Diffusion Council Flexible Duct Performance and Installation Standards.

B. ASHRAE-F: ASHRAE Handbook of Fundamentals.

C. ASTM A 653: Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot Dip Process

D. ASTM A 924: General Requirements for Steel Sheet Metallic-Coated by the Hot-Dip Process

E. IMC: International Mechanical Code.

F. NAIMA-DLS: North American Insulation Manufacturers Association Fibrous Duct Liner Standards, 1st Edition.

G. NFPA 90A: Standard for the Installation of Air Conditioning and Ventilating Systems.

H. NFPA 90B: Standard for the Installation of Warm Air Heating and Air Conditioning Systems.

I. SMACNA-DCS: SMACNA HVAC Duct Construction Standards, 3rd Edition.

J. UL 181: Underwriter Laboratories Factory-Made Air Ducts and Air Connectors.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Products shall comply with Section 15010, Paragraph 2.1, Acceptable Manufacturers.

B. Sheet Metal: All domestic manufacturers.

C. Spin-in Fittings: Sheet Metal Connectors Inc., United McGill, Royal Metal Products, Airflow Products Inc.

D. Duct Sealant: Durkee-Atwood, Hardcast, Duro-Dyne, Benjamin Foster, Grace Construction Products, United McGill.

E. Flexible Duct: Flexible Technology Inc., JP Lamborn Co.; Hart & Cooley, Thermaflex.

F. Acoustical Duct Lining: Johns-Manville.

2.2 GENERAL MATERIALS

A. Ducts: Construct of galvanized sheet steel, suitable for lock forming without flaking or cracking, conforming to ASTM A653 and A924, having a zinc coating of 0.90 ounces total per square foot for both sides of a sheet, corresponding to coating G90.

B. Fasteners: Use rivets and bolts throughout; sheet metal screws are only acceptable on ductwork constructed to 2-inch pressure class standard or less.

C. Spin-in Fittings: Factory fabricated of galvanized steel with die-formed mounting groove and damper with raised damper quadrant where ducts are to be insulated. Collar length for flexible duct attachment shall be at least 2" long. Provide 45 degree scoop when the spin-in fitting is installed in a duct which has a width of 12 inches or more.

D. Air-Tight Take-Off Fittings: Factory fabricated of galvanized steel. Flange shall be 1-1/2” wide with 1/8” self-adhesive gasket and pre-drilled fastener holes. Collar length for flexible duct attachment shall be at least 2” long. Where used on round duct mains, shall be saddle type appropriately sized for main duct diameter.

E. Duct Sealant: Shall be fire resistant with a flame spread rating of 25 or less, and a smoke developed rating of 50 or less. Sealant shall also be water resistant and compatible with mating materials and types of joints or connections being sealed, specifically made for sealing ducts. Exterior duct sealant shall be specifically intended for outdoor use as a duct sealant, shall be ultraviolet ray and ozone resistant where exposed to natural sunlight.

2.3 DUCT FABRICATION

A. Duct Gauge and Reinforcement: Shall be as shown in SMACNA-DCS according to the pressure classification of the system and the duct dimensions.

B. Joints and Seams: Construct in accordance with SMACNA -DCS, code requirements, and these specifications (more stringent governs). Ducts shall be constructed and sealed so that the leakage criteria is not exceeded. Round ducts shall be the spiral seam type; except that branch ducts to individual air inlets/outlets less than 16" diameter may be of other types as allowed by SMACNA-DCS. Coordinate joint spacing with duct reinforcement requirements so that transverse joints having the required stiffness may be incorporated in the reinforcement spacing schedule. Round duct transverse joints shall be made with beaded sleeve joints or flanged connections in accordance with SMACNA-DCS; except that branch ducts to individual air inlets/outlets less than 16" diameter may use other joining methods as a allowed by SMACNA-DCS.

C. Elbows and Tees: Shall be long-radius type with a center-line radius not less than 1-1/2 times the width or diameter of the duct. Where space does not permit the use of long-radius elbows, short-radius or square elbows with turning vanes may be used. Elbows in round duct systems

shall be stamped type, welded segmented type, or standing seam segmented type.

D. Transitions: Increase duct sizes gradually. Transitions for diverging air flow shall be made with each side pitched out not more than 22.5 degrees. Transitions for converging air flow shall be made with each side pitched in not more than 30 degrees. Except that eccentric transitions for round to flat oval may have up to a 45 degree pitch.

E. Branch Connections: Shall comply with SMACNA-DCS, and as required herein.

1. Rectangular-to-Rectangular: Rectangular take-off with 45 degree angle on “inside” of take-off, minimum 4" length. Reference SMACNA-DCS Figure 4-6. Close corner openings.

2. Rectangular-to-Round:

a. Serving Individual Air Inlet/Outlet: Spin-in type connector or air-tight take-off (unless a different fitting type is specifically noted).

b. Serving Branch Duct: Rectangular to round transition, with maximum degree pitch as specified for transitions. Rectangular end size shall have free area no less than round end. Rectangular connection to rectangular main shall be made as specified for “Rectangular-to-Rectangular” connections.

c. Serving Individual VAV Terminal Unit: Conical type connector, with connector 2" larger on one end and maximum 15 degree pitch on sides.

3. Round-to-Round:

a. Serving Individual VAV Terminal Unit: Conical type connector (or conical tee fitting), with connection at the main duct 2" larger than the end serving the VAV terminal unit, and a maximum 15 degree pitch on sides; or “Lo-Loss” tee fitting, equivalent to that manufactured by United McGill.

b. Other Connections: Air-tight take-off or constructed in accordance with SMACNA-DCS and recognized professional practices.

4. Other Connections: In accordance with SMACNA-DCS and recognized professional practices.

F. Lined Ductwork:

1. Rectangular Ducts: Contractor Fabricated ductwork with duct lining. Duct fabrication and liner installation shall comply with NAIMA-DLS. Lining material shall comply with paragraph titled “Duct Lining” in this specification section.

2. Round and Oval Ducts: Shall consist of acoustic insulation in between a perforated interior duct liner and solid exterior duct. Acoustic insulation shall be 1-inch thick, except where noted to be greater. Duct sections shall connect by mechanical means to

maintain positive concentricity of liner with duct. All fittings and transitions shall have perforated inner liner (except where noted otherwise). Lining material shall comply with paragraph titled “Duct Lining” in this specification section. United McGill "Acousti-k27" (or approved).

2.4 FLEXIBLE DUCT

A. Type: Factory insulated fully lined flexible duct.

B. Construction: Polyester film (or coated woven fiberglass) internal liner encapsulating a zinc coated steel wire helix to form an air-tight core, with surrounding fiberglass insulation and outer polyethylene (or metalized/fiberglass scrim) vapor barrier.

C. Thermal Characteristics: Certified Thermal resistance “R” of 4.2 Hr-SF-Deg F/Btu in accordance with ADC-FLEX.

D. Working Pressure: As required to suit maximum pressure to be encountered on system, but no less than 4" w.g. positive, 0.5" w.g. negative.

E. Length: Shall not exceed 8 feet where used on duct systems with a pressure class rating of 2-inches and less; maximum 5 feet length on higher pressure class systems.

F. Code Compliance: Shall comply with all applicable codes, NFPA 90A, NFPA 90B, and shall be UL listed and labeled as a Class 1 connector per UL 181.

2.5 DUCT LINING

A. Material: Flexible, inorganic glass fiber material, bonded with thermosetting resin, maximum thermal conductivity of 0.26 Btu-inch/hr-sq. ft.-degree F at 75 degrees F, coated to prevent erosion, conforming to NAIMA-DLS and exceeding that standard as specified herein. Surface shall be coated with an acrylic coating having anti-microbial agents and factory applied edge coating Johns-Manville “Permacote Linacoustic” (or approved).

B. Thickness: Lining shall be 1-inch thick except where noted otherwise.

C. Adhesives and Fasteners: Shall conform to NAIMA-DLS, and as suitable for the duct liner material and ductwork.

PART 3 - EXECUTION

3.1 DUCTWORK INSTALLATION

A. General: Install all ductwork and plenums in sizes and locations as shown on the drawings, complete with all accessories and connections to provide complete and operable duct systems.

B. Field Measurements: Prior to fabricating any duct materials, the Contractor shall field measure all areas where ducts will be installed to

verify room available and all offsets and fittings required.

C. Workmanship: All work shall comply with code, SMACNA-DCS, and other applicable standards. Ducts shall be installed level (unless noted otherwise) and in neat lines with the building construction using best professional practices.

D. Exposed Ducts: All ducts are to be installed concealed unless indicated otherwise. Ducts that are exposed shall be carefully fabricated, stored, and installed for best appearance. All dents, dings, scratches and other damage shall be repaired for a high quality finished look; all dirt, debris, labels, stickers, lettering, and marks removed; and the duct completely cleaned. Any sealant shall be cleaned to form a straight and even seam adjacent to joints, have no overlap onto duct areas not needing sealant, and have all excess sealant removed.

E. Flexible Duct: May only be used where specifically shown on the plans. Attach flexible duct to sheet metal in accordance with manufacturer's instructions, using sheet metal screws or draw bands to secure the duct; in addition, coat the inside of flexible duct at connection with duct sealant. Install flexible duct with a centerline turning radius not less than one duct diameter. Where this turning radius cannot be maintained with the flexible duct, sheet metal elbows shall be used or (at air inlets/outlets) provide a plenum at the air inlet/outlet to allow for a straight side connection.

F. Spin-in Fittings: May be used for branch ducts to individual outlets only. Apply a bead of duct sealant to all spin-in fittings where fitting seals against sheet metal duct.

G. Sealing: Seal all joints as required to meet duct leakage criteria, and as a minimum to Seal Class C.

H. Coordination: The Contractor shall fully coordinate the work of all trades to avoid interferences and conflicts. Due to the extremely tight spaces in portions of the building, the Contractor shall coordinate duct reinforcement spacing and supports with other trades as necessary to avoid interferences. In addition, the Contractor shall select duct gauge and reinforcement types to avoid interferences. Changes required due to lack of coordination between trades, improper spacing or selection of hangers, or improper duct gauge and reinforcement selection, shall be done at no additional cost to the owner.

I. Protective Caps: Provide temporary sheetmetal caps or heavy visqueen covers over all open portions of ductwork to prevent debris, dirt, and dust from entering the ductwork. Such covers shall be installed at the end of each work shift, and shall remain in place until all work activities or events that may cause duct contamination will no longer occur.

3.2 ACOUSTICAL DUCT LINING INSTALLATION

A. General: Install acoustical duct lining in ducts to extent shown on drawings, covering all interior surfaces. Round ducts shall use factory fabricated double-wall ducts as specified.

B. Installation: Installation shall comply with NAIMA-DLS and these specifications. The liner shall be cut to assure tightly butted joints.

C. Liner Attachments: The duct liner shall be applied with a 100% coverage of adhesive. Mechanical Fasteners shall be installed flush with the liner surface, and shall be spaced in accordance NAIMA-DLS.

D. Horizontal Duct Runs: Tops of ducts over 12" wide and sides of duct over 16" high shall have liner additionally secured with mechanical fasteners.

E. Vertical Duct Runs: Any side of duct over 12" in size shall have liner additionally secured with mechanical fasteners.

F. Exposed Edges: All joints, exposed edges and any damaged areas of the liner, shall be heavily coated with fire resistant adhesive/mastic.

G. Metal Nosing: Install metal nosings on the leading edges of the liner in ducts where the velocity exceeds 4000 feet per minute.

3.3 PREPARATION FOR SERVICE

A. Cleaning: All ducts shall be wiped or blown clean of all dust and debris prior to the installation of grilles or diffusers. Notify the Engineer to allow for an inspection prior to installing grilles or diffusers.

B. Contaminated Ducts: Where ducts have been contaminated by dirt or debris during the construction process, the affected duct systems shall be cleaned by an independent firm specializing in the vacuum cleaning of ductwork. All costs associated with such cleaning shall be the responsibility of the Contractor.

END OF SECTION

SECTION 15860 – DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 0 and Division 1 Specification Sections, apply to this Section.

1.2 WORK INCLUDED

A. Manual Dampers.

B. Backdraft Dampers.

C. Turning Vanes.

D. Flexible Connectors.

E. Duct Access Doors.

F. Duct Thermometers.

1.3 QUALITY ASSURANCE

A. Construction and installation of all duct accessories shall comply with applicable SMACNA-DCS, and exceed those standards as noted.

B. Comply with Section 15010.

1.4 SUBMITTALS

A. Submittals shall comply with Section 15010.

B. Submit product information on all items to be used.

1.5 REFERENCES

A. SMACNA-DCS: SMACNA HVAC Duct Construction Standards, 3rd Edition.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Products shall comply with Section 15010, Paragraph 2.1, Acceptable Manufacturers.

B. Manual Damper Hardware: Duro-Dyne, Young Regulator Co., Ventfabrics, Krueger.

C. Backdraft Dampers: Air Balance, Ruskin, Greenheck.

D. Turning Vanes: Duro-Dyne, Aero-Dyne, Oil Capital Sheet Metal, Airsan.

E. Flexible Connections: Ventfabrics, Duro-Dyne Elgen.

F. Duct Access Doors: National Controlled Air, Ventfabrics, United-McGill, Kees, Ruskin, Vent Products.

G. Building Access Doors: J. R. Smith, Zurn, Acudor, Elmdoor, Kees, J.C. Industries.

H. Duct Thermometers: Weksler, Weiss.

2.2 MANUAL DAMPERS

A. Type: Manually adjustable volume dampers.

B. Blades: Damper blades shall be fabricated of galvanized steel or stainless steel (unless a specific material is indicated), two gages heavier than duct in which installed, and in accordance with SMACMA-DCS. Maximum blade width 12 inches; fabricate multi-blade dampers with opposed blade pattern for ducts larger than 12" x 48".

C. Regulators: Damper regulator sets shall have quadrant dial regulator with locking nut, square end bearing one side, and spring round end bearing other side (small sizes) or open end square bearing (larger sizes), axis of blade the long dimension. Multiple blade dampers shall have individual quadrants for each blade or one quadrant with interconnected blades. Regulator sets shall be Duro-Dyne model numbers (or approved equal) as follows:

Max. Blade Dimension	Duro-Dyne Regulator Set	Shaft Size
10" and less	KS-145, 145L	1/4"
11" to 14"	KSR-195, 195L	3/8"
15" to 23"	SRS-388, SB-138, KP105	3/8"
24" and larger	SRS-128, SB-112, KP105	1/2"

D. Concealed Regulator: For remote damper adjustment with finished ceiling appearance. Shall consist of self-locking regulator of cast alloy construction (with serrated core, spring washer, housing, indicator, lock nut) cast into a cylindrical housing for flush ceiling installation. Housing cover shall be of steel construction, shall telescope into the regulator housing to be flush with the finished ceiling, and be secured to the housing with two screws. Provide with extension rods, linkages, miter gears, and all accessories as needed for proper damper operation. Plain Finish. Ventfabrics No. 666, 667 or Young Regulator Co. No. 301 (or approved equal).

E. Extractor Fittings: Galvanized steel construction, 24 gauge steel blades on 2 inch centers, with worm gear operator for adjustment through face of grille. Krueger EX-88 (or approved equal).

2.3 BACKDRAFT DAMPERS

A. Type: Airflow and gravity operated backdraft dampers with adjustable counterbalance weight.

B. Frame: Shall be constructed of minimum 18 gauge galvanized steel or stainless steel or minimum 0.063 thick 6063T5 extruded aluminum (unless a specific material is indicated).

C. Blades: Shall be constructed of minimum 0.05" thick extruded aluminum, or formed stainless steel (unless a specific material is indicated), with extruded vinyl edge seals. Seals shall prevent any noise due to damper opening/closing. Bearings shall be synthetic polycarbonate or acetal type. Damper linkage shall be with aluminum or galvanized steel tiebar. Counterbalance weights shall be attached to blades, be of galvanized steel construction, and be adjustable.

D. Configuration: Horizontal or vertical airflow as indicated on plans.

E. Performance: Dampers shall be tested in accordance with AMCA standards. Pressure drop at 700 fpm airflow velocity shall not exceed 0.025 in w.g. Counterbalance weights shall be adjustable so that blades begin to open at 0.02 in w.g. pressure differential (unless noted otherwise).

F. Pressure and Velocity Ratings: Shall suit maximum velocity and pressure differential to which dampers will be subjected; but no less than 2500 fpm and 1.0-in w.g. differential pressure.

2.4 TURNING VANES

A. Type: Galvanized steel turning vanes to guide airflow through duct elbows to minimize pressure drop.

B. Construction: Turning vanes shall comply with SMACNA-DCS. Vanes shall be fabricated of minimum 26 gauge galvanized steel; rails shall be fabricated of minimum 24 gauge galvanized steel. For duct widths less than 12 inches, vanes may be single wall construction; for widths 12” and greater, vanes shall be double wall "airfoil" type.

C. Spacing: Turning vanes shall be equally spaced in accordance with SMACNA-DCS, parallel to each other, and securely attached to runners.

D. Unequal Elbows: For elbows where the inlet and outlet dimensions are not the same, modify vane shape or angle to provide optimum turning.

2.5 FLEXIBLE CONNECTORS

A. Type: Flexible fabric type connectors, to provide vibration isolation at equipment duct connections and to allow for movement in duct systems.

B. Flexible Fabric:

1. General: Flexible glass fiber fabric with an inorganic elastomeric coating.

2. Width: Minimum 3” wide except at equipment 3 hp or larger with external vibration isolators fabric shall be minimum 6” wide.

3. Indoor Applications: Neoprene type, black color, minimum 22 oz/sq. yard, 500 lbs x 500 lbs tensile strength.

4. Outdoor Applications: Durolon type, while color ozone resistant, 24 oz/sq. yard, 250 lbs x 275 lbs tensile strength.

C. Metal Collars: Minimum 24 gauge galvanized steel 3” wide metal edge connectors, each side of fabric, connected to fabric by folded over metal seam.

D. Temperature Rating: Shall be suitable for temperatures from -40 to 200 deg F.

E. Fire/Smoke Rating: Material shall have a flame spread rating of not over 25, and a smoke developed rating of not higher than 50, and comply with requirements of IMC and NFPA 90A.

2.6 DUCT ACCESS DOORS

A. Construction: Access doors shall be of double wall construction, made with minimum 24 gage galvanized steel, tight fitting, with sealing gasket, and cam locks (or may be hinged type with latches).

B. Size:

1. General: Access doors shall be of sufficient size so that items concealed in duct can be serviced and inspected, and shall be adequately sized to allow complete removal of the item being served (where removal cannot be made without disturbing fixed ductwork).

2. Minimum size: Doors shall be minimum 14" x 14". Where duct size will not accommodate this size door, the doors shall be made as large as practicable.

3. Large Sizes: Doors larger than 14" x 14" shall have a minimum of 4 cam locks (or where hinged type is used, have a minimum of two (2) latches).

C. Insulation: Doors in insulated ducts shall be insulated type, with minimum 1 inch thick fiberglass insulation.

D. Round Ducts: Access doors on round ducts shall use either lined rectangular tap off with rectangular access door or curved insulated access door (for insulated duct); or curved type un-insulated access door (for un-insulated duct).

2.7 BUILDING ACCESS DOORS

A. Type: Hinged lockable steel access doors, for wall or ceiling installation.

B. Construction: Minimum 16 gauge frame and 14 gauge door, concealed hinge, cam and cylinder lock, anchoring provisions, and 1: wide frame to conceal rough building opening. Provide of 18-8 stainless steel construction with No. 4 finish where used in restrooms, locker rooms, kitchens, and similar "wet" areas. Provide of steel construction with prime coated finish in other areas.

C. Size: Size shall be 12" x 12" (unless indicated otherwise) but shall be large enough to allow necessary access to item being served and sized to

allow removal of the item (where access door is the only means of removal without disturbing fixed construction).

D. Fire Rating: Door shall maintain fire rating of element installed in; reference drawings for required rating.

E. Keys: Access doors shall all be keyed alike. Provide two (2) keys for each door.

2.8 DUCT THERMOMETERS

A. Type: Dial bi-metal.

B. Construction: Minimum 3-inch diameter corrosion protected case, remote or direct type bulb as required, plus or minus 1% (of scale range) accuracy, white face with black digits graduated in 2 degrees F increments. Thermometer wells of the separable socket-type shall be provided for each thermometer with direct-type bulb.

C. Ranges:

1. Sensing Outdoor Air: -20 to 120 degrees F.
2. Sensing Supply Air: 30 to 130 degrees F.
3. Sensing Return Air: 30 to 130 degrees F.

PART 3 - EXECUTION

3.1 MANUAL DAMPERS

A. General: Dampers shall be fabricated and installed in accordance with SMACNA-DCS requirements for volume dampers.

B. Locations: Install dampers at locations shown on the drawings in branch ducts to all air inlets/outlets, and at all other locations as required by the Balancer to allow for the balancing of the system. Locate dampers at a point where the damper is most accessible; orient damper regulator for best access.

D. Non Accessible Dampers: Provide flush-mounted concealed type damper quadrants for ducts concealed in walls or non-removable ceilings and where a remote damper operator has been indicated.

E. Initial Setting: Set and lock all dampers in the full open position prior to balancing.

F. Extractor Fittings: Provide where indicated on the plans and at wall type inlets/outlets where such outlets cannot be served by a manual damper in the branch duct.

G. Identification: Provide orange surveyor’s tape, approximately 18” long tied to each damper regulator (except not required on dampers in ducts exposed to view in finished areas).

3.2 BACKDRAFT DAMPERS

A. General: Install in accordance with manufacturer's instructions.

B. Application: Use counterbalanced type at all non-fan powered building exhausts and reliefs; all others shall be the standard type.

C. Adjustments: Adjust counterbalanced backdraft dampers to be open at 0.07" building pressure (unless noted otherwise), or as necessary for proper space pressurization and building air balance. Coordinate work and settings with air balancer.

D. Access Doors: Provide access doors to backdraft dampers, except that where damper is installed immediately behind a ceiling or wall grille, and is accessible by removing this grille, an access door is not required.

3.3 TURNING VANES

A. General: Install turning vanes in all duct elbows and "T" fittings, and at locations shown on the drawings.

B. Attachment: Securely attach turning vane runners to ductwork.

3.4 FLEXIBLE CONNECTORS

A. General: Provide flexible connectors at all duct connections to all equipment, where ducts of dissimilar metals are connected, and where shown on the drawings. Except that flexible connectors are not required on internally spring isolated fans where the fan is located in a separate mechanical room and a flexible connector has not been shown.

B. Round: For round ducts, the flexible material may be secured by zinc-coated, iron clinch type draw bands directly to adjoining duct; or with normal duct joining methods and using metal collars furnished with flexible connectors.

C. Slack: Install flexible connections with sufficient slack to permit 1 inch of horizontal or vertical movement of ducts or equipment at flexible connection point without stretching the flexible material. At building expansion joints install sufficient flexible material to allow for 2 inch movement in any direction; provide two flexible connectors separated by a 12 inch section of duct.

3.5 DUCT ACCESS DOORS

A. General: Provide duct access doors at all automatic control dampers, fire dampers, fire/smoke dampers, smoke dampers, backdraft dampers, all duct coils, thermostats, filters, control devices, and any other components in the duct system that require service or inspection. Coordinate with Section 15900 to confirm quantity and location of control devices.

B. Return and Exhaust Ducts: Provide access doors every 20 feet in return and exhaust air ductwork as required by NFPA 90.

C. Size and Location: Access doors shall be of sufficient size and so located so that the concealed items may be serviced and inspected or completely removed and replaced.

3.6 BUILDING ACCESS DOORS

A. General: Provide access doors in walls, floors, ceilings, etc. as indicated on the drawings and where needed to provide service access or maintenance to duct access doors, backdraft dampers, damper actuators, automatic dampers, coils, control devices, fans, HVAC equipment and similar items.

B. Coordination: Consult architectural drawings and coordinate location and installation of access doors with trades which are affected by the installation.

3.7 THERMOMETERS

A. Thermometers shall be provided in the main supply air ducts at each air handling unit and where indicated or specified and shall be so located as to be easily read from the operating floor. Thermometers shall be duct-mounting or remote type.

B. On thermally insulated ducts, casings, equipment, or piping, stand-off mounting brackets, bases, adapters, or extended tubes shall be provided. These items shall provide clearance not less than the thickness of the insulation. Stand-off mounting items shall be integral with the thermometer or standard accessories of the thermometer manufacturer.

C. Remote-type thermometers shall have sensing elements or thermal elements with capillaries.

END OF SECTION

SECTION 15870 – AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 0 and Division 1 Specification Sections, apply to this Section.

1.2 WORK INCLUDED

A. Supply Outlets.

B. Exhaust Inlets.

C. Return Inlets.

D. Louvers.

1.3 REFERENCES

A. SMACNA-DCS: HVAC Duct Construction Standards, 3rd Edition.

1.04 SUBMITTALS

A. Shall comply with Section 15010.

B. Submit product information on all items.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Products shall comply with Section 15010, Paragraph 2.1, Acceptable Manufacturers.

B. Diffusers, Grilles, and Registers: Carnes, Titus, Metal-Aire, Krueger, Price, Tuttle & Bailey.

C. Louvers: Ruskin, Greenheck.

2.2 GENERAL REQUIREMENTS

A. Air outlets shall be of the size, type, and with number of throws as shown on the drawings; and shall match the appearance and performance of the manufacturers' models specified and scheduled on the drawings.

B. Air outlet application shall be based on a noise level of NC 30 maximum.

C. Furnish all necessary screws, clips, duct collars, and transitions required to allow for the air outlet installation and connection to ductwork.

D. Finish: Factory enamel finish, color as selected by Architect/Engineer, except that LSG type and any other wall inlets/outlets used in the same room/area as the LSG shall have brushed aluminum finish.

E. Frame Style: Provide air outlets and inlets with frame style to match ceiling or wall construction installed in. Where supply air outlets or inlets are installed in T-bar ceiling systems, they shall be factory installed in 2' x 2' or 2' x 4' metal panel to match ceiling layout. Where installed against gypsum board surface, brick or similar hard surface or, where exposed, provide with 1-1/4" wide outer border. Where space does not permit installing 2' x 2' metal panel, provide outlets or inlets with 1-1/4" wide outer border. Where air outlets are installed adjacent to surface mounted light fixtures, outlets shall have 4-inch deep drop frames. (See reflected ceiling plan and/or electrical lighting plan for ceiling type and allowable space).

F. Contractor shall measure actual louver wall openings prior to ordering or fabricating louvers. Notify Architect/Engineer of any discrepancy between actual wall opening and specified opening.

G. Ceiling transfer grilles (TG) shall be same as CEG's unless specifically shown otherwise; wall transfer grilles (WTG) shall be same as WEG unless specifically shown otherwise.

2.3 SUPPLY AIR OUTLETS

A. Ceiling Diffuser (CD): Shall be of aluminum or steel construction, have louver face and square neck (integral round neck is acceptable provided that performance equal to specified diffuser is provided). Cores shall be easy snap-in/out core installation - with no tools required. Provide with air flow grid to allow uniform airflow. Grids shall be comprised of a single set of extruded aluminum vanes set on 2/3" centers and tapered to a semi-air-foil shape for greater performance efficiency. Krueger Series S.

B. Ceiling Register (CR): Same as CD but with opposed blade damper.

C. Wall Supply Grille (WSG): Shall be of steel construction, with 14 gauge horizontal bars at 0 degree on 1/2" centers, reinforced on 6" centers by vertical 14 gauge bars. Core shall be welded to 14 gauge frame. Provide with screw holes on maximum 8" centers. Kees GHDO.

D. Wall Supply Register (WSR): Same as WSG but with an opposed blade damper operable through the face of the grille.

E. Round Ceiling Diffuser (RCD): Aluminum construction, stationary cones, positive latched inner core designed for easy removal. Provide with straightening grids (steel or aluminum construction), and radial opposed-blade damper consisting of 3 sets of dampers, operable from diffuser face. Provide with safety chain from core to diffuser body to prevent accidental dislodging of core. Kreuger Model RS-2.

2.4 RETURN AIR INLETS

A. Ceiling Return Grille (CRG): Aluminum construction, "cube-core" or "egg-crate" type, with 0.025" thick X 1/2" deep strips mechanically joined to form 1/2" x 1/2" x 1/2" cubes, and opposed blade damper operable from face of register. Krueger Series EGC-5.

B. Ceiling Return Register (CRR): Same as CRG but without opposed blade damper.

C. Wall Return Register (WRR): Same as WRG but with an opposed blade damper.

2.5 LOUVERS

A. Type: High performance, 6" deep, stationary, drainable louvers. Ruskin Model ELF6375D or approved.

B. Frame: 6" deep, constructed of minimum 0.090" 6063 extruded aluminum, with integral caulking slots and downspouts in jambs and mullions.

C. Blades: Shall be constructed of minimum 0.125" 6063 extruded aluminum, at 37.5 degree angle on approximately 4 1/2" centers, with drain gutter.

D. Bird Screen: Shall be constructed of 3/4" mesh, 0.051" aluminum.

E. Performance: Nominal free area of 51%, with pressure drop and water penetration equal to specified manufacturer's model.

F. Wind Loading: Louver shall incorporate structural supports required to withstand a wind load of 30 lb. per square foot.

G. Finish: Provide with same finish and color as specified in Section 07600 for metal flashing.

2.6 MISCELLANEOUS

A. Screen: 1/2-inch mesh, constructed of either 0.051-inch aluminum wire or 19 gauge galvanized steel wire.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install air outlets in locations shown on the drawings and so as to conform with architectural features and lighting arrangements.

B. Paint ductwork which is visible behind air inlets and outlets flat black.

C. All outlets and inlets exposed to the weather shall be adequately flashed and installed in a manner to assure complete weatherproofness.

D. Sealing and caulking of all outlets and inlets exposed to the weather shall conform to Division 7 requirements.

E. Provide screened openings (SO) on all duct openings where indicated and where openings do not have grilles or registers.

F. Coordinate with the Division 9 Contractor for any necessary painting of air inlets/outlets/louvers/etc. prior to installation.

END OF SECTION

SECTION 15900 – ELECTRIC AND ELECTRONIC CONTROL SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 WORK INCLUDED

A. Control System Design.

B. Control System for Building Heating, Ventilation, Air Conditioning, Exhaust

C. Control Devices, Components, and Wiring.

D. Testing, Adjustment., and Commissioning.

E. Owner Training.

1.3 SUBMITTALS

A. Shall comply with Section 15010.

B. Submit product information on all items to be used.

C. Submit a complete set of shop drawings prior to installation containing the following information: interconnect drawings showing all wiring and control connections; control panel details; arrangement of devices in panels; schedule of dampers with sizes and where used; sequence of operation for all equipment; location of all control devices on scaled building plans; and list of actuators with sizes and where used.

D. Submit list of proposed component labeling.

E. Operation and Maintenance Manuals: In addition to the information required by that Section and Division 1, provide (for inclusion in the Manual) the following:

1. System description
2. Complete sequence of operation.
3. Reduced size (11" x 17") copies of record drawings.
4. Submittal data on all products.

1.4 GENERAL REQUIREMENTS

A. Design and Installation: The entire control system shall be designed and installed by skilled control system designers, electricians and mechanics, all of whom are properly trained and qualified for the work they perform.

B. Sole Responsibility: One single Contractor shall be responsible to design, furnish and install the complete control system.

C. Sequence: System shall have sequence of operation as specified in Section 15900.

1.5 WARRANTY

A. Warranty: After completion of the installation of the control system and acceptance by the Owner, the system shall be warranted as free against defects in manufacturing, workmanship and materials for a period of two years from date of substantial completion. In addition, the system shall be warranted to provide the sequence of operation and basic features specified, with the accuracy and flexibility also specified. The system shall be repaired or replaced, including materials and labor, if in Owner's and Engineer's reasonable opinion, system is other than as warranted.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Products shall comply with Section 15010, Acceptable Manufacturers.

B. Thermostats and Time Clocks: Honeywell, Paragon.

C. Actuators: Belimo, Honeywell.

D. Dampers: Ruskin, Greenheck.

E. Control Accessories: Idec, Hoffman, McDonnell, Tridelta, Edwards, Mamac, Penn, Belimo, Honeywell, Johnson Controls, Leviton, Arrow-Hart.

2.2 BASIC SYSTEM

A. System Type: The system shall be an electronic or electric type.

2.3 THERMOSTAT AND TIMECLOCK

A. Programmable Thermostat: Shall be 7-day programmable solid state type, specifically designed for commercial use. Unit (and related relay module, and controls) shall allow for 1st-stage economizer cooling, 2nd stage unit cooling, 1st stage heating, 2nd stage heating and provide other features as required by the sequence of operation. Thermostat shall have means to bypass time clock, have Auto-Cool-Off-Heat switching, setpoint adjustments, and time/day adjustments. Unit shall also have capability for averaging multiple remote thermostat sensors. Honeywell T7351 Series, other Honeywell series (as required to provide sequence and match unit furnished), or approved.

B. Thermostat Sensor: Remote temperature sensor for use with programmable thermostat, specifically designed for commercial use. Unit shall have space temperature sensor, unoccupied mode pushbutton override with LED, and temperature setpoint adjustment. Honeywell T7771 Series, or approved.

C. Logic module: Solid state control package to provide economizer functions. Shall include logic module, sensors, and accessories necessary to provide a complete and operational system, and shall be compatible for use with specified HVAC equipment and programmable thermostat.

D. Accessories: Provide duct temperature sensors required for mixed air applications; shall be the averaging type with a sensor element type so as to sense a representative sample of the medium being controlled. Provide sensors as required to work with economizer controls.

2.4 CONTROL DAMPERS

A. Type: Similar and equal to Ruskin Models CD-36 or CD-46. Dampers shall be parallel blade or opposed blade type, as selected by contractor to best suit application.

B. Leakage: Shall not exceed 5.8 cfm per square feet at 1-inch w.g. pressure differential across closed damper (for 24-inch damper width).

C. Blades: Single blade type, not exceeding 6 inches in width. Fabricated from 16 gauge galvanized steel, with neoprene, extruded vinyl or butyl rubber edge seals and flexible metal jamb seals; linkage interconnecting all blades and actuator axle.

D. Bearings: Nylon, molded synthetic or oil impregnated sintered metal bearings.

E. Frame: Constructed of galvanized steel hat channel, minimum 16 gauge.

2.5 ACTUATORS

A. Actuators shall use a brushless DC motor controlled by a microprocessor. Run time shall be constant, independent of torque. Actuator shall have manual positioning mechanism and control direction of rotation switch accessible on its cover. Provide with auxiliary switches as required for sequence of operation.

B. Actuator shall be proportional or two position type, as required for application. Actuator power and torque shall be sufficient to match items being controlled and allow proper operation against system pressures liable to be encountered. Actuator shall be capable of driving controlled items from full closed to full open in less than 15 seconds.

C. Units shall be complete with all linkages, brackets, and hardware required for mounting and to allow for proper control and operation.

D. All actuators shall spring return upon power interruption: The spring return position shall be a “fail safe" position as dictated by freeze, fire, temperature protection, energy saving, or safe operating requirements. Outside air dampers shall spring return closed. VAV terminal units and zone dampers do not require spring return actuators.

2.6 ACCESSORIES

A. Wiring and Conduit: Shall comply with Division 26 specifications and with code. Wiring that performs code required life safety shutdown of equipment or fire alarm interface shall comply with NFPA standards and local codes for fire alarm system wiring.

B. Control Cabinet: Wall mounted, NEMA construction type to suit application, minimum 14 gauge sheet metal, hinged front door with latch. Size as required to house controls.

C. Relays: Shall be rated for the application, with a minimum of two sets of Form C contacts, enclosed in a dust-proof enclosure. Relays shall have Hand-Off-Auto switch, and LED's (or pilot lights) to indicate the energized mode. Relays shall be rated for a minimum life of one million cycles. Operating time shall be 20 milliseconds or less, with release time of 10 milliseconds or less. Relays should be equipped with coil transient suppression devices to limit transients to 150% of rated coil voltage. Contact rating, and configuration selected to suit application.

D. Duct Smoke Detector: Ionization or photoelectric type, with sampling tube (sized to match duct used on) 2 sets from C contacts rated at 10 amps (115 VAC) and 1 set from A contacts rated at 2 amps (30 VDC), and trouble contacts. For use with 115 VAC power. Suitable for temperatures 32 deg F to 140 deg F, and duct velocities up to 4,000 feet per minute. Unit shall be complete with plastic housing, clear plastic cover, gaskets, mounting hardware, visual indication of power and alarm, test/reset switch, and all accessories for proper operation. UL listed and complying with applicable codes and standards.

E. Miscellaneous Components/Sensors/Transmitters/Transformers: Shall be manufacturer's standard, designed for application in commercial building HVAC control systems, compatible with other components so as to provide sequence of operation specified.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Provide all devices, sensors, relays, switches, dampers, actuators, conduit, tubing, wiring, motor starters and all other devices required to provide a complete integrated control system with the sequence of operation and features as specified. It is the Contractor's responsibility to coordinate with other trades for the installation of control devices in systems installed by others.

B. Installation: Install all control components in accordance with manufacturer's instructions and recommendations and best professional practices.

C. Coordination: Coordinate work with other trades to ensure that all trades have the information necessary so that they may properly install any necessary control components, interconnect with control components,

and install their work to accommodate controls. Identify all items requiring ceiling or wall access doors (or other special requirements) to trade installing access doors or performing related work.

D. Space Requirements and Locations: Carefully check space requirements and coordinate with other trades to ensure that items can be installed in the allotted spaces, including above finished suspended ceilings. Adjust locations of panels, equipment, devices, and the like, to accommodate work and prevent interferences. Determine the exact route and location of wiring, conduit and other control devices prior to beginning work.

E. Mounting: Mount controls adjacent to associated equipment on vibration free elements on free standing fabricated supports; mount and locate for best access.

F. Control Cabinets: All electrical devices, relays, and components shall be installed in protective covers (i.e. control cabinets), except where installed concealed above ceilings a cover is not required. Controls/devices shall be logically assembled in cabinet, with all devices and cabinet labeled.

G. Thermostats: Room thermostats shall be mounted 4'-6" above finished floor unless indicated otherwise. Thermostats shall connect to the HVAC unit serving the space the thermostat is located in, unless indicated otherwise. Not all thermostats are shown on the drawings and those shown are preliminary only. Contractor shall indicate all final thermostat locations on submittal drawings. Contractor is responsible to coordinate locations to avoid tackboards, casework, and other interferences.

H. Power: It shall be the responsibility of this Contractor to provide power for all control devices requiring power. Coordinate with the Division 16 Contractor to arrange for necessary power circuits. All control devices shall obtain power from circuits dedicated to control power.

I. Wiring, Conduit and Electrical:

1. General: Provide all electrical wiring and devices in accordance with applicable codes and Division 16 requirements.

2. Conduit: All wiring shall be installed in conduit and in accordance with Division 26 specifications, except that low voltage wiring within ceiling plenum spaces, mechanical mezzanines, and attics may be installed without conduit. Wiring in walls shall be in conduit.

3. Wire Labeling: label or code wiring at each end to show location of the opposite end. Each point of all field terminal strips shall be permanently labeled or coded to show the instrument of item served. Color coded cable with cable diagrams may be used to accomplish cable identification and terminal strip.

4. Service Loop: Provide minimum of 6” extra wiring at all wiring terminations for ease of future maintenance/servicing. Such extra wiring shall be neatly coiled/bundled to allow for uncoiling when the connected equipment is serviced.

5. Workmanship: Install all conduit and wiring parallel to building lines, in neat bundles, supported at not less than 5 foot intervals.

J. Component Labeling: All control components, except regular room thermostats, shall be equipped with name plates to identify each control component. Components in finished rooms shall be labeled as to generic item controlled for better user understanding; other devices shall be labeled with the same designation which appears on the Control Diagrams. Contractor shall submit list of proposed labeling prior to installing.

K. Thermostat Setpoints: Thermostat Setpoints (all adjustable) shall be as follows unless indicated otherwise:

Occupied Heating	70 degrees F
Unoccupied Heating	65 degrees F
Occupied Cooling	75 degrees F
Unoccupied Cooling	85 degrees F

L. Motor Starters: Shall be by Division 16; except for loads 1/2 hp and less which shall be by this Section.

M. Device Duct Installation: All control devices installed in ductwork shall be positively anchored and attached to the ductwork by mechanical means (fasteners, straps, unistrut, etc).

N. Miscellaneous Controls: Provide all necessary control wiring between units furnished under other specification sections to allow for proper operation.

3.2 TESTING, ADJUSTMENTS, AND COMMISSIONING

A. General: Contractor shall verify that the proper installation and connections have been provided for all control work. Contractor shall provide installation checkout, start-up services, and perform a thorough check of all systems to confirm that the specified sequence of operation has been provided. The commissioning specified herein is independent of any commissioning work performed by (or in conjunction with) an independent commissioning agent.

B. Dampers: Verify all dampers operate through their full range of motion and in the proper direction in response to controls signals.

C. Sensors/Thermostats: Check measurements of temperature sensors, thermostats, pressure sensors and other devices against independent readings to confirm proper operation and sensor locations. Readjust sensor locations as necessary to account for field conditions that may cause inaccurate measurements.

D. Calibration: Calibrate items as necessary to allow for their proper operation.

E. Start-Up: Start-up systems in accordance with equipment manufacturer's instructions and coordinate with trades that installed the items being controlled so that they (or manufacturer's representatives) are present at start-up. See equipment specification sections for equipment start-up

requirements. Test and observe all equipment being controlled and confirm proper controls operation.

F. Sequence Verification: Operate all equipment and items being controlled multiple times and under varying conditions to confirm the specified sequence of operation has been provided.

3.3 OWNER INSTRUCTION

A. Owner Instruction: Provide instruction to Owner on the operation and maintenance of the control system. Provide field demonstrations and show staff the locations of all control devices and demonstrate system sequence of operation.

END SECTION

SECTION 15905 – SEQUENCE OF OPERATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 WORK INCLUDED

A. Sequence of Operation.

1.3 SUBMITTALS

A. Shall comply with Section 15010.

B. Submit complete description of sequence of operation. Sequence submitted shall not be a direct copy of the sequence specified herein, but shall be written to reflect the actual control sequence provided.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.1 GENERAL

A. General: Provide complete system with sequence of operation as specified herein.

B. Time Control: Control system shall provide time clock control (i.e. occupied/unoccupied/ warm-up modes switching) for all HVAC and exhaust equipment. Provide independent occupied/unoccupied schedules and optimum start (i.e. warm-up) cycle for each HVAC unit, all fans having time clock control, and all heaters. Except that exhaust fans serving adjacent restroom areas may share time schedules.

C. Warm-up Control: Control system shall provide warm-up switching for all HVAC units and items indicated as having a warm-up cycle.

D. Adjustability: All temperature setpoints and time control settings shall be adjustable.

E. Thermostats: Various thermostats are not shown on the drawings but are required per the sequence of operation specified. Coordinate with Engineer for location of all such thermostats prior to installing. Indicate proposed locations on submittals.

F. Average Thermostats: Where average thermostats are indicated on plans combine and average temperature requirements from each sensor and use average requirements to control equipment.

G. Miscellaneous Dampers: See plans for units with motorized dampers in the ducts.

3.2 HEAT PUMPS

A. General:

1. Controls shall control the units cooling, heating, system dampers (economizer), in proper sequence to provide a supply air temperature that will satisfy space conditions.

2. Heating and cooling shall be properly sequenced so that there is no overlap between the use of heat and cooling.

B. Occupied Mode: Fan shall run continuously. Unit shall cycle in heating or cooling modes as required to satisfy space thermostat.

1. Heating: Heat pump shall operate at 1st stage of heating, with electric heater as final stage.

2. Cooling: Heat pumps with economizers shall use outside air as the first stage of cooling. Economizer shall be dry bulb type, using Outside Air (OA) temperature sensor, mixed air temperature sensor and supply air temperature control scheme. Economizer shall be enabled only when OA temperature is less than the units Return Air (RA) temperature. The OA/RA dampers shall be modulated as required to satisfy the supply air temperature control scheme. Heat pump shall operate in the cooling mode as the final stage of cooling.

C. Unoccupied Mode: Unit shall cycle on and off as required to maintain setback temperatures. Outdoor air dampers shall be fully closed.

D. Warm-up Mode: Unit shall run as in the unoccupied mode (outdoor air dampers fully closed) until the space temperature has warmed up to the occupied mode heating setpoint, then unit shall operate as specified for the occupied mode.

E. Mode Control: Units' mode of operation shall be determined by unit thermostat and bypass switch; warm-up mode shall be initiated by thermostat’s optimum start controls.

3.3 MISCELLANEOUS CONTROLS

A. Fire Alarm System Shutdown:

1. Provide necessary conduit, wiring, and accessories to shutdown each unit upon activation of that unit's smoke detectors. Connections shall be hardwired, independent of any control system logic, so that failure of control system or loss of control system will in no way prevent the fire alarm shutdown of the system. In addition to shutting down the unit with the alarmed

smoke detector, all equipment interlocked or served by that unit shall be off. Other units shall also shut-off as required to avoid building pressure differentials and similar undesirable effects. Upon reset of alarmed device, system shall automatically return to normal, provide time delay start of equipment to prevent excess load starting at the same time.

2. In addition to the above specified hardwired fire alarm shut-down (which pertains to equipment with smoke detectors), provide the following: Shut-down all air handling equipment when the building fire alarm system goes into alarm. Zone contacts in the fire alarm system are available for this purpose. This added shut-down may be accomplished by use of control logic and is not required to be hardwired but shall be of a fail-safe nature so as to provide the necessary shut-down in case of control failure. Reset shall be same as that specified for hard-wired unit smoke-detector shut-down.

END SECTION

SECTION 15950 – TESTING, ADJUSTING, BALANCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 0 and Division 1 Specification Sections, apply to this Section.

1.2 WORK INCLUDED

A. Air Balancing.

B. Report.

1.3 SUBMITTALS

A. Shall comply with Section 15010.

B. Submit name and qualifications of Company proposed to do the balancing, and sample balancing forms.

C. Submit list of personnel that will be assigned to the project and their qualifications, list of past projects.

1.4 REFERENCES

A. Associated Air Balance Council: National Standards for Field Measurements and Instrumentation.

B. ASHRAE: 2009 Handbook of Fundamentals.

C. American Conference of Governmental Hygienists: Industrial Ventilation, A Manual of Recommended Practice, 20th Edition.

1.5 GENERAL REQUIREMENTS

A. General: The air and hydronic balancing shall be done by a company which specializes in this type of work and is totally independent and separate from the company or contractor which has installed the systems to be balanced.

B. Professional Affiliation: Work of this section shall be performed by an AABC member balancer or NEBB certified balancer.

C. Prior to beginning balancing, submit the name of the company the Contractor proposes to have do the balancing to the Architect/Engineer for approval.

D. Notify the Architect in writing of all problems or discrepancies between actual conditions and what design documents show as work proceeds.

E. The Balancer shall be directly responsible to the Engineer and shall perform this work as directed by the Engineer.

PART 2 - PRODUCTS

2.1 GENERAL INSTRUMENTATION

A. Balancing equipment shall comply with Associated Air Balance Council recommendations for field measurement instrumentation.

B. All measuring instruments shall be accurately calibrated and maintained in good working order. Calibration dates and certifications shall be available at Engineer's request.

C. Instruments shall be capable of:

1. Air velocity instruments, direct reading in feet per minute with 2% accuracy.
2. Static pressure instruments, direct reading in inches water gauge with 2% accuracy.
3. Tachometers, direct reading in revolutions per minute with 1/2% accuracy; or revolution counter accurate with 2 counts per 1,000.
4. Thermometers, direct reading in degrees Fahrenheit with 1/10 of a degree accuracy.
5. Pressure gauges, direct reading in feet of water or psig with 1/2% accuracy.

PART 3 - EXECUTION

3.1 GENERAL

A. All air systems shall be completely balanced and adjusted to provide the air and water flow rates indicated, and to produce an even heating and cooling effect and control response.

B. Consult and coordinate with the Section 15900 (Controls) Contractor for the adjustment of all control devices to allow for proper system operation.

C. Make final adjustments for flow rates in order to optimize each space's comfort, including such considerations as temperature, drafts, noise, pressurization, and air changes. Where variances are made from design values, state reasons in report (e.g., "too noisy", "too drafty," etc.). All such variances are subject to approval by the Architect/Engineer.

D. All measurements and adjustments shall be in accordance with the Associated Air Balance Council National Standards.

3.2 AIR BALANCING

A. Pre-check of System: Prior to beginning balancing, perform, as a minimum, the following:

1. Verify that clean filters have been installed, that system is free from debris, and that all inlets/outlets are not obstructed.
2. Check all fans and equipment to verify that proper start-up and system preparation has been done by the installing contractor.

3. Check all door/window and similar building opening status to insure building is ready and proper pressurization can be obtained.
4. Open all dampers to full flow position, check positions and operation of all motorized dampers to allow full system flows.
5. Review controls and sequences of operation.

B. Tolerances: All air flow rates (supply, return, and exhaust) shall be adjusted to within plus 5 percent and minus 5 percent of the values shown in the contract documents, except that relative space-to-space pressure relationships shall always be maintained (e.g., restrooms shall be negative relative to other areas, general offices shall be positive, etc.).

C. All diffusers, grilles, and registers shall be adjusted to minimize drafts and to eliminate objectionable noise.

D. Air balancing shall be done with new, clean air filters installed. Adjust air deliveries so that design quantities will be obtained when filters are half dirty. This condition shall be simulated by covering a portion of the filter area.

E. Adjust fan speeds and fan drives as required to produce design air quantities.

F. Measurements and adjustments of the air handling and distribution equipment shall be executed in a manner consistent with the manufacturer's recommendations.

G. At completion of balancing, mark the final position of all balancing dampers and record all data.

H. Air flow measurements in main ducts shall be made with a duct traverse using a pitot tube and micromanometer. Summation of air terminal outlets and inlets is not sufficient. Quantity of duct leakage shall be indicated.

I. Duct traverses in rectangular duct shall measure the center of equal areas in the air flow stream, with centers not more than 6 inches apart. Round duct traverses shall measure at least 20 locations, with locations being the centers of equal annular area. Reference the ACGIH Industrial Ventilation Manual.

J. Balance each branch run so that there is at least one wide open run; balance branches relative to one another so that at least one branch damper is wide open. Except that where unique conditions exist, and the Engineer gives prior approval, one open damper on runs or branches, is not required.

K. Requirements for All Air Handling Systems: Data to be measured/recorded and provided in report:

1. Floor plans clearly showing and identifying all diffusers, grilles, O.A. louvers, ducts and all other items where air flow rates were measured.

2. Identify manufacturer, model number, size, and type of all air inlets/outlets.
3. Initial, trial, and final air flow measurements for all diffusers, grilles, O.A. louvers, ducts, and all other items where air flow rates were measured.
4. Design air flow rates and percentage final air flow rates are of design values.
5. The connected voltage and corresponding nameplate full load amps, and the initial and final amperages of all fan motors.
6. Initial and final RPMs of all fans.
7. Static pressures on inlet and outlet of all fans.
8. Fan initial and final CFMs.
9. Outdoor air CFMs (record minimum and maximum values).
10. Entering air temperature (db heating) across coils and fan.
11. Leaving air temperature (db heating) across coils and fan.
12. Static pressure drop across each filter and coil bank.
13. Data required for all equipment which are part of balanced systems:
    a. Equipment name and number (as used on drawings).
    b. Service.
    c. Equipment manufacturer and model numbers.
    d. Sheave and belt sizes (where applicable).
    e. Filters sizes and quantities (where applicable).
    f. Motor manufacturer and complete nameplate data.
    g. Design operating conditions.
    h. Actual operating conditions (flows, pressure drops, rpm, etc.).
14. Provide sheave changes as necessary to allow adjustment to fan speeds.

3.3 BALANCING REPORT

A. General: A balancing report shall be submitted as specified herein, documenting all balancing procedures and measurements.

B. Preliminary Report: Two preliminary review copies of the balancing report shall be submitted to the Architect/Engineer when the balancing work is 90% complete (or as near 90% complete as possible due to uncompleted work of other trades). In addition to containing all the information required of the final report, the preliminary report shall contain a list of all the work required of other trades in order to allow the balancing work to be completed. The Architect/Engineer will review the preliminary report and inform the Contractor of any additional items or revisions required for the final report.

Preliminary reports may be omitted where the Architect/Engineer grants approval.

C. Final Report: Shall be included in the Operation and Maintenance Manual. Submit reports to Contractor for inclusion in Manuals (or, when manuals have been already sent to Engineer, send report to Engineer who will insert report into Manual). Provide number of reports as required to match quantity of O&M Manuals, but in no case less than five (5).

D. Report Organization: The report shall be divided into logical sections consistent with the building or system layout (i.e. by floors, building wings, air handling units, or other convenient way). Tabulate data separately for each system. Describe balancing method used for each system.

E. Format: 8-1/2" x 11" size, neat, clean copies, drawings accordion folded. Report shall be typed, shall have a title page, table of contents, and divider sheets with identification tabs between sections. Information shall be placed in a three hole notebook, with the front cover labeled with the name of the Job, Owner, Architect/Engineer, Balancing Contractor, and Report Date.

F. General Balancing Information Required:

1. At the beginning of the report, include a summary of problems encountered, deviations from design, remaining problems, recommendations, and comments.
2. List of instruments used in making the measurements and instrument calibration data.
3. Names of personnel performing measurements.
4. Explanation of procedures used in making measurements and balancing each system.
5. List of all correction factors used for all diffusers, grilles, valves, venturi meters, and any other correction factors used.
6. Areas where difficulties were encountered in obtaining design flow rates, or where unstable operating conditions may exist.
7. Note any parts of the system where objectionable drafts or noises may be present and efforts made to eliminate same and why they may still be present.
8. Note where variances from design values occur; explain why.

G. Air Balancing Information: All previously cited required measurement/recorded data, any additional recorded data, and observations.

END OF SECTION

SECTION 15995 - COMMISSIONING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 0 and Division 1 Specification Sections, apply to this Section.

1.2 WORK INCLUDED

A. Commissioning of HVAC Systems.

B. Documentation.

1.3 SUBMITTALS

A. Comply with Section 15010.

B. Commissioning Firm's Experience: staff to be assigned.

C. Commissioning test plan.

D. Commissioning preliminary report.

E. Final commissioning report.

1.4 GENERAL REQUIREMENTS

A. Commissioning Firm: Work of this Section shall be done by a firm independent of the firm which installed the systems. Firm shall have experience in commissioning similar systems. Firm may be an air balancing firm, commissioning firm, or consulting engineer.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.1 GENERAL

A. Provide commissioning as required by Code and as specified herein.

B. Building or portions thereof, required by Code to be commissioned, shall not be considered complete (and able to be occupied) until such time that the building official determines that the preliminary commissioning report required by this Section has been completed. Reference WSEC.

3.2 HVAC SYSTEMS

A. HVAC control systems shall be tested to ensure that control devices, components, equipment and systems are calibrated, adjusted and operate in accordance with plans and specifications.

B. Sequences of operation shall be functionally tested to ensure they operate in accordance with approved plans and specifications.

3.3 DOCUMENTATION

A. Test Plan: Prepare a commissioning test plan and submit for approval prior to beginning commissioning work. Test plan to include:

1. Equipment and systems to be tested, including the extent of sampling tests.
2. Functions to be tested (for example, calibration, economizer control, etc.),
3. Conditions under which the test shall be performed (for example, winter design conditions, full outside air, etc.),
4. Measurable criteria for acceptable performance.

B. Preliminary Commissioning Report: A preliminary commissioning report of test procedures and results shall be prepared and submitted. Report shall include field notes of commissioning activities. Field notes of commissioning shall indicate sequence (or performance, mode of operation, etc.) to be checked, what was done to test this sequence, and the results. The preliminary report shall identify:

1. Deficiencies found during testing required by this Section, which have not been corrected at the time of report preparation and the anticipated date of correction.
2. Deferred tests which cannot be performed at the time of report preparation due to climatic (or other) conditions.
3. Climate (or other) conditions required for performance of the deferred tests, and the anticipated date of each deferred test.

C. Final Commissioning Report: A complete report of test procedures and results shall be prepared and filed with the Owner. Final report shall include all previously cited information. Report shall be in 8-1/2 x 11 format, in 3 ring notebook, clean legible, and logically organized with divider tabs.

END OF SECTION

SECTION 16010 – ELECTRICAL GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. General requirements specifically applicable to Division 16 in addition to provisions of General Conditions, Supplementary Conditions, Special Conditions, and Division 1.

1.2 REGULATORY REQUIREMENTS

A. Comply with requirements of the following codes as adopted and supplemented by authority having jurisdiction:

ANSI/NFPA 70 - National Electric Code

IBC - International Building Code

IMC - International Mechanical Code

WAC 296-46B - Washington State Electrical Safety Standards, Administration, and Installation

Washington State Energy Code

B. Comply with additional codes and regulations referenced in other sections.

C. Comply with additional codes and regulations required by authority having jurisdiction.

D. Obtain and pay for permits, and inspections from authorities having jurisdiction over work included under applicable Division Sections.

E. Include all testing, shop drawings, and documentation required by the inspection authorities for permitting and final approval.

1.3 SUBMITTALS

A. Comply with requirements of Division 1.

B. Confirm dimensions, ratings, and specifications of electrical materials, devices, fixtures, and equipment conform to project requirements prior to furnishing submittals. Coordinate electrical requirements with utilization equipment submitted under other sections and verify that voltage, phase, and rating are compatible with work shown in the electrical project documents.

C. Do not order materials or commence Work until applicable submittal has been reviewed and the DISTRICT has approved or taken other appropriate action.

1.4 SUBSTITUTIONS

A. Comply with requirements of Division 1. Products specified by naming one or more manufacturers establishes a basis for quality, styling, capacity, and function.

B. Substitution requests may be submitted for any manufacturer or named product unless specified as "no substitute".

C. Substitution approval does not relieve the Contractor of complying with the work requirements or the concept and intent of the project documents. Pay for any and all additional project costs that may be caused by Contractor requested substitutions, regardless of whether or not additional costs are overlooked, missed, or unforeseen, and regardless of when substitutions may be approved.

1.5 RECORD DOCUMENTS

A. Comply with requirements of Division 1. Maintain at project site one set of clean, dry, and legible red-lined record drawings for submittal at Contract Close-out. Record information concurrently with construction progress.

B. Indicate electrical changes in the contract documents. Include change orders, revised branch circuit and feeder wiring layouts, revised circuit identification, pull & junction boxes added during construction, and actual dimensioned location and routing of each underground conduit on record drawings.

1.6 OPERATION AND MAINTENANCE MANUALS

A. Comply with requirements of Division 1.

B. Include the following information where applicable:

1. Names, addresses, and telephone numbers of the contractor, the installing sub-contractor, and the local representative for each system or equipment.
2. All approved product data and shop drawings.
3. Identify all manufacturer warranties which exceed one year.
4. Model number and serial number of each piece of equipment provided.
5. Data from test results performed under the Contract.

C. Operation and maintenance data shall include complete parts lists, installation and maintenance instructions, safety precautions, operation sequence describing start- up, operation, and shut-down, internal and interconnecting wiring and control diagrams with data to explain detailed operation and control, and testing methods for each system and item of equipment.

D. Furnish a draft copy of Operations and Maintenance Manual for the DISTRICT review and incorporate comments prior to final submittal. Allow 14 days for the DISTRICT's review.

1.7 CONFLICTS

A. Where conflicts or variances occur between drawings and specifications, or within either document, include highest construction cost in the Contract price. The DISTRICT will determine which work is to be performed.

1.8 WARRANTY

A. In addition to requirements covered under General Conditions or Division 1, include manufacturer product warranties that exceed one year. Assemble or list warranties that exceed one year in Operation and Maintenance Manuals indicating start date.

1.9 INTENT OF DRAWINGS

A. Drawings are diagrammatic and do not attempt to show all features of work, exact construction details, or actual routing of conduit and cable. Provide wiring with necessary supports, off-sets, bends, risers, and boxes required for complete installation.

1.10 COORDINATION

A. Examine architectural, civil, structural, and mechanical drawings and specifications and consult with other trades, as required to coordinate use of Project space and sequence of installation.

B. Arrange wiring and equipment to avoid interference with other work and to maximize accessibility for maintenance and repairs.

1.11 REQUIREMENTS FOR EQUIPMENT FURNISHED UNDER OTHER SECTIONS OR BY OWNER

A. Provide power wiring; disconnect switches, and electrical connection of equipment. Provide field wiring for control circuits, except Automatic Temperature Control (ATC) wiring. ATC shall be responsibility of Division 15 unless specifically noted otherwise.

1.12 DEFINITIONS

A. Electrical terms used in these specifications are as defined in NEC Art. 100 unless otherwise noted.

B. Concealed: Hidden from view as in walls, trenches, chases, furred spaces, crawl spaces, unfinished attics, and above suspended ceilings.

C. Exposed: Exposed to view in any room, hallway, passageway or outdoors.

D. Furnish: Obtain and/or prepare and deliver to the project.

E. Indicated: Shown, scheduled, noted, or otherwise called out on the drawings.

F. Install: Enter permanently into the project complete and ready for service.

G. Provide: Furnish and install complete and ready for service.

H. Equipment Connection: Make branch circuit connection, mount and connect control devices as required. Provide disconnect and overcurrent protection when required by NEC and IMC, if not otherwise indicated or furnished with equipment.

I. Wiring: Conductors in raceway or an approved cable assembly.

J. Open Cable or Wiring: Conductors above grade not installed in conduit or raceway.

K. Panel: Distribution panelboard, lighting and appliance panelboard, load center, and/or low voltage cabinet.

1.13 SCHEDULE OF VALUES

A. Provide Schedule of Values for use by the DISTRICT to evaluate progress payment requests during construction.

B. Submit Schedule of Values for review and approval. Include additional line items as requested.

PART 2 - PRODUCTS

2.1 MATERIALS, EQUIPMENT

A. General: Furnish only products that are new and free from defects with a manufacture date that is less than six months from date of installation. Where product and applicable software updates or upgrades are available from the manufacturer, furnish the latest version unless otherwise specified.

B. Listing and Labeling: Furnish and install only products that are listed and labeled by one or more of the following testing laboratories as approved by the Authority Having Jurisdiction:

Underwriter's Laboratories, Inc.	(UL)
ETL Testing Laboratories, Inc.	(ETL)
Factory Mutual	(FM)

PART 3 - EXECUTION

3.1 WORKMANSHIP

A. Install work using procedures defined in ANSI/NECA 1-2006, Standard Practices for Good Workmanship in Electrical Construction.

3.2 INSTALLATION

A. Provide all labor, equipment, material, accessories, and testing for electrical systems complete and operating.

B. Provide testing, documentation, and filing required to comply with commissioning requirements of Chapter 15 of the Energy Code. Include documentation in Operation and Maintenance Manuals.

3.3 CUTTING AND PATCHING

A. Provide cutting and patching to complete electrical work and to provide openings in elements of Work for electrical penetrations. Comply with requirements of Division 1.

B. Locate and execute cuts so as not to damage other work or weaken structural components. Core drill or saw cut rigid materials.

C. Patch to restore to original condition. Refinish surfaces to match adjacent finishes. For continuous surfaces, refinish to nearest intersection; for an assembly, refinish entire unit.

3.4 EQUIPMENT FURNISHED UNDER OTHER SECTIONS OR BY OWNER

A. Review equipment submittals prior to installation and electrical rough-in. Verify location, rating, size, and type of connections. Coordinate field wiring requirements and details with supplier and installer. Notify the DISTRICT of conflicts between requirements for actual equipment being furnished and equipment indicated in contract documents prior to commencing Work.

B. Install controllers, operator stations, and control devices such as limit and temperature switches furnished with equipment.

C. Make final connections to equipment. Provide cord and plug where required for plug-in connection.

END OF SECTION

SECTION 16050 – BASIC MATERIALS & METHODS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Conduit and fittings.

B. Building wire and cable.

C. Wiring connections and terminations.

D. Boxes.

E. Wiring devices.

F. Photo controls.

G. Cable tray.

H. Supporting devices.

I. Earthwork for underground electrical

1.2 RELATED SECTIONS

A. Excavation and Backfill for Underground Conduit: Comply with Division 2 - Site Work.

1.3 SUBMITTALS

A. Submit product data for conduit fittings, wire and cable, watertight connectors, wiring devices, photo controls, and cable tray.

B. Submit shop drawings for installation of cable tray, including wire basket type.

PART 2 - PRODUCTS

2.1 CONDUIT

A. Rigid Steel Conduit (RGS): ANSI C80.1; hot dipped galvanized.

B. Intermediate Metal Conduit (IMC): Hot dipped galvanized.

C. Electric Metallic Tubing (EMT): ANSI C80.3; galvanized tubing.

D. Flexible Metal Conduit: Galvanized steel. Heavy wall except reduced wall may be used where concealed in building construction.

E. Liquid Tight Flexible Metal Conduit: Galvanized steel, PVC jacket.

F. Non-Metallic Conduit: NEMA TC 2; EPC-40-PVC and EPC-80- PVC.

2.2 FITTINGS

A. RGS and IMC Conduit: ANSI/NEMA FB 1; threaded type. Provide hubs and connectors with insulated throat for conduit larger than 3/4 inch diameter

B. EMT Conduit: ANSI/NEMA FB 1; steel, compression type. Crimp-on, drive-on, indenter, and set screw type prohibited. Provide connectors with insulated throat for conduit larger than 3/4 inch diameter.

C. Flexible Conduit: ANSI/NEMA FB 1; steel, single screw squeeze type.

D. Liquid tight Flexible Conduit: ANSI C33.84, steel. Provide PVC coated fitting where installed outdoors.

E. PVC Conduit: NEMA TC 3; solvent welded type, same manufacture as conduit.

F. Corrosion Protection: Zinc plated minimum indoors and hot dipped galvanized minimum outdoors and indoor wet locations for all metal fittings and accessories.

2.3 WIRE AND CABLE

A. Copper Building Wire, AC or DC, Interior: Type THWN-2, 600 volt insulation; conductors 8 AWG and larger shall be stranded. Type XHHW-2 may be substituted for conductor sizes 4 AWG and larger.

B. Copper Building Wire, AC, or DC, Outdoors: Type XHHW-2, 600 volt insulation; conductor 8 AWG and larger shall be stranded.

C. Non Metallic Sheathed Cable: Type NM, copper conductors, 600 volt insulation rated 90 degrees C, with integral equipment ground conductor.

2.4 WIRE CONNECTORS

A. Connectors for Wire Size 8 AWG and Smaller: Insulated steel spring twist-on pressure connector with plastic cap. Outdoors use watertight type with prefilled sealant gel.

B. Connectors for Wire Size 6 AWG and Larger: Solderless pressure or compression type with pre-formed insulated cover. Outdoors make watertight using in line shrink sleeve or pigtail cap and sealing mastic.

C. Outdoor Taps Below Grade for Wire Size #6 AWG and Larger: Ilsco PED series underground multi-tap, wire range and number of ports as required.

D. Gutter/Wireway Taps for Wire Size #6 AWG and Larger: Ilsco type PDB series AL/CU lug type distribution block, number of poles and quantity/size of primary/secondary lug ports as required for the application.

2.5 BOXES

A. Outlet Boxes: ANSI/NEMA OS 1; galvanized sheet steel, with ½-inch male fixture studs or plaster rings as required. Non-metallic boxes conforming to ANSI/NEMA OS2 may be used where recessed for NM cable installation.

B. Surface Outlet Boxes for Outdoor and Wet Locations: Cast aluminum with baked enamel or epoxy finish, gasketed cover, stainless steel hardware. Outlet boxes shall have threaded hubs.

C. Junction and Pull Boxes: Outlet box with blank cover except boxes larger than 4 inch square shall be screw cover type, galvanized steel with grey

enamel finish, NEMA 1 indoors and NEMA 3R outdoors, unless otherwise indicated.

2.6 WIRING DEVICES

A. Wall Switches: Hubbell 1221, Leviton 1221, Pass & Seymour 20AC1, Cooper 2221; specification grade, 20 ampere, 277 volt, quiet type. Single pole, double pole, 3-way, 4-way as required. Color: Ivory

B. Duplex Receptacles: Specification grade 5362 series, NEMA 5-20R, grounding type, as manufactured by Hubbell, Leviton, Pass & Seymour, Cooper. Color: Ivory.

C. Ground Fault Circuit Interrupter (GFCI) Receptacles: Same manufacture, rating, and color as duplex receptacles except devices shall comply with UL 943, Class A, for 2006.

D. Duplex Receptacles, Weather Resistant for Damp and Wet Locations: Same manufacture, rating, and color as duplex and GFCI receptacles except devices shall be UL listed as weather resistant and permanent special purpose identification shall be visible on the device.

E. Flush Mounted Device Plates: Super heavy duty for high abuse application, rigid high impact thermoplastic, smooth finish, color to match device. Thermoset, phenolic, urea, nylon, and flexible polycarbonate not approved. Cooper PJ series manufacture.

F. Surface Mounted Device Plates: Raised galvanized steel on steel boxes; cast or stamped sheet aluminum on cast boxes.

G. Damp and Wet Location Device Plates: Gasketed opaque polycarbonate cover assembly, listed as weatherproof when in use, stainless steel mounting hardware. TayMac Corporation specification grade or approved equal.

2.7 PHOTO CONTROLS

A. General: Weatherproof, off-day/on-night, 2000 watt tungsten rated, SPST with time delay, adjustable 2-50 footcandles; Tork, Paragon, General Electric, Intermatic.

B. Flush Mounted: Weatherproof, button type, thermal relay, 1000 watt, SPST, with stainless steel cover plate and gasket.

2.8 CABLE TRAY

A. Communications Room Cable Tray: NEMA VE 1; class 12A, aluminum open ladder type with 9 inch rung spacing; 4 inch deep with side rails.

B. Distribution Cable Tray: NEMA VE 1; high strength steel 2 inch X 4 inch welded wire mesh basket type tray, pre-galvanized zinc or zinc plated with clear sealer, 4 inch deep X 12 inch wide unless otherwise indicated. Chalfant VersaTray, Cooper B-Line WB Series, GS Metals Flextray, or approved.

C. Accessories: Provide manufacturer's standard elbows, tees, clamps, connectors, splice plates, hangers, brackets, supports, and attachments. Elbows and tees shall have 24 inch radius.

2.9 SUPPORTING DEVICES

A. Metal Conduit Clamps & Straps: Steel, screw type; zinc or cadmium plated minimum indoors, hot dipped galvanized minimum outdoors.

B. Support Channel: Slotted 12-gauge steel channel with fittings, fasteners, brackets, clamps, floor plates, and accessories required; Pre-galvanized zinc coated (G90) indoors, ASTM 123 hot dipped galvanized outdoors.

C. Fasteners: Expansion anchors in concrete toggle bolts in hollow masonry, plaster, or gypsum board wall construction; sheet metal screws in metal construction; wood screws in wood construction; set screw type beam clamps on steel columns and beams; U.L. listed clips for metal studs. Metal parts and accessories to be zinc or cadmium plated minimum indoors and hot dipped galvanized minimum outdoors.

D. Roof Supports: Do not install conduit exposed on roofs.

PART 3: EXECUTION

3.1 WIRING METHODS

A. GENERAL

1. Fixed wiring shall be conductors installed in conduit except where cable is specifically permitted in this specification.

2. Conceal all wiring within construction unless otherwise noted on drawings or specifically authorized by the Architect/Engineer.

B. CONDUIT REQUIREMENTS

1. Rigid Steel Conduit (RGS): May be used in all areas.

2. Intermediate Metal Conduit (IMC): May be used in all areas indoors. except where RGS is indicated.

3. Electrical Metallic Tubing (EMT): May be used in dry and damp locations where not subject to damage. May not be used in concrete, where in contact with earth, or where RGS is indicated. May not be used for service entrance conductors inside a building.

4. Flexible Conduit: May be used concealed in cabinets and where concealed in walls, up to 1 inch maximum trade size. Required for final equipment connections (maximum length 36 inches). Use liquid tight in damp or wet locations.

5. Rigid Non-Metallic Conduit (PVC): May be used underground.

C. WIRE AND CABLE REQUIREMENTS

1. Use copper conductors.

2. Non-Metallic Sheathed Cable: Type NM cable consisting of copper conductors with ground may be used for branch circuit wiring and for feeders where permitted by Code and concealed inside wall and ceiling spaces, exposed above 9 feet, or installed in cable tray. May not be used for service and power distribution shown on one line diagram.

3.2 SUPPORT - GENERAL

A. Support wiring, conduit, raceways, boxes, equipment, and fixtures from building structural members. Provide additional framing, channel, or listed support attachments as required to span or support between structural members and to avoid interference from pipes, ducts, and other equipment.

B. Do not install support anchors to penetrate thru roof deck.

C. Do not violate the integrity or exceed the capacity of the building structure used for support. Provide/fabricate additional support elements to transmit loads to the floor or other parts of the building structure that can carry the load as approved by the Architect/Engineer.

3.3 CONDUIT SIZING, ARRANGEMENT, AND SUPPORT

A. Minimum conduit trade size ½-inch except 3/4-inch for all homeruns and 3/4-inch where installed below grade outdoors.

B. Arrange conduit to maintain headroom and present a neat appearance.

C. Route conduit parallel and perpendicular to walls and adjacent piping.

D. Maintain 12-inch clearance between conduit and heat sources such as heating appliances.

E. Locate holes in joists within center third of member depth measured from the edge and at least 24 inches from load bearing points. Maximum hole diameter one inch.

F. Support conduits from building structure with conduit straps or rods and hangers.

G. Do not support conduit with perforated pipe straps or tie wraps. Remove all wire used for temporary conduit support during construction, before conductors are pulled.

H. Do not bore holes in truss members or notch structural members.

3.4 CONDUIT INSTALLATION

A. Use conduit hubs or sealing locknuts for fastening conduit to cast boxes and for fastening conduit to sheet metal boxes in damp locations.

B. Use conduit bodies to make sharp changes in direction, as around beams.

C. Use factory elbows for PVC conduit and for bends in metal conduit larger than 1 inch. Conduit bends for signal systems that are greater than 45 degrees shall be minimum radius sweeps as follows:

Under 2 inches	Standard radius
2 inches - 3 inches	24 inch radius
Over 3 inches	36 inch radius

D. Install insulated bushings on each end of conduit larger than 1 inch.

E. Use suitable conduit caps to protect installed conduit against entrance of dirt and moisture.

F. Install pull wire in empty conduits.

G. Metal Conduit Installed Below Grade: Provide 20 mil thick factory PVC coating, field wrapped 10 mil thick pressure sensitive plastic tape with 50 percent overlap, or paint with bitumastic compound; extend 8 inches above grade at risers.

H. Conduit Below Concrete Slabs On Grade: Install at minimum depth required for vertical penetration of radius bend at conduit risers.

I. Underground Conduit for Site Power (Below 600 Volts) and Signal Systems: Install to provide 24 inches minimum cover up to final grade unless otherwise indicated or specified. Maintain minimum 7.5 inch on center spacing between power conduits; maintain minimum 12 inch spacing between power conduits and signal conduits; maintain minimum separation from public utilities established by regulation.

J. Conduits at Roof Decks: Conduit installed within 1.5 inches of the nearest surface of metal corrugated roof decks and conduit concealed within roofing systems on top of roof decks shall be RGS or IMC conduit.

K. Do not install conduit in concrete slab on grade.

L. Do not install conduit in direct contact with underside of roof deck.

3.5 CONDUIT PENETRATIONS

A. Roof Penetrations: Provide flashing around each conduit which penetrates a roof. Materials and installation shall comply with applicable provisions of Division 7 for roofing. Seal top of flashing around conduit with a weatherproof non-hardening mastic.

B. Exterior Walls: Core drill or cast sleeve for each conduit one size larger than conduit diameter. Seal all openings at each penetration with acrylic weatherproof caulking suitable for painting. Below grade seal with "Chase-Foam" silicone sealant or other approved method acceptable to Architect/Engineer.

C. Interior Walls and Partitions: Cut one size larger than conduit diameter. Seal all openings at each penetration with low VOC level general purpose interior sealant as specified in Section 07900.

3.6 CONDUCTOR INSTALLATION

A. Minimum Conductor Size: #12 AWG, except #10 AWG minimum for outdoor and exterior building lighting circuits.

B. Splice conductors only in junction or outlet boxes.

C. Arrange conductors neatly at termination such that a clamp-on ammeter may be used.

D. Clean conduit free of debris before conductor installation; install conductors using pulling lubricant.

3.7 CONDUCTOR IDENTIFICATION

A. Provide non-metallic wire markers on each conductor in panelboards and in junction boxes having more than 6 conductors. Identify branch circuit or feeder number for power and lighting circuits.

B. Color Coding of Insulated Equipment Ground: Solid green.

C. Color Coding of 208/120 and 120/240 Volt System: Phase A - black, Phase B - red, Phase C - blue, Neutral - white.

D. Color Coding of 480/277 Volt System: Phase A - brown, Phase B - orange Phase C - yellow, Neutral - gray.

E. Color Coding of Switch Legs: Pink

F. Color Coding of Travelers (3-Way and 4-Way Switching): Purple

G. Provide color tracers on neutrals to differentiate circuits on multi-wire branch circuits with separate neutrals.

3.8 BOX LOCATIONS

A. Provide electrical boxes for outlets, junctions and equipment connections as shown and as required for splices, taps, wire pulling, and code compliance.

B. Electrical box locations shown are approximate unless dimensioned. Obtain equipment outlet locations from equipment manufacturer prior to rough-in. Coordinate outlet and wall switch locations with finish elements shown on Architectural drawings. Install to fit conditions or as directed.

C. Change location of wall outlets, wall switches, and lighting outlets up to fifteen feet without charge when requested by Architect/Engineer prior to installation.

D. Height of outlets unless otherwise directed: See Drawings.

3.9 BOX INSTALLATION

A. Set wall outlet and wall switch boxes vertically.

B. Support boxes independently of conduit, piping, and ductwork; securely fasten in place.

C. Provide recessed outlet boxes in finished areas. Flush front edge of box or plaster ring even with finished surface.

D. Provide blank cover plate over all boxes that do not contain devices or are not covered by equipment.

E. Do not install flush boxes on opposite sides of a wall within the same stud space. Maintain 24 inch minimum box separation in fire rated wall assemblies.

3.10 WIRING DEVICES

A. Ground Fault Circuit Interrupter (GFCI) Protection: Provide for receptacles located outdoors, and as otherwise indicated. GFCI receptacles are not required where branch circuit is protected by GFCI circuit breaker.

3.11 CABLE TRAY FOR COMMUNICATIONS CIRCUITS

A. Install in accordance with requirements of NEMA VE 2 and manufacturer's instructions. Provide shop drawings for installation of cable trays showing layout, supports, connectors, accessories, and installation details.

B. Unless otherwise indicated support cable tray from building structure with center support using ½ inch threaded rod. Provide supports at each end, each connection point, and other points required to maintain maximum support spacing of 12 feet on center for ladder type tray and 6 feet on center for wire basket type tray.

3.12 EARTHWORK FOR UNDERGROUND ELECTRICAL

A. Locating and Protecting Existing Utilities: Existing utilities in areas of new construction must be identified and located by the Contractor prior to commencing Work. Location of underground utilities shown on plans are diagrammatic and shall not be considered as a complete representation of all utilities that may exist on site.

1. Coordinate with Owner to identify and locate existing underground utilities including landscape irrigation in areas of Work.

2. Prior to excavation, contact and coordinate with local Utilities Underground Location Center to identify and locate existing underground public utility services in areas of Work, including power, water, sewer, telephone, gas, and cable TV.

3. Prior to excavation, obtain services of a utility locator service to scan areas of Work and to locate and mark where known and unknown private underground utilities or other interfering obstructions exist.

4. Existing active utilities damaged or interrupted by the Contractor during construction shall be replaced at the Contractor's expense. Repairs to power and signal systems using junction boxes or splices will not be accepted.

B. Excavation and Backfill: Comply with requirements of Division 2.

C. Finish Operations:

1. Restore all surfaces disturbed by new construction to its original grade and condition unless otherwise indicated. Comply with requirements of Division 2.

3.13 LABELING

A. Outlets: Identify panel and circuit number on faceplate of convenience and special purpose outlets. Use self-adhesive, polyester or vinyl laminated labels with machine generated alpha-numeric circuit identification, 1/4 inch high black letters on clear background. Exception: Use white letters on black or brown color device plates.

B. Junction Boxes: Label or mark cover with panel and circuit number. Locate on inside of cover except locate on outside of junction box cover in attics, crawl spaces, equipment rooms and above accessible ceilings.

3.14 TESTS

A. Perform continuity test on all feeder and branch circuit conductors. Verify proper phasing and that no short circuits or accidental grounds exist.

B. Check all convenience outlets for correct wiring connections using a polarity circuit tester.

C. Torque test conductor lug terminations to manufacturers recommended values.

END OF SECTION

SECTION 16060 – GROUNDING & BONDING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Power system grounding.

B. Electrical equipment and raceway grounding.

C. Communication system grounding.

1.2 SUBMITTALS

A. Submit reports for tests required under part 3 of this section.

1.3 OPERATIONS AND MAINTENANCE DATA

A. Include data on testing procedures, obtained test values, and correction of deficiencies in the Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Ground Rods: Copper-clad steel, 3/4 inch diameter, 10 feet long unless otherwise indicated.

B. Mechanical Connectors at Accessible Ground Rods: Tin-plated, heavy duty, high strength, corrosion resistant copper alloy, hex head bolt and clamp.

C. Mechanical Connectors at Ground Connections: Heavy duty, solderless, bolted pressure or compression type connectors or clamps labeled as being suitable for the purpose. Manufacturer's standard grounding lug when furnished as part of panelboards and other equipment.

D. Exothermically Welded Connections: Copper Thermit weld process conforming to manufacturer's instructions; use molds, weld material, tools, and accessories supplied by the manufacturer. ERICO CADWELD or equal.

E. Ground & Bonding Conductors: Bare, soft drawn copper; stranded for 8 AWG and larger, unless otherwise indicated or specified.

F. Grounding Bus Bars: UL 467; ¼ inch thick X 4 inch high tin plated copper bus with predrilled holes for bolted lug terminations, 2 inch high insulated spacers, and stainless steel standoff wall brackets. Provide 16 inch long with holes for (8) horizontal terminations unless otherwise indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Ground electrical service system neutral per Code. Size grounding electrode conductor, main bonding jumper, equipment bonding jumpers, and supplemental electrode bonding connections per applicable paragraphs of NEC Article 250 except when larger size is shown or specified. Minimum of two (2) NEC 250.52 permitted grounding electrodes must be installed and

shall include a concrete encased electrode where concrete building foundation is provided.

B. Make grounding connections which are buried or otherwise inaccessible using exothermic welds. Where installed outdoors, bury ground conductors with minimum 18 inches of cover unless otherwise indicated.

C. Driven Electrodes: Drive ground rods full depth unless otherwise indicated or specified. Provide 10 feet minimum separation between driven electrodes.

D. Equipment Grounding Conductor: Provide separate insulated green equipment grounding conductor in feeders and in branch circuits. Provide equipment grounding conductor in non-metallic conduits and flexible conduit. Size equipment grounding conductors per NEC 250.122 unless larger size is shown or specified.

E. Provide grounding locknuts on each end of feeder conduits serving panelboards. Exception: Provide grounding bushing with bonding jumper where conduit is used as equipment ground.

F. Provide conduit sleeves where ground conductors pass through concrete slabs. Metal conduit sleeves shall have threaded end extending above slab to accommodate a grounding bushing or conduit hub per NEC 250.64(E).

G. Provide minimum 1/0 AWG conductor for communications service grounding. Leave 10 feet slack conductor at terminal board. Connect conductor to building ground electrode system.

H. Ground exposed non-current carrying metal parts of equipment fastened in place or connected by permanent wiring and likely to become energized per Code. In Comm. room, bond cable tray and equipment racks to terminal board ground bus using #6 minimum AWG conductor.

I. Concrete Encased Electrode: Provide bare copper conductor per project plans encased by at least 2 inches of concrete and located within and near bottom of concrete foundation or footing that is in direct contact with earth. Size electrode to match grounding electrode conductor or No. 4 AWG, which ever is larger. Provide 3/4" non-metallic conduit sleeve where conductor enters concrete foundation.

J. Grounding Bus Bars: Provide at building electrical service entrance and at all telecommunication terminal boards. Install 12 inches above floor unless otherwise indicated.

K. Additional Electrodes: Where maximum resistance to ground is specified, provide additional driven electrodes as needed to meet specified requirements or provide one electro-chemical ground rod set in 6 inch diameter bored hole backfilled with bentonite clay. Provide handhole for inspection access and 15 feet minimum separation from other electrodes.

3.2 SEPARATELY DERIVED SYSTEMS

A. Ground secondary neutral and housing of all transformers per Code. Size grounding electrode conductor, bonding jumper, equipment bonding jumpers, and supplemental electrode bonding connections per applicable paragraphs of NEC Article 250 unless larger size is shown or specified. In addition, provide a driven ground electrode when indicated.

B. Install grounding electrode conductor in 1 inch conduit between transformer and grounding electrode connection. Bond free end of conduit to grounding electrode conductor using grounding type bushing or hub.

3.3 TESTS

A. Service Entrance Ground Electrode System: ANSI/IEEE 81; measure and record ohmic value by performing fall of potential tests using a ground testing megger. Tests shall be performed with the ground electrode system disconnected/isolated from neutral and with the test current probe located at least 100 feet from the nearest ground system electrode.

B. Maximum Acceptable Resistance to Ground: 5 ohms.

END OF SECTION

SECTION 16148 – OCCUPANCY SENSORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Occupancy sensors for automatic on/off control of lights and other electrical loads.

1.2 SUBMITTALS

A. Submit product data for all items specified under Part 2 of this section.

1.3 OPERATION AND MAINTENANCE DATA

A. Include submittal data along with installation and operating instructions in Operations and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Room Sensors: Novitas, Sensor Switch, Unenco, Watt Stopper, Leviton.

2.2 ROOM SENSORS

A. Sensor: Dual technology (ultrasonic/passive infrared) occupancy detector, continuous self adapting sensitivity and time delay, manual override, LED motion indicator, compatible with fluorescent electronic ballasts. Rated area coverage shall conform to manufacturer's recommendation for complete room coverage without gaps, using single or multiple sensors as required. Sensors may be wall or ceiling mounted type.

B. Transformer/Relay: 120/277 volt control interface providing NEC class 2 input/output to occupancy sensor(s) and automatic line voltage switch control. Relay contacts shall be isolated, normally open, rated 20 amperes for ballast loads and 1 HP.

2.3 MATERIALS

A. Line Voltage Wire: Comply with Section 16050.

B. Low voltage wire: UL type CL2, NEC class 2, with PVC jacket overall, #18 AWG, copper conductors, color coded.

C. Conduit and outlet boxes: Comply with Section 16050.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Locate and install in accordance with manufacturer’s instructions.

B. Room Sensors: Provide number and location required for complete coverage within room (including toilet and shower stalls) and to minimize false activation thru open doors as recommended by manufacturer. Ceiling mounted sensors shall not be used above 12 feet. Provide additional transformer/relays as required where multiple branch circuits are controlled.

C. Areas with Inaccessible Ceiling Space: Install transformer/relay in same outlet box for ceiling sensor. Provide box depth, trim ring, and high/low voltage divider as required.

D. Manual OFF: Wall switches shall be wired on load side of relay/transformers to provide manual off control of room lighting.

3.2 TESTING

A. Test occupancy sensor lighting control system in each space per manufacturer's installation instructions. Correct coverage deficiencies, replace malfunctioning devices, and retest as required. Submit test reports indicating compliance with specifications and manufacturer's installation requirements.

END OF SECTION

SECTION 16302 – UNDERGROUND ELECTRICAL DISTRIBUTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Medium voltage cable, terminations, and accessories.

B. Pad mounted transformers.

C. Pad mounted medium voltage switchgear.

D. Vaults.

E. Conduit and ducts for electrical and communications site utilities occurring greater than 5 feet from a building.

1.2 RELATED SECTIONS

A. Concrete for equipment pads: Comply with Division 3 - Concrete.

B. Excavation and backfill for duct banks: Comply with Division 2 – Site work.

C. 600 volt cable, terminations, and splices: Comply with Section 16050.

D. Grounding & Bonding: Comply with applicable requirements of Section 16060.

1.3 SUBMITTALS

A. Submit product data for cable, terminations, vaults, conduit/duct, and accessories.

B. Submit feeder identification and color coding plan.

C. Submit reports for tests required under part 3 of this section.

1.5 OPERATION AND MAINTENANCE DATA

A. Include data for transformers, tests, and field inspection reports in Operation and Maintenance Manuals.

1.6 QUALITY ASSURANCE

A. Installer: Company specializing in installation of primary voltage systems with minimum 5 years experience. Cable splicer shall have minimum 3 years experience and be subject to Engineer approval.

B. Field Inspection and Testing: Company specializing in testing and maintenance of medium voltage cable and equipment. Approved Testing Agencies:

Sigma Six Solutions, Inc.

2200 West Valley Hwy North, Suite 100

Auburn, Washington 98001

253-333-9730

Western Electrical Services Inc.

14311 29th Street East

Sumner, WA 98390

888-395-2021

Electrical Reliability Services

22222 West Valley Hwy North, Suite 160

Auburn, Washington 98001

425-656-3646

C. 600 Volt Cable, Terminations, and Splices: Comply with Section 16050.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Medium Voltage Cable: BICC Cables, Okonite, Pirelli, Rome, Southwire.

B. Terminations: 3M-Scotch, or Snohomish County PUD approved.

C. Vaults: Oldcastle Precast or Snohomish County PUD approved.

2.2 PRIMARY CABLE

A. Cable: CEA S-68-516, AEIC CS6, UL 1072: Type MV-90, single conductor, non-shielded, 5 KV, 90 degrees C, 133% insulation level, ethylene-propylene-rubber (EPR) insulation, extruded conductor, black polyvinyl chloride jacket, suitable for conduit or direct burial installation.

B. Conductor: Class B stranded copper.

2.3 TERMINATORS

A. Live Front: IEEE Standard 48, Class 1; 5 KV rated cold shrink silicone rubber termination kit. 3M QT-III 7620T Series or Snohomish County PUD approved.

2.4 PAD MOUNTED 1-PHASE TRANSFORMERS – DRY TYPE

A. Outdoor pad mount, dry type, 5 KV class transformer with integral primary fusing and lighting arrestors, **furnished by others.**

B. Ratings: KVA, primary and secondary voltage configuration as indicated.

C. Additional Product Information: Product submittal and available shop drawings for each transformer shall be provided prior to rough-in.

2.5 PAD MOUNTED SWITCHGEAR - AIR

A. Outdoor Air insulated, manually operated, pad mounted switchgear, Federal Pacific type PSI-10, **furnished by Snohomish County PUD.**

B. Furnished switchgear shall be made available or otherwise delivered to site prior to rough-in.

2.6 VAULTS

A. Precast concrete vaults with AAHSTO-H20 traffic rated covers unless otherwise indicated; embossed utility identification on cover. Dimensions and features as indicated.

B. Cable Racks: Heavy duty non-metallic cable support assembly consisting of support arms and /or saddles installed on vertical slotted stanchions for adjustable rack height, as manufactured by Underground Devices Inc. or approved equal.

C. Pad Mount Vault Covers: Precast reinforced concrete pad mount vault cover furnished by vault manufacturer, with cable opening(s) and lift inserts.

2.7 CONDUIT AND DUCTS

A. Direct Buried Conduit/Duct: NEMA TC-2; PVC, schedule 40.

B. Fittings and Accessories: Same manufacturers as duct; to include manufactured spacers, couplings, adapters, end bells, caps, and plugs.

C. Elbows (including sweeps greater than 45 degrees) and Risers: ANSI C80.1; rigid steel conduit hot dipped galvanized.

D. Outdoor Risers Above + 8 Feet: NEMA TC-2; PVC, schedule 40.

2.8 ACCESSORIES

A. Equipment Pads: Concrete slab foundation, 8" thick reinforced with 6" x 6" No. 6 welded steel fabric uniformly centered in slab. Slab shall be placed on a well compacted 9" deep gravel subbase so that the top is 3" above grade. All edges shall have ½ " chamfer. Conduit entrance dimensions and location shall comply with equipment manufacturer’s recommendations.

B. Underground Warning Tape: Polyethylene tape with metallic core, 6 inch wide, printed caution identifying type of buried utility, red color for electric, orange color for communications. Shared duct banks shall be identified as electric.

C. Tags: Engraved waterproof plastic secured to cable with nylon tie wrap. Provide 1 inch high block letters and numbers, black on yellow background, unless otherwise directed by Owner.

D. Grounding and Bonding Materials: Comply with Section 16060.

E. Miscellaneous Materials: Provide connectors, hardware, brackets, stand-offs, small gauge wire, straps, terminals, breakout boots, tape, lugs, and other miscellaneous parts required for complete installation.

PART 3 - EXECUTION

3.1 INSTALLATION GENERAL

A. Conform to requirements of ANSI C2 (National Electrical Safety Code).

B. Comply with manufacturer's instructions for storage, handling, and installation for each product furnished.

C. Install transformers and switchgear furnished by others.

3.2 CABLE, TERMINATIONS

A. Pull in cables using manufacturer approved lubricants and pulling methods; do not exceed pulling tensions and bending radius.

B. Install cables in vaults to provide 20 foot minimum coil, arrange cables to avoid interference with duct entrances.

C. Ground cable shield at each termination.

D. Install cables without splices.

E. Provide cable tags at each termination. Identify phase and feeder for each cable. In addition, provide color coded tape on outer jacket of each cable and wrapped 1.5 inches wide to identify phase. Identification and color coding shall comply with Snohomish County PUD requirements.

F. Provide protective caps/plugs on all unused bushings/bushing wells.

3.3 TRANSFORMERS

A. It shall be the Contractor's responsibility to accept delivery of transformers furnished by others and to transport as required for storage and installation.

B. Provide equipment pad; install and secure transformer to pad with minimum of four corrosion proof anchors.

C. Repaint all scratched and marred surfaces to original condition using color and type of paint recommended by the manufacturer.

D. Provide ground electrode system consisting of four (4) driven electrodes connected together with #4/0 bare copper grounding conductor 29 inches minimum below grade. Comply with requirements of Section 16060.

E. Bond non-current carrying metal equipment parts and secondary neutral to ground.

F. Measure secondary voltage after loads are connected and systems are energized. Adjust taps for rated secondary voltage.

3.4 SWITCHGEAR

A. It shall be the Contractor's responsibility to accept delivery of switchgear furnished by others and to transport as required for storage and installation.

B. Provide vault with pad mount cover/pad; Install and secure switchgear enclosure to pad with minimum of four corrosion proof anchors.

C. Repaint all scratched and marred surfaces to original condition using color and type of paint recommended by the manufacturer.

D. Provide ground electrode system consisting of four (4) driven electrodes connected together with #4/0 bare copper grounding conductor 18 inches minimum below grade. Comply with requirements of Section 16450.

E. Bond non-current carrying metal equipment parts to ground.

3.5 VAULTS

A. Set on 9 inch minimum deep gravel base extending 12 inches minimum beyond each side. Set flush with final grade except in landscape or unfinished areas set 1 inch above grade.

B. Unless other grounding electrode provisions are indicated, provide a driven electrode with connector at each manhole, handhole, and vault used for electrical distribution rated above 600 volts. Extend rod up 4 inches inside vault near one corner or leave 36 inches of #4/0 bare copper lead-in conductor.

3.6 CONDUIT AND DUCTS

A. Install minimum depth below final grade measured from top of conduit or duct as follows, unless otherwise indicated:

Power above 600 volts	36 inches
Power below 600 volts	24 inches
Signal	24 inches

B. Maintain minimum 12 inch separation between power conduits and signal conduits; maintain minimum separation from public utilities established by regulation.

C. Join conduit and ducts per information provided in applicable NEMA and ANSI product references. Use solvent cement for PVC products.

D. Conduit bends greater than 45 degrees shall be 36 inch minimum radius sweeps. Use rigid steel conduit in bends greater than 45 degrees for cable pulls that exceed 250 feet or as otherwise required by serving Utility.

E. Provide plastic interlocking conduit spacers for multi-way conduit banks. Maintain 3 inch separation between conduits for multi-way power. Maintain 2 inch minimum separation between conduits for multi-way signal. Secure conduits with tie straps or snap-lock holders. Install spacers 8 feet maximum on center.

F. Clean and swab inside of conduit and ducts prior to pulling cables. Cap or plug unused conduit and ducts. Where exposed, capped conduit and ducts shall be made up using female threaded adapter and screw cap.

G. Terminate at vaults using end bells; grout openings watertight from both inside and outside at wall penetrations using water seal grout. Terminate at risers and stub ups with bushings.

H. Provide underground warning tape above all underground conduits and ducts. Install tape 12" below final grade.

I. Metal Conduit Installed Below Grade: Provide 20 mil thick factory PVC coating, field wrapped 10 mil thick pressure sensitive plastic tape with 50 percent overlap, or paint with bitumastic compound; extend 8 inches above grade at risers.

J. Provide waterproof non-metallic pull rope in each empty conduit and innerduct; minimum test strength 500 pounds. Do not leave tapes in conduits.

3.7 TESTING

A. Ground Electrode Systems: ANSI/IEEE 81; measure and record Ohmic values by performing fall of potential test using a ground testing megger. Tests shall be performed with the ground electrode system disconnected/isolated from neutral and with the test current probe located at least 100 feet from the nearest ground system electrode.

END OF SECTION

SECTION 16400 – ELECTRICAL DISTRIBUTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Load Centers

B. Enclosed Circuit Breakers

C. Disconnect switches

D. Fuses

E. Dry type transformers

F. Nameplates

1.2 SUBMITTALS

A. Submit product data for panelboards, load centers, circuit breakers, dry type transformers, and enclosed circuit breakers.

B. Submit shop drawings for panelboards, and dry type transformers.

C. Coordinate dimensions of equipment with site and project space dimensions to verify equipment will fit, conform to indicated layout, and meet NEC and manufacturer clearance requirements.

D. Submit reports for tests required under part 3 of this section.

E. Submit short circuit and arc flash hazard study. Include fault current calculations, arc flash hazard analysis, and arc flash labeling information. Study and report shall be prepared by a Professional Engineer and submitted by the equipment manufacturer.

1.3 OPERATION & MAINTENANCE DATA

A. Include data for panelboards, circuit breakers, and transformers in Operation & Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Load Centers, Circuit Breakers and Disconnects: Square 'D', Siemens, Cutler-Hammer.

B. Fuses: Bussman and Littelfuse.

C. Dry Type Transformers: Square 'D', General Electric, Siemens, Cutler-Hammer, Tierney.

2.2 LOAD CENTERS

A. General: Federal Specification W-P-115c, Type 1, Class 2, Service Entrance rated; plug-on circuit breaker load center.

B. Electrical Ratings, Configuration, Special Features: As shown on drawings. Indicated ampere interrupting capacity (AIC) is the rms symmetrical integrated equipment short circuit rating of the complete assembly.

C. Cabinet: Recessed or surface mounted as scheduled with flush indoor cover and hinged door, 4 inches deep x 14 inches wide minimum.

D. Finish: Manufacturer's standard enamel over rust inhibitor for all exposed and interior surfaces.

E. Circuit Directory: Index card or label on inside door.

F. Circuit Breakers: NEMA AB 1; molded case, thermal magnetic trip. Multi-pole breakers shall have internal common trip.

   a. Provide type SWD circuit breakers for lighting circuits.

   b. Provide type HACR circuit breakers for air conditioning equipment.

   c. Provide approved manufacturer handle padlock attachment on circuit breakers serving branch circuits for permanently connected appliances without local disconnecting means and where otherwise indicated.

G. Provide ground bus.

H. Portable Generator Provision: Provide split bus panel design and circuit breakers with mechanical interlock that manually select between normal or generator power to select loads as scheduled on project drawings.

2.3 ENCLOSED CIRCUIT BREAKERS

A. Circuit Breakers: NEMA AB 1; molded case, thermal magnetic trip, AIC rating greater than available symmetrical short circuit amperes. Multi-pole breakers shall be single handle with common pole operation.

B. Electrical Ratings, Configuration, and Special Features: As shown on drawings. The indicated ampere interrupting capacity (AIC) shown on the drawings is the full rms symmetrical equipment short circuit rating of bussing and of all overcurrent devices installed.

C. Enclosures: NEMA ICS6; Type 12/3R for outdoor locations, external vertical operating handle, pad locking provisions, and suitable for use as service equipment. Include neutral and/or ground kits as required.

2.4 DISCONNECT SWITCHES

A. Safety Switches: NEMA KS 1; heavy duty, quick make, quick break, handle with lock out / tag out provisions. Provide rating, number of poles, and fusing required for load served.

B. Toggle Switches for Small Motors and Appliances: NEMA WD 1; horsepower rated 20 ampere general use snap switch with lock-out attachment.

C. Switch Enclosures: NEMA ICS 6; Type 1 for dry locations, Type 3R for damp or outdoor locations.

2.5 FUSES

A. Approved Fuses, 600 Amperes and Less, for Branch Circuits and Power Distribution:

1. ANSI/UL 198C Class J low peak with time delay unless otherwise indicated except ANSI/UL 198E Class RK5 may be used in safety switches for protection of motor loads, HVAC equipment, and transformers.

2.6 DRY TYPE DISTRIBUTION TRANSFORMERS

A. Two Winding Transformers: ANSI/NEMA ST 20, NEMA TP-1 Class I compliant; general purpose, air cooled; ratings as shown on drawings.

B. Insulation System and Average Temperature Rise: 220 degree C insulation, 150 degree C rise above 40 degree C ambient.

C. Primary Winding Taps: Six (6) 2-1/2% taps, 2 above and 4 below normal.

D. Sound Levels: Not to exceed ANSI/NEMA ST 20 standards.

E. Isolate core and coil from enclosure using vibration absorbing mounts.

2.7 NAMEPLATES AND LABELS

A. Nameplates: Engraved three-layer laminated plastic, white letters on black background, affixed with stainless steel screws, adhesive acceptable in dry locations. Use black letters on yellow background for series combination rating identification. Use white letters on red background for emergency distribution.

B. Letter Height: ½ inch for series combination rating identification. 1/4 inch for panelboards, circuit breakers, switches, and disconnecting means; equipment served.

C. Flash Protection Labels: ANSI Z535.4; Self adhesive vinyl label based on the approved arc flash study with informational text to include:

ANSI approved warning header

Equipment Identification

Arc Flash Hazard boundary, category, and rating

Appropriate PPE required

PART 3 - EXECUTION

3.1 LOAD CENTERS

A. Height: 78 inches maximum measured from finish floor to top of enclosure; 78 inches maximum measured from finish floor to highest device handle for panelboards over 66 inches high.

B. Provide typewritten circuit directory for each panelboard listing load description for each circuit. Use final room names and numbers as verified with the Owner.

C. Stub 3 empty 3/4-inch conduits to accessible location above accessible ceiling from each recessed panelboard.

3.3 FUSES

A. Install fuses in fusible switches.

B. Size fuses for motor loads at 150% of nameplate full load amperes; size fuses for air conditioning and refrigeration equipment at maximum recommended nameplate rating.

3.4 DRY TYPE TRANSFORMERS INDOORS

A. Connect raceway to transformer case using flexible conduit.

B. Mounting: Floor, wall, or trapeze mount as required. Mount transformers on ½ inch minimum oil resistant neoprene vibration isolating pads with cross-ribbed or waffle design and located at each anchor point.

3.5 NAMEPLATES AND LABELS

A. Panelboards: Provide nameplate to identify equipment designation, voltage, and source of supply for each, e.g. Panel A, 208/120V, Fed from Panel M. Provide arc flash protection label. Provide series combination rating nameplate where such rating is applicable.

B. Individual Enclosed Circuit Breakers, Safety Switches, and Disconnecting Means: Provide nameplate to identify load served and circuit source and circuit number.

C. Nameplate and Label Location: Secure to equipment fronts.

3.6 TESTS

A. Dry Type Transformers: Measure primary and secondary voltages after loads are connected and systems are energized. Adjust taps for -1% to +2% of rated secondary voltage.

END OF SECTION

SECTION 16500 - LIGHTING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Interior luminaires and accessories.

B. Exterior luminaires and accessories.

C. Lamps.

D. Ballasts.

1.2 COORDINATION

A. Determine final luminaire locations according to architectural reflected ceiling plans and elevations. In spaces open to structure, coordinate final luminaire locations and mounting heights with ductwork, piping, and structural members and submit final plan to Architect/Engineer for approval.

1.3 SUBMITTALS

A. Submit product data for all items specified under Part 2 of this section and scheduled on the drawings. Include in submittal and in Operations and Maintenance Manual a coversheet listing each fixture type with corresponding lamp and ballast data.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Luminaires & Accessories: Identified in Fixture Schedule.

B. Fluorescent Lamps: General Electric, Osram Sylvania, North American Philips.

C. High Intensity Discharge (HID) Lamps: General Electric, Osram Sylvania, Venture Lighting.

D. Fluorescent Ballasts, Electronic: Advance, GE, Osram Sylvania.

2.2 LAMPS

A. Fluorescent T8: 3500K, 85 CRI minimum. Initial lumens at 25°C/77°F shall be 3000 minimum for 48 inch lamps and 5900 minimum for 96 inch lamps.

B. Compact Fluorescent: 3000K, 82 CRI minimum.

C. General Use Incandescent: Inside frosted, 125 volt rating.

2.3 FLUORESCENT BALLASTS

A. General: ANSI C82.1; electronic solid state high frequency type, high power factor, Class P, CBM/ETL certified, 10% maximum total harmonic distortion (THD), 1.5 maximum line current crest factor, normal ballast factor.

B. Sound Rating: Group A.

C. Low Temperature Ballasts: Minimum starting ambient temperature of 0 degrees F.

D. Ballast Location: Center mount on suspended fixtures.

E. Accessories: Provide ballast disconnect.

2.4 FLUORESCENT BALLASTS - COMPACT LAMPS

A. General: ANSI C82.1; programmed start electronic solid state high frequency type, high power factor, Class P, CBM/ETL certified, 10% maximum total harmonic distortion (THD), 1.7 maximum line current crest factor, 1.00 nominal ballast factor, dual rated 120/277 volts, for broad range lamp applications.

B. Sound Rating: Group A.

C. Accessories: Provide ballast disconnect.

2.5 LED FIXTURES

A. Outdoor Lighting: IP66 rated, 4000K - 5000K color temperature, 70 CRI minimum, 60 watts/lumen minimum efficacy, listed for -20 degree C to 40 degree C ambient operation, integral surge protection, rated L70 at 50,000 hours per IESNA LM-80.

2.6 FIXTURE ACCESSORIES

A. Provide necessary hangers, brackets, plates, anchors, and other mounting accessories required by construction features and ceiling conditions. Comply with requirements of Section 16050, Basic Materials and Methods.

B. Fluorescent Ballast Disconnect: UL listed polarized male-female plug set to disconnect simultaneously from the source of supply all conductor of the ballast, including the grounded conductor. Provide for each ballast within ballast housing of light fixture.

C. Allow sufficient length for pendants, cables, chains, conduit, or rods as specified to install hanging fixtures at 8 feet above finished floor or 36 inches below the ceiling, whichever is lower, unless otherwise indicated in the construction documents.

2.7 LIGHTING FIXTURE SCHEDULE

A. See Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide lamps in lighting fixtures and lamp holders provided under this Section.

B. Set lighting fixtures plumb, square, and level; measure mounting heights to center of fixture for wall mounted and to bottom of fixture for pendant hung.

C. Recessed lighting fixtures weighing less than 56 lbs (25.4 kg) may be supported from metal ceiling suspension systems when auxiliary support from structural members using two #12 AWG wire hangers at diagonal corners are provided (hangers may be slack). Fixtures weighing 56 lbs or more must be supported directly from the structure by approved hangers.

D. Securely fasten recessed and surface fixtures in place; provide seismic clips (one each corner) for lay-in fixtures.

E. Support lighting fixtures from building structural members; provide metal channels or additional blocking and framing as required for fixture support between structural members or to avoid interference from mechanical pipes and ducts. Conceal supports within building construction in finished spaces.

F. Mounting height for wall mounted fixtures and for hanging fixtures supported by pendants, cable, chain, conduit, rods, or other means shall be determined by the architect/engineer during construction unless otherwise indicated in the construction documents.

G Install suspended fixtures so that no obstruction is located within the swing range.

3.2 RELAMPING

A. Relamp luminaires which have failed lamps at completion of work.

3.3 ADJUSTING AND CLEANING

A. Align and tighten luminaires and clean reflectors, lenses and diffusers at completion of work. Clean paint splatters, dirt, and debris from installed luminaires.

END OF SECTION

SECTION 16720 – SECURITY ACCESS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Expansion of existing security management system and related components.
2. Access Control to buildings and selected areas using encoded proximity cards.
3. Monitor intrusion alarm devices.
4. Video surveillance cameras

1.2 REFERENCES

A. NEC 765.
B. UL 294, UL 1076, ULC.
C. FCC – Part 15, Part 68
D. NFPA70, NEC.

1.3 ACTION SUBMITTALS

A. Product data: Provide data sheets for each item of equipment, equipment ratings, and for finishes. Include manufacturer's installation instructions. Distinguish between factory, shop and field-assembled work.
B. Shop drawings: Indicate layout, wiring diagrams, device locations, and dimensions. The shop drawings shall include, but not necessarily be limited to:

1. Title page with symbols legend, wire legend, general notes, vicinity map, and a drawing sheet index.
2. A site plan showing all exterior work. The scale shall be not less than 1: = 20'.
3. Floor plans for each floor at a scale not less than 1/8" = 1' – 0".
4. Installation details illustrating all typical conditions for each component required.

C. Include single line riser diagrams showing complete system connections. Include wiring requirements.

1.4 INFORMATIONAL SUBMITTALS

A. Installer Certificates: Signed by access control system manufacturer certifying that installer is approved, authorized, or licensed by manufacturer to install system and specific products
B. Demonstration of certification shall be on manufacturer letterhead or manufactured issued certification forms.
C. Programming worksheets, providing places to record user defined data, time zones, access levels, access groups, holidays, input and output definition, reader and door control definition, controller information and operator level assignments.

1.5 CLOSEOUT SUBMITTALS

A. Record Drawings: Accurately indicate actual location of all devices, wire and cable, and controlling equipment. Record all device serial numbers and device troubleshooting.
B. Operation data: Include operating instructions.
C. Maintenance data: Include maintenance and repair procedures.

1.6 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Lenel Systems International certified (Value Added Reseller, VAR), employing certified technicians and programming engineers on local staff for installation, programming and troubleshooting.
   2. Technicians certified by manufacturer for specified products.
B. Installer shall employ factory-trained service personnel within 50 miles of the job site. These personnel shall have a minimum of five (5) years' experience in servicing integrated Lenel Access Control, Alarm Monitoring and CCTV.
C. Fully qualified repair and maintenance personnel shall be available on a twenty-four (24) hour a day basis, three hundred and sixty-five (365) days a year, with four (4) hour maximum response time for service.
D. Pre-installation Conference:

   1. Conduct conference at Project site
   2. Review methods and procedures related to security management systems including, but not limited to the following:

a. Device Locations and rough-in requirements
b. Wiring requirements, testing and labeling
c. Installation clearances and mounting requirements

PART 2 - PRODUCTS

2.1 SYSTEM MANUFACTURERS

A. Access control manufacturer:
1. Listed: Lenel Systems International.
2. Approved Substitutions: No substitutions will be considered.
3. Version: Lenel OnGuard, version compatibility to be confirmed with existing database versions in operation to insure proper communications and system operations.
4. System peripherals are listed below and no substitutions will be considered so as to utilize existing facility product standards for access control hardware and software.

B. Security surveillance software manufacturer:
1. Listed: Lenel Systems International
2. Approved Substitutions: No substitutions will be considered.
3. Version: Lenel OnGuard, version compatibility to be confirmed with existing version in operation to insure proper communications and system operation.
4. System peripherals are listed below and no substitutions will be considered so as to utilize existing facility product standards.

2.2 SERVER COMPUTER

A. Existing By Owner.

2.3 CLIENT WORKSTATION COMPUTERS

A. Existing by Owner

2.4 VIDEO STORAGE APPLIANCE

A. Provided by Owner.

2.5 ACCESS CONTROL PANELS

A. Listed Manufacturer: Lenel Systems International
B. Approved Substitutions: No substitutions will be considered.
C. Panels – Lenel Systems International:

1. LNL-2200 Series, Intelligent System Controllers

D. Quantity: As required to service the number of readers and other devices shown on the drawings.

2.6 ACCESS CONTROL ENCLOSURES

A. Listed Manufacturer: Hoffman.
B. Approved Substitutions: No substitutions will be considered.
C. Wire management and assembly per drawings
D. Quantity: Per drawings

2.7 POWER SUPPLY AND BATTERIES

A. Listed Manufacturer: Altronix Corporation and Pelco.
B. Approved Substitutions: No substitutions will be considered.
C. Access control components: Model AL400ULACMCB 12VDC output. Locate where shown on the drawings.
D. Lock power supplies: Model AL1024ULACMCB 24VDC. Locate where shown on the drawings.
E. Camera Power Supplies: WCS-1-4
F. Provide power supplies in quantities sufficient to power the electro-mechanical locking devices (owner provided) required located on drawings.
G. Batteries: Battery Plus, model CLTXPA12-7.5F. Provide in sufficient quantity as to achieve a four hour battery stand-by capacity for the entire security management system.

2.8 INTRUSION PANELS

A. Listed Manufacturer: Bosch
B. Approved Substitutions: No substitutions will be considered.
C. D7412GV3-C with Bosch Network Interface Module B420.
D. SWG-1450 Lenel Intrusion Support
E. Batteries: Battery Plus, model CLTXPA12-7.5F.
F. Quantity: As required to service the number of devices shown on the drawings.

2.9 Intrusion Arming Station

A. Devices:

1. Bosch D1255 Command Center,
2. HID 6125CKN0000
3. Lenel SWG-1450\
4. Quantity: As required per drawings

2.10 CARD READERS

A. Listed Manufacturer: HID Global.
B. Approved Substitutions: No substitutions will be considered.
C. Reader only: 6125BKN0000, Multi-CLASS card reader.
D. Quantity: Per drawings.

2.11 ACCESS CARDS

A. Owner Provided

2.12 INTRUSION: DOOR POSITION SWITCHES

A. Listed Manufacturer: Nascom.
B. Approved Substitutions: No substitutions will be considered
C. Models: N1178CW/ST1KSP
D. Quantity: Per drawings.
E. Use diode and resistors for configuring supervision on the door position switch. See drawings for wiring configuration.

2.13 INTRUSION: ROLLUP / GARAGE DOOR POSITION SWITCHES

A. Listed Manufacturer: Nascom.
B. Approved Substitutions: No substitutions will be considered
C. Models: : N505AUTM/ST1KSP
D. Quantity: Per drawings.
E. Use diode and resistors for configuring supervision on the door position switch. See drawings for wiring configuration

2.14 INTERIOR INTRUSION MOTION SENSOR

A. Listed Manufacturer: Bosch
B. Approved Substitutions: No substitutions will be considered.
C. Device Model M-BLD1-P-F1
D. Quantity: Per drawings.

2.15 EXTERIOR INTRUSION MOTION SENSOR

A. Listed Manufacturer: ProTech
B. Approved Substitutions: No substitutions will be considered.
C. Device Model: PIRAMID XL2 with Lens-A
D. Quantity: Per drawings.

2.16 Electromechanical Locking Hardware

A. OWNER PROVIDED: Electrified Best Cylindrical Lockset

2.17 Power Transfer Device

A. OWNER PROVIDED: WIRE TRANSFER HINGE

2.18 INTERIOR CAMERAS

A. Listed Manufacturer: Axis Communications.
B. Approved Substitutions: No substitutions will be considered
C. Fixed position dome, Model P3364-V series
D. Mount – Per Details
E. Channel License – One (1) Lenel SW-LNR-CH1
F. Quantity: Per drawings

2.19 EXTERIOR CAMERAS

A. Listed Manufacturer: Pelco
B. Approved Substitutions: No substitutions will be considered
C. Pan-Tilt-Zoom, Model, SD4E35-PG-E1
D. Power Supply, Model, WCS1-4
E. Mount: per Details
F. Channel License – One (1) Lenel SW-LNR-CH1
G. Quantity: Per drawings

2.20 OTHER MATERIALS

A. All materials not specifically listed, but required for a complete and operational system shall be furnished and installed by the installer, subject to approval by the Project Lead.

PART 3 - EXECUTION

3.1 OTHER MATERIALS

A. Examine, with the Installer present, the building, substrates, and conditions under which the work is to be installed, and must notify the Project Lead in writing of any conditions detrimental to the progress of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner that is acceptable to the installer. Commencement of the work of this section indicates acceptance of the existing conditions.

B. Verify compliance with the following requirements and other conditions affecting installation of security management system:

1. All necessary back-boxes, connectors, supports, conduit, cable, and wire are in place and installed to provide a complete and reliable system.
2. Conduit, cable, and wire are installed. Conduit fill shall not exceed forty (40) percent.
3. All cables, wires, wiring forms, antennas, terminal blocks, and terminals are identified by labels, tags, or other permanent markings. The markings shall clearly indicate the function, source and destination of all cabling, wiring and terminals. All cables and wires shall be identified, utilizing heat-shrunk, pre-printed, wire markers.
4. Where required, 120 VAC, 60 Hz power from the appropriate electrical panel, through a junction box, to the system device is present.

3.2 GENERAL INSTALLATION

A. Install, make fully operational, and test the security management system as indicated both on the drawings and in this specification. Where information is not available, the worst case condition must be assumed for bidding purposes to ensure a complete, functional system.
B. Mount equipment with sufficient clearance to meet all applicable codes and facilitate observation and testing.
C. Securely fasten equipment with appropriate fittings to ensure positive grounding and be free of ground loops throughout the entire system.
D. Gather wires and fasten to create an orderly installation.
E. Provide seismic bracing on appropriate equipment.
F. The **ELECTRICL CONTRACTOR** shall furnish and install 120 VAC, 60 cycle, 1 phase, 20 amp circuits to the power supplies and intelligent field controllers AND shall terminate 120VAC conductors to the power supplies. The **ELECTRICAL CONTRACTOR** shall also supply and install all conduit, raceway, and back boxes shown or required on the drawings. The **ELECTRICAL CONTRACTOR** shall furnish all cable and cabling as required and indicated in the drawings.

3.3 WORK BY OWNER

A. NETWORK: The OWNER shall furnish, install and terminate:

a. Racks as required
b. Patch Panels
c. Patch Cables

d. PoE Enabled Network Switches
e. IP Address's

B. FINISH HARDWARE: Electro-mechanical hardware supplied by **OWNER** shall be installed, terminated, tested, and operationally interconnected with the security management system by the **Installer** supplying the security management system.

3.4 SYSTEM COMPONENTS

A. Assemble devices and subsystems and fully test prior to delivery to the site for actual installation.
B. Wall-mount central components in the order recommended by the manufacturer.

3.5 IDENTIFICATION AND TAGGING

A. Identify all cables, wires, wiring forms, antennas, terminal blocks, and terminals by labels, tags, or other permanent markings. Clearly indicate the function, source, and destination of all cabling, wiring and terminals. All cables and wires be identified utilizing heat-shrunk, pre-printed wire markers.
B. Label all terminal points appropriately.

3.6 START-UP RESPONSIBILITY

A. Properly ground each piece of electronic equipment prior to applying power. Properly ground all shielded wire shields to the appropriate earth ground at the hub end only, not at the remote or device end.
B. Initiate system operation. Utilize competent start-up personnel on each consecutive working day until the system is fully functional and ready to start the acceptance test phase. If, in the Project Lead's judgment, the Installer is not demonstrating progress in solving any technical problems, the Installer shall supply Manufacturer's factory technical representation and diagnostic equipment at no additional cost, until resolution of those defined problems.
C. Where appropriate, bring the System online in its basic state. It is the responsibility of the Owner to provide the specific database information that will provide full, integrated system operation.

3.7 PREPARATION FOR ACCEPTANCE (PRIOR TO FINAL INSPECTION)

A. Systems, equipment, and devices shall be in full and proper adjustment and operation, and properly labeled and identified.
B. All materials shall be neat, clean, and unmarred and parts securely attached.

C. All extra materials as specified shall be delivered and stored at the premises as directed.
D. Test reports of each system and each system component, and As-Built project drawings shall be complete and available for inspection and delivery as directed by the Project Lead.

3.8 SYSTEM ACCEPTANCE REQUIREMENTS

A. Before final acceptance of work, the CONTRACTOR shall perform and/or deliver each of the following in the order stated:

1. Systems Operation and Maintenance Manuals
2. Record Drawings

B. System Testing:

1. Execution: Activate all alarm or other output devices that are in the system for proper operation, including supervisory and trouble circuit tests.
2. Report: A checkout report for each piece of equipment shall be prepared by the Installer and submitted to the Project Lead, one copy of which shall be registered with the equipment manufacturers after acceptance by Project Lead. This report shall include at least the following:

   a. Complete listing of every device, the date it was tested and by whom, and the results and date tested (if failure occurred during any previous tests).
   b. The final test reports shall indicate that every device tested successfully.
   c. Submit two typed copies of the test reports on 8 ½" x 11" paper, in a neatly bound folder to the Project Lead for approval. Failure to comply with this will result in a delay of final testing and acceptance.

3. Final Acceptance Test:

   a. After the testing report and record drawings have been approved by the Project Lead, the completed system shall be tested in the presence of the Project Lead.
   b. Acceptance of the system shall require a demonstration of the stability of the system.

3.10 SYSTEM PROGRAMMING

A. Owner will provide or install network, network appliances, network connectivity, TCP/IP address scheme, and related network, related wire, cable and racking.

B. Include all labor necessary to properly install and program the basic system operation. All such programming shall implement the features requested by the Owner during the pre-installation interview and shall be consistent with the owner executed programming worksheets.
C. Provide, in advance, manufacturer programming worksheets for completion by the Owner.

3.11 WARRANTY PERIOD SERVICE

A. Normal service shall be defined as minor repairs and/or adjustments. Service of this nature shall be provided at no cost to the Owner during normal business hours, which are between 8:00 AM and 5:00 PM, Monday through Friday.
B. Emergency service shall be required for emergencies defined as critical equipment not being functional, and shall be furnished at no cost to the Owner. Emergency service shall respond within a Six (6) hour period, twenty-four (24) hours per day, and three hundred and sixty-five (365) days a year. A list of critical equipment shall be developed by the Project Lead and the Installer.

END OF SECTION

SECTION 16741 – TELECOMMUNICATIONS PREMISES WIRING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Cable and Accessories

B. Station Outlets

C. Cross-Connect Components

D. Equipment Mounting

E. System Design

1.2 REGULATORY REQUIREMENTS

A. Conform to requirements of the latest revisions of the following standards:

TIA/EIA-569A	Commercial Building Standard for Telecommunications Pathways and Spaces
TIA/EIA-568B.1, 2, 3	Commercial Building Telecommunication Standards
TIA/EIA-455-61	FOTP-61, Measurement of Fiber or Cable Attenuation Using an OTDR
TIA/EIA-606	Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
TIA/EIA-607	Commercial Building Grounding and Bonding Requirements for Telecommunications

1.3 SYSTEM DESCRIPTION

A. Provide design and installation of a Premises Distribution System (PDS) consisting of unshielded twisted pair (UTP) horizontal station wiring with fiber optic backbone for data PDS.

B. Horizontal station PDS: Conform to TIA/EIA Category 6 requirements. Terminate each station jack via a dedicated cable to designated patch panel(s) in the Communications Room.

C. Tidal Generator System Communications:

a. Fiber: Provide two (2) multi-strand fiber optic cables from subsea cable land terminations to a patch panel in the Communication Room.

b. UTP Cable: Conform to TIA/EIA Category 5e requirements or better. Provide tidal generator system communications interconnect cable as scheduled. Leave sufficient cable each end for termination by others.

1.4 SUBMITTALS

A. Submit product data for all items specified under Part 2 of this section.

B. Submit shop drawings showing floor plans station outlet locations, horizontal station cable routing, backbone cable routing, and alpha numeric identification of terminals and jacks. Include elevation plans showing layout of cross-connect and wire management hardware.

C. Submit terminal labeling plan.

D. Submit documentation for tests required under Part 3 of this section.

1.6 OPERATION & MAINTENANCE DATA

A. Include data and extended warranty information for complete PDS in Operation and Maintenance Manual.

B. Include cable certification test results for each UTP and Fiber Optic cable.

1.7 QUALIFICATIONS

A. Company: Contractor specializing in the design, installation, and testing of high speed data and voice network systems for a minimum of five years.

B. Installers: Trained and experienced technicians of the company, certified by the product manufacturer and by Building Industry Consulting Service International (BICSI) for the PDS cabling, hardware, and accessories being installed, shall perform the work.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURER

A. UTP Cable: Systimax, Bert-Tek, CommScope, AMP, or other approved under the PDS warranty certification.

B. UTP Station Outlets and Cross-Connect Components: Systimax, AMP, Ortronics, Leviton

C. Fiber Optic Cable, Equipment, and Accessories: Siecor, CommScope, AMP, Ortronics, OCC or other approved under the PDS warranty certification.

2.2 CABLE

A. Station PDS Cable: UL type CMR, TIA/EIA Category 6, 24 AWG solid copper, 4-pair unshielded twisted pair, color coded jacket overall. Cable installed below slab on grade shall have a water blocking core and suitable for installation below grade in conduit.

B. Tidal Generator System Communications:

1. Fiber: Singlemode Indoor/Outdoor Riser Rated Fiber Optic Cable (Data Backbone): UL listed Type OFNR, (8) strand, match clad fiber-optic distribution cables, tight buffered with fire retardant polyethylene, glass reinforced polymer central strength member, aramid yarn

flexible strength elements, and fire retardant polyethylene outer jacket and water blocking system. Optimum performance from 1265 nm to 1625 nm.

2. UTP: UL type CMR, TIA/EIA Category 5e (350MHz) or better, 24 AWG solid copper, 4-pair unshielded twisted pair, color coded jacket overall.

2.3 CABLE ACCESSORIES

A. Cable Support: Extra wide base J hooks, with tie wraps. Caddy cable cat system or approved. Staples, straps, bridle rings, and similar supports are prohibited.

B. Fiber Protection, Inside Plant: Non-metallic corrugated flexible raceway, 3/4 inch minimum diameter, orange color, UL listed for use with OFNR fiber cable. Carlon Riser-Gard or approved.

D. Wire Management, Backboards: Provide open “D” style wire rings for horizontal and vertical cable management, including strain relief, bend radius, and cable routing.

2.4 STATION OUTLETS

A. Outlet Jacks: TIA/EIA -Category 6, T568A RJ45, 8-position/8-conductor, keyed modular jack, with color coded replaceable icons to identify use.

B. Faceplates: Thermoplastic with identification strip top and bottom; 2 module/4 port capacity; color to match wiring devices. Provide blank modules for unused plate opening.

2.5 CROSS-CONNECT COMPONENTS

A. Station Outlet Cross Connect: TIA/EIA Category 6 printed circuit board patch panels, 6-port modular construction with RJ45 keyed 8-position jacks, AT&T 110 connector system, T568A wiring, identification strips, and 19 inch rack mounting. Provide one 24 port cross connect panel per rack (3 total).

B. Fiber Cross Connects, Indoor: Twenty four (24) port ST style panel installed in protective cabinet with provisions for fiber storage, fiber routing, and connector identification; 19 inch rack mounting, unless otherwise indicated. Provide fiber cross connect panel in center rack (1 total).

C. Fiber Cross Connects, Outdoor: Twenty four (24) port ST style panel installed in locking, outdoor, IP65 rated, wall mount cabinet with provisions for fiber storage, fiber routing, and connector identification. Provide one (1) panel assembly.

D. Fiber Optic Connectors: Single mode ST style. Quick cure epoxy adhesive. Bayonet style coupling with multi-mode ceramic or glass-in-ceramic ferrule, keyed for repeatable performance.

2.6 EQUIPMENT MOUNTING

A. 2-Post Equipment Racks, Floor Mounted: UL listed; seismic rated, self supporting frame designed for open rack mounting of telecommunications equipment, base anchor design, pre-drilled EIA mounting holes, 19 inches wide by 84 inches high (44 RMU) unless otherwise indicated. Provide with vertical 6 inch wire management section each side, vertical power strip mounting hardware, equipment mounting hardware (50 pack), and floor mounting hardware. Chatsworth 13853 series or approved. Finish: black. Provide two (2) each.

B. 4-Post Server Frames, Floor Mounted: UL listed; seismic rated, self supporting frame designed for open rack mounting of telecommunications equipment, base anchor design, square punch mounting holes, 19 inches wide by 84 inches high (45 RMU) unless otherwise indicated. Provide with vertical 8 inch wire management section each side, vertical power strip mounting hardware, equipment mounting hardware (25 pack), and floor mounting hardware. Chatsworth 15053 QuadraRack series or approved. Finish: black. Provide one (1) each.

C. Plug Strips: Vertical rack mounted, 120 VAC power strip, with (20) NEMA 5-20R rear mounted receptacle outlets, and 10-foot cord with NEMA 5-20P plug input. Provide one (1) power strip per rack. Geist MJBN202-102S20ST5 or approved.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with product manufacturer installation instructions. Conform to requirements of TIA/EIA- 568-B and TIA/EIA-569 for the specified Category.

B. Unless otherwise indicated, provide one cable drop per jack.

C. Label station outlets sequentially using the following alpha/numeric identification plan. Label station cable at each end with a permanent cable marker to match the corresponding terminal number. Label each station jack using polyester film adhesive pre-labeled markers to indicate corresponding terminal number.

D. Conceal wiring in suspended ceiling spaces and in wall construction unless otherwise indicated. Utilize conduit rough-in shown on project drawings. Install cable in neat parallel runs within cable trays and down to cross-connect hardware without rolls, twists, or loops.

E. Install cables continuous without splicing. Install open cable in cable trays. Bundle multiple cables with nylon tie wraps.

F. Provide cable slack to meet TIA/EIA standards, minimum.

G. Maintain a minimum 6 inch separation from parallel power wiring. Do not share bore or knock out holes thru wall studs and other structural members with power wiring.

H. Secure floor mounted equipment racks with four (4) 5/8 inch diameter anchor bolts, one near each corner of floor base. Use lead expansion anchors in concrete floors.

I. Bond together all equipment racks to room cable tray and to communications service ground using #1/0 AWG conductor minimum. Comply with Section 16060 for grounding materials.

J. Provide fiber optic cable within protective non-metallic raceway system. Install raceway to within 18 inches of fiber termination.

K. Install data icons at all station jacks.

L. Install cross connect panels at top of racks, fiber above station cross connect.

3.3 TESTING

A. UTP Cabling

1. Test station drops for specification compliance at completion of work. Correct deficiencies by replacing terminations, components, or cable as required.

2. Perform continuity test on each wire/pair prior to cover. Verify no open circuits, short circuits, or accidental grounds exist.

3. PDS shall be certified to meet or exceed the specifications as set forth in TIA/EIA TSB40 and TIA/EIA 606-A for specified Category compliance. Certifications shall include the following parameters for each pair of each cable installed:

    a. Wire map (pin to pin connectivity)
    b. Length (in feet)
    c. Attenuation to Crosstalk Ratio (ACR)
    d. DC Loop Resistance
    e. Ambient noise
    f. Near-End Crosstalk (NEXT)
    g. Equal-Level Far-End Crosstalk (ELFEXT)
    h. Return Loss (RL)

4. Use test equipment such as the Ideal LANTEK 6 or approved equal to measure all essential cable parameters specified by TIA/EIA and UL thru Category 6. Provide a written record of these tests.

5. Correct malfunctions when detected and proceed with testing. Record test results on a "UTP Cable Test Results" form showing frequency tested and PASS/FAIL results.

B. Fiber Optic Cabling

1. OTDR Acceptance Tests: Test fiber optic cable for continuity, normalized fiber loss, and overall length verification, using an Optical Time Domain Reflectometer (OTDR). Attenuation measurements in dB/km shall be performed for each fiber at 1310 nm and 1550 nm wavelength. Perform tests of cable both on reel when delivery of cable is taken, and after cable is installed and before connectorizing. Attenuation of singlemode fibers shall be no greater than 0.4 dB/km at 1310 nm and 0.3 dB/km at 1550 nm. Installed cables with any damaged fibers shall be removed and replaced at Contractor expense.

2. Visual Inspection Reports: Visual inspection of each field installed fiber optic connector shall be documented to include report on end face quality, polish, and informational comments.

3. Optical Loss Tests: Fibers shall be loss tested in both directions at 1310 nm and 1550 nm wavelengths after connectorization. Acceptable attenuation shall be any value less than the fiber attenuation plus 0.2 dB per connector.

4. Use test equipment such as the Ideal FIBERTEK or approved equal to measure all essential parameters specified. Provide a written record of these tests.

5. Correct malfunctions when detected and proceed with testing. Record test results on a "Fiber Optic Cable Test Results" form showing PASS/FAIL results.

3.3 DOCUMENTATION

A. Documentation includes the following and shall be delivered to the Architect/Engineer within 20 working days after the wiring is completed.

1. Certification documents and test results

2. Record drawings

3. Permanent ID record at the telecommunication room.

END OF SECTION

SECTION 18000 – MARINE OPERATIONS

Contents

1 General 3
1.1 Summary 3
1.2 Reference Specifications, Codes, and Standards 5
1.3 Submittals 6
1.3.1 Submittal 1: Program Execution Plan and Schedule 7
1.3.2 Submittal 2: CONTRACTOR'S Revisions to HIRA 8
1.3.3 Submittal 3: Design Documentation Package (30% and Final) 8
1.3.4 Submittal 3: Cable Lay Plan (CLP) (30%, 60%, and Final) 9
1.3.5 Submittal 4: Cable Connection Plan (CCP) (30%, 60%, and Final) 9
1.3.6 Submittal 5: Recovery and Redeployment Plan (RRP) (30%, 60%, and Final) 10
1.3.7 Submittal 5: Installation Readiness Review (IRR) 10
1.3.8 Submittal 6: Progress Reports 11
1.3.9 Submittal 7: Integration and Marine Operations Daily Reports and Logs 11
1.3.10 Submittal 8: ROV Observation Video, Logs and Position Records and Report 12
1.3.11 Submittal 9: Final Cable Lay, Cable Connection, and Recovery and Redeployment Report 13
1.3.12 Submittal 10: Problem and Corrective Action Reports 13
2 Execution, Materials, and Manufacturing 14
2.1 General 14
2.1.1 Scope of Work Requirements 14
2.1.2 General System Requirements 14
2.2 Specific System Requirements 15
2.2.1 Cable Lay Requirements 15
2.2.1.1 Cable Lay Plan (CLP) Requirements 15
2.2.1.2 Cable Lay Execution Requirements 16
2.2.1.3 Cable Laying Vessel (CLV) 17
2.2.1.4 Verification and Testing 18
2.2.2 Cable Connection Requirements 19
2.2.2.1 Cable Connection Plan Requirements 19
2.2.2.2 Cable Connection Execution Requirements 20
2.2.2.3 Cable Connection Vessel (CCV) 21
2.2.2.4 Verification and Testing 22

2.2.3 Recovery and Redeployment Requirements 22
2.2.3.1 Recovery and Redeployment Plan (RRP) Requirements 23
2.2.3.2 Recovery and Redeployment Execution Requirements 24
2.2.3.3 Recovery Vessel (RV) 26
2.2.3.4 Verification and Testing 27
2.2.4 Turbine Umbilical Storage Platform (TUSP) 27
2.2.4.1 Purpose 27
2.2.4.2 Design and Fabrication Requirements 29
2.2.4.3 Integration, Verification and Testing 30
2.2.5 Subsea Cable Skid (SCS) Requirements 31
2.2.5.1 Purpose 31
2.2.5.2 Requirements 32
2.2.5.3 Design and Fabrication 32
2.2.5.4 Verification and Testing 32
2.2.6 HDD Pulling Hardware and Equipment Requirements 32
2.2.6.1 Purpose 32
2.2.6.2 Requirements 33
2.2.6.3 HPH Design and Fabrication and/or Procurement 33
2.2.6.4 HBA Design and Fabrication and/or Procurement 33
2.2.6.5 PHE Design and Fabrication and/or Procurement 34
2.2.6.6 Verification and Testing 34

Figures

Figure 1: Notional TUSP Concept 28
Figure 2: Notional TUSP Concept on Sub Sea Base 28
Figure 3: Notional Subsea Cable Skid 31

Tables

Table 1 Key Program Submittals 6

PART 1 - GENERAL

1.1 SUMMARY

The CONTRACTOR shall be responsible for design, procurement, integration, installation, and validation testing of the items described in this section. The CONTRACTOR shall coordinate all design, procurement and installation activities with the DISTRICT. The installation is an integrated effort by the DISTRICT requiring detailed planning and coordination of every aspect of the activities.

In many case there has been extensive work done to define concepts that resulted in the referenced specifications and installation concept scenarios presented. These concepts have been coordinated with OpenHydro and University of Washington through the DISTRICT'S ongoing contracts with them. The CONTRACTOR is encouraged to utilize these concepts but the DISTRICT recognizes that the CONTRACTOR may have approaches that it believes can save money, improve performance or both. The DISTRICT is open to other ways of doing specific items where the specifics have not already been determined by license or permit or existing agreements with other program participants.

At a minimum, the CONTRACTOR shall perform the following items:

Shore landing. The shore landing shall consist of a Horizontal Directional Drilled (HDD) conduit(s) suitable for pulling the Trunk Cable (TC) into and terminating to the power control and conditioning building. The CONTRACTOR shall be responsible for complete installation of the HDD including the diver operations required at the exit point.

Trunk Cable, Umbilical Cable and Terminations. The TC provides the connection of the turbine to the shore. There shall be one cable per turbine. The CONTRACTOR shall be responsible for the design (only if alternate cable is submitted), procurement, testing and shipment of the cable and the dry mate terminations of the cable. A section of the TC shall be cut from the completed manufacturing run and terminated on both ends with dry mate connectors. It is to be used as a Turbine Umbilical (TU) from the turbine to In-Line Pressure Vessel (IPV) connection with the TC. There shall be two terminated TC's and four terminated TU's procured along with the mating bulkhead receptacles. Connector selection shall be coordinated with the DISTRICT. The TC design and HDD design are interrelated by the diameter of the cable, which must be pulled through the HDD conduit. The TC design is constrained by the power, control and data requirements of the turbine and also by the Adaptive Monitoring Package (AMP). Section 18010 – Marine Cable (MC) specification provides the cable requirements and specifications for qualified vendors. Section 18020 – Marine Cable Accessories (MCA) specification provides the termination requirements and concepts for a qualified vendor.

Turbine Umbilical Storage Platform (TUSP) on the Turbine Subsea Base (SSB). The CONTRACTOR shall be responsible for the design coordination, detailed design, build and installation oversight of the TUSP and incorporated ROV landing platform on the subsea base. The DISTRICT shall fasten the CONTRACTOR supplied TUSP, Turbine Junction Bottle (TJB)

and TU to the SSB. The CONTRACTOR shall deliver the terminated TU's to the turbine mobilization site (Greater Puget Sound area) and oversee the installations. See this specification for the requirements of the TUSP.

Marine Operations (MO). The marine operations shall be planned and coordinated with the DISTRICT and other trade contractors. The CONTRACTOR shall develop detailed installation plans for every aspect of the installation activities. These plans shall include safety and environmental sections compliant with all applicable local, state and federal regulations. The plans shall include emergency response to possible equipment or natural events that may occur. The CONTRACTOR shall mobilize the required personnel, equipment and vessels to accomplish each of the installation activities. The CONTRACTOR shall perform each of the installation activities and provide validation of the proper installations. Detailed requirements for the MO are presented in this specification.

HDD subsea exit. The HDD subsea exit requires diver support to monitor the drilling mud and change the drilling heads as required. This is an activity normally left to the HDD subcontractor. See HDD Specification contained in contract plans.

TC installations including the pull into the HDD shore power control and conditioning building. This activity shall be done prior to turbine installations, based on a sea to shore installation approach. All moorings shall be temporary and a minimum of 1500 meters from PC-1. The only temporary mooring planned in any MO is adjacent to the HDD exit point for the pull of the cables into the bores. The cables shall be laid along the route provided in the contract plans. Video inspection of the cable laydown in real time shall be accomplished by an ROV to assure there is no vertical or horizontal loops (hockles) in the cable and that no cable bends are less than the minimum bend radius of the cable occur nor any suspensions of greater than 1m occur. See Section 18010 for cable installation requirements.

TU and TC connections and cable laydown. Once the turbine has been deployed, the CONTRACTOR shall retrieve the TU from the SSB and recover it to a Cable Connection Vessel (CCV). The TC shall be recovered from the seafloor to the CCV and the two ends shall be connected together using an IPV and cable performance shall be verified from the shore power control and conditioning building.

Post installation as built locations and inspections of turbines and cables. The CONTRACTOR shall inspect the turbine base and cable laydowns after all installations are complete and provide video recording of those inspections. The CONTRACTOR shall provide as built locations for the entire cable lengths and turbine locations.

Recovery and redeployment of the turbines. In the event that one or both of the turbines needs to be removed from the installation site, post deployment and during the operational phase of the tidal energy project, the CONTRACTOR may be required to assist the DISTRICT in the recovery and potential redeployment operation. During recovery, the TU will be cut by an ROV near the subsea base and retrieved aboard a barge of opportunity while the vessel backs down the cable path. The cut section of the TU will be separated from the In-line Pressure Vessel (IPV) and confidence loops will be installed on the TC dry mate connectors. The IPV and TC will then be lowered to the seafloor using the Subsea Cable Skid (SCS) while the vessel

maneuvers back down the cable path. The redeployment of the turbines is an identical process to the original installation.

ROV support operations. The CONTRACTOR shall provide ROV services for monitoring, inspection, and recording of all MO. The CONTRACTOR shall design ROV support tooling and TUSP accommodations to assist the ROV in work at the SSB and in accomplishing the tasks required to recover and inspect the TU and TC ends.

Specifically, the CONTRACTOR shall furnish all labor, equipment, and materials necessary to plan, design, procure, fabricate, test, integrate, and install the following items:

1. Cable Lay - Install the two Trunk Cables (TC)
2. Cable Connection – Connect the two TCs to the two Turbine Umbilical Cables (TU)
3. Recovery and Redeployment (as required) – Cut and recover the TU from the seafloor. Recover the TU from the TUSP during redeployment.
4. Design and provide accessory equipment necessary for the above tasks including:
    a. Turbine Umbilical Storage Platform (TUSP)
    b. Subsea Cable Skid (SCS)
    c. HDD Pulling Hardware and Equipment
    d. For the RRP, cutting the TU and attaching a line for recovery to the Recovery Grip (RG)

Horizontal Directionally Drilled Pulling Head (HPH)

HDD Bellmouth Assembly (HBA)

HDD Miscellaneous Pulling Hardware and Equipment (PHE)

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

The procurement and deployment shall conform to all Federal, State, and local codes, ordinances, and laws having jurisdiction over this project. In the event of a conflict between these Specifications and the above-mentioned codes, the more stringent of the two shall govern.

The CONTRACTOR shall comply at all times with the relevant requirements of:

1. United States Coast Guard (USCG) specifically Title 33
2. National Oceanic and Atmospheric Administration (NOAA)
3. American Society for Testing and Materials (ASTM)
4. American National Standards Institute (ANSI)
5. National Electric Safety Code (NESC)
6. National Fluid Power Association (NFPA)
7. National Electric Code (NEC)

8. Recommended Practice for Electrical Installations on Shipboard, Standard No. 45, Institute of Electrical and Electronic Engineers (IEEE)
9. International Maritime Organization (IMO), Safety of Life at Sea (SOLAS 48, 60 and 74)
10. USA diving code
11. IMCA diving code

1.3 SUBMITTALS

The submittals are considered to be deliverable documentation items that the DISTRICT and other program contractors will review and the DISTRICT will approve. Where Submittals listed here are also identified in Division 1, the latter requirements take precedence. The following are key program submittals:

Table 1 Key Program Submittals

Submittal	Due Date
Overall Project Schedule	3 wks after NTP
Contractor's Revisions to HIRA	3 wks after NTP
Design documentation package (30%)	5 wks after NTP
Cable Lay Plan (30%)	5 wks after NTP
Cable Connection Plan (30%)	5 wks after NTP
Recovery & Redeployment Plan (30%)	5 wks after NTP
Design documentation package (Final)	11 wks after NTP
Cable Lay Plan (60%)	11 wks after NTP
Cable Connection Plan (60%)	11 wks after NTP
Recovery & Redeployment Plan (60%)	11 wks after NTP
Cable Lay Plan (Final)	8 wks prior to Install
Cable Connection Plan (Final)	8 wks prior to Install
Recovery & Redeployment Plan (Final)	8 wks prior to Install
Installation Readiness Review	2 wks prior to Install
Progress Reports	Monthly by the 10th
Marine Operations Daily Reports	Daily during Marine Ops (MO)
ROV Observation Video, Logs and Position Records and Report	2 wks following MO
Final Cable Lay and Connection Report	3 wks following MO
Problem and Corrective Action Reports	As Required

Review and acceptance of the CONTRACTOR's Submittals by the DISTRICT shall not be construed in any way as relieving the CONTRACTOR of its responsibilities under this Specification.

CONTRACTOR shall submit Marine Operations Section 18000, Marine Cable Section 18010, and Marine Cable Accessories Section 18020 in one package for review by the DISTRICT.

Submittals shall be:

1. Produced in MS Word, PowerPoint, Excel, Visio, Project as applicable and also provided as PDF files
2. Provided in accordance with the schedule in 1.3 above or as amended by mutual acceptance
3. Include project title, report title, date submitted, company name, author name and title, disclaimers, caveats
4. Provided by electronic means (email or file transfer site)
5. Provided in digital media as appropriate for daily logs, as built records and video recordings
6. Provided in hard copy handout (10 or less as required) for review meetings

The following lists the individual submittal requirements required by the CONTRACTOR:

1.3.1 Submittal 1: Program Execution Plan and Schedule

1. Program Plan shall contain as a minimum:
2. Organizational structure of CONTRACTOR and subcontractors
3. Responsibility matrix for each element of work
4. Staffing plan or chart
5. The schedule shall include the items identified herein and be in conformance with Section 01050 Master schedule.
6. The schedule of planned activities shall include :
7. Planning
8. Design activities and design reviews
9. Procurement
10. Fabrication
11. Integration
12. Inspections and tests
13. Installations

1.3.2 Submittal 2: CONTRACTOR'S Revisions to HIRA

1.3.3 Submittal 3: Design Documentation Package (30% and Final)

The purpose of this package is for the CONTRACTOR to clarify their design direction on the following items:

1. Marine Cable (MC) - Only if CONTRACTOR selects a cable not preapproved by the DISTRICT in accordance with Section 18010
2. Marine Cable Accessories (MCA) – Section 18020
3. Turbine Umbilical Storage Platform (TUSP)
4. Subsea Cable Skid (SCS)
5. HDD Pulling Hardware and Equipment
6. Horizontal Directionally Drilled Pulling Head (HPH)
7. HDD Conduit Bellmouth Assembly (HBA)
8. HDD Miscellaneous Pulling Hardware and Equipment (PHE)
9. Other items as determined necessary by the CONTRACTOR

At a minimum, the CONTRACTOR shall submit the following as required for each item listed above:

1. The information, in coordination with Section 01050, provides sufficient detail to allow the DISTRICT to determine whether the proposed equipment, materials, and procedures meet the Specification requirements.
2. All drawings to scale using S.I. units. Principal dimensions shall also indicate equivalent English units.
3. All analysis and calculations supporting the designs
4. All assumptions used in the analysis and calculations
5. All interface definitions and specifications
6. Inspection and test methods and plans
7. Certifications
8. Acceptance criteria
9. Physical properties including overall dimensions, volume, materials, space requirements, and weight
10. Mechanical properties such as yielding strength, bending strength, maximum tension, lifting capacity, operating speed, and service life
11. Hydrodynamic properties, where applicable, such as working depth, maximum operating current, sea state capability

12. Electrical properties including system architecture, power requirements, resistance, power generated, frequency, battery life, and lighting
13. Methodologies of fabrication, construction, and manufacturing
14. Details related to packaging and delivery
15. Detailed specifications including model numbers, trade names, classification, and individual part numbers for significant purchased items
16. The CONTRACTOR shall prepare and present a 30%, and Final Design Review covering the items in this section and any other items deemed essential to the understanding of CONTRACTOR's designs and approach.

1.3.4 Submittal 3: Cable Lay Plan (CLP) (30%, 60%, and Final)

The DISTRICT has included a conceptual Cable Lay Storyboard in Appendix-B. The CONTRACTOR may adopt and further refine this plan or submit an alternate plan that meets or exceeds the requirements of this Specification. The storyboards were developed in coordination with the turbine supplier and numerous consultants. The CONTRACTOR shall be aware that it is unlikely any significant deviations from these plans will be approved.

Submittal requirements shall include but not be limited to the following:

1. The CONTRACTOR shall submit Preliminary Cable Lay Plan (CLP) that illustrates the processes identified in the Cable Lay Plan Requirements and Cable Lay Execution Requirements.
2. The CONTRACTOR shall prepare and present 30%, 60%, and Final Cable Lay Plans covering the items in this section and any other items deemed essential to the understanding of CONTRACTOR'S designs and approach in accordance with the schedule identified above.
3. The CLP shall include a northing reference, current direction, tidal cycle, installation timeline, and chronological sequence of events.

1.3.5 Submittal 4: Cable Connection Plan (CCP) (30%, 60%, and Final)

The DISTRICT has included a conceptual Cable Connection Storyboard in Appendix-D1. The CONTRACTOR may adopt and further refine this plan or submit an alternate plan that meets or exceeds the requirements of this Specification. The storyboards were developed in coordination with the turbine supplier and numerous consultants. The CONTRACTOR shall be aware that it is unlikely any significant deviations from these plans will be approved.

1. The CONTRACTOR shall submit Preliminary Cable Connection Plan (CCP) that illustrates the processes identified in the Cable Connection Plan Requirements and Cable Connection Execution Requirements.
2. The CONTRACTOR shall prepare and present 30%, 60%, and Final Cable Connection Plans covering the items in this section and any other items deemed

essential to the understanding of CONTRACTOR's designs and approach in accordance with the schedule identified above.

3. The CLP shall provide a storyboard of planned installation evolutions including a northing reference, current direction, tidal cycle, installation timeline and chronological sequence of events.

1.3.6 Submittal 5: Recovery and Redeployment Plan (RRP) (30%, 60%, and Final)

The DISTRICT has included a conceptual Recovery and Redeployment Storyboard in Appendix-D2. The CONTRACTOR may adopt and further refine this plan or submit an alternate plan that meets or exceeds the requirements of this Specification. The storyboards were developed in coordination with the turbine supplier and numerous consultants. The CONTRACTOR shall be aware that it is unlikely any significant deviations from these plans will be approved.

1. The CONTRACTOR shall submit Preliminary Recovery and Redeployment Plan (RRP) that illustrates the processes identified in the Recovery and Redeployment Plan Requirements and Recovery and Redeployment Execution Requirements.
2. The CONTRACTOR shall prepare and present 30%, 60%, and Final Recovery and Redeployment covering the items in this section and any other items deemed essential to the understanding of CONTRACTOR's designs and approach in accordance with the schedule identified above.
3. The RRP shall provide a storyboard of planned installation evolutions including a northing reference, current direction, tidal cycle, installation timeline and chronological sequence of events.

1.3.7 Submittal 5: Installation Readiness Review (IRR)

The IRR is the final review of the CLP, CCP, and RRP (if required) is conducted with all the other participants in the marine and supporting shore operations. Successful completion of the IRR requires DISTRICT acceptance. No marine operations may commence without that approval.

The IRR shall include the following:

1. Final CLP, CCP, and RRP (if required) with a complete review of all vessels and operations and the supporting timelines.
2. Final review of schedules for installations
3. Final review and coordination of all supporting operations to include at a minimum:
    a. Mobilizations
    b. Vessel and vessel operator and alternates identification, roles and responsibilities, contact information and alternates
    c. Roles and responsibilities of project participants
    d. Vessel safety responsibilities

e. Communications protocols

f. Vessel traffic, notice to mariners and ferry traffic notifications and coordination

g. Emergency medical and evacuation procedures

h. Transits

4. Testing protocols and timelines
5. Installation activities and timelines
6. Failure modes and effects analysis and recovery scenarios
7. Weather constraints and project responsibilities to call for weather

1.3.8 Submittal 6: Progress Reports

The Progress Reports are intended to be brief written reports to keep the DISTRICT informed of progress, problems, schedule status and any workarounds being accomplished.

Progress shall include at a minimum the following items:

1. Highlights of items planned and accomplished
2. Problems encountered and the solutions being pursued
3. Schedule overview of planned and completed tasks and on-going task progress
4. Key interface issues or concerns and solution suggestions
5. Requested help
6. Budget status for non-fixed price items

1.3.9 Submittal 7: Integration and Marine Operations Daily Reports and Logs

Daily logs and records shall be maintained by the CONTRACTOR during integration and marine operations.

Daily logs and records shall be submitted to the DISTRICT by noon of the following day to which the records correspond.

Reports shall include project related information to include as a minimum:

1. Integration activities
   a. Events
   b. Milestones
   c. Inspections
   d. Problem reports
   e. Action registers
   f. Testing accomplished and results

2. Marine Operations
    a. Locations
    b. Weather and traffic observations
    c. Any safety issues and resolutions
    d. Accomplishments
    e. Problem reports
    f. Plans for next day
3. Marine Operations logs, at a minimum, shall include:
    a. Position and event logs
    b. Cable positions
    c. ROV observations
    d. Marine traffic
    e. Weather
    f. Problems and resolutions
    g. Variations in schedule or costs

1.3.10 Submittal 8: ROV Observation Video, Logs and Position Records and Report

A final report shall be prepared containing the following information as a minimum:

1. Track lines
2. Position logs
3. Observation logs with georeferencing
4. All digital video media georeferenced
5. Problem reports
6. Listing of all ROV equipment used
7. Calibration data as appropriate
8. Daily logs
9. Screen captures of significant items to include
10. Cable on bottom
11. Cable entering HDD
12. IPV set down
13. Any hazards or threat in cable vicinity
14. Any cable suspensions, loops or hockles

15. Any items of environmental significance
16. Other items of interest
17. As-builts
18. Cable weighting materials
19. Cable performance during current at SSB to seafloor transition.

1.3.11 Submittal 9: Final Cable Lay, Cable Connection, and Recovery and Redeployment Report

Upon completion of the installation sequences, a final report shall be prepared containing the following information as a minimum:

1. Description of vessels and equipment used
2. Logs of all cable activities to include:
3. Route position with running cable tensions versus plans
4. Route position with running cable angles versus plans
5. Any cable bends exceeding specified bend diameters
6. Cable equipment malfunctions
7. Cable test results
8. Any cable mishaps
9. IPV inspection reports
10. Summary of daily reports
11. As built location of all deployed items and cables
12. Cable pulling plan at vault including sheaves, quadrants, etc. to prevent over bending of the cable beyond the minimum bending radius.
13. Identification and description of any deviations from preplanned cable routes

1.3.12 Submittal 10: Problem and Corrective Action Reports

These reports are brief descriptions of problems in design, fabrication, integration or testing and how those issues were resolved.

At a minimum, the reports shall describe the:

1. Problem
2. Root cause analysis
3. Corrective action taken

PART 2 – EXECUTION, MATERIALS, AND MANUFACTURING

2.1 GENERAL

2.1.1 Scope of Work Requirements

The CONTRACTOR shall be responsible for executing the system concepts, analysis, design, planning, procurement, fabrication, integration, in process inspections and testing, final acceptance inspections and testing of deliverable configuration items consisting of:

1. Marine Cable (MC)
2. Marine Cable Accessories (MCA)
3. Turbine Umbilical Storage Platform (TUSP)
4. Subsea Cable Skid (SCS)
5. HDD Pulling Hardware and Equipment
    a. Horizontal Directionally Drilled Pulling Head (HPH)
    b. HDD Bellmouth Assembly (HBA)
    c. HDD Miscellaneous Pulling Hardware and Equipment (PHE)

Prior to the Marine Operations described in this section the CONTRACTOR shall have installed the two HDD conduit(s) into which the TC is pulled and the shore power control and conditioning building (PCCB) where the TC is ultimately terminated.

The requirements for each of the CONTRACTORS execution responsibilities are described in the following sections.

2.1.2 General System Requirements

The following are the general requirements for the system elements:

1. The CONTRACTOR shall design for:

a. Operational life of 5 years at the project site

b. Operating depth of 100m in Puget Sound seawater

c. Marine operations in ≤ Beaufort Sea State 3

d. Live boat operations unless 1500 meters separated from PC-1.

e. Standby tugs to support station keeping

f. Site conditions per contract plans

g. The extreme current environment as detailed in the University of Washington report titled “Admiralty Inlet Site Characteristics”, included as Appendix-I in Division -1 of this specification.

h. The proper selection of materials, dimensions, and tolerances necessary to assure compliance with the marine environment.

i. Materials shall not bend, break, crack, soften, or exhibit other immediate or latent defects that adversely affect storage, operation, or environmental capabilities of their intended function.

No marine operations shall commence prior to the successful completion of the Installation Readiness Review (IRR).

During the execution of the approved CLP, CCP and RRP, the CONTRACTOR shall provide redundant levels of station keeping capability to ensure that marine operations are completed despite potential contingencies.

2.2 SPECIFIC SYSTEM REQUIREMENTS

2.2.1 Cable Lay Requirements

The purpose of the Cable Lay is to precisely place two TCs on the bottom along a predetermined route with a live boat operation, to install the TC in the HDD conduits and terminate the cable at the shore end.

2.2.1.1 Cable Lay Plan (CLP) Requirements

The CONTRACTOR shall provide a CLP detailing all of the planning, designs, vessels, equipment, fabricated items and such other materials and items as may be necessary to safely install two Trunk Cables (TC) as specified herein and detailed in the following section (Cable Lay Execution Requirements).

Details shall include at a minimum the following:

1. Vessels required
    a. Station keeping of Cable Laying Vessel (CLV)
    b. Cable lay equipment spread
    c. Deck layouts
    d. Support equipment and vessels
2. Personnel requirements
3. ROV utilization
    a. Method for collecting cable as built location
    b. Installation video recording of cable lay
    c. Inspection and observations
4. Personnel safety (Safety Plan Outline). The Safety Plan shall include a code of safe practices and an emergency plan in accordance with OSHA and Washington/OSHA requirements.
5. Environmental considerations (Environmental Protection Plan Outline)
6. Diver considerations for HDD cable pull (Dive Plan Outline)

7. Testing of the cable pre lay, during lay and post lay
8. Deployment of the Subsea Cable Skid (SCS)
9. Laying of the TC with accuracy required,
10. Installing the HPH, HBA, and PHE
11. Installing the TC in the HDD
12. Floating the TC to the HDD
13. Pulling the TC through the HDD
14. Identification all tidal windows, within 6 weeks before or after each cable lay
15. Minute by minute schedule for installation and deployment operations occurring where station keeping is vital to operational success.
16. Detailed procedures showing the reversibility of each deployment process
17. Analysis, simulations, calculations, CAD drawings and other supporting detail

2.2.1.2 Cable Lay Execution Requirements

The CONTRACTOR shall deploy the TC in coordination with the overall project schedule to ensure a maximum submergence time of 60 days prior to the turbine installation.

To ensure proper placement of the TC end at the turbine deployment site, the CONTRACTOR shall install the TC from sea to shore. No proposals from shore to sea shall be approved.

The CONTRACTOR shall design and install the TC in accordance with the manufactures specifications.

The CONTRACTOR'S cable lay process shall meet as a minimum the following requirements:

1. Be performed with live boat operations unless where 1500 meters separated from PC-1.
2. All evolutions must be reversible without damage to the TC
3. Positioning accuracy of the CLV and TC position on the bottom is per the predetermined cable route per the contract plans.
4. The absolute position accuracy of the SCS deployment shall be within ±5 meter of the preplanned position within 15 meters of the SSB cross member (short base of SSB triangle). The exact position to be defined during the design phase.
5. The cable lay must be in one continuous operation
6. ROV inspection of the cable laydown is required for 100% of the route.

7. Cable lay process will utilize a preplanned deployment that calculates the cable characteristics of tension and departure angle for the cable based on route position, length deployed, depth, forward progress speed and current direction and velocity
8. Cable deployed length, tension, departure angle, forward speed and position shall be recorded
9. The TC shall be managed at all times during the CLP operation. At no time shall the cable be pulled excessively, dragged on the bottom, twisted, flexed, or otherwise handled that could cause damage to the cable.
10. No suspensions of ≥1 meter in length are allowed
11. The TC shall not have slack resulting in loops or raised portions when on the seafloor
12. Cable route may be deviated from if suspensions, other hazards or threats to the cable are seen along the route. The DISTRICT Representative on board will be the final approval authority.
13. The CONTRACTOR during deployment shall not exceed the minimum bending radius of the TC as defined in Section 18010.
14. The CONTRACTOR shall use divers and support vessels to monitor, guide, and visually record the TC pull through the HDD pipe(s).
15. Standby tug(s) are required for operations except at the HDD bore exit site if anchored in accordance with anchoring limitations contained herein.
16. Acquire and record the as built position of the TC suitable for generation of easement documents.

2.2.1.3 Cable Laying Vessel (CLV)

The CLV is intended to be a barge of opportunity equipped with self-powered cable handling and deployment capabilities. Propulsion for the CLV is anticipated to be Z-drive tugs or power units on the barge that enable the vessel to live-boat maneuver and station keep throughout the entire planned cable route during full tidal cycles. The CONTRACTOR may elect to use a cable ship as an alternate CLV.

The CONTRACTOR shall supply a Cable Laying Vessel (CLV) capable of meeting the execution requirements as described herein and having, at a minimum, the following capabilities:

1. Full day (24 hour) manned operations
2. USCG inspected barge or vessel
3. Stable platform in specified operating conditions and areas
4. Live boat station keeping

5. Propulsion on board or with tugs adequate for station-keeping and heading control in all tidal conditions in the entire project area to ±5m accuracy with simultaneous progress along a predetermined route
6. Deck area sufficient to house motor generator sets, hydraulic power units, TC handling gear, TC cable engines or powered reels, winches, cable path supports, control stations, storage of rigging, floats and other hardware required, personnel required to accomplish the cable lay operation
7. TC instrumentation
8. Navigation
9. Deck area sufficient to allow cable handling without exceeding the minimum bend radius of the TC
10. Adequate deck space for a carousel or cable reel for one or two TC
11. Cable chute(s)
12. Personnel access space to equipment and cable ends
13. Station-keeping capability in all tidal conditions for the cable pull into the HDD conduit(s)
14. Protected and environmentally controlled housing for control room, work space, test equipment and monitoring equipment
15. Emergency systems for ballast control, flooding, fire, medical emergency
16. Emergency TC clamps and cutting facilities
17. Lifting and handling gear certifications
18. Radio communications and backup to USCG, other vessels and project personnel

2.2.1.4 Verification and Testing

The following verification or tests are required to verify equipment and procedures prior to commencement of TC deployment:

1. Review of final CLP
2. Verification and demonstration of positioning control of the CLV in full tidal cycle
3. Installation Readiness Review (IRR) for cable laying
4. Transitioning the TC from the cable pan or reel to the cable chute.
5. Calibrations and records of equipment to be used during cable lay.

The following verifications and tests are required following installation and at other times as deemed necessary by the CONTRACTOR:

1. Insulation Resistance and DC resistance of each copper element in the TC and TU

2. Optical Time Domain Reflectometer (OTDR) for each fiber optic element in the TC and TU
3. Verification, through ROV survey, of cable route to assure suspensions, loops or other hazards are not present

2.2.2 Cable Connection Requirements

The purpose of the Cable Connection is to connect the pre-installed TC to the TU once the turbine has been deployed.

2.2.2.1 Cable Connection Plan Requirements

The CONTRACTOR shall provide a CCP detailing all of the planning, designs, vessels, equipment, fabricated items and such other materials and items as may be necessary to safely connect the two preinstalled Trunk Cables (TC) to the Turbine Umbilical's (TU) as specified herein and detailed in the following section (Cable Connection Execution Requirements).

Details shall include at a minimum the following:

1. Identification all tidal windows, within 6 weeks before or after each cable connection
2. Minute by minute schedule for installation and deployment operations occurring where station keeping is vital to operational success.
3. Detailed procedures showing the reversibility of each connection process
4. Vessels required
5. Station keeping of Cable Connection Vessel (CCV)
6. Cable lay equipment spread
7. Deck layouts
8. Support equipment and vessels
9. Personnel requirements
10. ROV utilization
11. Method for collecting cable as built location
12. Installation video recording of cable lay
13. Inspection and observations
14. Personnel safety (Safety Plan Outline) The Safety Plan shall include a code of safe practices and an emergency plan in accordance with OSHA and Washington/OSHA requirements.)
15. Environmental considerations (Environmental Protection Plan Outline)
16. Recovery of the TU and TC
17. Connection of the IPV housing joining TC and TU

18. Redeployment of the TU and TC
19. Analysis, simulations, calculations, CAD drawings and other supporting detail

2.2.2.2 Cable Connection Execution Requirements

The CONTRACTOR shall connect the TC to the TU within 48 hours of each turbine deployment respectively.

The CONTRACTOR shall design and install the cable connection in a manner consistent with the MC and MCA manufactures specifications.

The CONTRACTOR'S cable connection process shall meet as a minimum the following requirements:

1. All evolutions must be reversible without damage to the TC/TU
2. Be performed with live boat operations.
3. Cable connections and verification operations shall not exceed 2 hours from the time the cable ends are brought on deck
4. Propulsion on board or with tugs adequate for station-keeping and heading control in all tidal conditions in the entire project area
5. Positioning accuracy of the CCV and TC/TU position on the bottom is per the predetermined cable route as specific in the contract plans as further refined by the CONTRACTOR
6. The absolute position accuracy of the IPV deployment shall be ±5 meter of the preplanned position. The exact position will be refined during the submittal process.
7. The cable retrieval, connection, verification testing and laydown must be in one continuous operation
8. Cable verification of TC and TU prior to connection to include Insulation Resistance, DC resistance of each copper element and Optical Time Domain Reflectometer (OTDR) for each fiber optic element and other tests deemed necessary
9. Following verification of the connection, CCV is to standby for 1 hour (TBR) prior to cable redeployment while pre-commissioning testing is performed by others from the power control and conditioning building.
10. ROV inspection of the cable laydown is required for 100% of the operation.
11. Cable laydown process will utilize a preplanned deployment that calculates the cable characteristics of tension and departure angle for the cable based on route position, length deployed, depth, forward progress speed and current direction and velocity
12. Cable deployed length, tension, departure angle, forward speed and position shall be recorded

13. The TC/TU shall be managed at all times during the CCP operation. At no time shall the cable be pulled excessively, dragged on the bottom, twisted, flexed, or otherwise handled that could cause damage to the cable.
14. No suspensions of ≥1 meter length are allowed
15. The TC/TU shall not have slack resulting in loops or raised portions when on the seafloor
16. Shape of cable redeployment shall be in accordance with contract plans
17. Cable route may be deviated from if suspensions, other hazards or threats to the cable are seen along the route. The DISTRICT representative on board will be the final approval authority.
18. Suitable standby tug(s) are required for operations in case of emergency
19. The CONTRACTOR shall not anchor the CCV or any support vessel at any point during the CCP.
20. Testing of the cable pre-connection and post connection and verification of the connections
21. Acquire and record the as built position of the TC, TU, and IPV suitable for generation of easement documents.

2.2.2.3 Cable Connection Vessel (CCV)

The CONTRACTOR shall supply a CCV capable of meeting the execution requirements as described herein and having, as a minimum, the following capabilities:

1. Full day (24 hour) manned operations
2. Lifting and handling gear certifications
3. USCG inspected barge or vessel
4. Stable platform in specified operating conditions and areas
5. Live boat station keeping
6. Propulsion on board or with tugs adequate for station-keeping and heading control in all tidal conditions in the entire project area to ±5m accuracy with simultaneous progress along a predetermined route
7. Deck area sufficient to allow cable handling without exceeding the minimum bend radius of the TC and TU
8. Deck area sufficient to house motor generator sets, hydraulic power units, TC and TU handling gear, TC and TU cable path supports, chute(s), control stations, storage of rigging, personnel required to accomplish the cable connection operation
9. TC and TU test instrumentation

10. An IPV work station shall be provided to secure the IPV and lock down the TC/TU for the connection and verification operations
11. Easy personnel access and work space to IPV
12. Navigation
13. Protected and environmentally controlled housing for control room, work space, test equipment and monitoring equipment
14. Emergency systems for ballast control, flooding, fire, medical emergency
15. Emergency TC/TU clamps and cutting facilities
16. Radio communications and backup to USCG, other vessels and project personnel

2.2.2.4 Verification and Testing

The following verification or tests are required at a minimum to verify equipment and procedures prior to commencement of cable connection:

1. Final review of the CCP
2. Verification of positioning control in full tidal cycle
3. Successful completion of Installation Readiness Review (IRR)
4. The CONTRACTOR shall execute and demonstrate the station keeping capabilities of the CCV as a single vessel or under tugboat control.
5. Calibrations and records of equipment to be used during cable connection

The following testing and verification shall be accomplished during the cable connection process:

1. Insulation Resistance, DC resistance of each copper element in the TC and TU
2. Optical Time Domain Reflectometer (OTDR) for each fiber optic element in the TC and TU
3. Verification of IPV sealing process and testing of watertight integrity prior to cable redeployment

The following testing and verification shall be accomplished during the cable connection process:

1. Verification, through ROV survey, of cable laydown to assure suspensions, loops or other hazards are not present

2.2.3 Recovery and Redeployment Requirements

The purpose of the Recovery and Redeployment is to assist the DISTRICT in the removal of one or both turbines from the installation site, post deployment and during the operational phase of the tidal energy project. The recovery procedure will require an ROV to cut the Turbine Umbilical (TU) near the subsea base. The ROV will attach a recovery line to the TU

near the cut section that will be used to winch the cable aboard the Recovery Vessel (RV). The CONTRACTOR may elect to use the either the CLV or CCV during the recovery process in lieu of the RV.

The RV will back down the cable path as it winches aboard the TU, IPV, and approximately 100 ft. (30 m) of the TC, or as required to safely manage the bending limitations of the TC. The TU is then separated from the IPV and confidence loops are installed on the ends of the TC dry mate connectors. The IPV is purged with a dry nitrogen gas and sealed. The IPV is placed in the Subsea Cable Skid (SCS) and lowered to the seafloor in a manner similar to the original TC installation. The redeployment operation replicates the Turbine Units deployment (by others) and the Cable Connection Plan (CCP) as outlined in the Contract Documents.

2.2.3.1 Recovery and Redeployment Plan (RRP) Requirements

The CONTRACTOR shall provide a RRP detailing all of the planning, designs, vessels, equipment, fabricated items and such other materials and items as may be necessary to safely cut and recover the TU, disconnect the TU from the IPV, and redeploy the IPV in the SCS as specified herein and detailed in the following section (Recovery and Redeployment Execution Requirements).

Details shall include at a minimum the following:

1. Identification all tidal windows, within 4 weeks before or after the planned recovery and redeployment operation.
2. Minute by minute schedule for recovery and redeployment operations occurring where station keeping is vital to operational success.
3. Detailed procedures showing the reversibility of each recovery and redeployment process.
4. Vessels required
5. Station keeping of Recovery Vessel (RV)
6. Cable recovery equipment spread
7. On deck cable handling equipment
8. Subsea Cable Skid (SCS) equipment spread
9. Deck layouts
10. Support equipment and vessels
11. Personnel requirements
12. ROV utilization for cutting cable and attaching recovery line
13. Method for recovering cable
14. Video recording of cable cutting, recovery and SCS redeployment

15. Inspection and observations
16. Personnel safety (Safety Plan Outline) The Safety Plan shall include a code of safe practices and an emergency plan in accordance with OSHA and Washington/OSHA requirements.)
17. Environmental considerations (Environmental Protection Plan Outline)
18. Recovery of the TU
19. Disconnection of the IPV housing joining the TC and TU
20. Redeployment of the TU and IPV in the SCS
21. Analysis, simulations, calculations, CAD drawings and other supporting detail

2.2.3.2 Recovery and Redeployment Execution Requirements

At a minimum, the CONTRACTOR shall execute the cable cutting portion of the RRP within 4 weeks of notice by the DISTRICT. After the recovery process is complete, the DISTRICT will provide an estimated redeployment schedule. The CONTRACTOR shall execute the redeployment sequence of the RRP (CCP) within 4 weeks of notice to proceed by the DISTRICT.

The CONTRACTOR shall design the recovery in a manner consistent with the MC and MCA manufactures specifications. The CONTRACTOR shall design the redeployment process to replicate the approved Cable Connection Plan (CCP).

The CONTRACTOR'S recovery and redeployment process shall meet as a minimum the following requirements:

1. All evolutions must be reversible without damage to the turbine, IPV and TC.
2. Be performed with live boat operations. No anchoring is allowed.
3. Propulsion onboard or with tugs adequate for station-keeping and heading control in all tidal conditions in the entire project area.
4. The TU cutting, retrieval, disconnection, verification testing and SCS laydown must be in one continuous operation.
5. ROV capable of cutting and attaching a recovery line to the TU from a deck winch.
6. Recover the cut TU, IPV and TC on board the RV.
7. Hold each of the cables while the TU is disconnected from the IPV.
8. After the TU is disconnected from the IPV, confidence loops shall be installed on each of the TC dry mate connectors.
9. The CONTRACTOR shall coordinate with the DISTRICT to provide transportation of the TUSP from the Mobilization Site to the CONTRACTOR's refurbishment facility.

10. The CONTRACTOR will prepare and deliver the TUSP in accordance with the Cable Connection Plan (CCP). It shall be the CONTRACTOR's responsibility to coordinate delivery schedule with the DISTRICT.
11. The CONTRACTOR shall prepare the TUSP and related equipment to the standards required for the original deployment. This may involve cleaning, refurbishment, and painting, depending on the condition of the equipment when removed.
12. To assure conformance with the specifications and material limitations, the CONTRACTOR shall observe the TUSP and TU connections performed by the DISTRICT.
13. Cable verification of TC prior to redeployment of the IPV/SCS shall include Insulation Resistance, DC resistance of each copper element and Optical Time Domain Reflectometer (OTDR) for each fiber optic element and other tests deemed necessary.
14. Following verification of the connection, the RV is to standby for 1 hour (TBR) prior to redeployment while testing is performed by others from the Power Control and Conditioning Building (PCCB).
15. Dry nitrogen purging of the IPV after confidence loops and end flange is attached.
16. Turbine Umbilical disconnection, installation of confidence loops, IPV purging, and verification operations shall not exceed 2 hours from the time the cable ends are brought on deck.
17. Transfer the IPV to the SCS.
18. Load handling equipment/methods to deploy the TC, IPV and SCS.
19. Positioning accuracy of the RV and IPV/TC/SCS on the bottom is per the predetermined cable route as specified in the contract plans and further refined by the CONTRACTOR.
20. The absolute position accuracy of the IPV in the SCS shall be ±5 meter of the preplanned position. The exact position will be refined during the submittal process.
21. ROV inspection of the TC/IPV/SCS is required for 100% of the operation.
22. SCS laydown process will utilize a preplanned deployment that calculates the cable characteristics of tension and departure angle for the cable based on route position, length deployed, depth, forward progress speed and current direction and velocity.
23. Cable deployed length, tension, departure angle, forward speed and position shall be recorded.
24. The TC/IPV shall be managed at all times during the RRP operation. At no time shall the cable be pulled excessively, dragged on the bottom, twisted, flexed, or otherwise handled that could cause damage to the cable.
25. No suspensions of ≥1 meter length are allowed.

26. The TC shall not have slack resulting in loops or raised portions when on the seafloor.
27. Shape of the TC redeployment shall be in accordance with the initial location prior to recovery and in accordance with the contract plans.
28. Suitable standby tug(s) are required for operations in case of emergency
29. The CONTRACTOR shall not anchor the RV or any support vessel at any point during the RRP.
30. Acquire and record the as built redeployment position of the TC, IPV and SCS suitable for location during the redeployment process.

2.2.3.3 Recovery Vessel (RV)

The CONTRACTOR shall supply a RV capable of meeting the execution requirements as described herein and having, as a minimum, the following capabilities:

1. Full day (12 hour) manned operations
2. Lifting and handling gear certifications
3. USCG inspected barge or vessel
4. Stable platform in specified operating conditions and areas
5. Live boat station keeping
6. Propulsion on board or with tugs adequate for station-keeping and heading control in all tidal conditions in the entire project area to ±5m accuracy with simultaneous progress along a predetermined route
7. Deck area sufficient to allow cable handling without exceeding the minimum bend radius of the TC.
8. Deck area sufficient to house motor generator sets, hydraulic power units, TC/TU/SCS handling gear, TC and TU cable path supports, chute(s), control stations, storage of rigging, personnel required to accomplish the recovery operation.
9. TC and IPV test instrumentation
10. An IPV work station shall be provided to secure the IPV and lock down the TC for the disconnection, purging and verification operations.
11. Easy personnel access and work space to IPV and SCS.
12. Navigation
13. Protected and environmentally controlled housing for control room, work space, test equipment and monitoring equipment
14. Emergency systems for ballast control, flooding, fire, medical emergency
15. Emergency TC/TU clamps and cutting facilities

16. Radio communications and backup to USCG, other vessels and project personnel

2.2.3.4 Verification and Testing

The following verification or tests are required at a minimum to verify equipment and procedures prior to commencement of the RRP:

1. Final review of the RRP
2. Verification of positioning control in full tidal cycle
3. Successful completion of Installation Readiness Review (IRR)
4. The CONTRACTOR shall execute and demonstrate the station keeping capabilities of the RV as a single vessel or under tugboat control.
5. Calibrations and records of equipment to be used during the recovery process.

The following testing and verification shall be accomplished during the recovery process:

1. Insulation Resistance, DC resistance of each copper element in the TC.
2. Optical Time Domain Reflectometer (OTDR) for each fiber optic element in the TC.
3. Verification of IPV sealing process and testing of watertight integrity prior to SCS redeployment.
4. Verification of the confidence loops that are attached to each of the TC dry mate connectors.

2.2.4 Turbine Umbilical Storage Platform (TUSP)

2.2.4.1 Purpose

The purpose of the TUSP is to provide a landing platform for CONTRACTOR's ROV and storage of 200 m of TU deployed with the turbine. The TUSP features a stable platform and locking devices for the ROV so it can perform observation and work functions adjacent to the stored cable. The ROV will release the cable end from the ICD and bring a retrieval line to the surface for the Cable Connection Vessel (CCV) to pull the cable end up for connection to the TC. A notional concept of the TUSP is shown in Figure 1and the TUSP on the Subsea Base is shown in Figure 2.

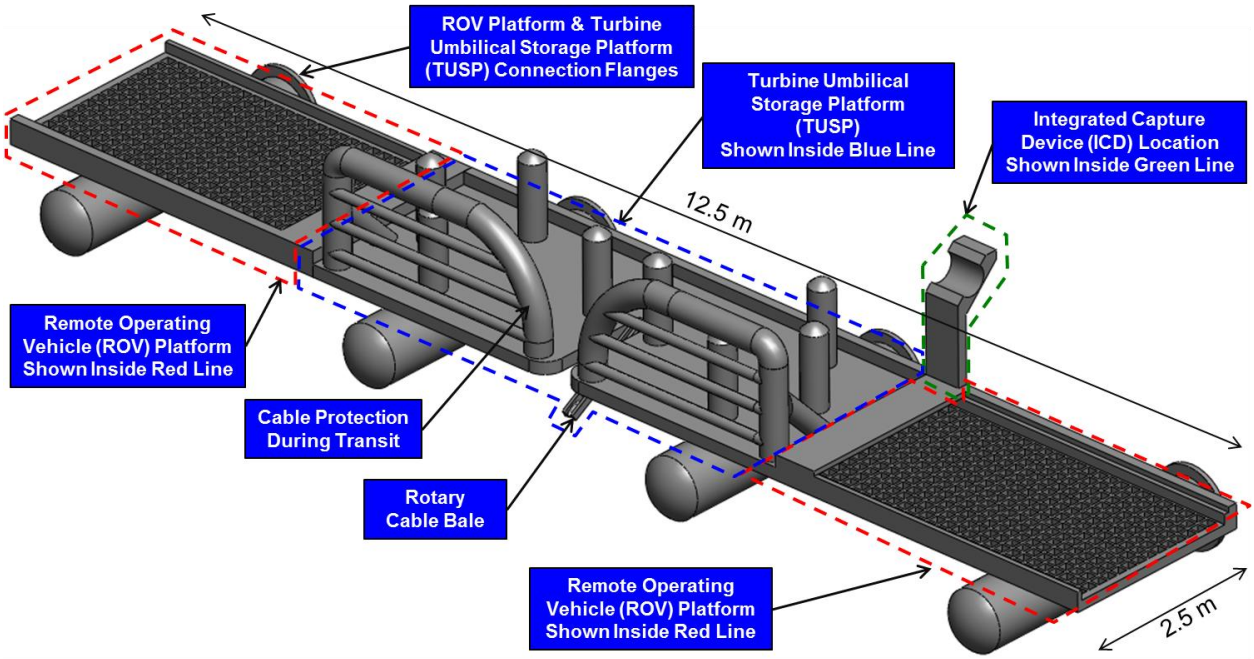


Figure 1: Notional TUSP Concept

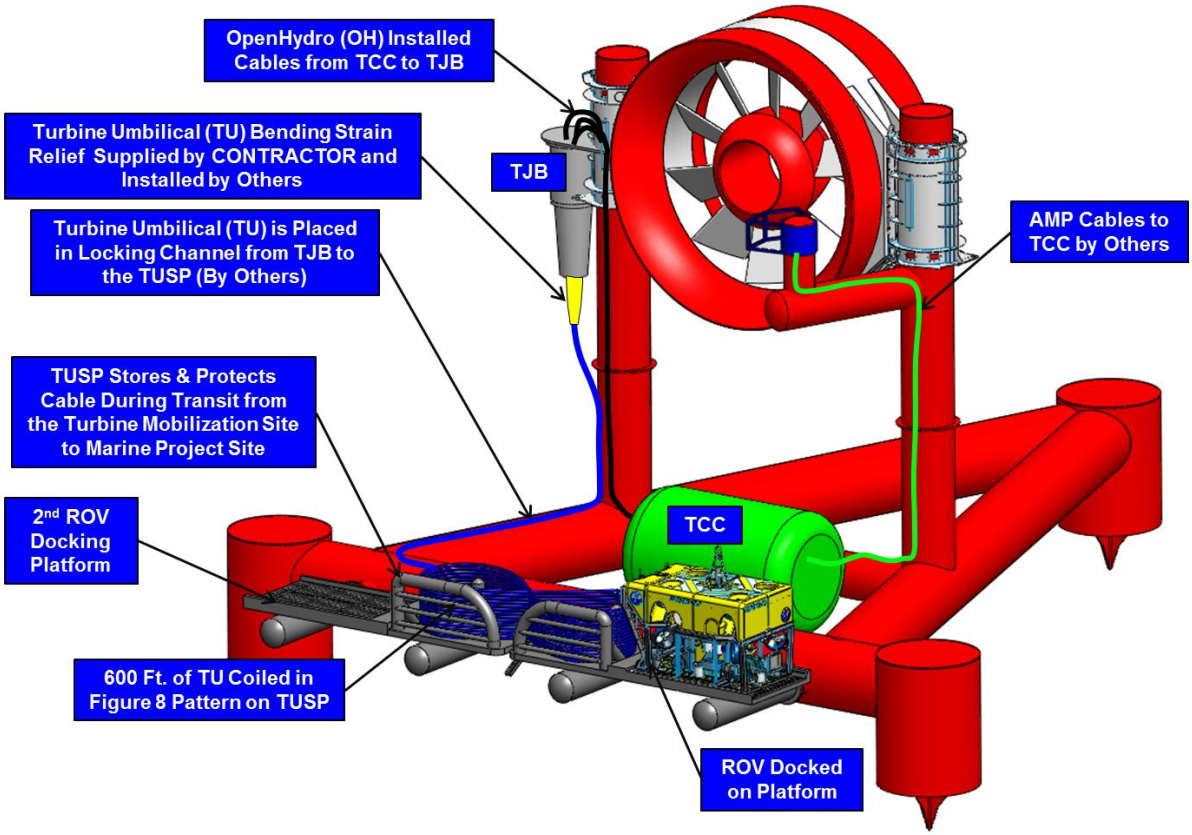


Figure 2: Notional TUSP Concept on Sub Sea Base

2.2.4.2 Design and Fabrication Requirements

The following requirements, at a minimum, shall be accommodated in the TUSP design and fabrication:

1. Requirement for the TUSP must be coordinated with the DISTRICT.
2. There shall be a total of 2 TUSP's constructed, one for each turbine.
3. The TUSP shall be constructed to fit an envelope of 2.5 m x 12.5 m x 1.4 m.
4. Additional weight of 5.25 lb./ft. shall be added to the entire length of the cable beginning 10 feet from the subsea base and factored in to the TUSP design.
5. Structure:
    a. Contains 200 meters ± 5 meters of TU with termination and extra cable weight
    b. Provide stable platform for ROV observation and work from both sides
    c. Provide TUSP on the short horizontal base of the Sub Sea Base (SSB)
    d. Provide minimal interface to the SSB using bolt on flanges
    e. Provide low drag during towing
    f. Structural material is to be coordinated with DISTRICT
    g. Corrosion and antifouling coatings to be coordinated with DISTRICT
    h. Hydrodynamic loading analysis of the TUSP during the transit conditions anticipated. All assumptions used in the calculations shall be provided. These calculations shall be stamped by a licensed Professional Engineer registered in the State of Washington.
    i. Structural loading analysis of the proposed TUSP and its connection point. All assumptions used in the calculations shall be provided. These calculations shall stamped by a licensed Professional Engineer registered in the State of Washington.
    j. The TUSP shall be designed for ease of transportation, lifting and integration with the SSB. This may include design elements such as pad eyes, forklift pockets, or other rigging components.
6. ROV Interfaces

All ROV interfaces shall be designed and implemented for use by any inspection or light work class ROVs. All ROV interfaces designs shall be owned by the DISTRICT.

    a. Locks ROV in place for work tasks
    b. Provides TU termination release with ROV activation
    c. Maintains clean profile to guard against ROV umbilical fouling
    d. Provides access to retrieval line

e. Allows free movement of both manipulators

7. TU Handling

a. Stores TU in a pan arrangement either coiled or figure 8 pattern

b. Secures the TU in the pan for transit and deployment

c. Provides accommodation for locking the termination in place for turbine transit and deployment with ROV operated release (See ICD in MCA Division 18020)

d. Provides bend limiters for the cable where it exits the TUSP

e. Provides bend limiters to prevent bending of the cable beyond the minimum bending radius

f. Provides bend limiters in storage and retrieval

g. Provides bend limiters and strain relief attachment point to TUSP when TU is removed from the TUSP (See Bale Assembly in MCA-Division 18020)

h. Provides protection of the cable and termination during transit to and integration at turbine mobilization site

2.2.4.3 Integration, Verification and Testing

The following tasks are required prior to integration at the Turbine Mobilization Site:

1. Update the TUSP test plan contained in the CCP
2. Test the TUSP with the ROV (in water)
3. Receive, inspect, test, store and stage the TC, TU and other cable segments
4. Verify TU terminations are water tight
5. Add any required weight to the TU
6. Load the TU into the TUSP
7. Test the ICD and other ROV operated tooling
8. Test the TU removal process.
9. Reload the TU into the TUSP

The following tasks are required during system integration and test activities at the Turbine Mobilization Site:

1. Coordination with DISTRICT integration activities

a. Witnessing installations involving TUSP and TU

b. Securing test equipment and performing testing of the TU to include:

i. Insulation resistance of the copper cable elements

ii. DC resistance of the copper cable elements

iii. Optical Time Domain Reflectometer (OTDR) measurements of the optical fibers

2. Inspection and test of the TUSP and TU during installation and integration phases including:

i. Dockside (Turbine Mobilization Site)

i. Installed on Installer-Barge

ii. AMP testing

iii. OpenHydro testing

3. Final inspection and testing prior to deployment

2.2.5 Subsea Cable Skid (SCS) Requirements

2.2.5.1 Purpose

The cable lay is planned from sea to shore to assure no excess cable is left on the bottom and that the placement is within the tolerance specified. The purpose of the SCS is to hold the subsea end of the TC in place during deployment, to provide protection for the termination and to accommodate the ROV operations for recovery of the end of the TC for CCP and RRP operations. It is a temporarily installed device to be removed after cable connection. The CONTRACTOR may recommend use of an acoustic release; however, a backup ROV release will still be required.

A notional SCS is shown in Figure 3 below.

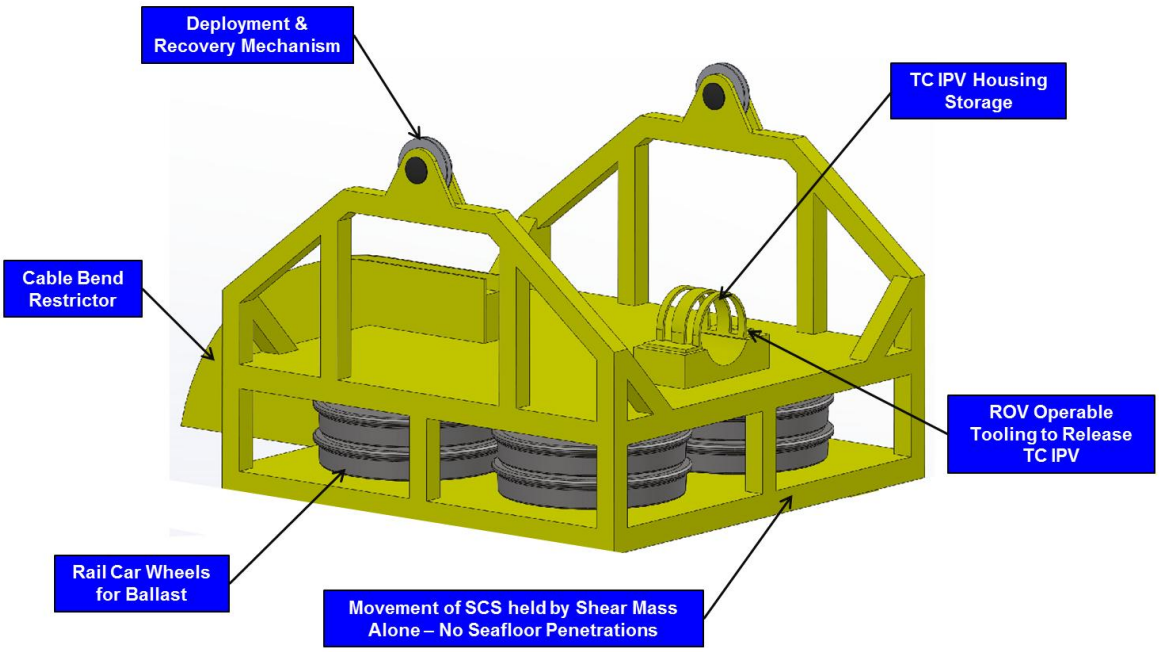


Figure 3: Notional Subsea Cable Skid

2.2.5.2 Requirements

The following requirements shall be met at a minimum on installation and retrieval

1. Survive, without movement, the tidal currents over full cycles with and without cable installed in SCS
2. Maintain the ROV interface once installed
3. Must be retrieved after cable connection and cable laydown within 60 days
4. The SCS shall be stored during the project demonstration period for potential future use if the turbines or cables are recovered for maintenance.

2.2.5.3 Design and Fabrication

The following requirements shall be met at a minimum in the design and fabrication of the SCS:

1. Hold the cable end in place on the bottom during Trunk Cable installation
    a. Consistent with requirements for no anchoring, the SCS shall not penetrate the seafloor surface. Resistance to movement shall be achieved by shear mass.
    b. Protect the IPV end of the TC during TC installation
    c. Maintain the cable end in position during all tidal cycles
    d. Allow ROV docking and tool use to remove the TC IPV end
    e. Able to be easily retrieved with ROV or acoustic release and surface vessel
    f. Environmentally friendly
    g. Be reusable for Recovery and Redeployment operations as required.

2.2.5.4 Verification and Testing

The SCS and ROV docking and tool use shall be tested prior to deployment with the cable to assure ease of ROV docking and tool use.

1. In air test with IPV and ROV to assure proper operation of docking and tool
2. In water test with simulated IPV and cable segment to assure ROV docking in current environment and proper tool use
3. In water test with to assure ROV release of IPV

2.2.6 HDD Pulling Hardware and Equipment Requirements

2.2.6.1 Purpose

The purpose of the HDD Pulling Hardware and Equipment is to provide the hardware and equipment to install the TC into the HDD conduit(s) during the Cable Lay operation.

2.2.6.2 Requirements

The HDD Pulling Hardware and Equipment consists of the following:

1. Horizontal Directionally Drilled Pulling Head (HPH)
2. HDD Bellmouth Assembly (HBA)
3. HDD Miscellaneous Pulling Hardware and Equipment (PHE)

The following items shall be designed and built and/or acquired by the CONTRACTOR.

2.2.6.3 HPH Design and Fabrication and/or Procurement

The HPH is the HDD pulling head, which allows the cable to be pulled into HDD conduit and also provides a water block to the cable (TC Sock) so water cannot penetrate to the cable elements during the cable pull. The HPH design is an integrated design with the cable and HDD. It is coordinated with the HDD specifications of drill diameter, conduit inside Diameter (ID), type of conduit (coefficient of friction), and number of bends in the HDD bore. The HPH is also coordinated with the design of the cable for Outer Diameter (OD), outer material (coefficient of friction) and water intrusion. The HPH will be installed on the Cable Lay Vessel (CLV) and attached to the pulling line.

The HPH requirements at a minimum shall include:

1. Grip cable with enough force to pull the cable through the HDD conduit with a factor of safety (FS) of ≥2
2. Grip strength below the breaking strength of cable by a FS ≥1.5
3. Grip to provide full grip strength in both directions in case cable becomes jammed in conduit and has to be withdrawn
4. Smooth contours on all surfaces to facilitate pulling in the conduit(s)
5. ID of the conduit of ≥1.7 the OD of the HPH
6. Pulling of the messenger line prior to pulling the cable.
7. Pulling point shall have a swivel rated for the full range of tension calculated
8. Incorporate the cable sock (TC sock) to protect against water intrusion in cable during the time the end of the cable is in the water
9. The TC will be subject to tensile loading during the cable pull, the HPH shall be designed to protect the internal and external cable components including but not limited to the conductors, fiber optics, sheathing, and armor

2.2.6.4 HBA Design and Fabrication and/or Procurement

The HBA is placed at the submerged entrance to the conduit(s) as a bending limiter for the TC as it enters the conduit. It is diver installed once the HDD conduit has been installed. It may contain the conduit plug that prevents silt and debris from entering the

conduit(s) prior to the pulling operation. The HBA also performs the function of assisting the cable from dragging silt and debris into the conduit(s) during the cable pull.

The HBA requirements at a minimum are the following:

1. Designed for diver installation on OD of the HDD conduit(s)
2. Designed to limit entry bending angle of the TC above the minimum bend radius of the TC
3. Attachment to conduit(s) to withstand calculated forces of the cable pull with FS ≥2
4. Removable at end of the cable pull without disturbing the TC or conduit(s)
5. Compatible with or provides the conduit(s) plug

2.2.6.5 PHE Design and Fabrication and/or Procurement

The PHE is the balance of hardware and equipment necessary to perform the cable pull. The cable pull must not allow the TC to drag across the bottom and therefore requires floating the cable to a point adjacent to the HBA. The pulling apparatus is required to provide the pulling forces and may consist of winches, sheaves, anchor points, tractors, wire guides and other hardware that will be dependent on the site conditions at the time of the pull.

At a minimum, the equipment shall include:

1. TC floats and attachment hardware
2. TC float cable management vessels
3. Pulling line or cable
4. Tension-meter (recording capability) for full calculated tension of cable pull with FS
5. Sheaves and pulling line control hardware
6. Motive force for the pull having adequate reserve power to pull to full gripping strength of the HPH and fine control to eliminate any shock loading or over tension to the TC
7. Diver support with video for cable management, recording and observation at HBA
8. Radios for communication to CLV, TC float vessels, shore based personnel and diver observers at HBA

2.2.6.6 Verification and Testing

The following verification or tests are required prior to the TC pulling operations:

1. Review of all calculated forces by a licensed Washington State Professional Engineer during the Final Design Review
2. Review of the complete procedure during final CLP review
3. HPH tensile tested with sample TC to design ratings above

4. TC Sock tested with sample TC to assure water tight integrity to 30 meters
5. HBA installation ease on HDD conduit in air by divers

SECTION 18010 – MARINE CABLE

PART 1 - GENERAL

1.1 SUMMARY

1. The CONTRACTOR shall furnish all labor, equipment, and materials necessary to supply a Marine Cable (MC) from each of the turbine deployment locations to the shore side Power Control and Conditioning Building (PCCB).
2. The Marine Cable is a purchased contiguous cable which is cut in to two sections, the Trunk Cable (TC) and Turbine Umbilical (TU).
3. The MC, as a part of the complete system, shall perform the following functions:
    a. Conducts power from the Turbine Units to the PCCB. Preapproved designs include three high power elements per phase.
    b. Conducts monitoring and control signals between the PCCB, Adaptive Monitoring Package (AMP), and the Turbine Units, in both directions.
    c. Conducts low power from the PCCB to the Turbine Units for command, control, and monitoring systems. Preapproved design includes two low power elements per phase with two low power element spares.

1.2 REFERENCE SPECIFICATION, CODES, STANDARDS

1. The procurement and deployment shall conform to all Federal, State, and local codes, ordinances, and laws having jurisdiction over this project. In the event of a conflict between these Specifications and the above mentioned codes, the more stringent of the two shall govern.
2. CONTRACTOR shall adhere to all applicable standards which include but are not limited to the following:
    a. ASTM B3 Standard Specification for Soft or Annealed Copper Wire
    b. ASTM B8 Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
    c. ASTM D1047 Specification for Poly (Vinyl Chloride) Jacket for Wire and MC
    d. ASTM D2633 Methods of Testing Thermoplastic Insulations and Jackets for Wire and MC
    e. ASTM D2655 Specification for Crosslinked Polyethylene Insulation for Wire and MC Rated 0 to 2000 V
    f. ASTM D470 Methods of Testing Crosslinked Insulations and Jackets for Wire and MC (10.01)
    g. ANSI/EIA 364-38B-1999 Electric Connectors - MC Pull-Out Test
    h. ANSI/ICEA S-108-720-2004 Standard for Extruded Insulation Power MCs Rated Above 46 through 345 KV

i. ANSI/UL 4-2003 Armored MC

j. ANSI/TIA/EIA 455-61A-2000 Measurement of Fiber or MC Attenuation Using an Optical Time Domain Reflectometer (OTDR)

k. ASTM A-411-08 – Galvanizing

3. National Electric Code (NEC)
4. National Electrical Safety Code (NESC)

1.3 SUBMITTALS

1. CONTRACTOR shall submit detailed shop drawings for all elements of the MC. Two sample MC cross sections are provided in Section 2.8. It shall be the CONTRACTOR responsibility to either adopt and further refine these designs or develop an alternate design that accomplishes the same objectives. The DISTRICT has preapproved the two manufacturers identified in this specification, alternate manufacturers, should the CONTRACTOR wish to submit, shall be considered by the DISTRICT in the submittal process after the contract is awarded. Alternate manufacturer submittals shall be considered by the DISTRICT in accordance with the criteria outlined in Section 01300-1.07 of the specification.
2. Review and acceptance of the CONTRACTOR's Submittals by the DISTRICT shall not be construed in any way as relieving the CONTRACTOR of its responsibilities under this Contract.
3. CONTRACTOR shall submit complete and detailed submittals for Marine Operations Section 18000, Marine Cable Section 18010, and Marine Cable Accessories Section 18020 in one package for review by the DISTRICT.
4. At a minimum the CONTRACTOR shall provide all shop drawings, catalog cuts, working drawings, diagrams, warranty information, and other descriptive certifications for each element of the MC, including but not limited to:

    a. Company name of vendor or manufacturer.

    b. Detailed specifications including model numbers, trade names, and individual part numbers.

    c. Brief description of each item including its intended use and performance characteristics.

    d. Any and all potential product limitations.

    e. Physical properties including overall dimensions and weight.

    f. Mechanical properties such as yielding strength, corrosive properties, hydrodynamic capabilities, density, specific gravity, and coefficients of friction.

    g. Electrical properties including conductivity, resistance, permeability, and attenuation.

    h. Methodologies of construction, manufacturing, and installation.

    i. Testing methods and certification processes.

    j. Details related to packaging and delivery of the MC.

5. Qualifications: Submit written documentation of the MC manufacturers. Provide detailed information of the following:
    a. Quantify the amount of projects where the companies have successfully constructed, tested, and deployed products similar in scale. Not required if CONTRACTOR proposes one of the preapproved MC manufactures.
    b. Describe any and all previous installations where any defect including but not limited to water intrusion, electrical failure, or other deficiency was discovered and the remedies the company provided. Not required if CONTRACTOR proposes one of the preapproved MC manufactures.
    c. Copies of any and all certifications from the manufacturers that proves conformance with the specifications and testing methods in Section 2.6.
    d. Ability of the manufacture to respond to any product faults with an authorized representative during installation, maintenance intervals, or warranty period.
6. The CONTRACTOR shall submit a detailed schedule showing all of the major procurement, manufacture, in process inspection/tests and final acceptance testing, including durations, with starting and completion dates shown. The schedule shall include:
    a. The time needed to manufacture and test the MC.
    b. The time needed to package and deliver the MC.
    c. Time required for integrating and testing the MC.
    d. Proposed schedule of completion detailing milestones as a measurement device for progress payments.
    e. Milestones in accordance with the quality assurance requirements Section-2.5 of this specification.
7. CONTRACTOR shall submit a detailed procurement plan that is integrated with the CONTRACTOR's schedule submitted in accordance with the Section 01050. The Plan shall contain at minimum the following elements:
    a. Demonstrate how the MC will be delivered to their respective destinations in accordance with the overall project schedule.
    b. Outline the shipping and handling procedure for the MC.
    c. Detail the interfaces necessary between the MC manufacturer and the Marine MC Accessories (MCA) integrator.
    d. Define the required staging areas, infrastructure, equipment, and personnel needed at the project location and manufacturing sites.
8. All drawings shall be submitted to scale using S.I. units. Principal dimensions shall also indicate equivalent English units.
9. Each submittal shall be reviewed, stamped, and signed as reviewed and approved by the CONTRACTOR prior to submission. The CONTRACTOR's approval shall indicate review and approval with respect to the following responsibilities:
    a. The correctness of the drawings, for shop fits and field connections and for the results obtained by the use of such drawings.
    b. Verification of model, part numbers, type, and similar data.

c. Determination of accuracy and completeness of dimensions and quantities.

d. Safety precautions.

e. Errors or omissions on the submittals.

f. Coordination and performance of work of all associated trades.

g. Identification of deviations from Contract requirements.

10. CONTRACTOR shall detail a proposed list of marine and terrestrial resources necessary to support the procurement and delivery of the MC. CONTRACTOR shall additionally provide evidence of the qualifications of each resource specifically with projects of similar size and scope.

PART 2 - REQUIREMENTS

2.1 MANUFACTURING

Electromechanical MC – The proposed MC specifications shall include but are not limited to the criteria contained in this section:

1. CONTRACTOR shall supply a MC conforming to all requirements of this specification. In use, the MC will conduct power and control signals to and from the SSB. The TC will be stored and handled by cable engines mounted on a Cable Laying Vessel (CLV). This will subject the TC to flexural cycling over the storage and delivery systems as the vessel is driven by the sea surface motion and as the TC is deployed and retrieved.
2. The MC shall be designed to perform without degradation for a minimum of 5 years at a saltwater depth of 328 ft. (100 meters).
3. The deliverable MC lengths shall be a minimum of 7,872 ft. (2.4 km), and 9,840ft, (3km) for a total of 17,712 ft. (5.4 km) after all MC samples have been removed. Two 50 foot test sections, cut and removed from the single MC run shall be furnished to the DISTRICT at the time of delivery.
4. The MC will be of a round construction consisting of nine high power conductors, five low power conductors, 12 optical fibers, outer jacket, and a minimum of two layers of armor wire. Fillers and binding tape shall be used to aid in construction. Cross sectional designs shown in Figure 1 & 2 have been furnished by each of the preapproved vendors listed below. It shall be the CONTRACTOR's responsibility to either adopt and further refine these designs or develop a MC that accomplishes the same objectives with DISTRICT approval.
5. The DISTRICT has preapproved MC designs from Geospace Technologies and Rochester Wire & MC, LLC. The CONTRACTOR may select one of the two suggested MC designs or provide the DISTRICT with alternate design that meets or exceed all of the requirements contained herein. The following is the contact information for each preapproved manufacturers:

Geospace Offshore Cables	***Rochester Wire & MC, LLC***
Contact: Terry Dahlke	Contact: Ellen Giles
tdahlke@geospace.com	egiles@te.com
7007 Pinemont Drive	751 Old Brandy Rd.
Houston, TX 77040	Culpeper, VA 22701
Phone: (713) 986-4444	Phone: (540) 825 - 2111
Fax: (713) 986-2438	Fax: (540) 825 - 2238
www.geospace.com	www.rochesterMCs.com

6. Except as limited herein, the CONTRACTOR shall be responsible for the proper selection of materials, dimensions, and tolerances necessary to assure compliance with the performance requirements of this specification. In general, materials shall not blister, crack, outgas, soften, flow, or exhibit other immediate or latent defects that adversely affect storage, operation, or environmental capabilities of the MC delivered to this specification.

2.2 MECHANICAL PROPERTIES

These properties reflect the preapproved cable designs. If the contractor elects to submit a custom design, equivalent characteristics shall apply.

1. The maximum diameter of the MC shall not exceed 1.95 inches.
2. The MC when measured in standard atmospheric pressure shall weigh less than 4,339 Lbs/kft. The specific gravity of the MC will meet or exceed the quantity of 2.64.
3. The MC shall withstand exposure to a hydrostatic pressure equal to a water depth of 328 ft. (100 meters) without water leakage or deformation.
4. The tensile breaking strength of the MC shall be a maximum of 173,350 Lbs (771 KN).
5. All conductors shall maintain continuity (free from breaks) when the MC is subjected to a load of 28,892 Lbs (128.5 KN).
6. The MC shall be able to static bend a minimum radius of 39 in (989 mm) without sustaining any damage.
7. All strength member calculations shall conform to a minimum safety factor of 6.
8. All extruded conductor insulation, dielectric material, inner jacket, and outer jacket shall be of virgin material only (no regrinds).
9. All filler material shall be constructed from High Density Polyethylene (HDPE).
10. Exterior jacketing material shall be made from HDPE.
11. Interior jacketing material may be low or medium density polyethylene. if
12. Armor shall consist minimally of two layers counter-wound, concentric armor. All armor shall be constructed from Galvanized Improved Plow Steel. Galvanizing must be in accordance with the requirements of ASTM A411 – 08.

2.3 ELECTRICAL PROPERTIES

1. The MC shall be capable of continuous reliable operation without performance degradation in accordance with the requirements of this specification in seawater depth of 328 ft. (100 meters).

2. The MC shall meet the electrical requirements contained in this section after being stored for any extended periods at temperatures specified in 2.4.3.
3. The nominal DC resistance of the electrical conductors shall be a maximum as follows:

Conductor	ohms/kft	ohms/Km
Low Power	2.60	8.53
High Power	0.76	2.49

4. The minimum voltage for the conductors shall meet the following:

Conductor	VAC_{LL}	VDC	V/MIL
Low Power	979	1385	53
High Power	4535	6414	125

5. The optical requirements shall meet the following attenuation in dB/Km:

Optical Attenuation	@1310 nm	@1550 nm
12 SMFO	0.414	0.311

6. The strands shall be completely shielded with a layer of semi-conducting extruded cross-linked polyethylene of a material compatible with the insulation. The strand shielding shall be in intimate contact with the strands and shall be completely free stripping from the strands. No tape shall be applied under the extruded shield without permission of the DISTRICT.
7. The following individually identifies each of the specifications for the power conductors .

Low Power Conductor	13 AWG BSC, Unilay Stranded Copper Wire IAW ASTM B8, Class B No Splices over MC Length
Insulation	Cross Linked Polyethylene (XLPE) Free of Voids, Breaks, Inclusions
High Power Conductor	8 AWG BSC, Unilay Stranded Copper Wire IAW ASTM B8, Class B No Splices over MC Length
Insulation	Cross Linked Polyethylene (XLPE) Free of Voids, Breaks, Inclusions

8. The Single Mode Fiber Optic (SMFO) requirements shall meet the following requirements:

Fiber Optical Element	12 SMFO, 8.3/125/245 µm 304 Stainless Steel Tube

Insulation	Low Density Polyethylene (LDPE) 0.032” Minimum Wall Thickness Free of Voids, Breaks, Inclusions

9. The fiber, power conductors, and fillers shall be bound together, and wrapped with Copper/Mylar tape with a minimum overlap of 10 percent.
10. The wire and cables shall be free of kinks, abrasions, inclusions, cracks, laps, cuts, voids, and damage. The wire and cables shall be uniform and consistent and shall be free from defects which may adversely affect the serviceability of the MC.
11. Any repair of the insulation, dielectric, inner jacket, or outer jacket shall use preapproved repair processes. The location of the repair, type of defect and repair affected shall be recorded.

2.4 THERMAL PROPERTIES

1. The MC shall be capable of continuous reliable operation without performance degradation over the ambient temperature range of -22°F (-30°C) to 194°C (90°C) in air.
2. Thermal calculations for the normal and emergency operating modes in accordance with IEC recommendations 60287 and 60853, respectively, shall be supplied. Short circuit calculations shall be carried out and supplied according to IEC recommendation 949. The thermal design shall meet the following maximum conductor temperatures:
   a. 194°F (90°C) for normal operating conditions
   b. 221°F (105°C) for emergency condition
   c. 482°F (250°C) for short circuit condition
3. The MC shall not be damage or degraded when stored in air over a temperature range of -58°F (-50°C) to 194°F (90°C) in air.

2.5 QUALITY ASSURANCE REQUIREMENTS

1. The CONTRACTOR is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the CONTRACTOR may utilize any commercial laboratory acceptable to the procuring activity. The DISTRICT reserves the right to perform and/or witness any of the inspections or tests set forth in this specification where such inspections are deemed necessary to assure supplies and services conform to the prescribed requirements.
2. The CONTRACTOR shall provide the DISTRICT with a detailed inspection, test plan, and schedule for approval a minimum of 8 weeks prior to beginning any fabrication of the MC. The plan shall contain charts showing the traceability and flow of supplies, materials, and data, together with the inspection and test functions to be performed. The various processes and inspection points shall be clearly identified to the DISTRICT.
3. Test and measuring equipment and inspection facilities of sufficient accuracy, quality, and quantity to perform the required inspection shall be established and maintained by the CONTRACTOR. All tests and measurement equipment shall be calibrated to National Bureau of Standards (NBS) traceable standards by a certified

calibration laboratory and shall be within the date range specified on the calibration records.

4. Unless otherwise specified, all inspections and tests shall be made under the following conditions:

Temperature	Room Ambient (15°C – 30°C)
Humidity	Room Ambient up to 95%
Pressure	Ambient Atmosphere

5. CONTRACTOR shall perform MC testing and certify compliance with this specification employing one or more of the following methods.
    a. **Examination** – Verification by examination shall consist of visual inspection and measurement of the physical characteristics of the device.
    b. **Demonstration** - Verification by demonstration shall consist of a functional demonstration of qualitative operations.
    c. **Test** - Verification by test shall consist of quantitative indication of compliance with requirements.
    d. **Analysis** – Verification by analysis may consist of either review or evaluation of prior analysis of a MC fabricated with identical material or an analysis of this MC to verify compliance with the requirement.
6. Acceptance tests shall be completed before test samples are removed. All quantitative data shall be recorded and submitted to the DISTRICT.

2.6 ELECTRICAL AND MATERIAL TESTING

1. The MC shall be subjected to and pass all of the specified verifications contained herein. Pass/fail criteria for in-process electrical performance tests must be determined in order for the MC to meet the acceptance requirements. These criteria along with the test methods shall be specified in the inspection/test plan required in Section 2.5.2.
2. The insulated power conductors shall be tested for DC resistance and insulation resistance prior to use in the MC. The insulated conductor shall be examined for workmanship, minimum insulation thickness, and conductor diameter.
3. The fiber optic element shall be tested using an OTDR for attenuation prior to use in the MC. The fiber optic cables shall be examined for workmanship, minimum insulation thickness, and diameter.
4. The MC core shall be examined prior to installation of the jacket for conformance with the construction requirements and workmanship contained herein.
5. The MC shall be visually examined for any material and workmanship defects over the entire length. The MC diameter shall be measured at random places over the length. A 2 foot sample shall be cut off from each end and dissected. The dissected MC shall be examined for:
    a. Inner & Outer Jacket Thickness
    b. Construction Features
    c. Workmanship Defects

6. To determine conformance to the DC resistance requirements, the MC shall be measured in accordance with ASTM B 193. Compensation may be applied as required to establish the value of resistance at standard temperatures.
7. To determine conformance to the characteristic impedance the MC shall be measured in accordance with ASTM D4566-08E1 Standard Test Methods for Electrical Performance Properties of Insulations and Jackets for Telecommunications Wire and MC.
8. To determine conformance to the attenuation requirement, the MC shall be measured in accordance with ASTM E1614.
9. The fiber shall be tested in accordance with the OTDR requirements of ANSI/TIA/EIA 455-61A-2000.
10. The insulation resistance shall be at a minimum of 5000 MΩ·km and periodically tested for conformance. The exterior jacket shall be tested in accordance with a preapproved spark test or equivalent to verify jacket integrity.
11. A test sample of cable from each manufacturing lot shall be pressure tested in a test tank to 328m ocean depth equivalent for a minimum of 24 hours. Each end of the cable shall be available outside the pressure tank for electrical and optical test purposes. Testing shall include, as a minimum, the following within one hour of reaching pressure and within one hour of completion of the soak test:
    a. Insulation resistance
    b. Continuity
    c. Optical path loss

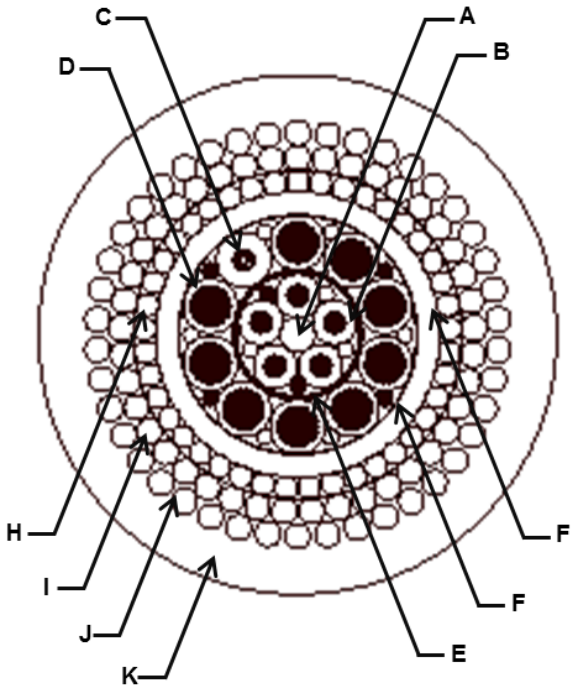
2.7 PACKAGING AND SHIPPING REQUIREMENTS

1. There shall be no water in the strands and between the jacket and insulation of the MC when shipped. Each end of each conductor shall be made watertight and any free water present anywhere in the MC is grounds for rejection of the MC.
2. The MC will be provided with overall colored or numbered tapes applied at regular intervals of 100 feet.
3. The MC shall be shipped on a reusable reel. The reel shall be strongly constructed to aid in protecting the MC from damage during handling and storage.
4. The MC placement on the reel shall leave both ends readily available for testing and terminating.
5. The MC reel shall be lagged with 2 by 6 inch (nominal) number 2 common lumber. Lagging shall be edge to edge around the reel circumference and shall be strapped with two or more steel straps over the lagging.
6. The weight of each MC shall be permanently marked on each reel.
7. Contract number, MC part number, and footage shall be permanently marked on outer surfaces of the reel flanges in 0.5 inch high lettering. The location of the outer end of the MC shall be marked on the lagging.
7. The MC shall be made accessible to or delivered to the MCA company In accordance with the overall project schedule.

8. To determine conformance with the voltage requirements, the completed MC on shipping reels, shall be tested at the AC and DC voltages specified in the individual MC specifications and in the referenced AEIC specification.
9. To determine conformance with the optical requirements, each fiber on the completed MC shipping reels, shall be tested with an OTDR.

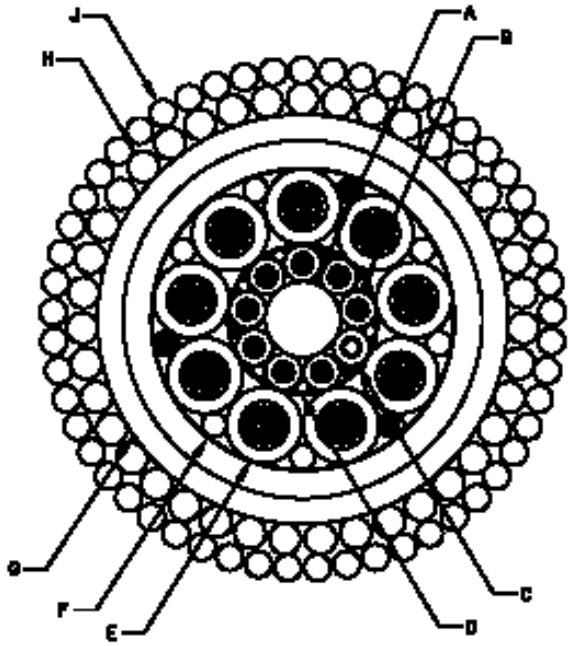
2.8 APPROVED MC DESIGNS

1. The following two MC cross sections represent designs previously approved by the DISTRICT. The CONTRACTOR may select one of the following designs or provide an alternate MC that meets all of the requirements contained in this specification.



A – Solid HDPE Filler Rod
B – Lower Power Conductor
#13 AWG XLPE Ins. (5)
C – Fiber Optical Element
SMFO (12)
D – Higher Power Conductor
#8 AWG XLPE Ins. (9)
E – Inner Assembly – Layer 1
(5) Item B
(2) Drain Wires
Tape – Cu/Poly
F – Inner Assembly – Layer 2
(9) Item D
(1) Item C
(4) Drain Wires
Tape – Cu/Poly
G – Inner Belt – HDPE 0.162”
H – 1st Armor (41) 0.0775”
I – 2nd Armor (41) 0.0885”
J – 3rd Armor (42) 0.098”
K – Outer Jacket – HDPE 0.315”

Figure 1: Notional Design from Rochester Wire & Cable, LLC



A – Solid HDPE Filler 0.20”
B – Lower Power Conductor
13 AWG XLPE Ins. (5)
C – Fiber Optical Element
SMFO (8)
(12)
D – Cabled Bundle
(1) Item A
(8) Item B
(1) Item C
Drain Wire (3) – 18 AWG
HDPE Fillers (6)
Tape – Copper/Mylar 0.0017
E – High Power Conductor
8 AWG XLPE Ins. (9)
F – Cabled Bundle
(1) Item C
(9) Item E
Drain Wire (3) – 16 AWG
HDPE Fillers (6)
Tape – Copper/Mylar 0.0017
G – Two Pass HDPE Jacket 0.198”
H – 1st Armor (39) 235 KPSI 25.5°
J – 2nd Armor (58) 238 KPSI 23.2°

Figure 2: Notional Design from Geospace Technologies

SECTION 18020 – MARINE CABLE ACCESSORIES

Contents

1 General 2
1.1 Summary 2
1.2 Reference Specification, Codes, Standards 2
1.3 Submittals 4
2 Products 7
2.1 General 7
2.2 TURBINE Junction Bottle (TJB) and In-Line Pressure Vessel (IPV) 10
2.3 TU and TC Cable Terminations 13
2.4 TU mechanical termination and Bending Strain Relief 15
2.5 Integrated Capture Device (ICD) 16
2.6 Protective Devices (PD) 18
2.7 Recovery Grip (RG) 18
2.8 Quality Assurance Requirements 18
2.9 Testing 19
2.10 Packaging and Shipping Requirements 21

PART 1 - GENERAL

1.1 SUMMARY

The CONTRACTOR shall furnish all labor, equipment, and materials necessary to furnish Marine Cable Accessories (MCA) for each of the MC sections from the Turbine Units to the shore side Power Control and Conditioning Building (PCCB).

The MCA, as a part of the complete system, shall perform the following functions:

a. Provide watertight interfaces between each of the MCA systems, Marine Cable (MC) sections, and In-Line Pressure Vessel (IPV) housings.

b. Transfer power from the Turbine Junction Bottle (TJB) through the Turbine Umbilical (TU), IPV and Trunk Cable (TC) to the PCCB for two complete systems.

c. Transfer monitoring and control signals through the TC, TU, and IPV between the PCCB, and the TJB, in both directions for two complete systems.

d. Transfer low power through the TU and TC from the PCCB to the TJB for command, control, and monitoring systems for two complete systems.

e. Provide bending and strain relief for each MC connection at all proposed MCA.

f. Provide armor termination for the TC and TU at all proposed interfaces.

g. Allow deployment and recovery of the IPV and TC and TU terminations during a minimal tidal window, between each of the MCA system elements.

The MCA consists of the following hardware items:

a. Turbine Junction Bottle (two total, one for each turbine)

b. Underwater Dry Mate Bulkhead Receptacles (six total receptacles, one set for each TJB)

c. TU terminated on both ends (four total, one for each turbine and two spares)

d. TC terminated on subsea end (two total, one for each turbine)

e. In-line Pressure Vessel (IPV) (two total, one for each TC)

f. TU mechanical termination and Bending Strain Relief (BSR) for the TUSP rotary bale (four total, one for each turbine and two spares)

g. Dry use electrical and optical terminations and connectors for:

   i. IPV and TJB internal connectors (four sets plus one spare set)

   ii. Test cable terminations (four sets plus one spare set)

h. Protective Devices (blank flanges, O-ring surface protection, etc.)

i. Integrated Capture Device (ICD) (two total, one for each TUSP)

j. Grip located on the TU for the purposes of executing the RRP as required.

1.2 REFERENCE SPECIFICATION, CODES, STANDARDS

1. The procurement and deployment shall conform to all Federal, State, and local codes, ordinances, and laws having jurisdiction over this project. In the event of a conflict

between these Specifications and the referenced codes, the more stringent shall govern.

2. CONTRACTOR shall adhere to all applicable standards which include but are not limited to the following:
   a. ASTM B488 - 11 Standard Specification for Electrodeposited Coatings of Gold for Engineering Uses
   b. ASTM A484 / A484M - 11 Standard Specification for General Requirements for Stainless Steel Bars, Billets, and Forgings
   c. ASTM A582 / A582M – 12E1 Standard Specification for Free-Machining Stainless Steel Bars
   d. ASTM Volume 03.02, August 2012 Corrosion of Metals; Wear and Erosion
   e. ASTM D149 - 09 Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies
   f. ASTM B265 - 11 Standard Specification for Titanium and Titanium Alloy Strip, Sheet, and Plate
   g. ASTM A700 - 05 Standard Practices for Packaging, Marking, and Loading Methods for Steel Products for Shipment
   h. ASTM B861 - 10 Standard Specification for Titanium and Titanium Alloy Seamless Pipe
   i. ASTM E427 - 95(2006) Standard Practice for Testing for Leaks Using the Halogen Leak Detector(Alkali-Ion Diode)
   j. ASTM E1003 - 05 Standard Test Method for Hydrostatic Leak Testing
   k. ASTM G188 - 05(2011) Standard Specification for Leak Detector Solutions Intended for Use on Brasses and Other Copper Alloys
   l. ASTM E432 - 91(2011) Standard Guide for Selection of a Leak Testing Method
   m. ASTM E499 / E499M - 11 Standard Practice for Leaks Using the Mass Spectrometer Leak Detector in the Detector Probe Mode
   n. ASTM D1414 - 94(2008) Standard Test Methods for Rubber O-Rings
   o. B476-01(2006) Standard Specification for General Requirements for Wrought Precious Metal Electrical Contact Materials
   p. ASTM B477 - 97(2008) Standard Specification for Gold-Silver-Nickel Electrical Contact Alloy
   q. STM A666 - 10 Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
   r. ASTM B150 / B150M - 08 Standard Specification for Aluminum Bronze Rod, Bar, and Shapes
   s. ASTM A20 / A20M - 11 Standard Specification for General Requirements for Steel Plates for Pressure Vessels
   t. A370 Test Methods and Definitions for Mechanical Testing of Steel Products

u. ASTM B3 Standard Specification for Soft or Annealed Copper Wire

v. ASTM B8 Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

w. ASTM D1047 Specification for Poly (Vinyl Chloride) Jacket for Wire and Cable

x. ASTM D2633 Methods of Testing Thermoplastic Insulations and Jackets for Wire and Cable

y. ANSI/EIA 364-38B-1999 Electric Connectors - Cable Pull-Out Test

z. ANSI/ICEA S-108-720-2004 Standard for Extruded Insulation Power Cables Rated Above 46 through 345 KV

aa. ANSI/UL 4-2003 Armored Cable

bb. ANSI/EIA-364-32 Thermal Shock (Temperature Cycling) Test Procedure for Electrical Connectors

cc. ANSI/EIA-364-28 Vibration Test Procedure for Electrical Connectors

dd. ANSI/EIA/ECA-364-21 Insulation Resistance Test Procedure for Electrical Connectors

ee. ANSI/ECA-364-23 Contact Resistance Test Procedure for Electrical Connectors

ff. ANSI/TIA/EIA455-61A-2000 Measurement of Fiber or Cable Attenuation Using an Optical Time Domain Reflectometer (OTDR)

gg. National Electric Code (NEC)

hh. National Electrical Safety Code (NESC)

1.3 SUBMITTALS

In general all submittals shall be in conformance with the requirements set forth in Division-1 of this Specification.

1. CONTRACTOR shall submit detailed shop drawings for all elements of the MCA. Conceptual designs are contained herein. It shall be the CONTRACTOR responsibility to further refine these designs or develop alternate designs that accomplishes the same objectives.
2. Review and acceptance of the CONTRACTOR's Submittals by the DISTRICT shall not be construed in any way as relieving the CONTRACTOR of its responsibilities under this Contract.
3. CONTRACTOR shall submit complete and detailed submittals for Marine Operations Section 18000, Marine Cable Section 18010, and Marine Cable Accessories Section 18020 in one package for review by the DISTRICT.
4. At a minimum the CONTRACTOR shall provide all shop drawings, catalog cuts, working drawings, diagrams, warranty information, and other descriptive certifications for each element of the MCA to demonstrate its suitability for the intended use, including but not limited to:
   a. Company name of vendor or manufacturer.
   b. Detailed specifications including model numbers, trade names, and individual part numbers.

c. Brief description of each item including its intended use and performance characteristics.

d. Any and all potential product limitations relative to the intended use described in this specification.

e. The load forces acting on each subsystem shall be transferred through and at each MCA interface. Contactor shall provide the DISTRICT with an individual force analysis of each MCA interface.

f. Physical properties including overall dimensions, weight, materials, contacts, membranes, seals, O-rings, lubrication, and mounting connections.

g. Mechanical properties that provide proof of adequacy for the intended use including but not limited to yield strength, density, durability, mating cycles, mating forces, pull out forces, water depth rating, submerged design life, pressure ratings, torque values, vibration resistance, shock values, and maximum misalignment .

h. Properties of electrical and optical connections including but not limited to working and maximum voltage, current, and frequency range, , , minimum breakdown voltage, conductor cross sections and contact resistance, pin to pin capacitance, , , permeability of individual cable elements and overall cable jacket, fiber optic transmission spectra, attenuation (optical loss of each connection), insertion losses. and intra-capacitance,.

i. Environmental properties including but not limited to working temperature range, minimum storage temperatures, cathodic protection, thermal aging, and corrosive properties.

j. Additional installation requirements for individual elements relative to submerged design life of not less than 5 years.

k. Methodologies of construction, manufacturing, and installation for each MCA component and subsystem.

l. In process inspection methods required in this specification

m. Any demonstration testing to validate designs and performance

n. In process and factory acceptance testing methods for each MCA component.

o. Certification processes for each MCA component and subsystem.

p. Details related to packaging and delivery of the MCA.

q. Details related to installation interfaces between the MCA the DISTRICT's other systems.

5. Qualifications: Submit written documentation of the MCA designer(s), manufacturer(s) and integrator(s). Provide detailed information of the following:

a. Quantify the amount of projects where the companies have successfully constructed, tested, and deployed products similar in scale.

b. Describe any and all previous installations where any defect including but not limited to water intrusion, electrical failure, or other deficiency was discovered and the remedies the company provided.

c. Copies of any and all certifications from the manufacturers that proves conformance with the listed testing methods.

d. Documentation of the manufactures calibration system including but not limited to the following:

   i. Measurement standards used for calibrating tools shall be traceable to the National Institute of Standards and Technology (NIST).

   ii. Calibration procedures including, as a minimum, standards to be used, measurement parameters, accuracy, tolerances, environmental factors, and steps in the calibration process.

   iii. Records related to the dates of calibration, limitation of use, calibration intervals, and traceability of the tool to the documentation.

e. Ability of the manufacture to respond to any product faults with an authorized representative during installation, maintenance intervals, or warranty period.

6. The CONTRACTOR shall submit a detailed schedule showing all of the major procurement, manufacture, in process inspection/tests and final acceptance testing, including durations, with starting and completion dates shown. The schedule shall include:

   a. The time needed to design and manufacture each of the MCA individual components listed herein, showing key milestones in the design, manufacturing, inspection and test processes.

   b. The expected schedule for each key in process and final inspection and final testing activity to include any qualification testing to demonstrate adequacy of the design and manufacturing for th intended use.,

   c. The schedule and duration needed to package and deliver each of the individual MCA components. Time required for integrating and testing each of the individual components,

   d. Proposed schedule of completion detailing milestones as a measurement device for progress payments.

   e. Milestones in accordance with the quality assurance requirements in Section-2.10 and 2.11 of this specification.

7. CONTRACTOR shall submit a detailed procurement plan that is integrated with the CONTRACTOR's schedule submitted in accordance with the Section 01050. The Plan shall contain at minimum the following elements:

   a. Describe how the MCA will be delivered to their respective destinations in accordance with the overall project schedule.

   b. Outline the shipping and handling procedure for each MCA.

   c. Detail the interfaces necessary with the MC and SSB manufacture to terminate and test each of the individual components.

   d. Define the required staging areas, infrastructure, equipment, and personnel needed at the project location and manufacturing sites.

8. All drawings shall be submitted to scale using S.I. units. Principal dimensions shall also indicate equivalent English units.

9. Each submittal shall be reviewed, stamped, and signed as reviewed and approved by the CONTRACTOR prior to submission. The CONTRACTOR's approval shall indicate review and approval with respect to the following responsibilities:

a. The correctness of the drawings, for shop fits, field connections, and for the results obtained by the use of such drawings.

b. Verification of model, part numbers, type, and similar data.

c. Determination of accuracy and completeness of dimensions and quantities.

d. Safety precautions.

e. Errors or omissions on the submittals.

f. Coordination and performance of work of all associated trades.

g. Identification of deviations from Contract requirements.

10. CONTRACTOR shall detail a proposed list of marine and terrestrial resources necessary to support the procurement, delivery, and integration of all MCA. CONTRACTOR shall additionally provide evidence of the qualifications of each resource specifically with projects of similar size and scope.

PART 2 - PRODUCTS

The MCA are the cable electrical, optical and mechanical terminations, junction boxes and connectors required to physically terminate and connect the Trunk Cable (TC) to the Turbine Umbilical (TU) through the In Line Pressure Vessel (IPV) and connect the TU to the turbine through the Turbine Junction Box (TJB). The MCA provides the connectors for the interface to the turbine in the TJB.

2.1 GENERAL

The MCA consists of the following hardware items:

1. Terminal Junction Bottle (TJB) (two total, one for each turbine)
2. Underwater Dry Mate Bulkhead Receptacles for TJB (six total receptacles, one set of three for each TJB)
3. In-line Pressure Vessel (IPV) (two total, one for each TC)
4. TU terminated on both ends (four total, one for each turbine and two spares)
    a. TU cable terminations (eight total, two for each TU)
5. TU mechanical termination and Bending Strain Relief (BSR) (four total, one for each TU)
6. TC terminated on subsea end (two total, one for each turbine)
    a. TC Cable termination (two total, one for each TC)
7. Dry use electrical and optical terminations and connectors for:
    a. IPV and TJB internal connectors (four sets plus one spare set)
    b. Test cable terminations (4 sets plus one spare set)
8. Protective Devices (PD) (blank flanges, O-ring surface protection, etc.) (as required)
9. Interface Connection Device (ICD) (one for each TUSP)
10. Grip located on the TU for use by an ROV during the execution of the RRP operation as required.

An overall diagram representing these items is presented in **Error! Reference source ot found.**below:

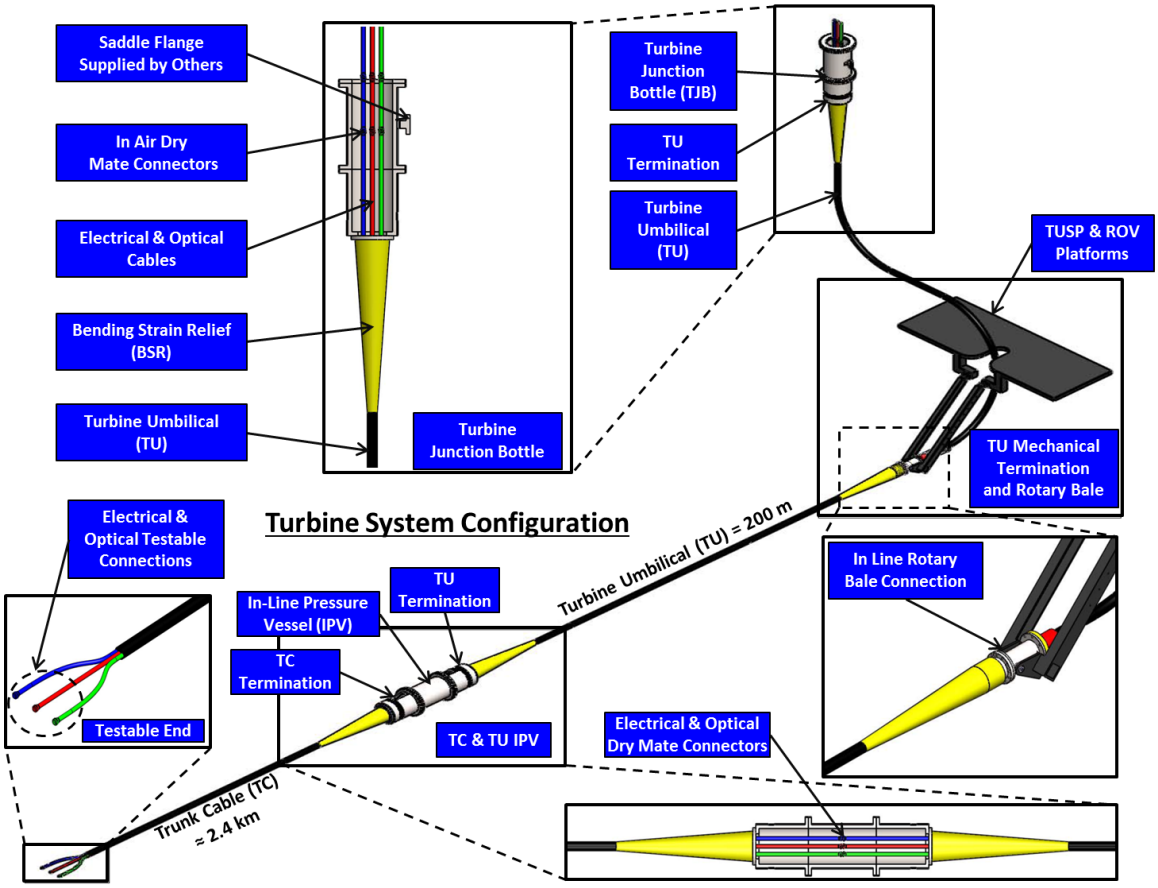


Figure 1 MCA Hardware Items

Marine Cable Accessories – The MCA specifications shall include but are not limited to the criteria contained in this section:

1. CONTRACTOR shall supply MCA conforming to all requirements of this specification. .
2. The DISTRICT has preapproved MacArtney, Inc. and Teledyne ODI as MCA suppliers. The CONTRACTOR may select one or both of the two suggested MCA suppliers or submit to the DISTRICT an alternate supplier that meets or exceeds all requirements contained herein in accordance with Section 01300. The following is the contact information for each preapproved supplier:

MacArtney, Inc. **Contact: Lars Hansen** 2901 West Sam Houston Parkway North Suite D-260 Houston, TX 77043 Phone: (713) 266 - 7575 Fax: (713) 266 – 7519 lfh@macartney.com	**Teledyne ODI** **Contact: Brock Rosenthal** Ocean Innovations 7709 Prospect Place La Jolla, California 92037 Phone: (858) 454-4044 Fax: (858) 454-5775 brock@o-vations.com

3. The MCA shall be designed for ease of installation and testing. A draft of the MO for installation and recovery plan are included in the Appendices of this specification.
4. The MCA shall be designed with housings and shrouds to protect the connectors and MC interfaces from damage or degradation during the installation of the turbine units, IPV, or Horizontal Directional Drilling (HDD) TC pull.
5. The MCA shall be designed to perform without degradation for a minimum of 5 years in saltwater at a design depth of 328 ft. (100 meters) within the photic zone.
6. The MCA shall be designed to prevent damage to individual components including but not limited to the TC, TU, and turbine units.
7. The MCA shall be designed to withstand damage from shock, and vibration due to installation using CONTRACTOR supplied vessels and equipment in the Puget Sound marine environment.
8. The MCA shall be constructed from compatible materials to withstand damage or degradation in a corrosive marine environment within the photic zone. Attention shall be paid to the interfaces with materials supplied by other DISTRICT contractors.
9. The MCA shall make provision for physical requirements including but not limited to electrical isolation, confidence loop circuits, keying of connectors, and permanent clear coding of connector pins.
10. The MCA shall make provisions for PD consistent with the conditions with shipping, integration testing and installation including but not limited to protective shrouds, dry packaging, heat-shrinkable sleeving, strain relief, electrical insulation, dummy storage receptacles, covers, etc.
11. Individual connections shall be designed with machined components including but not limited to connector bodies, backshell bodies, dummy receptacles, lock nuts, support rings, and grommets.
12. The CONTRACTOR shall cut and terminate each MC consistent with the lengths and specifications shown in Table 18020-1 following confirmation of the lengths with the DISTRICT.

Table 18020-1: MCA Specification

	Lengths		Connection Location and MCA Proposed		
Description	Meters	Feet	PCCB	IPV	TJB
TC #1	2400	7874	See Div-16	In air dry mate	NA
TC #2	2400	7874	See Div-16	In air dry mate	NA
Turbine TU #1	200	656	NA	In air dry mate	In air dry mate
Turbine TU #2	200	656	NA	In air dry mate	In air dry mate
Turbine TU #3 (Spare)	200	656	NA	In air dry mate	In air dry mate
Turbine TU #4 (Spare)	200	656	NA	In air dry mate	In air dry mate
Turbine TU #5 (Spare)	200	656	NA	In air dry mate	In air dry mate

Table 18020-1: MCA Specification

Description	Lengths		Connection Location and MCA Proposed		
	Meters	Feet	PCCB	IPV	TJB
Turbine TU #6 (Spare)	200	656	NA	In air dry mate	In air dry mate
Test Cable #1	15	50		In air dry mate	In air dry mate
Test Cable #2	15	50		In air dry mate	In air dry mate

2.2 TURBINE JUNCTION BOTTLE (TJB) AND IN-LINE PRESSURE VESSEL (IPV)

The TJB and IPV are intended as common pressure vessel designs with terminations that have one difference on the turbine side of the TJB. The intent of the TJB and IPV is to provide a dry connection of the electrical and fiber optic elements with mechanical termination that passes the full working load of the TC and TU through the pressure vessels.

The TC and TU terminations provide the mechanical termination and water blocked breakout of the electrical and fiber optic cable elements of the TC and TU. When one or both of the TC or TU terminations is missing, the pressure vessels shall have blank end plates capable of the full design depth. The TJB top plate contains three, CONTRACTOR supplied, underwater dry mate connectors consisting of plate mounted bulkhead receptacles. The TJB is mounted to the turbine unit by a flange provided by others. These are the only two significant differences between the IPV and TJB.

Figure 2 and Figure 3 show the notional IPV and TJB designs.

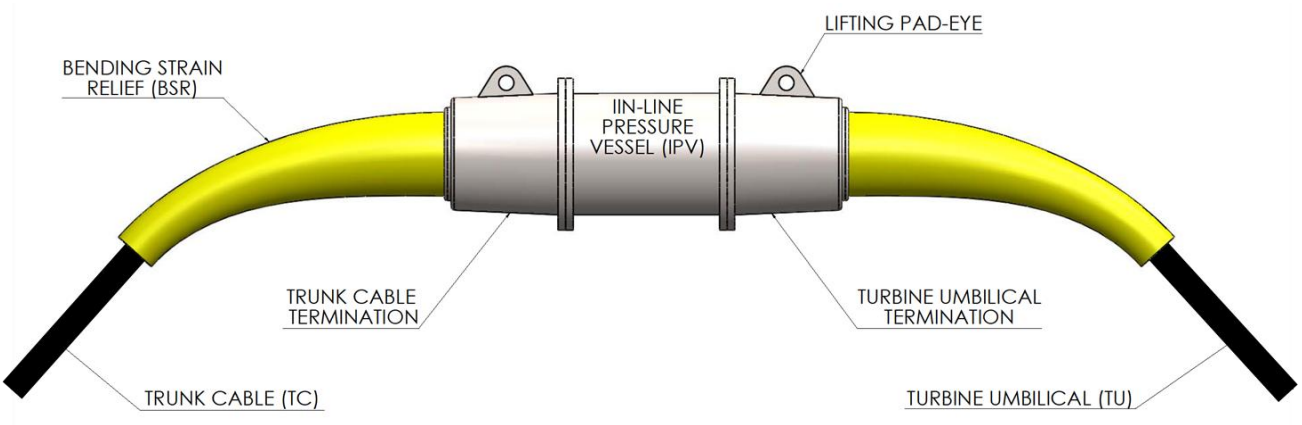
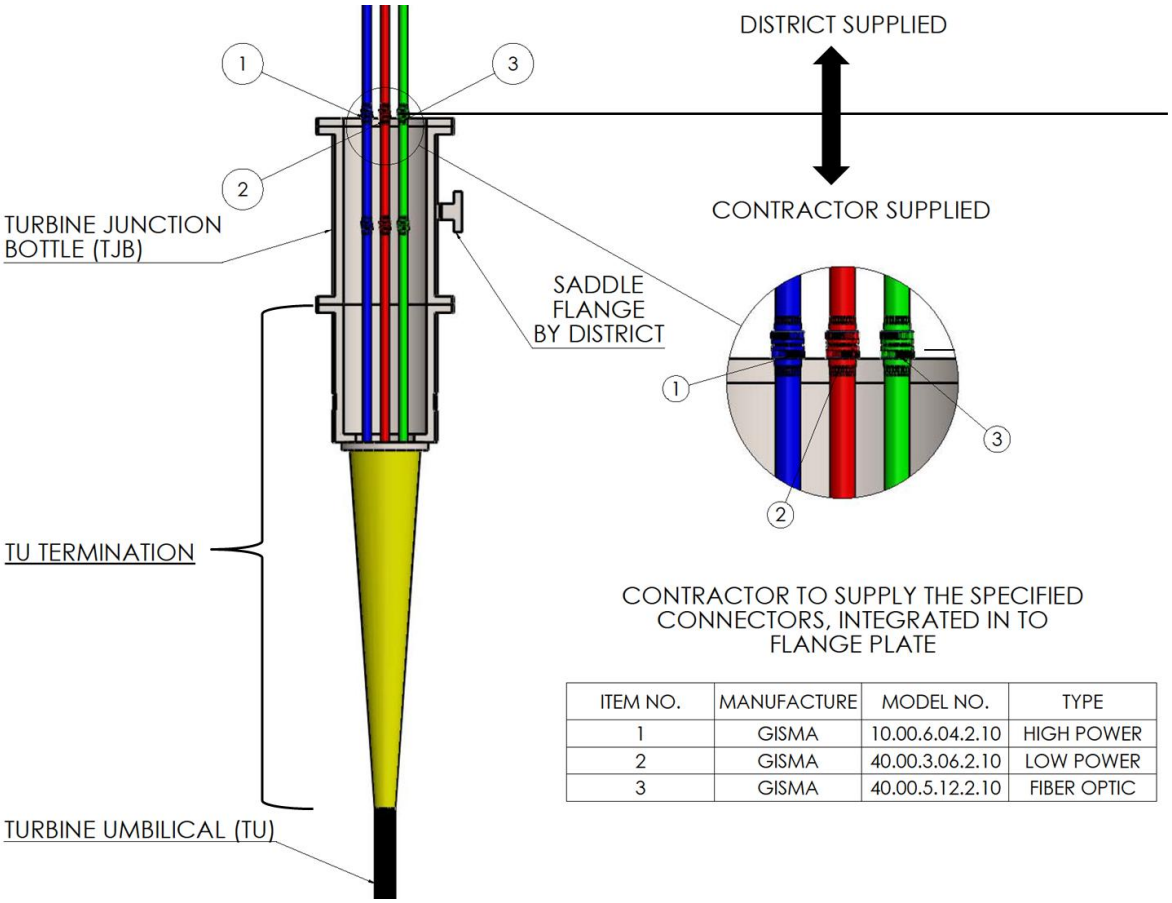


Figure 2 Notional IPV Design



ITEM NO.	MANUFACTURE	MODEL NO.	TYPE
1	GISMA	10.00.6.04.2.10	HIGH POWER
2	GISMA	40.00.3.06.2.10	LOW POWER
3	GISMA	40.00.5.12.2.10	FIBER OPTIC

Figure 3 Notional TJB Design

The DISTRICT has preapproved dry mate connector products from both Gisma and Seacon. The CONTRACTOR may select one of the two suggested connector suppliers or submit to the DISTRICT an alternate supplier that meets or exceed all requirements contained herein in accordance with Section 01300. In water dry mate connectors are only required on the TJB top plate and are not required for the internal connectors but are desirable. The following is the contact information for each preapproved supplier:

Gisma Contact: Lars Hansen 7007 Pinemont Drive Houston, TX 77040 Phone: (713) 266 - 7575	Seacon 1700 Gillespie Way El Cajon, CA 92020 Phone: (619) 562 - 7071 Fax: (619) 562 - 9706 www.seaconworldwide.com

CONTRACTOR shall design, fabricate, test and deliver two TJB for mounting by others on the turbine units (provided by the DISTRICT) and two IPV for CONTRACTOR use. CONTRACTOR shall also supply pressure plates (total eight) for each pressure vessel end cap for testing, integration and installation operations.

The DISTRICT has included a conceptual IPV and TJB design in Figure 2 and Figure 4Figure 3, respectively, of this specification. It is the CONTRACTOR responsibility to further

refine the design or provide the DISTRICT with an alternate design that meets or exceeds the specifications contained herein.

Requirements for the IPV and TJB include but are not limited to the following:

1. The IPV and TJB shall provide a protective watertight housing for the individual dry mate connections. The IPV shall be used to deploy, retrieve, and interconnect the the TC and TU ends.
2. The TC and TU terminations shall be designed to mate with the IPV and TJB flanges, to provide TU and TC full tensile load transfer as specified Division 18010, water block for the TC and TU cable elements to design depth of 100m and bending strain relief for the TC and TU.
3. The BSR shall prevent flexing of the TC and TU beyond its minimum bending radius.
4. One TJB end plate shall contain the three connector receptacles and shall contain protection for the mated plugs as directed by the DISTRICT. The receptacle are:
   a. Gisma: 10.00.6.04.2.10 with pressure caps
   b. Gisma: 40.00.3.06.2.10 with pressure caps
   c. Gisma: 40.00.5.12.2.10 with pressure caps

   CONTRACTOR is required to coordinate closely with the DISTRICT on the order to assure compatible keying and pin clocking on the mating plugs procured by DISTRICT.
5. The IPV and TBJ design shall incorporate double o-ring seals (piston and face) at all locations where there is a potential for water intrusion.
6. The design shall include watertight temporary protective housing covers for each IPV and TJB that are removable and reusable with identical O-ring seals as specified above.
7. The IPV and TJB shall be constructed from a metallic corrosion resistant material compatible with other materials the CONTRACTOR has selected and that the DISTRICT is utilizing. The environment is seawater, photic zone, 100m design depth. All IPV fasteners shall be non-corrosive and compatible with the housing material.
8. The IPV and TJB shall be machined to prevent damage to the TC, TU, dry mate connectors, and individual whips from sharp edges, burrs, cuts, or abrasion.
9. The IPV and TJB shall be designed to operate in a saltwater depth of 328 ft. (100 meters) for a service life of 5 years.
10. The IPV and TJB shall be a modular design capable of securely fastening the TC to the TU.
11. The IPV and TJB shall be designed to house the individual dry mate connections described herein
12. The IPV and TJB shall prevent damage or degradation to the internal connectors and MC sections during deployment and recovery from shock, vibration, tension, and impact loading.

13. The IPV and TJB design shall incorporate a pad eye or other mechanical device for handling, deployment and retrieval.
14. The IPV and TJB design shall not include the use of any oil or petroleum products as a water blocking agent.
15. The IPV shall be designed for ease of connector testing, assembly, and disassembly during sea based deployment operations.
16. The IPV and TJB design shall be properly sized to adequately store and secure each of the dry mate connectors and to allow the hand connection of the mating connectors while the end plates with TU and TC are controlled in close proximity to the pressure vessels.
17. CONTRACTOR shall design, furnish, and install vibration and shock restraints for the connectors and associated cabling within the IPV and TJB.
18. The IPV and TJB shall be designed with a pass through two valve system to allow dry nitrogen purging and backfilling. The valves shall have mechanical protection to prevent valve damage during handling and deployment.
19. The specific gravity of the IPV shall be ≥6. CONTRACTOR shall provide the DISTRICT with a weight analysis of the final IPV design including but not limited to the connectors, bulkheads, cables, bend stiffeners, and armor termination. The analysis shall include the weight of the MC between the ends of the bend stiffeners.
20. CONTRACTOR shall provide to the DISTRICT a copy of all IPV and TJB analysis calculations including but not limited to deformation, axial stress, circumferential stress, buckling, maximum principal stress, radial displacement, maximum shear stress, Von Mises stress, margin of safety, shear modulus, and deflection.
21. Testing requirements are specified in **Error! Reference source not found.** - REF _Ref352668388 \h * MERGEFORMAT **Error! Reference source not found.**, below.
22. Packing and shipping requirements are specified in 2.10 - Packaging and Shipping Requirements, below

2.3 TU AND TC CABLE TERMINATIONS

The CONTRACTOR shall provide the design, fabrication, inspection, testing, packaging and delivery of the TC and TU cable terminations as discussed above and in close coordination with Division 18010 Marine Cable requirements.

It is CONTRACTOR responsibility to maintain the coordination of the MC design and fabrication with the TC and TU termination design and fabrication and the IPV and TJB design and fabrication and to plan for and implement the integration of these program elements.

CONTRACTOR shall deliver:

a. Four TU terminated on both ends (one for each turbine and two spares)
b. Two TC terminated on:

i. subsea end identical to TU terminations (two total, one for each turbine)

ii. Refer to Division-16 for on shore terminations

The requirements for the TU and TC termination design, fabrication, inspection, testing packaging and shipping are contained in 2.2- TURBINE Junction Bottle (TJB) and In-Line Pressure Vessel (IPV) above and are not repeated here.

CONTRACTOR shall furnish and install in air or in water dry mate connectors for use inside the IPV, TJB as shown in Table 18020-1 MCA Specification.

The dry mate connectors shall meet the following requirements:

1. The connectors shall be capable of transferring power and optical signals from 9 high power conductors, 5 low power conductors, and 12 optical fibers as specified in Section 18010 (assumes CONTRACTOR submits preapproved cables).
2. The CONTRACTOR shall independently verify the lengths and specifications shown in Table 18020-1 prior to cutting and terminating each MC The CONTRACTOR shall design, furnish, and install dry mate connectors as detailed in Table 18020-1
3. Connectors shall be protected from abrasion, cut through, vibration, chafing, flexing, and sharp edges inside IPV and TJB.
4. The connectors shall be designed for a minimum of 200 mating operations.
5. Connectors shall be designed with threaded closure systems or other means to assure positive closure while in the installation and in situ conditions.
6. Connectors shall be designed with an alignment mechanism including but not limited to keyways
7. Dry mate connectors shall be designed with dummy receptacles that are capable of loop testing continuity, power, and resistance of the electrical transmission lines prior to turbine connection.
8. Dry mate connectors shall be designed with dummy receptacles that are capable of loop testing the fiber optic lines that conforms to ANSI/TIA/EIA455-61A-2000 prior to turbine connection.
9. The connectors shall be capable of continuous reliable operation without performance degradation over the ambient temperature range of -22°F (-30°C) to 176°F (80°C) in air.
10. The connectors shall not be damaged or degraded when stored in air over a temperature range of -22°F (-30°C) to 176°F (80°C) in air
11. Wires exiting from connectors shall be stress relieved. Contact materials for the connectors shall be designed to meet or exceed the power and optical requirements described in this specification.
12. Electrical contacts shall be plated with a minimum of 1 micrometer of gold at 5 micrometers Nickel.
13. The maximum contact resistance for the high power connectors shall be between 0.5 and 1 milliohm.

14. The maximum voltage for the MC is described in Division 18010 Marine Cable.

15. MCA shall be designed to confine line voltages to the connectors to preclude exposing voltage points when the connectors are disconnected.

16. The maximum current for the MC is described in the following table. The low and high power connectors shall be designed to transfer the amperage shown at each of the MCA interfaces.

Conductor	Maximum Connector Current
Low Power	10 Amps
High Power	10 Amps

17. The optical requirements for the connectors shall meet the following requirements at each of the MCA interfaces.

Optical Attenuation 850 nm – 1550 nm (Dry)	Typical	Maximum
Single Mode Fiber	<0.5 dB	<1.0 dB

18. The Single Mode Fiber Optic (SMFO) requirements for the MC are defined below. The connectors shall be designed to integrate with the specified optical wire.

Fiber Optical Element	12 SMFO, 8.3/125/245 μm 304 Stainless Steel Tube
Insulation	Low Density Polyethylene (LDPE)

19. Except as limited herein, the CONTRACTOR shall be responsible for the proper selection of materials, dimensions, and tolerances necessary to assure compliance with the performance requirements of this specification. In general materials shall not blister, crack, outgas, soften, flow, or exhibit other immediate or latent defects that adversely affect storage, operation, or environmental capabilities of the connections delivered to this specification.

2.4 TU MECHANICAL TERMINATION AND BENDING STRAIN RELIEF

The purpose of the TU mechanical termination and BSR is to transfer the tension from the TU to the TUSP in a manner that transmits the full working load of the cable to the TUSP in a controlled manner that restricts the bending radius of the cable to the specified limit and controls the catenary of the cable to the sea floor from the TUSP.

The CONTRACTOR shall provide the design, fabrication, inspection, testing, packaging, delivery and integration of the four TU mechanical terminations and BSR in close coordination with Division 18010 Marine Cable design and the TUSP design in Division 18000 Marine Operations.

The CONTRACTOR shall provide the TU mechanical termination and BSR meeting but not limited to the following requirements:

1. The mechanical termination shall transmit the full working load of the TU without cutting or disturbing the inner or outer armor layers of the cable nor any of the inner elements of the cable.
2. The material of the termination shall be compatible with the TU armor (galvanized improved plow steel if preapproved cables are used) while in air or in a seawater environment either submerged or in storage in air.
3. The termination shall allow connection to the rotary bale on the TUSP allowing free rotation of the cable to the sea floor during cable retrieval and redeployment after the TU and TC are connected (See Division 18000 Marine Operations).
4. The termination shall limit the bending radius of the cable during all evolutions of deployment and in use to no more than the maximum bending radius of the cable under full working load.
5. CONTRACTOR shall provide to the DISTRICT a copy of all termination of all design drawings and termination analysis calculations including but not limited to deformation, axial stress, circumferential stress, buckling, maximum principal stress, radial displacement, maximum shear stress, Von Mises stress, margin of safety, shear modulus, and deflection.
6. Testing requirements are specified in **Error! Reference source not found.** - **Error! ference source not found.**, below.
7. Packing and shipping requirements are specified in 2.10 - Packaging and Shipping Requirements, below

2.5 INTEGRATED CAPTURE DEVICE (ICD)

The purpose of the integrated capture device is to protect and secure the TU termination during integration, testing and deployment of the turbine and provide access for the ROV to retrieve the hauling line during the cable connection marine operation in accordance with Division 18000.

The CONTRACTOR shall provide the design, fabrication, inspection, testing, packaging, delivery and integration of the two ICD in close coordination with Division 18010 Marine Cable design and the TUSP design and marine operations in Division 18000 Marine Operations.

The DISTRICT has included a conceptual ICD design in Figure 4 below. It is the CONTRACTOR responsibility to further refine the design or provide the DISTRICT with an alternate design that meets the requirements contained in this specification.

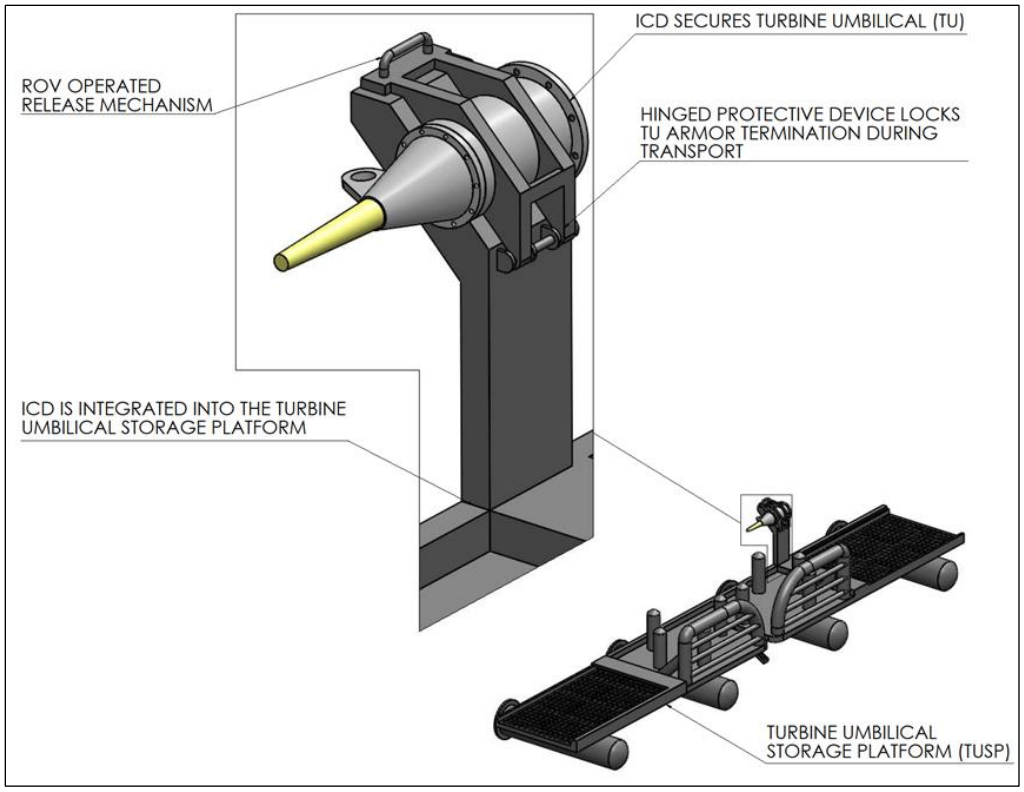


Figure 4 Integrated Capture Device (ICD) Conceptual Design

The CONTRACTOR shall provide the ICD mechanical termination and BSR meeting but not limited to the following requirements:

1. The ICD shall be designed as required to be completely operated by the CONTRACTOR's proposed ROV.
2. The ICD design shall be incorporated with the TUSP, TU termination and IPV designs.
3. The ICD shall restrict flexing of the TU below the minimum bend radius during recovery and redeployment of the SSB.
4. The ICD shall be designed to prevent damage or degradation of the TU components including but not limited to the electrical conductors, fiber optics, jacketing, armor, and fillers.
5. The ICD shall be designed to prevent damage or degradation to the IPV, its components, and surface finish.
6. The ICD shall be designed and constructed from materials able to operate at a saltwater depth of 328 ft. (100 meters) for a design life of 5 years without system degradation. Materials shall be compatible with the TUSP.
7. CONTRACTOR shall provide to the DISTRICT a copy of all ICD design drawings, analysis and calculations
8. Testing requirements are specified in **Error! Reference source not found.** - **Error! ference source not found.**, below.

9. Packing and shipping requirements are specified in 2.10 - Packaging and Shipping Requirements, below

2.6 PROTECTIVE DEVICES (PD)

PD are required to protect the various MCA during shipping, integration and testing activities whch may occur at various locations not always under CONTRACTOR direct control or during installation where extra protection may be warranted.

The CONTRACTOR shall provide the design, fabrication, inspection, testing, packaging, delivery and integration of the PD in close coordination with Division 18010 Marine Cable design and the marine operations in Division 18000 Marine Operations.

The following are considered essential for successful system completion but are not intended to limit what the CONTRACTOR may wish to supply to protect the MCA:

1. In water dry mate connector receptacle and plug protective caps
2. In water dry mate connector receptacle O-ring surface protective caps
3. IPV and TJB end flange O-ring surface protection
4. IPV and TJB endplate O-ring surface protection
5. Protective wrap for dry mate connector terminated TC and TU ends
6. Protective wrap or crating for TU and TC terminated ends
7. Others as required based on intended test, integration, installation needs

2.7 RECOVERY GRIP (RG)

In the event a turbine will be recovered, a ROV will be deployed to cut the TU. After cutting the TU, the ROV will attach a recovery line to the Recovery Grip (RG) which will be used to winch the weight of the TU, IPV, and approximately 100 ft. of the TC aboard the Recovery Vessel (RV).

The entire length of the TU beginning 15 ft. beyond the subsea base will have additional weight added. A RG shall be added to the TU just prior to the location of the added weight. At a minimum the RG shall meet the following requirements:

1. The RG shall be installed on the TU approximately 12 ft., just beyond the proposed location for cutting the TU for the RRP operation.
2. The RG shall be capable of holding the entire weight of the cut TU, IPV and a portion of the TC as required to safely manage its limitations. The design shall incorporate a minimum safety factor of 3.0.
3. The RG shall be designed with an attachment point for the recovery line by an ROV.
4. Placement of the RG on the TU shall not cause damage to the cable’s components including the insulation, armor, electrical wires, or fiber optics.

2.8 QUALITY ASSURANCE REQUIREMENTS

1. The CONTRACTOR is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the CONTRACTOR may utilize any commercial laboratory acceptable to the procuring activity. The DISTRICT reserves the

right to perform and/or witness any of the inspections or tests set forth in this specification where such inspections are deemed necessary to assure supplies and services conform to the prescribed requirements.

2. The CONTRACTOR shall provide the DISTRICT with a detailed inspection, test plan, and schedule for approval with the final design submittal and review. The plan shall contain charts showing the traceability and flow of supplies, materials, and data, together with the inspection and test functions to be performed. The various processes and inspection points shall be clearly identified to the DISTRICT.
3. Test and measuring equipment and inspection facilities of sufficient accuracy, quality, and quantity to perform the required inspection shall be established and maintained by the CONTRACTOR. All tests and measurement equipment shall be calibrated to the National Institute of Standards and Technology (NIST) traceable standards by a certified calibration laboratory and shall be within the date range specified on the calibration records.
4. Unless otherwise specified, all inspections and tests shall be made under the following conditions:

Temperature	Room Ambient (15°C– 30°C)
Humidity	Room Ambient up to 90%
Pressure	Ambient Atmosphere

5. CONTRACTOR shall identify and perform MCA analysis, examination, demonstration and testing and certify compliance with this specification employing one or more of the following methods at the in process and final acceptance stages as appropriate to the criticality of the function.
    a. **Examination** – Verification by examination shall consist of visual inspection and measurement, in critical processes and at final acceptance, of the physical characteristics of the device.
    b. **Demonstration** - Verification by demonstration shall consist of a functional demonstration of qualitative operations.
    c. **Test** - Verification by test shall consist of quantitative indication of compliance with requirements.
    d. **Analysis** – Verification by analysis may consist of either review or evaluation of prior analysis of a MCA fabricated with identical material or an analysis of this MCA to verify compliance with the requirement.
    6. **Acceptance** - tests shall be completed before test samples are removed or discarded. All quantitative data shall be recorded and submitted to the DISTRICT. The DISTRICT reserves the right to witness any inspections or tests.

2.9 TESTING

The MCA shall be subjected to and pass all of the specified verifications contained herein. Pass/fail criteria for in-process electrical performance tests shall be determined in order for the MCA to meet the acceptance requirements. These criteria along with the test methods shall be specified in the inspection/test plan required in Section 2.10.2.

1. Analysis

a. All MCA specified above as requiring analysis shall demonstrate that analysis prior to fabrication.

b. Any item that CONTRACTOR deems critical to installation and operations shall have supporting analysis prior to fabrication including:

i. O-ring dimensions and surface finish

ii. Compression and piston sealing surfaces

iii. Strain terminations

iv. Water blocks

v. Structural members

vi. Structural interfaces with TUSP, SSB and SSB TU Strain Termination

vii. Pressure vessel

2. Examination

a. All critical materials and in process inspections where the item is obscured by the next process step or where the process is critical and cannot be later verified shall receive in process inspection to verify conformance to process requirements.

b. Items requiring in process inspections are included here but CONTRACTOR is cautioned to add others as the criticality evolves in the design and manufacturing disclosure process:

i. O-ring surface finish and dimensions

ii. Compression and piston sealing surface flatness and finish

iii. Welds and welder certifications

iv. Critical dimensions

v. Strain terminations at all phases of fabrication and assembly

vi. Water blocks at all phases of fabrication and assembly

vii. SSB TU Strain Termination

viii. Mechanical interfaces to DISTRICT supplied items

ix. Potting materials

x. ROV interfaces

3. Demonstration

a. Items that can be verified through demonstration shall be unless they are of proven design in regularly produced quantities without modification or it is impossible to demonstrate due to size or application

b. Demonstration of the following items is required as a minimum. CONTRACTOR may wish to demonstrate other items:

i. TU and TC strain terminations

ii. Pressure vessels

iii. Termination water block

iv. ROV ICD performance in water

v. TU mechanical termination and BSR with rotary bale on TUSP

vi. Terminated TU pressure test

i. TU weak link

4. Testing

a. In process, acceptance and integration testing is required on most items to assure conformance with requirements.

b. Testing of the following items is required at a minimum and CONTRACTOR may identify other items for testing during the design phase:

i. IPV and TJB pressure test may be concurrent with demonstration

ii. TU and TC terminations mechanical, electrical and optical

iii. In air dry mate connector after assembly to TU and TC. The fiber optic element shall be tested for attenuation using an ODTR. The contact resistance of each electrical dry mate connection shall be tested for compliance with the CONTRACTOR submittals

iv. ICD performance may be concurrent with demonstration

v. IPV and TJB assembly helium leak test with a maximum conformance value of $\leq 1.10 \times 10^{-6}$ atm·cm^3/s.

vi. To determine conformance with the voltage requirements, the completed connectors on MC shipping reels, shall be tested at the AC and DC voltages specified in the individual specifications and in the referenced AEIC specification.

vii. To determine conformance with the optical requirements, each fiber on the completed MC shipping reels, shall be tested with an OTDR.

2.10 PACKAGING AND SHIPPING REQUIREMENTS

1. There shall be no water in the MCA when shipped. Each end of each MCA shall be made watertight. Any free water present is grounds for rejection of the system.
2. IPV and TJB shall be shipped with end caps in place.
3. Terminated TU and TC shall be shipped separately. Packaging and shipping methods and routes shall be preapproved by the DISTRICT prior to packaging and shipping.
4. Connectors shall be cleaned, lubricated as appropriate, and sealed with dummy receptacles prior to shipping.
5. Each connector shall be uniquely and permanently labeled and marked for identification. The corresponding marking value shall be recorded and delivered to the DISTRICT prior to shipping.
6. The MCA shall be doubly protected prior to shipping and specific attention shall be given to protecting the flexing/bending of the MC and MCA interface.
7. The DISTRICT may need to replace a TU during operation due to acts of God. The CONTRACTOR shall store the spare TU's in a coiled manner that is readily

deployable. The spare TU's shall be crated in a container that can withstand outdoor storage for a period of 5 years from the date of delivery. The TU's storage container shall be designed for movement by a forklift capable of lifting and transporting the TU weight.

APPENDICES - TABLE OF CONTENTS

APPENDIX A – DEFINITIONS
APPENDIX B – CABLE LAY STORYBOARD
APPENDIX C - TURBINE DEPLOYMENT STORYBOARD
APPENDIX D1 – CABLE CONNECTION STORYBOARD
APPENDIX D2 – RECOVERY AND REDEPLOYMENT STORYBOARD
APPENDIX E – MATERIALS AND EQUIPMENT SUPPLY MATRIX
APPENDIX F – GEOTECHNICAL REPORT (ONSHORE)
APPENDIX G – GEOPHYSICAL INVESTIGATION (OFFSHORE)
APPENDIX H - GEOLOGICAL SETTING TECHNICAL MEMO (OFFSHORE)
APPENDIX I - SUMMMARY OF SITE CONDITIONS
APPENDIX J – 2012 ROV CABLE-ROUTE SURVEY
APPENDIX K – FERC LICENSE CONDITIONS
APPENDIX L – FERC PLANS REQUIRING CONTRACTOR INPUT
APPENDIX M - ISLAND COUNTY PERMITS
APPENDIX N - WSDOE PERMITS AND CONDITIONS
APPENDIX O - WSDNR LEASE CONDITIONS
APPENDIX P - WSDOT PERMIT CONDITIONS
APPENDIX Q - WDFW PERMIT CONDITIONS
APPENDIX R – NOAA FISHERIES CONDITIONS
APPENDIX S – TURBINE SUPPLY AND MAINTENANCE AGREEMENT
APPENDIX T – OWNER CONTROLLED INSURANCE PROGRAM
APPENDIX U – DEPARTMENT OF ENERGY GRANT TERMS
APPENDIX V – OPENHYDRO NON-DISCLOSURE AGREEMENT

END

Appendix A

DEFINITIONS

TIDAL ENERGY PROJECT DEFINITIONS		
Full Name	***Acronym***	***Additional Description/Definitions***
Adaptive Monitoring Package	**AMP**	Developed and supplied by the University of Washington
American National Standards Institute	**ANSI**	
American Society for Testing and Materials	**ASTM**	
Armor Wires		Normally galvanized steel wires lay around the core of the cable, to provide both tensile strength and protection
Armored Cable		Cable covered with protective wires in an attempt to prevent damage to the cable from fishing gear, anchors, and seafloor objects
Articulated Piping		A system of pipes which are fitted over the cable to prevent damage and the possibility of the cable floating due to current velocity
Attenuation		The loss of electrical or optical strength suffered by a signal passing along a cable or fiber
Bell Mouth		Circular opening above the Cable tank through which the cable passes from the seafloor to the Horizontal Directional Drilling. Allows the cable to freely pass without exceeding the bend radius
Bending Strain Relief	**BSR**	Pliable protection of the cable to prevent flexing or bending beyond the minimum bend radius
Bight		Any loop of rope or cable. Often used to refer to the single loop of cable hauled on board the cable ship
Bow to Stern Transfer		Operation in which the cable is transferred from the bow sheaves to the after cable machinery around the outside of the ship. Usually performed at the start of a lay when a previously laid end is picked up forward and then passed aft
Break test		A mechanical test performed on the cable to its failure point
Buoy		Common term used to mark the location of cable ends or lines
Cable Chart		Chart showing positions of all submarine cables in the area
Cable Connection Plan	**CCP**	The governing document that shows the CONTRACTOR'S intended operations to recover, connect, and redeploy the Trunk Cable (TC) and Turbine Umbilical (TU) and In-Line Pressure Vessel (IPV) housings
Cable Connection Vessel	**CCV**	A vessel prepared by the CONTRCATOR as require to facilitate the Cable Connection Plan
Cable Data		Information giving the electrical, optical, and mechanical details of cable
Cable Drum		Large power driven drum used to pick up and pay out cable
Cable Lay Plan	**CLP**	The governing document that shows the CONTRACTOR'S methodology for deploying the Trunk Cable (TC), Subsea Cable Skid (SCS), and final pulling of the TC through the Horizontal Directional Drilling (HDD) using the HDD Pulling Head (HPH)
Cable Lay Vessel	**CLV**	A vessel usually custom built or constructed to install (lay) and repair cables. Station keeping capability provided by a minimum of 2 tugs with a standby tug at all times
Cable Mile		One cable nautical mile = 6087-feet
Cable Pan		A portable cable storage tank
Cable Recovery Plan	**CRP**	The governing document that shows the CONTRACTOR'S methodology to recover, connect, and redeploy the Turbine Umbilical (TU) and Trunk Cable (TC).

TIDAL ENERGY PROJECT DEFINITIONS		
Full Name	***Acronym***	***Additional Description/Definitions***
Contractor Mobilization Site	**CMS**	Shore facility used to prepare and outfit the Cable Lay Vessel (CLV) and Cable Connection Vessel (CCV)
Copper Communication Cable	**CCC**	
Current Transducer	**CT**	
Demand Energy Networks	**DEN**	Manufacturer of power conversion system
Design Depth		A saltwater depth of 328 ft. (100 meters)
District Furnished Equipment		Items provided by the DISTRICT to be incorporated into the project by the CONTRACTOR
Dynamometer		Term describing strain measuring equipment on cable gear. Now generally superseded by the term load cell
Energy Significant Flow	**ESF**	max energy and efficiency
Factory Acceptance Test	**FAT**	
Fail To Close	**FTC**	
Fail To Open	**FTO**	
Fiber Optic		Technology employed in cable systems presently being installed, being a digital medium of telecommunications utilizing pulsed lasers to transmit & receive signals through glass fibers
File Transfer Protocol	**FTP**	
Functional Components		System elements such as the Cable Lay Vessel (CLV), Turbine Umbilical Storage Platform (TUSP), Subsea Cable Skid (SCS), HDD pulling head (HPH), and other specialty items designed and constructed to facilitate the Marine Operations (MO)
HDD Bellmouth Assembly	**HBA**	Bellmouth for the subsea end of the HDD conduit to help guide the TC into the conduit
High Density Polyethylene	**HDPE**	Piping material commonly used for HDD operations
High Tension Feed	**HTF**	High voltage
Horizontal Directional Drilling	**HDD**	Operation used to drill and advance conduits without opening a trench.
Horizontal Directional Drill Pulling Head	**HPH**	Pulling head that provides a positive connection for the load path between the cable and pull line. It also protects the cut cable end from water intrusion during the HDD operations

TIDAL ENERGY PROJECT DEFINITIONS		
Full Name	***Acronym***	***Additional Description/Definitions***
Housing		Small pressure proof insulated tubular insert in cable containing the splices and providing electrical path for powered systems. Provides mechanical strength to protect the splices
Human Machine Interface	**HMI**	
Hydraulic Power Unit	**HPU**	
Industrial Personal Computer	**IPC**	
In-Line Pressure Vessel	**IPV**	Interconnecting assembly between the Trunk Cable (TC), Turbine Umbilical (TU), and Turbine Junction Bottle (TJB)
Installer Barge		Purpose built barge supplied by OpenHydro for the sea trials testing and Turbine Unit Deployment.
Integrated Capture Device	**ICD**	Mechanical device that secures the Turbine Umbilical (TU) In-Line Pressure Vessel (IPV) housing to the turbine Subsea Base (SSB) using an inspection class ROV during retrieval
International System of Units		Abbreviate as S.I., is the modern form of the metric system
Layback		Distance from the stern (or principle point of navigation) to the position of a towed vehicle or point at which the cable touches the seabed
Linear Cable Engine	**LCE**	Machine at aft end of the vessel used to bear the weight of and pick up/pay out cable. Consists of a series of wheels and tires which grip the cable top and bottom
Load Cell		Tension measuring system whereby compression on a unit provides a scaled reading of the actual tension on a cable. Located on dynamometer assemblies or cable engine frames
Low Density Polyethylene	**LDPE**	
Low Tension Feed	**LTF**	Low voltage
Marine Cable	**MC**	The subsea electromechanical cable that is cut into the trunk cable (TC) and Umbilical cable (TU).
Marine Cable Accessories	**MCA**	The interfaces between the Turbine Junction Bottle (TJB) and TU; the TU and the TC and the TC and the shore switch vault that are require during various stages of the project. Refer to specification Division-18020.
Marine Operations	**MO**	The associated installation procedures to deploy the marine cable, subsea base, and individual marine cable accessories
Marine Project Site	**MPS**	Location from the turbine deployment site to the shore side switch vault as indicated in the Project Plans

TIDAL ENERGY PROJECT DEFINITIONS		
Full Name	***Acronym***	***Additional Description/Definitions***
Medium Density Polyethylene	**MDPE**	
Miscellaneous Specialty Items		Includes items to facilitate observe record and protect the installation of the Marine Operations (MO)
Motor Generator Set	**MG Set**	Used to supply temporary power
National Bureau of Standards	**NBS**	specifies the calibration standards for various cable
National Electric Code	**NEC**	
National Electric Safety Code	**NESC**	
National Institute of Standards and Technology	**NIST**	
National Oceanic and Atmospheric Administration	**NOAA**	
Network Attached Storage	**NAS**	
Open Centre Turbine: 6-meter diameter; mark 08 hardware design	**OCT-06-08**	
OpenHydro	**OH**	Manufacturer of tidal turbine system
OpenHydro Generator Coil Group	**CG**	
Optical Communication Cable	**OCC**	
Optical Time Domain Reflectometer	**OTDR**	An instrument which is used to accurately measure the various parameters: attenuation per foot, splice loss etc. of an optical fiber. This will allow the assessor to gauge the quality, integrity or suitability of the fiber.
Owner Controlled Insurance Program	**OCIP**	The program under which General Liability and Excess Liability insurance is procured by the Owner on behalf of the General Contractor, eligible Contractors and Subcontractors of all tiers while they are working at the Project Site.
Performance Testing		Test or tests to be carried out during multiple steps throughout the project. Tests shall be performed by CONTRACTOR after delivery under the supervision of the DISTRICT to determine whether work meets the Contract Specifications
Power Control and Conditioning Building	**PCCB**	Located shore side
Power Feed Equipment		A constant current/ high voltage power supply used to supply power to a submarine cable system
Programmable Automation Controller	**PLC**	

TIDAL ENERGY PROJECT DEFINITIONS		
Full Name	***Acronym***	***Additional Description/Definitions***
Project Site		Deployment site located in Admiralty Bay including the cable route to shore, shore landing and PCCB
Protective Devices	**PD**	Protective connector caps and other items for use with the MCA
Puget Sound Energy	**PSE**	Local utility and grid operator
Pulling Hardware and Equipment - Miscellaneous	**PHE**	The hardware and equipment used to pull the TC into the HDD conduits
Recoverable Interface		An interconnecting assembly designed for retrieval
Remote Operated Vehicle	**ROV**	A submersible unmanned vehicle used to inspect cables during an installation. It can also be used to carry out surveys and inspection of the seabed
Rotary Bale		Device designed to provide mechanical strain termination and bend radius control as the TU is directed towards the sea floor from the TUSP.
Service Life		The project design life of 5 years
Shore Landing		Area designated to land the TC through the HDD conduit adjacent to the PCCB
Single Line Diagram/One-Line Diagram	**SLD**	
Single Mode Fiber Optics	**SMFO**	Type of fiber optic cable elements used in the MC and related systems
Site Acceptance Test	**SAT**	
State of Charge	**SOC**	Battery system
Subsea Base	**SSB**	Gravity foundation structure that holds the Turbines and all ancillary equipment associated with the Turbine Units
Subsea Cable Skid	**SCS**	A weighted weldment designed to hold the Trunk Cable end during pre-lay operations
Supervisory Control and Data Acquisition	**SCADA**	Command, control and data acquisition system for turbine control and monitoring consisting of both shore and undersea segments
Tow Trialing		Testing and Verification of turbine functionality performed immediately prior to Turbine Unit Deployment. Turbine Units are mated with the Installer Barge, a tug tows the Installer Barge while Turbine Units are lowered into the flow stream, causing the blades to spin, informing the desired test results
Trunk Cable	**TC**	Cable from PCCB to subsea dry mate termination at the end of the Turbine Umbilical (TU)
Turbine		Open center turbines with approximately a six (6) meter diameter

TIDAL ENERGY PROJECT DEFINITIONS		
Full Name	***Acronym***	***Additional Description/Definitions***
Turbine Control Centre	**TCC**	Subsea pressure vessel mounted on the SSB containing the control and power circuits for the turbine
Turbine Deployment Site		A predetermined installation site identified in the Project Plans for each turbine
Turbine Junction Bottle	**TJB**	Final interface between the Turbine Umbilical (TU) cable and turbine
Turbine Mobilization Site	**TMS**	Facility, with adequate quayside depth and capabilities, to be used for final assembly of the Turbine Units, together with final integration with the Installer Barge and facilitation of Sea Trials Testing. Site is likely located in the greater Puget Sound region
Turbine Recovery		Removal of the Turbine Units from the Turbine Deployment SiteTurbine Deployment Site at and delivery to a location in the Puget Sound area for salvage as mutually agreed to by the Parties
Turbine Umbilical	**TU**	A 200 meter section of cable that extends from the subsea base to the IPV
Turbine Umbilical Storage Platform	**TUSP**	A flanged structure designed to transport the TU in a figure 8 pattern integrated with the SSB
Turbine Units		Means a Turbine attached to a Subsea Base to be provided by OpenHydro as well as all related auxiliary equipment, accessories components, and materials
Underwriters Laboratory	**UL**	
Uninterruptible Power Supply	**UPS**	
United States Coast Guard	**USCG**	
Virtual Network Computing	**VNC**	
Virtual Private Network	**VPN**	
Weight		Measurement of tension in cable during laying or repair operations, normally expressed in tons or pounds

Appendix B

CABLE LAY PLAN (CLP)

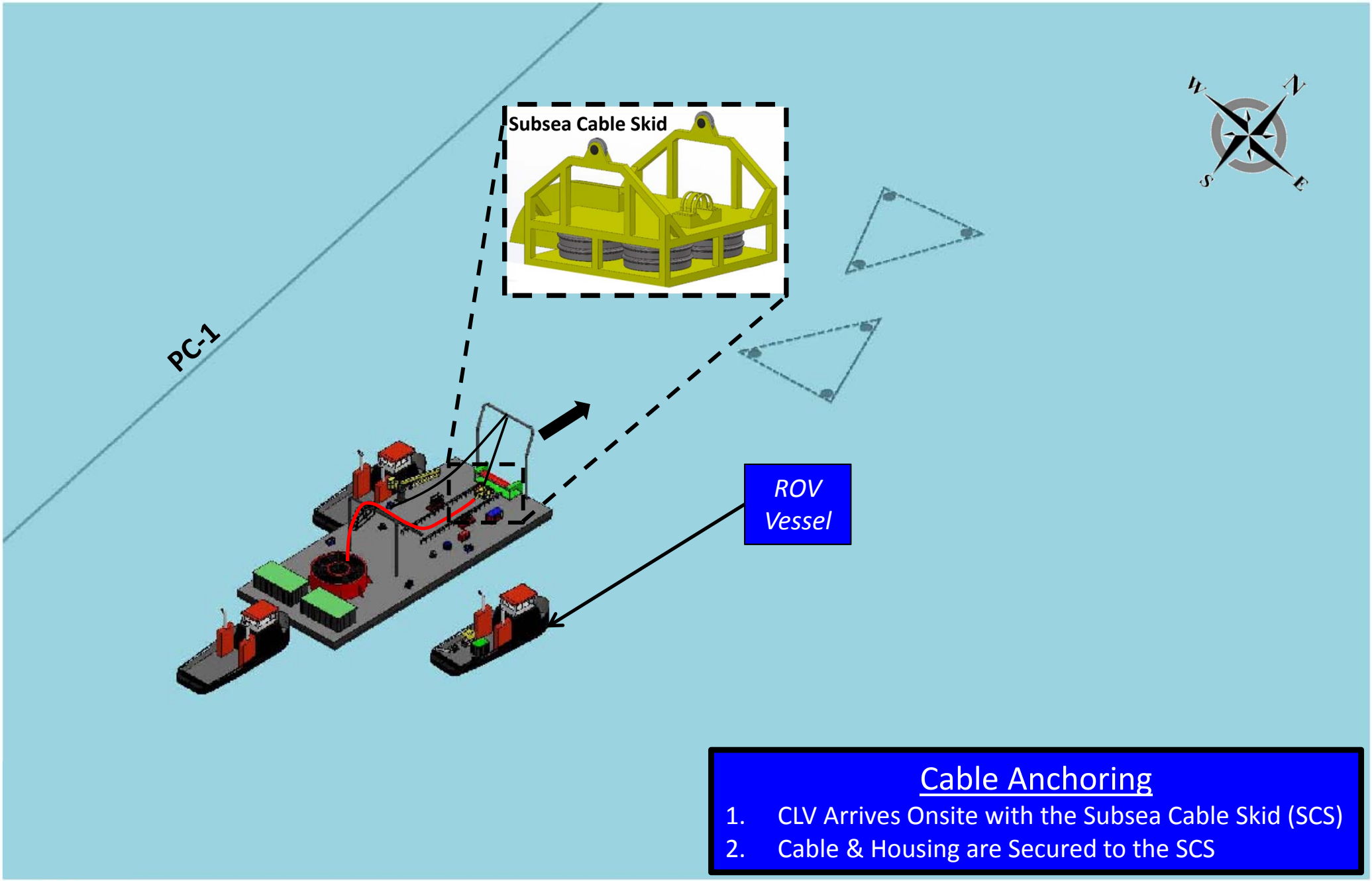
Sound & Sea Technology
April 11, 2013

Cable Lay Plan (CLP)

SnoPUD Tidal Energy Project

April 11, 2013

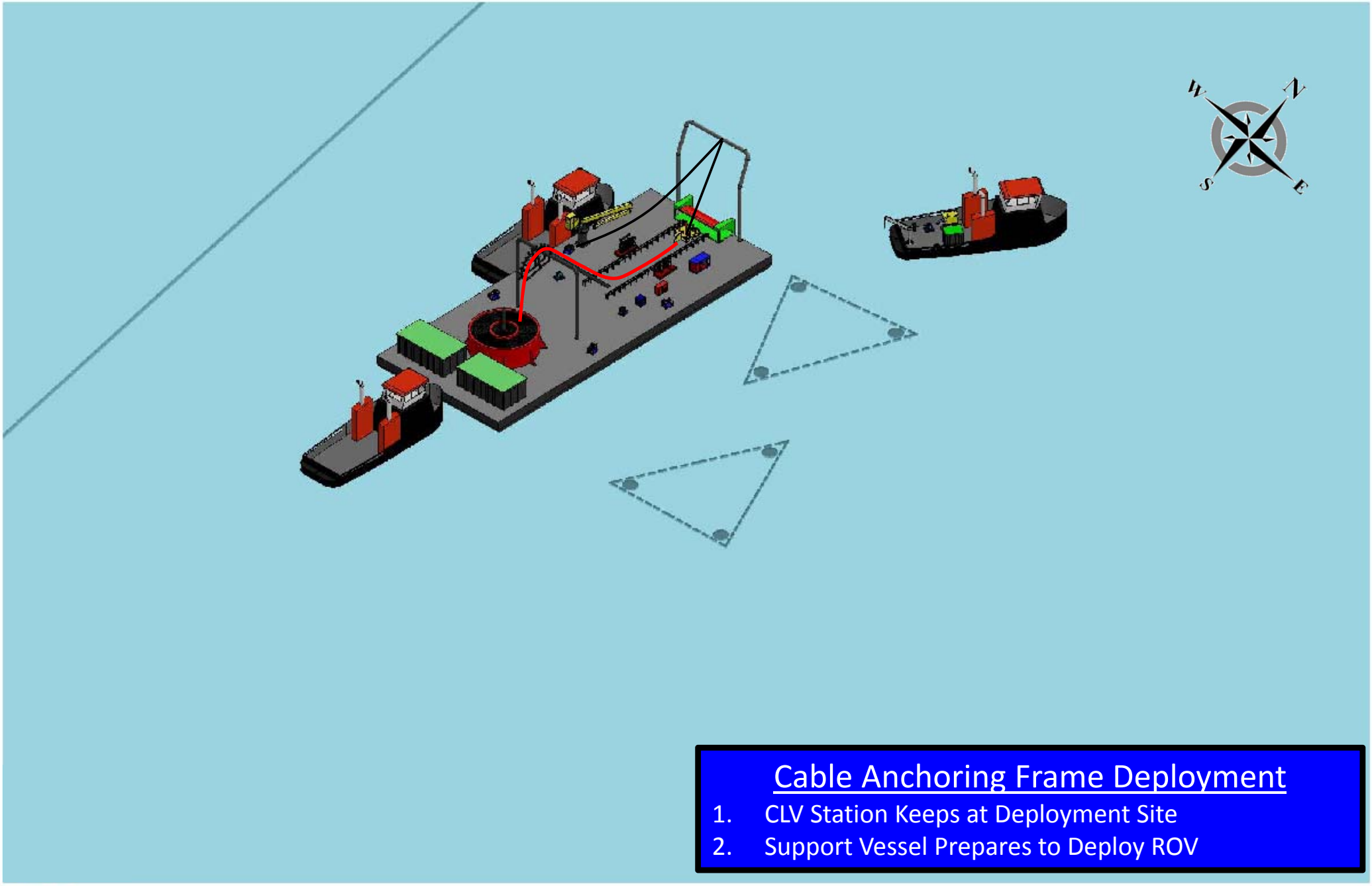
Cable Lay Plan



Cable Anchoring

1. CLV Arrives Onsite with the Subsea Cable Skid (SCS)
2. Cable & Housing are Secured to the SCS

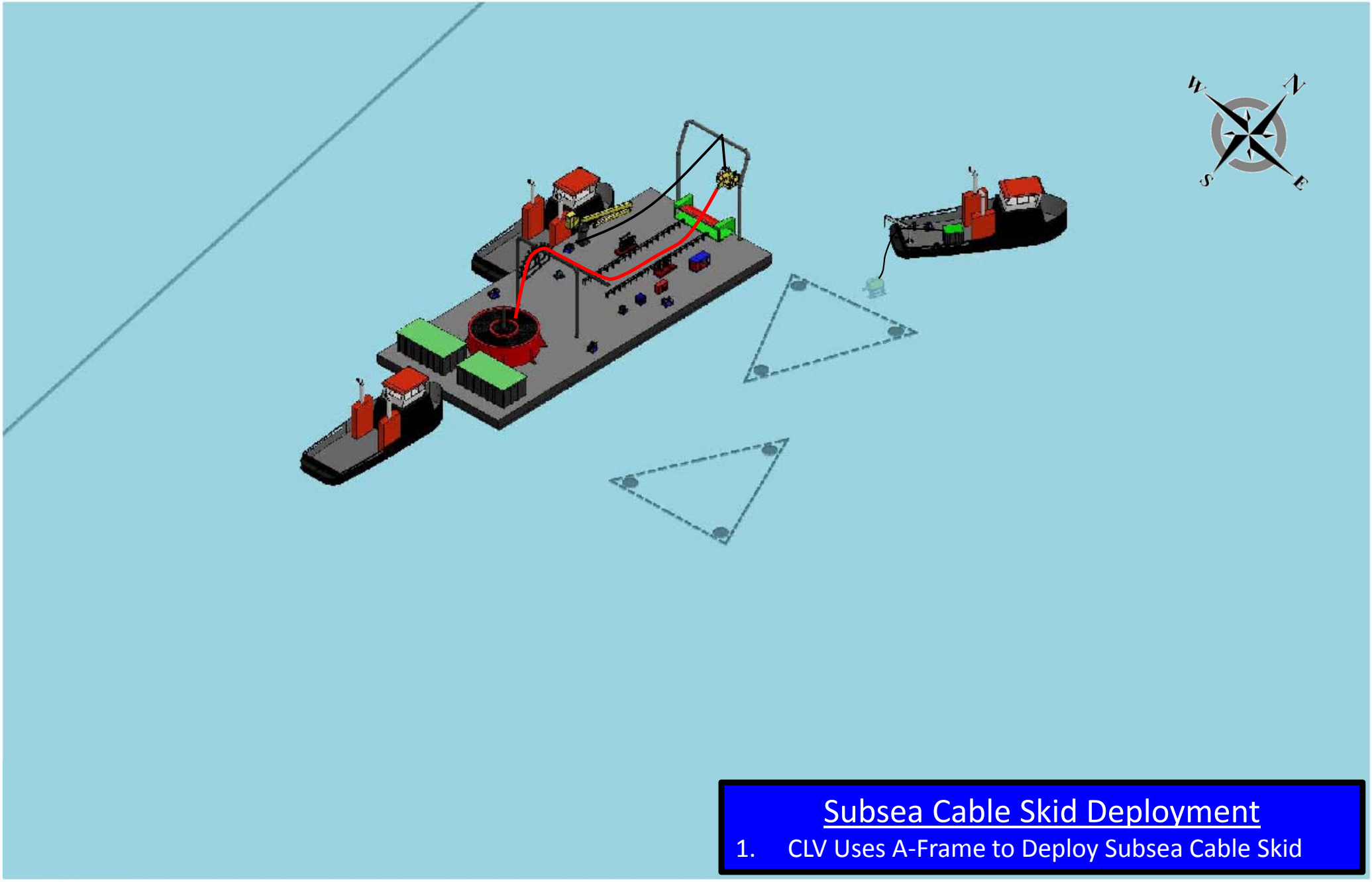
Cable Lay Plan



Cable Anchoring Frame Deployment

1. CLV Station Keeps at Deployment Site
2. Support Vessel Prepares to Deploy ROV

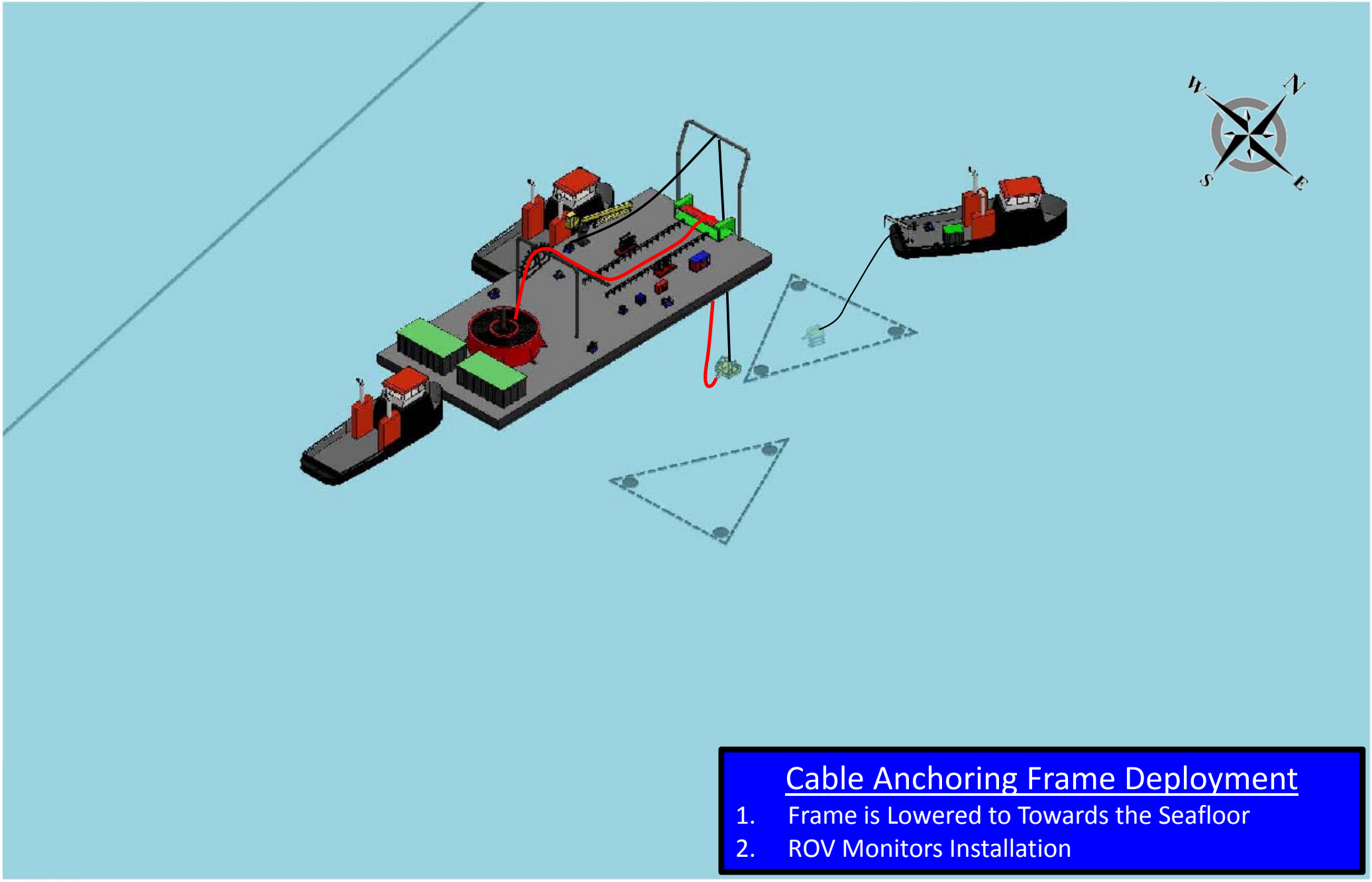
Cable Lay Plan



Subsea Cable Skid Deployment

1. CLV Uses A-Frame to Deploy Subsea Cable Skid

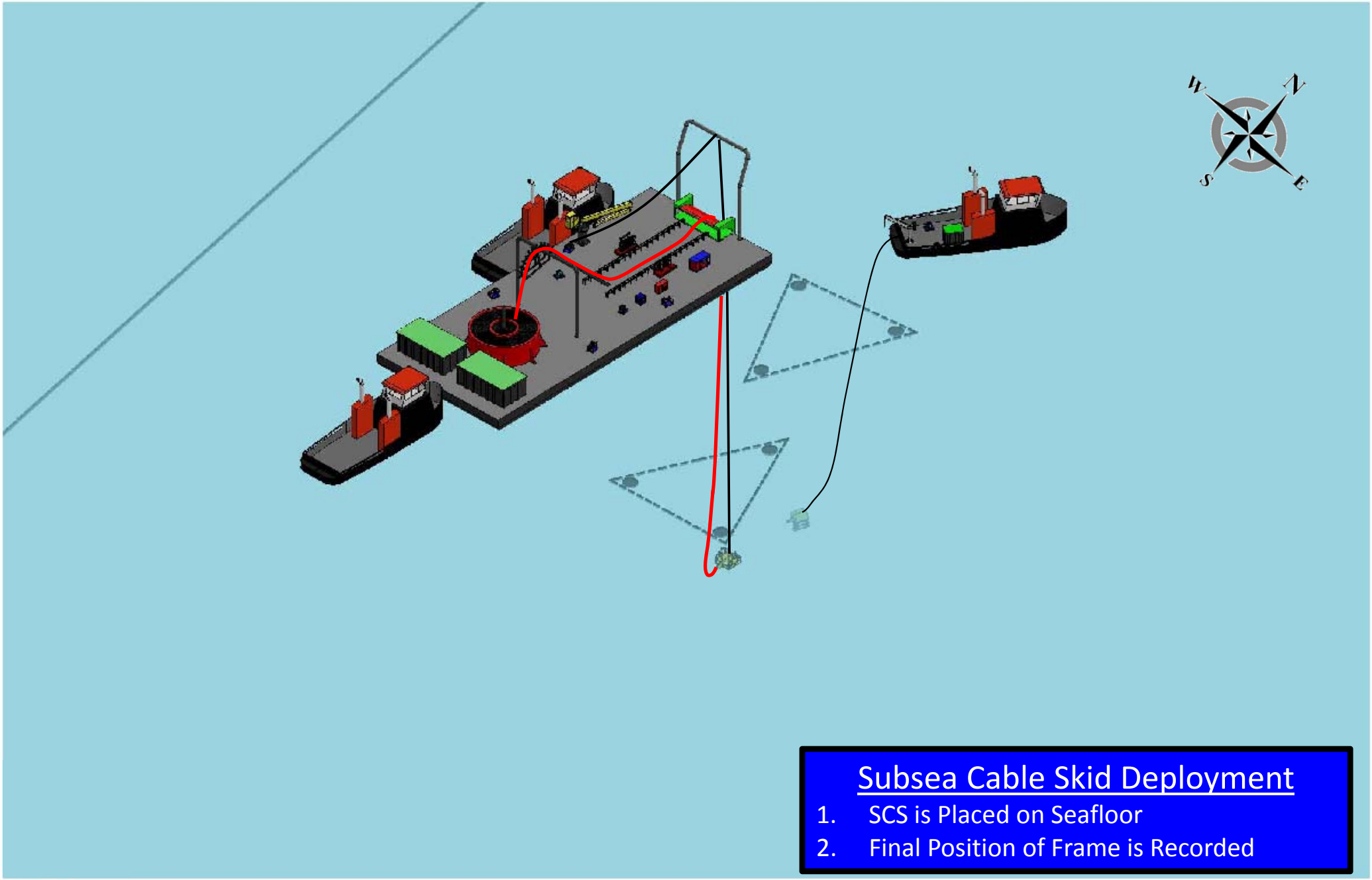
Cable Lay Plan



Cable Anchoring Frame Deployment

1. Frame is Lowered to Towards the Seafloor
2. ROV Monitors Installation

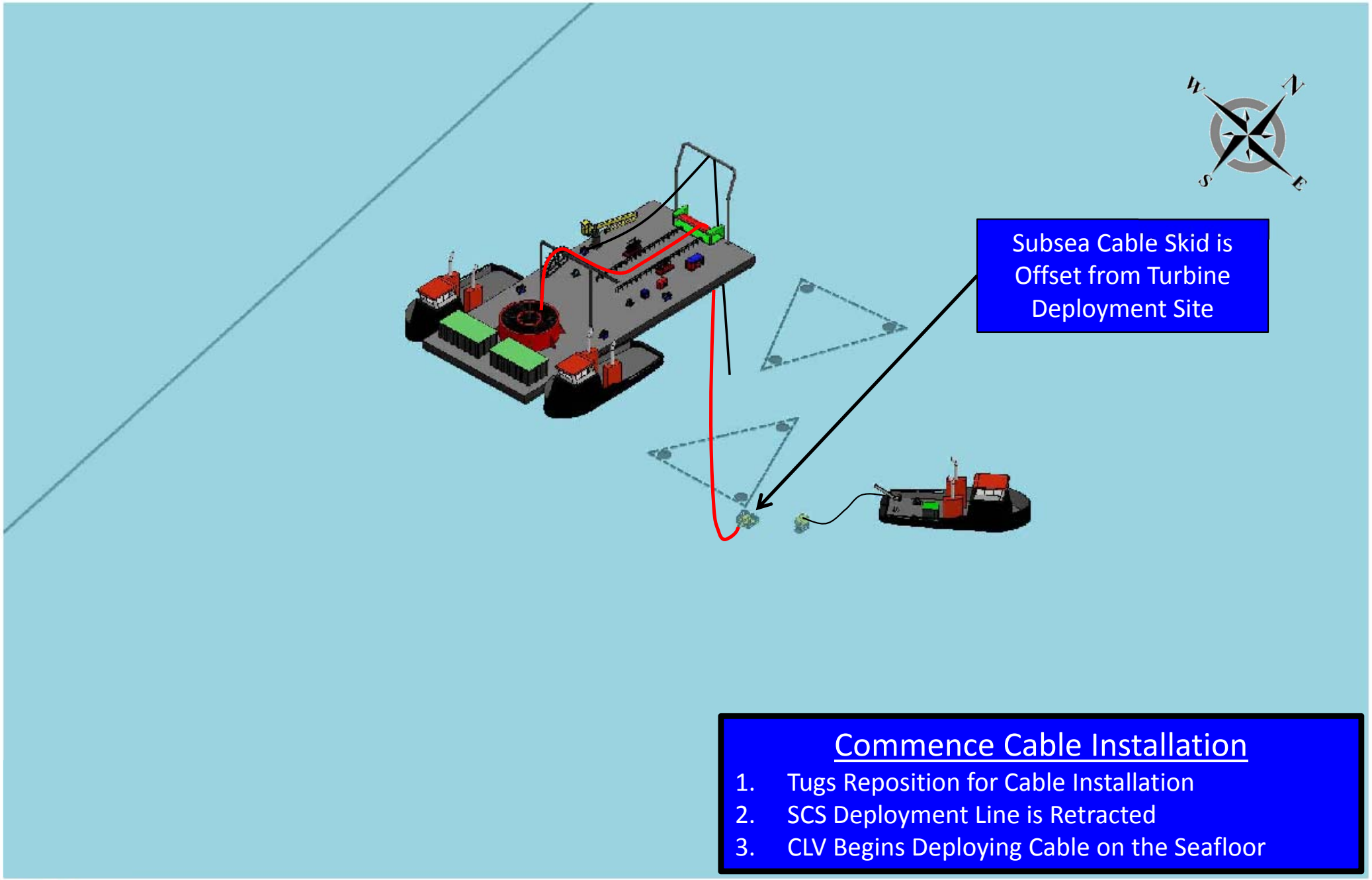
Cable Lay Plan



Subsea Cable Skid Deployment

1. SCS is Placed on Seafloor
2. Final Position of Frame is Recorded

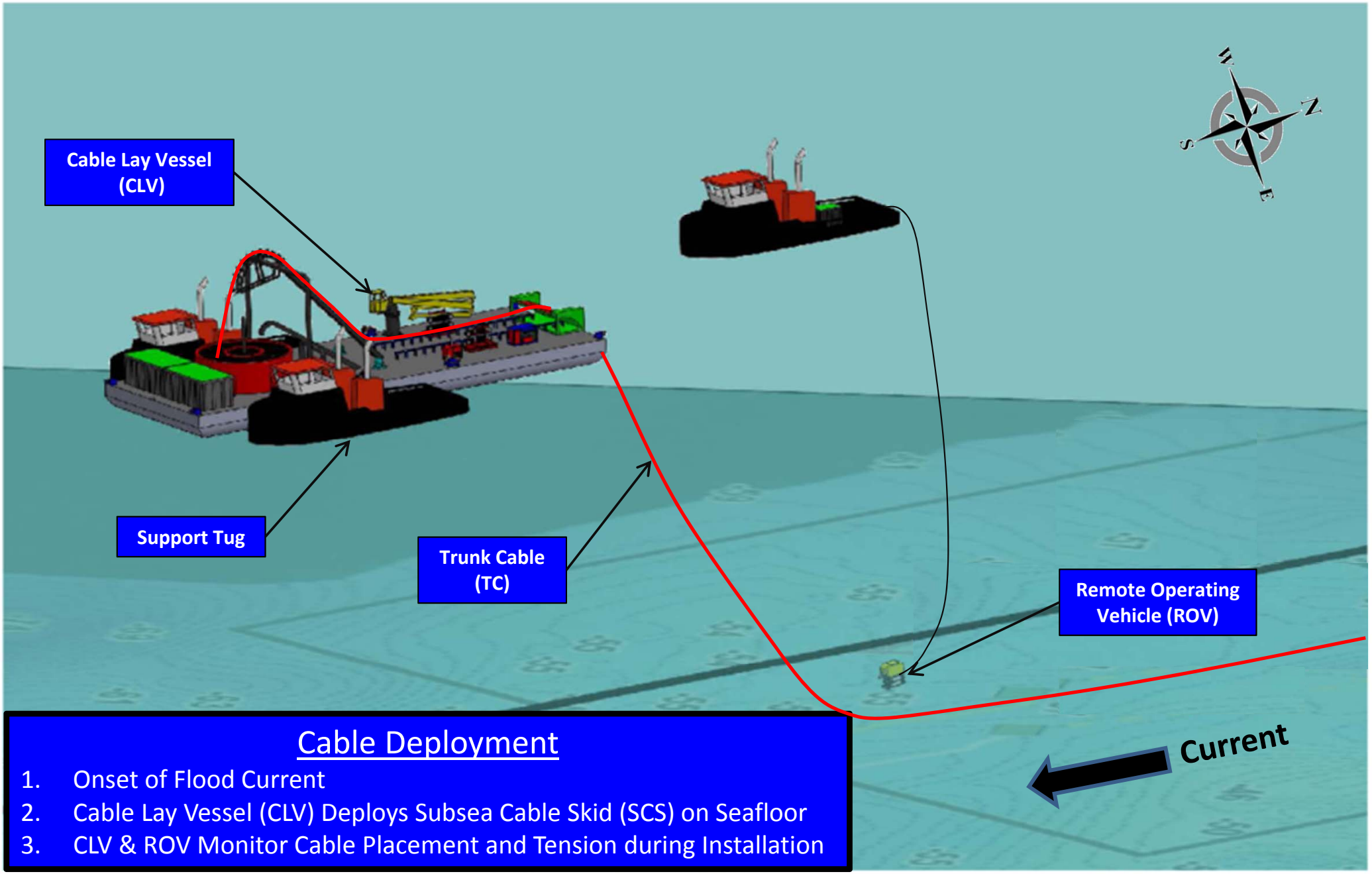
Cable Lay Plan



Commence Cable Installation

1. Tugs Reposition for Cable Installation
2. SCS Deployment Line is Retracted
3. CLV Begins Deploying Cable on the Seafloor

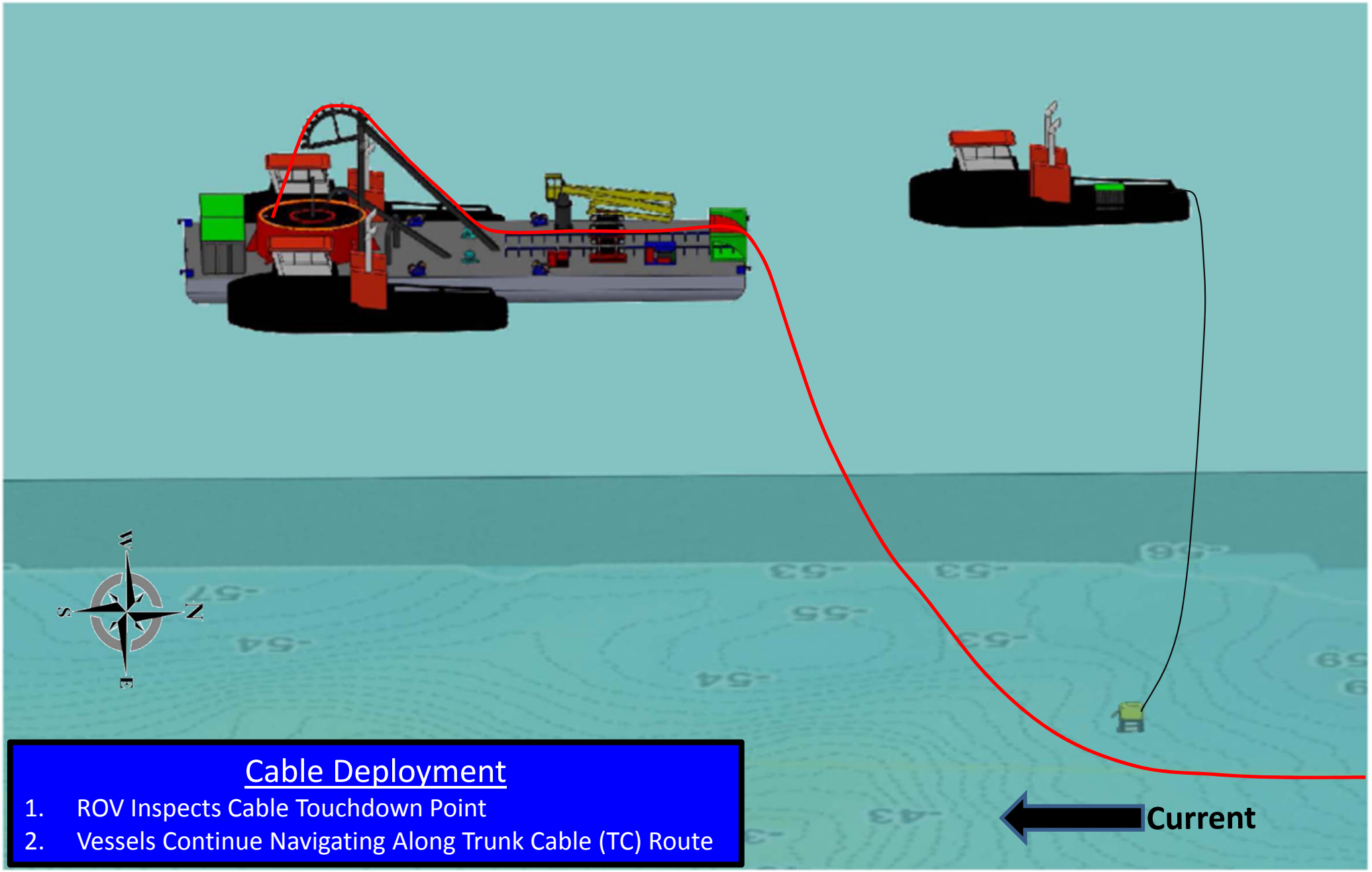
Cable Lay Plan



Cable Deployment

1. Onset of Flood Current
2. Cable Lay Vessel (CLV) Deploys Subsea Cable Skid (SCS) on Seafloor
3. CLV & ROV Monitor Cable Placement and Tension during Installation

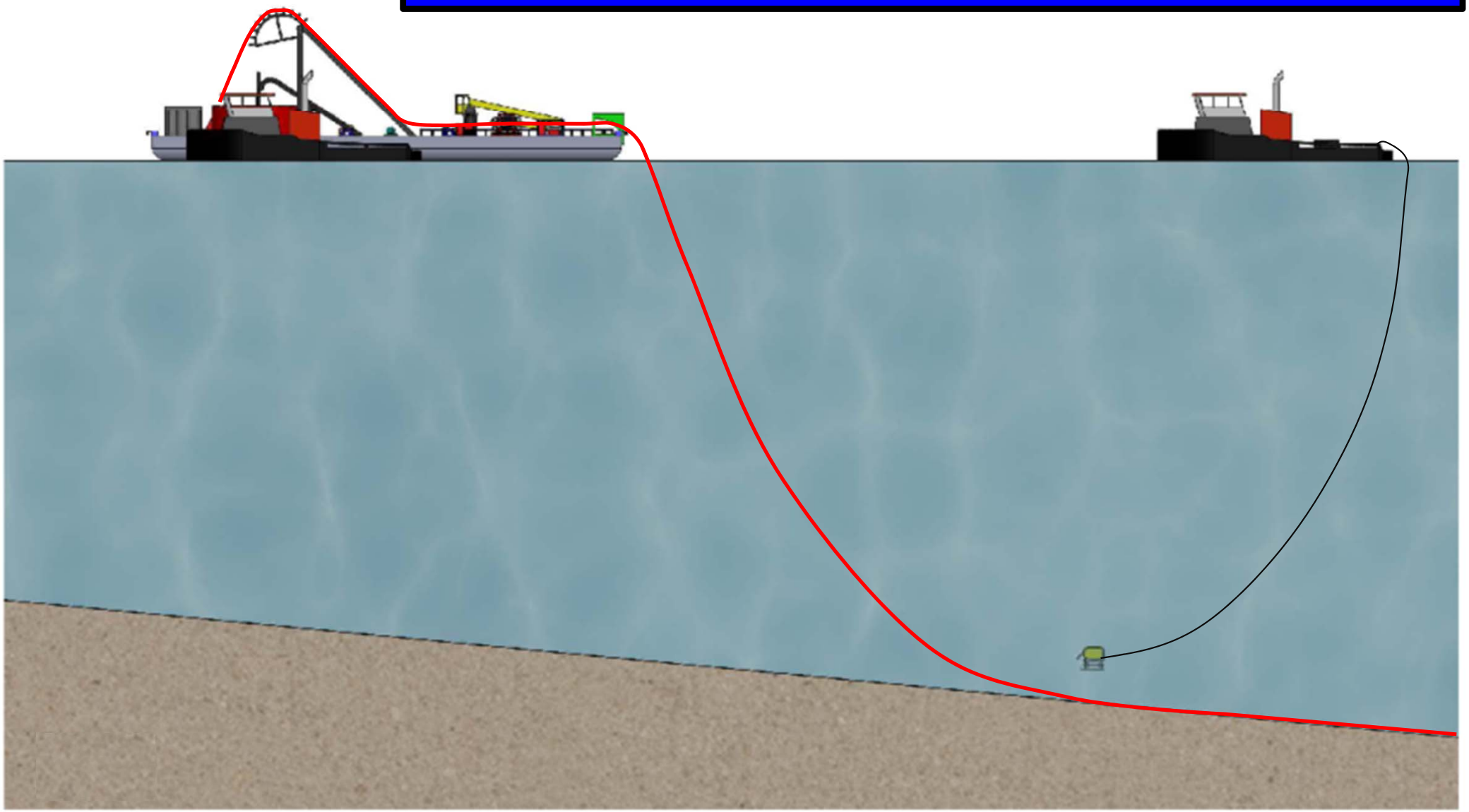
Cable Lay Plan



Cable Lay Plan

Cable Deployment

1. CLV Arrives at the Trunk Cable (TC) Horizontal Directional Drill (HDD) Pipe Outlet
2. ROV Monitors Cable Installation and Records Final Trunk Cable (TC) Position



Cable Lay Plan

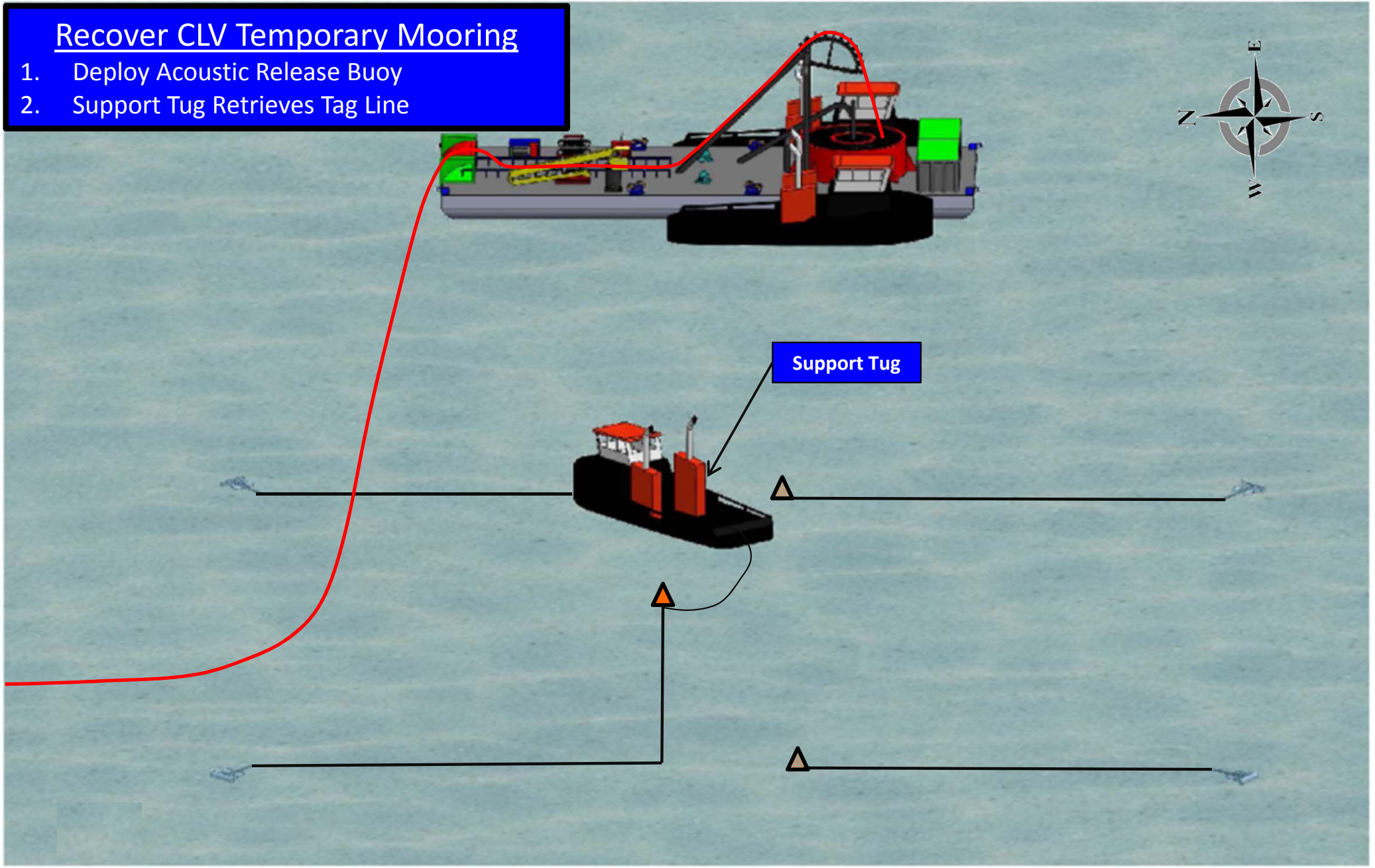
Recover CLV Temporary Mooring

1. CLV Arrives at Predetermined Temporary Mooring Site

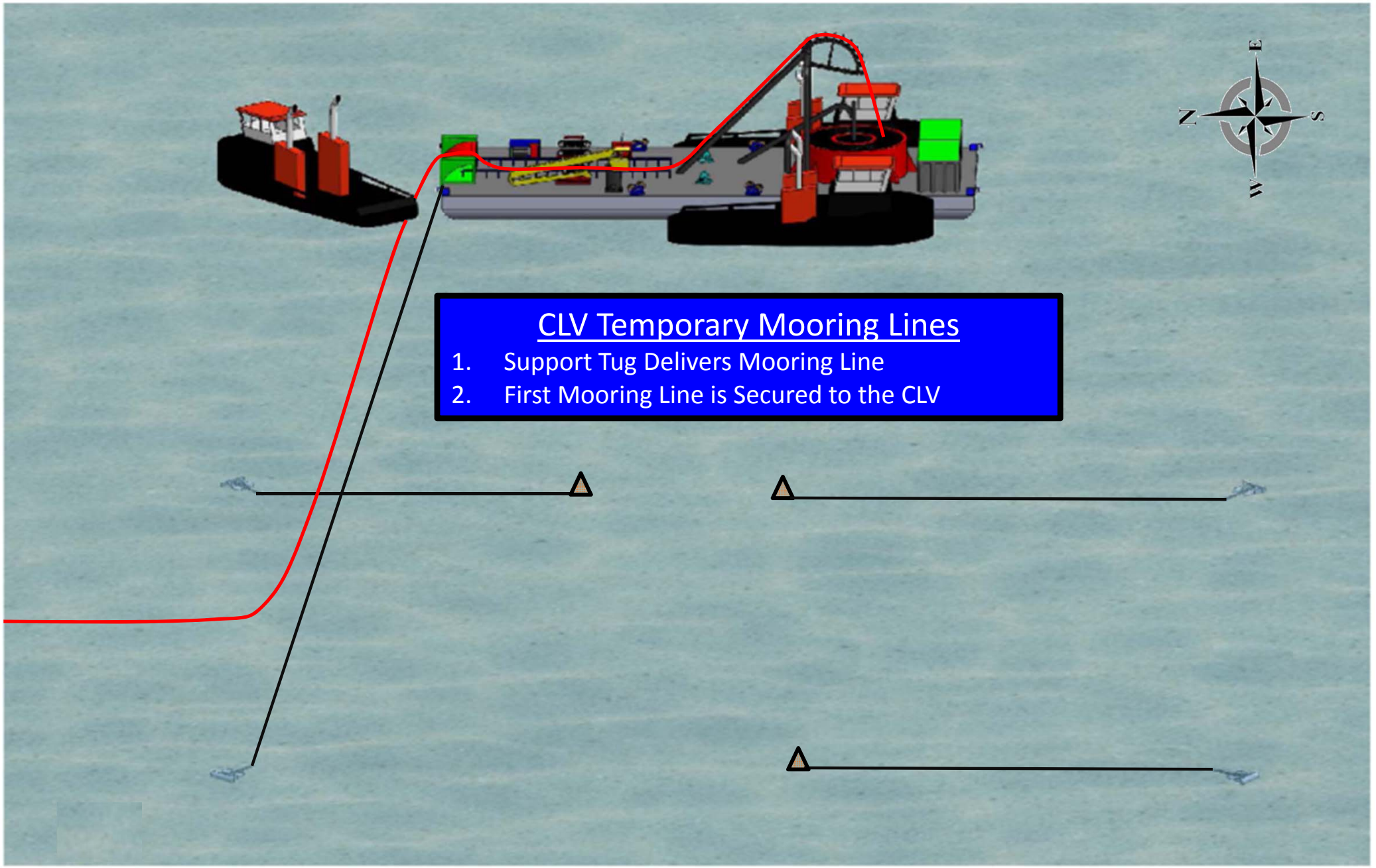
Preset 4-Point Temporary Mooring Anchors & Lines

Acoustic Release Buoy

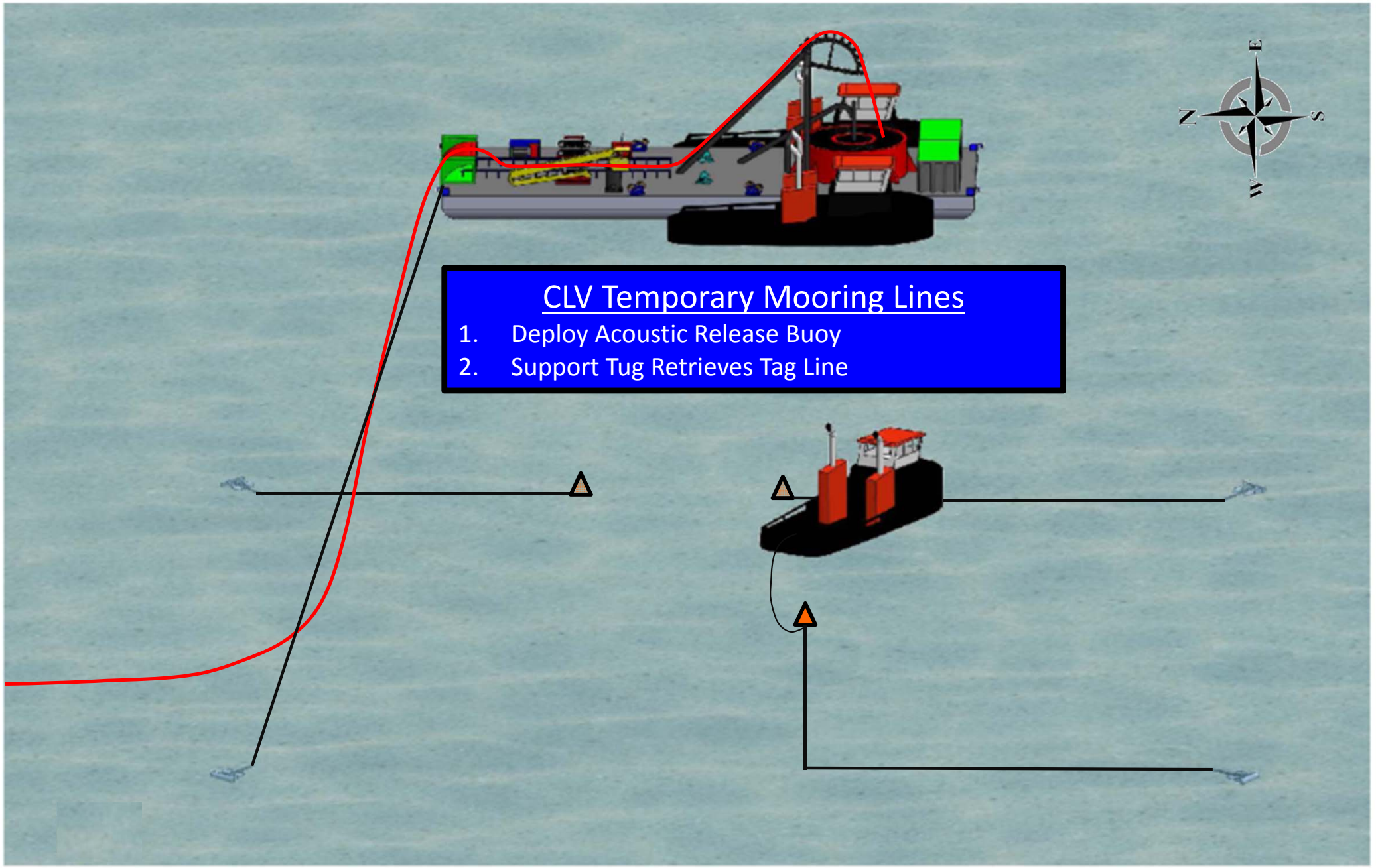
Cable Lay Plan



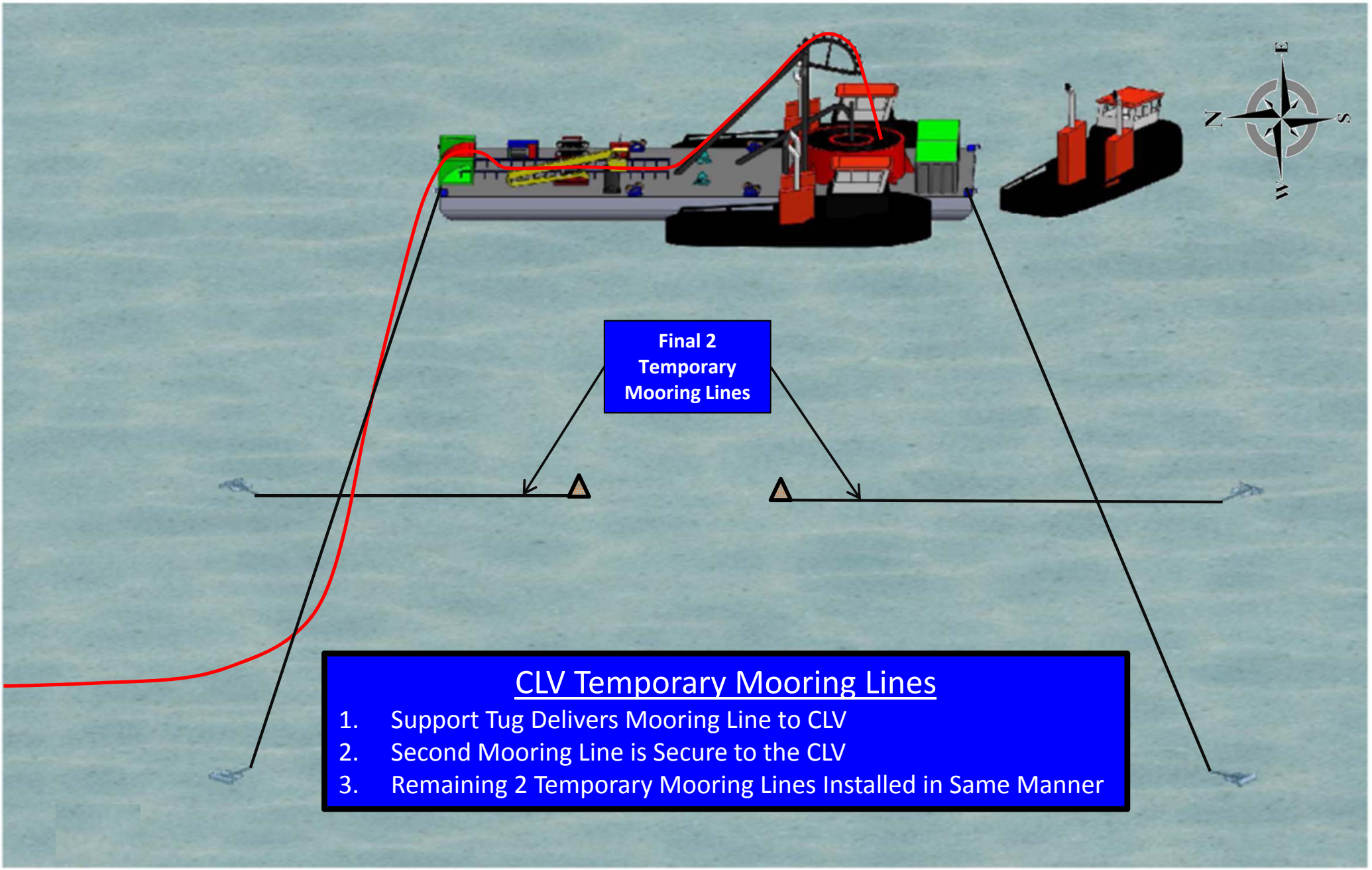
Cable Lay Plan



Cable Lay Plan



Cable Lay Plan



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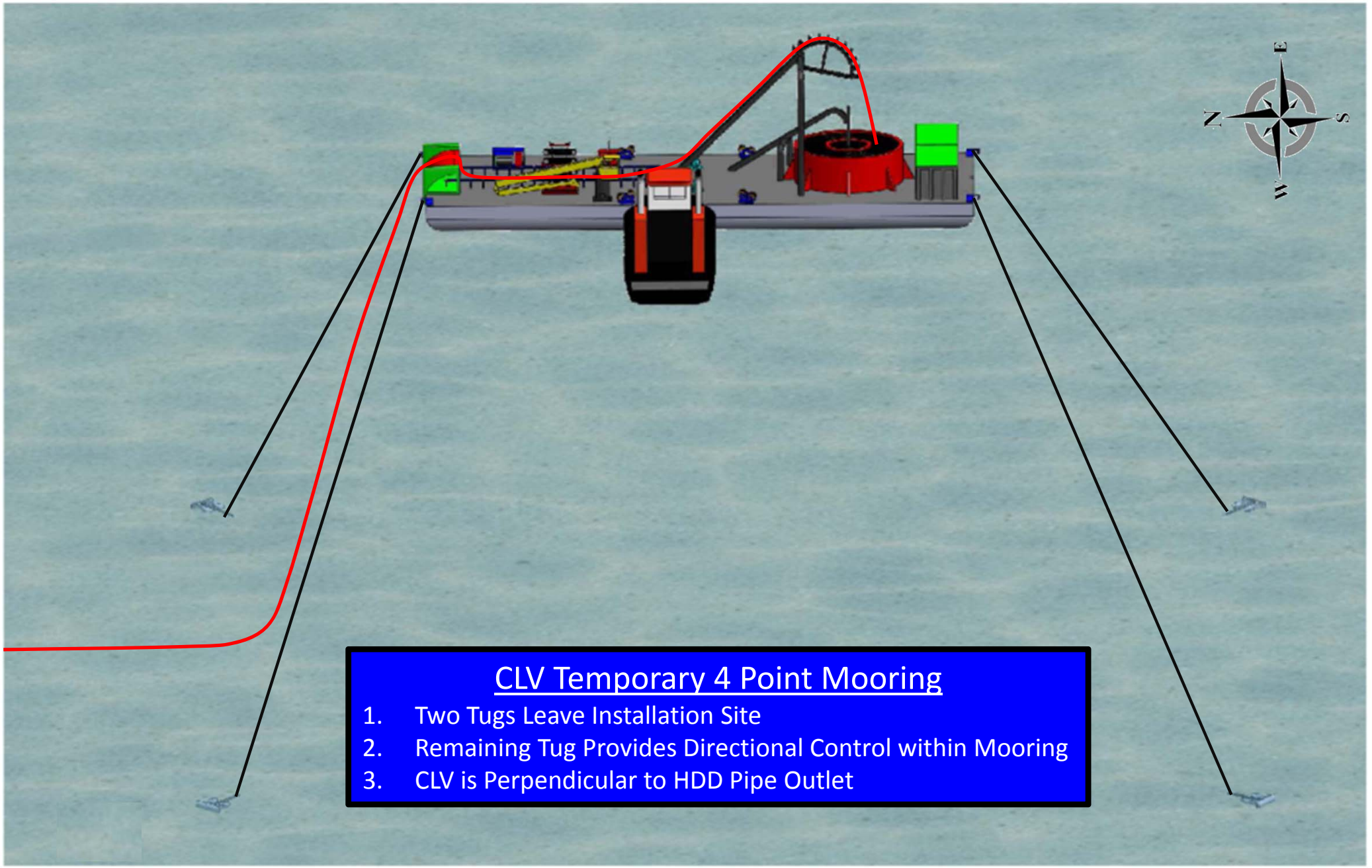
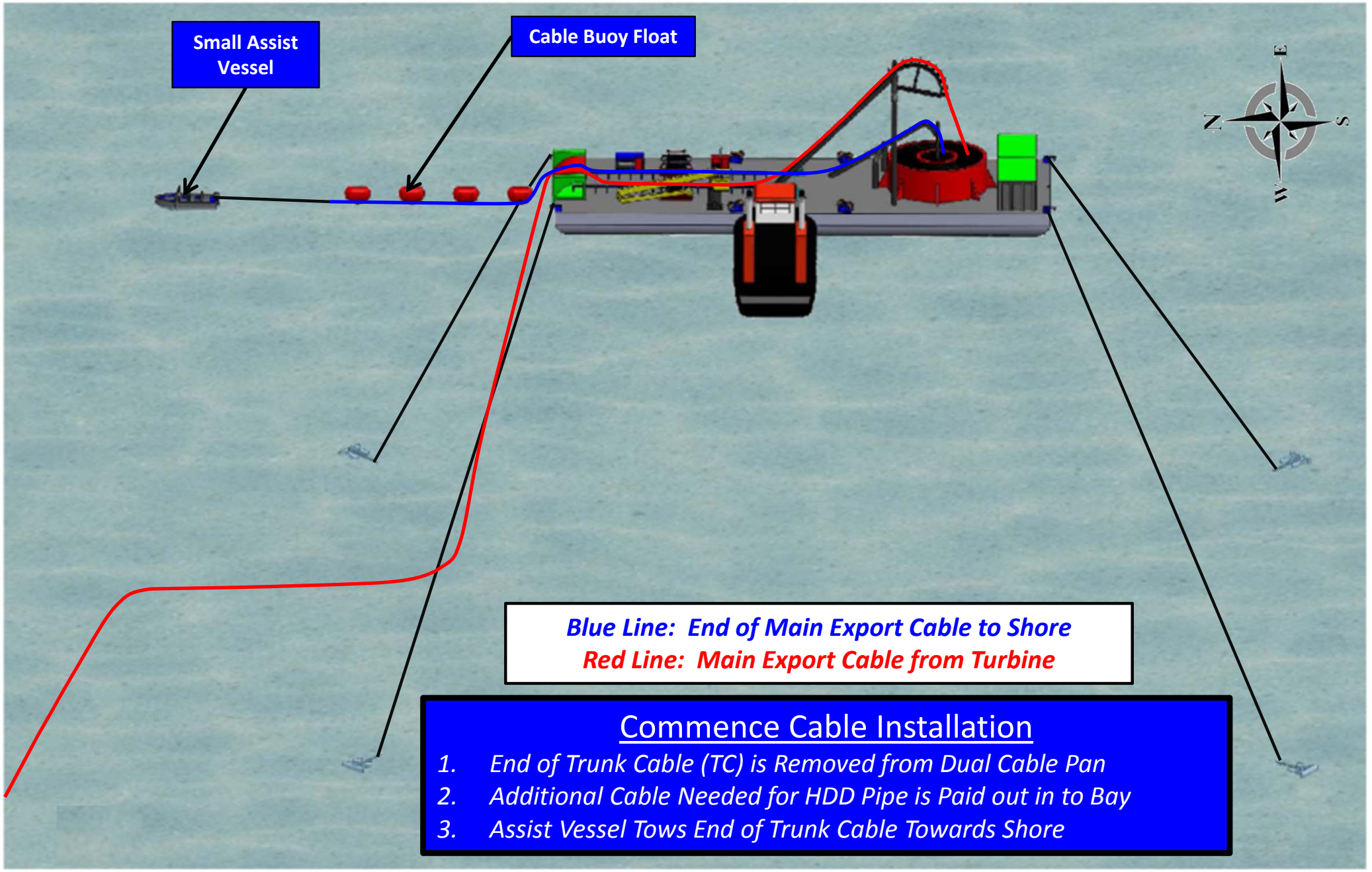
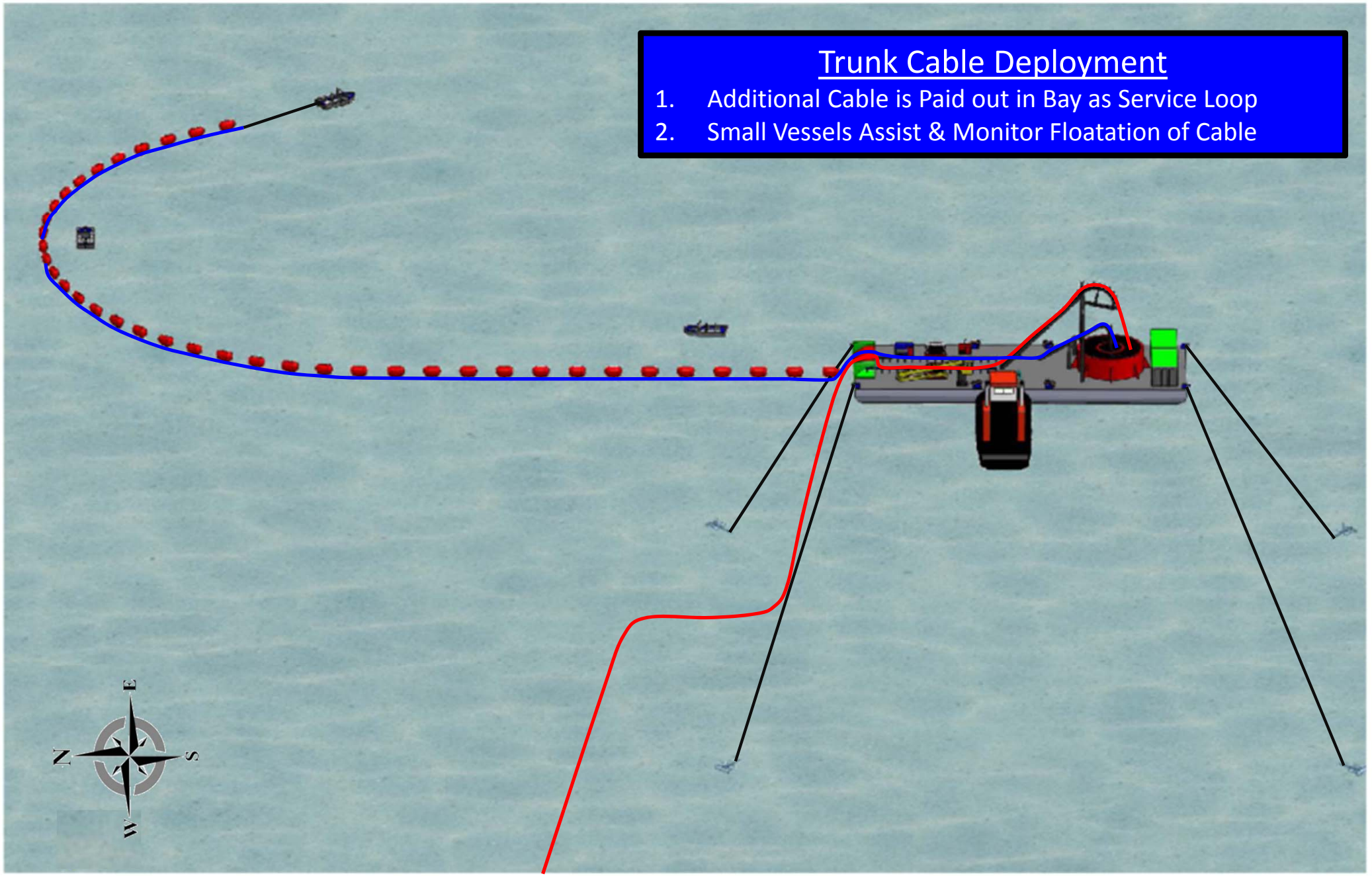


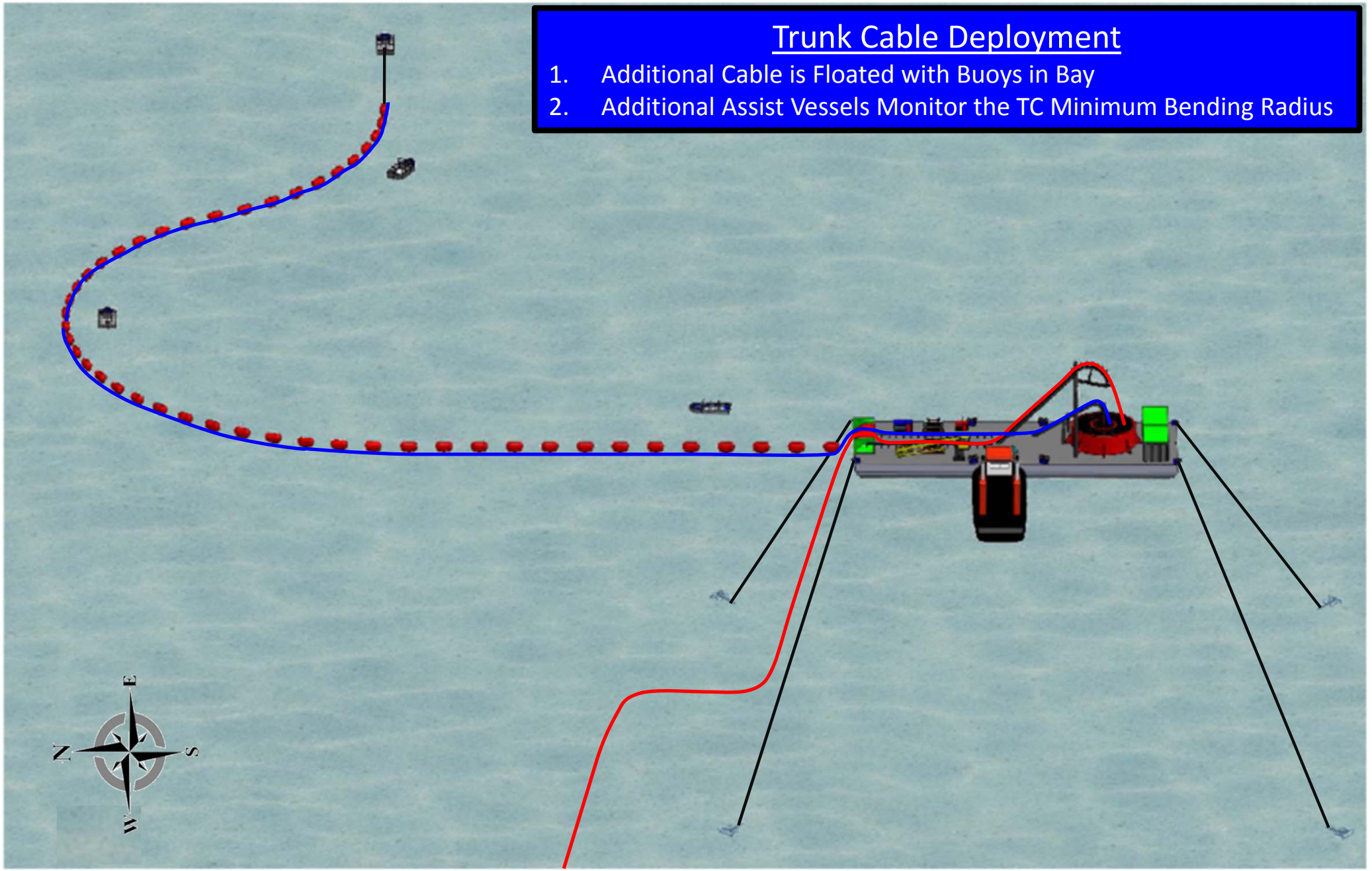
Cable Lay Plan



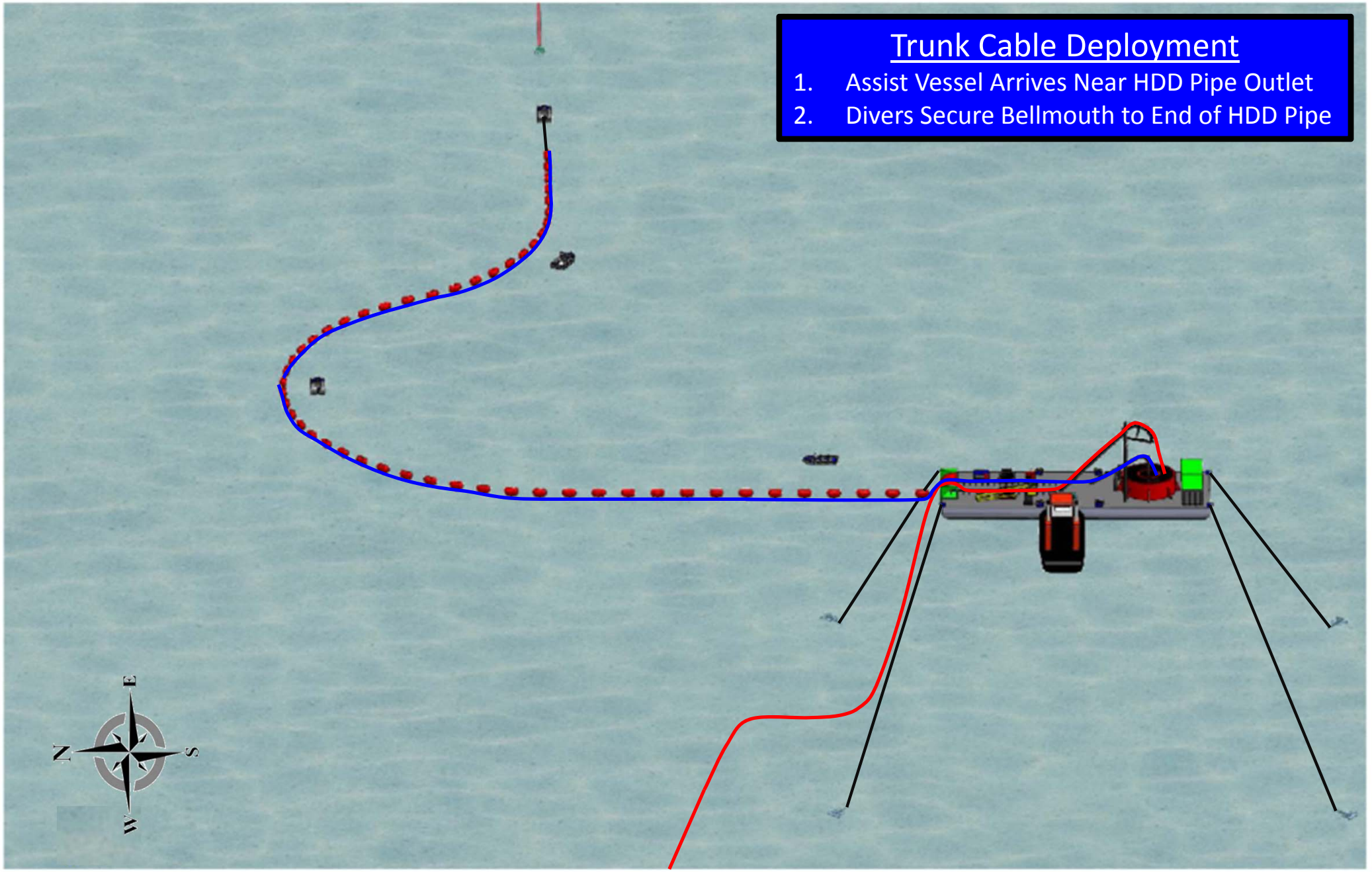
Cable Lay Plan



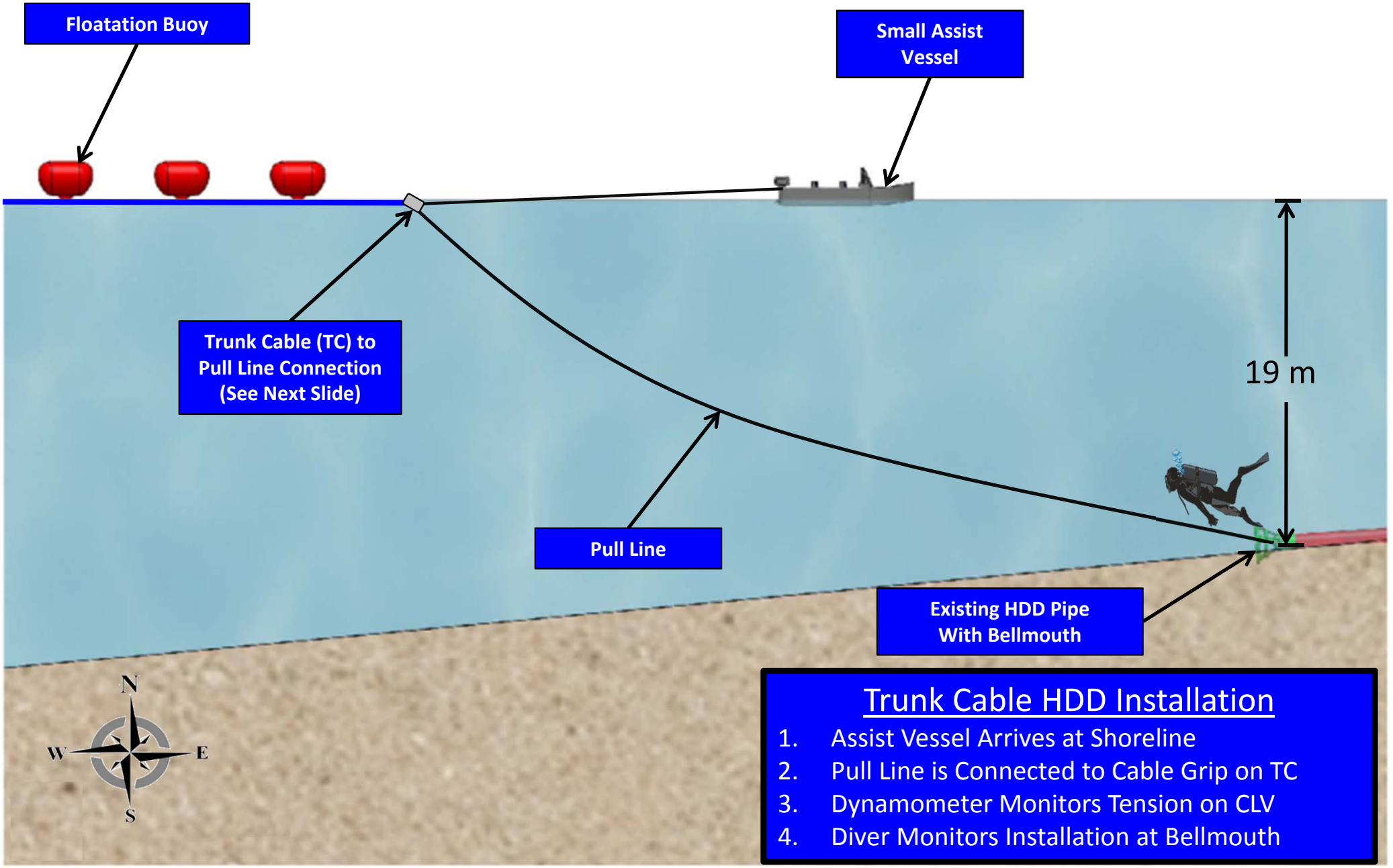
Cable Lay Plan



Cable Lay Plan



Cable Lay Plan

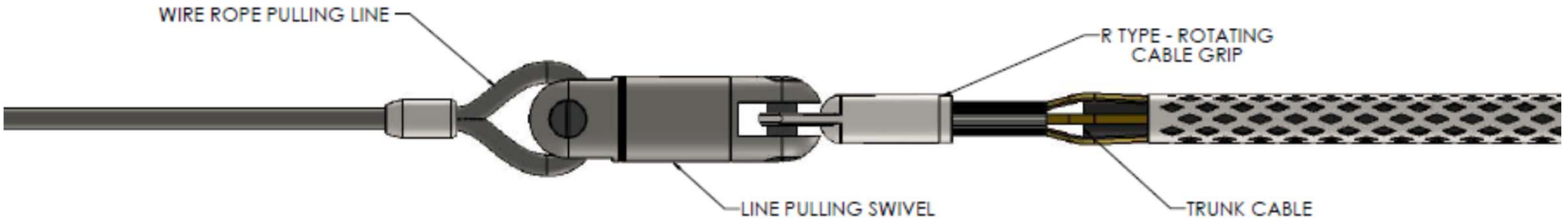


Trunk Cable HDD Installation

1. Assist Vessel Arrives at Shoreline
2. Pull Line is Connected to Cable Grip on TC
3. Dynamometer Monitors Tension on CLV
4. Diver Monitors Installation at Bellmouth

Cable Lay Plan

To Shore | **To Sea**



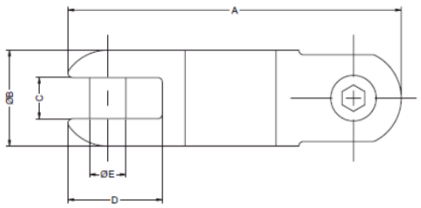
R Type - Rotating Multi-Weave Cable Grip

Like the MU type, the rotating eye cable grip has a triple weave construction and is color coded for ease of identification. In addition, its steel forged revolving head is ideal for connecting to Slingco swivels and shackles. Warning: The Slingco R Type Rotating Eye Cable Grip does not revolve under load.

Slingco part no.	Color	Size range	Revolving eye diameter	Lattice length	Approx breaking strength (lbs)
Galvanized					
ZCS2177	Dark green	0.25 - 0.50"	0.875"	31"	7,000
ZCS2178	Brown	0.50 - 0.75"	1.00"	45"	10,500
ZCS2179	Light blue	0.75 - 1.00"	1.00"	43"	14,100
ZCS2180	Gold	1.00 - 1.25"	1.625"	65"	25,000
ZCS2181	Black	1.25 - 1.50"	1.875"	59"	31,000
ZCS2182	Red	1.50 - 1.75"	1.875"	82"	31,000
ZCS2183	Dark blue	1.75 - 2.25"	1.875"	82"	43,000
ZCS2779	Yellow	2.00 - 2.50"	1.875"	72"	43,000
ZCS2780	Orange	2.50 - 3.00"	1.875"	72"	43,000

Line Pulling Swivel - Stainless Steel

Slingco Line Swivels are designed to the highest specifications for underground and overhead pulling applications. All swivels are stringently quality tested and inspected to ensure optimum reliability and performance.



Slingco part no.	Safe working load (lb)		A	ØB	C	D	ØE
	Underground	Overhead					
ZSW2091	2,250	1,350	3 3/8"	7/8"	3/8"	7/8"	5/16"
ZSW2092	3,500	2,100	4"	1"	7/16"	11/16"	3/8"
ZSW2093	5,000	3,000	4 5/16"	1 1/4"	9/16"	1 1/4"	3/8"
ZSW2094	7,000	4,200	5 3/16"	1 3/8"	9/16"	1 13/32"	1/2"
ZSW2096	10,000	6,000	6 3/16"	1 25/32"	45/64"	1 3/4"	5/8"
ZSW2097	15,000	9,000	7 5/16"	2 3/32"	25/32"	2 1/8"	23/32"

3:1 factor of safety used, based on the ultimate load for underground use
5:1 factor of safety used, based on the ultimate load for overhead use

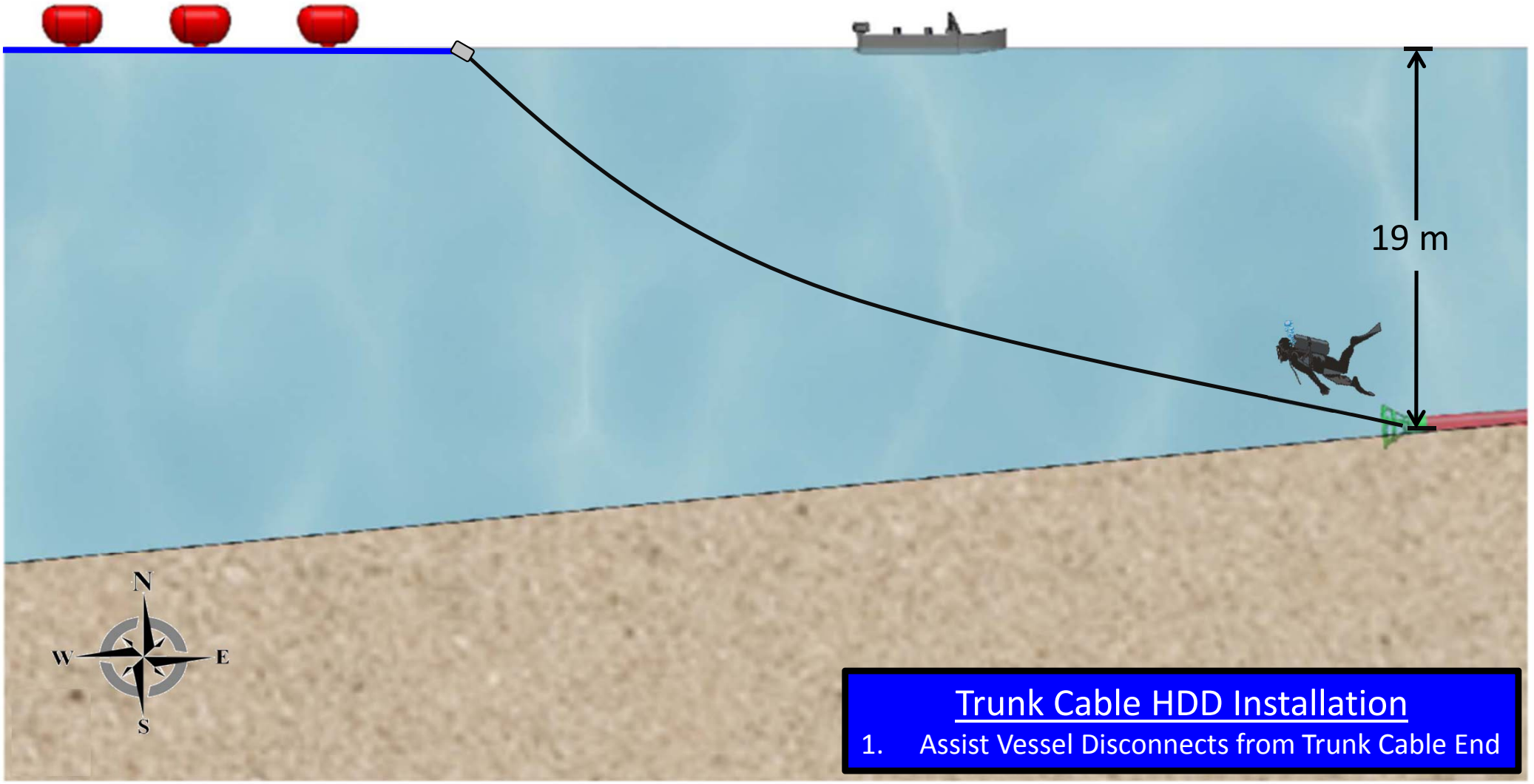
Swivel and Cable Grip match-up

Revolving Eye	Flexible Eye MU	Approx breaking strength of cable grip (lb)	Cable grip color code	Size range O.D.	Recommended swivel	Safe working load of swivel (lb)
ZCS2177	ZCS1710	7,000	Dark green	0.25 - 0.50"	ZSW2092	3,500
ZCS2178	ZCS1711	10,500	Brown	0.50 - 0.75"	ZSW2093	5,000
ZCS2179	ZCS1712	14,100	Light blue	0.75 - 1.00"	ZSW2093	5,000
ZCS2180	ZCS1713	25,000	Gold	1.00 - 1.25"	ZSW2096	10,000
ZCS2181	ZCS1714	31,000	Black	1.25 - 1.50"	ZSW2096	10,000
ZCS2182	ZCS1715	31,000	Red	1.50 - 1.75"	ZSW2096	10,000
ZCS2183	ZCS1716	43,000	Dark blue	1.75 - 2.25"	ZSW2097	15,000

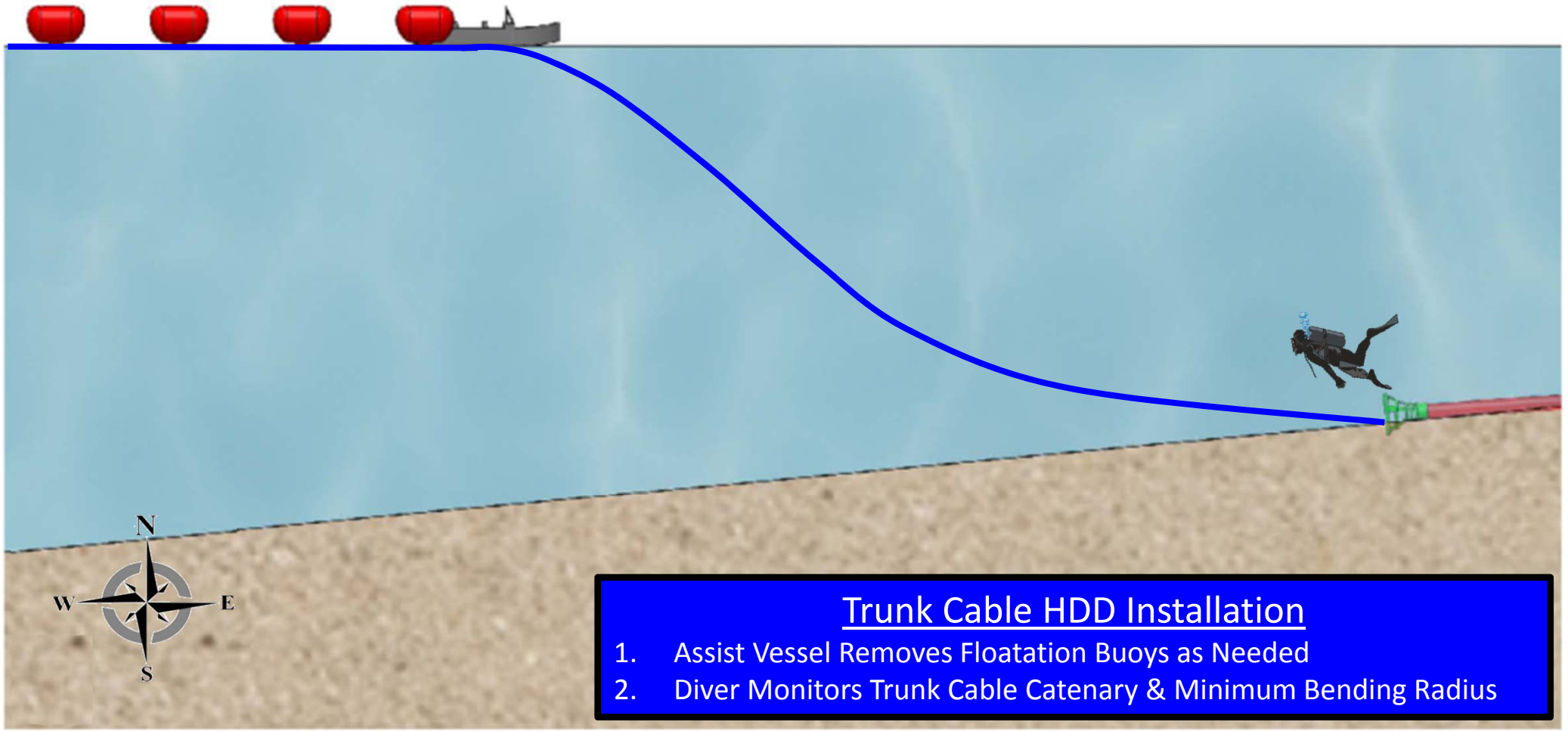
The above is intended as a rough guide. The recommended working load should be determined by the competent person(s) using the cable grip and/or Slingco swivel

Trunk Cable Pulling Hardware

Cable Lay Plan



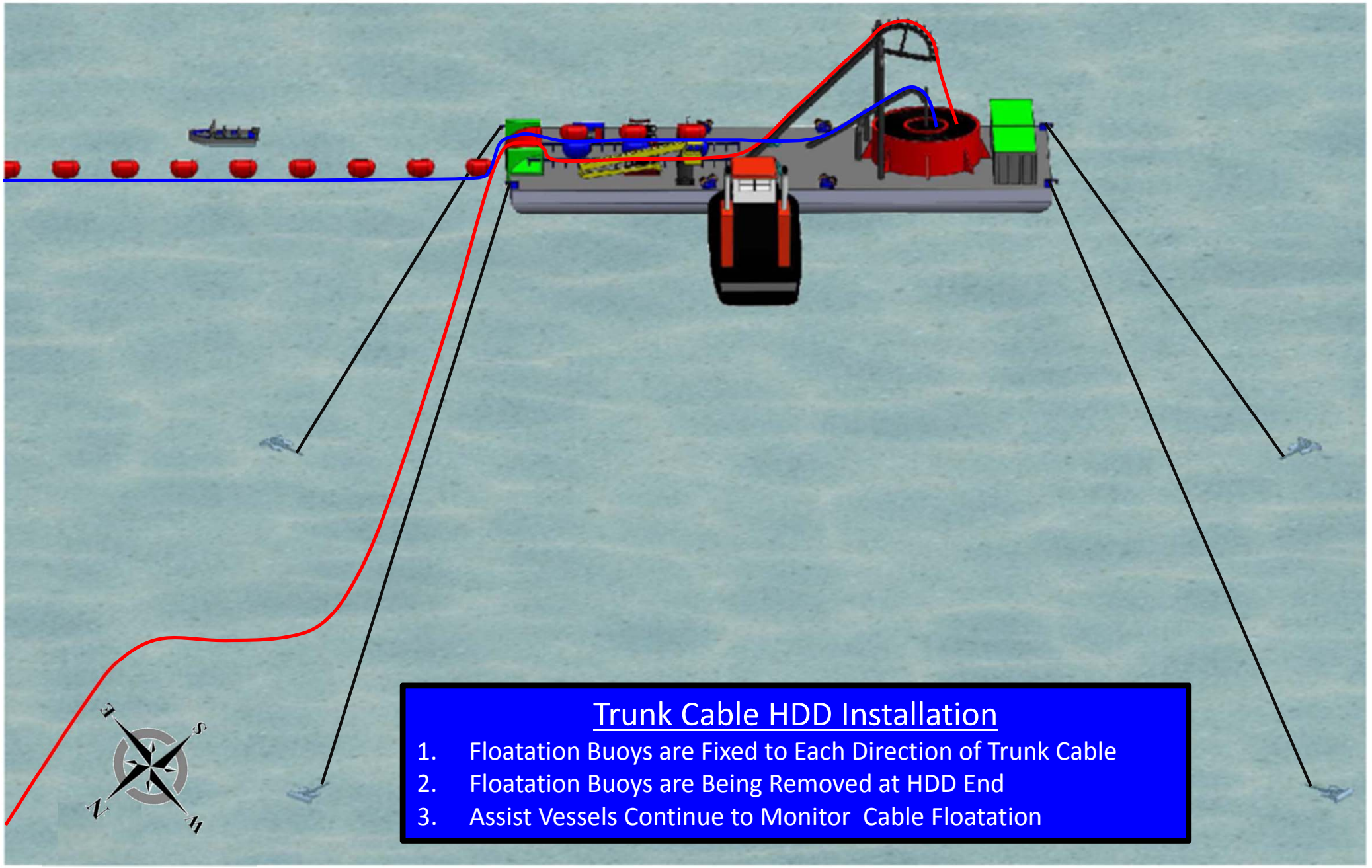
Cable Lay Plan



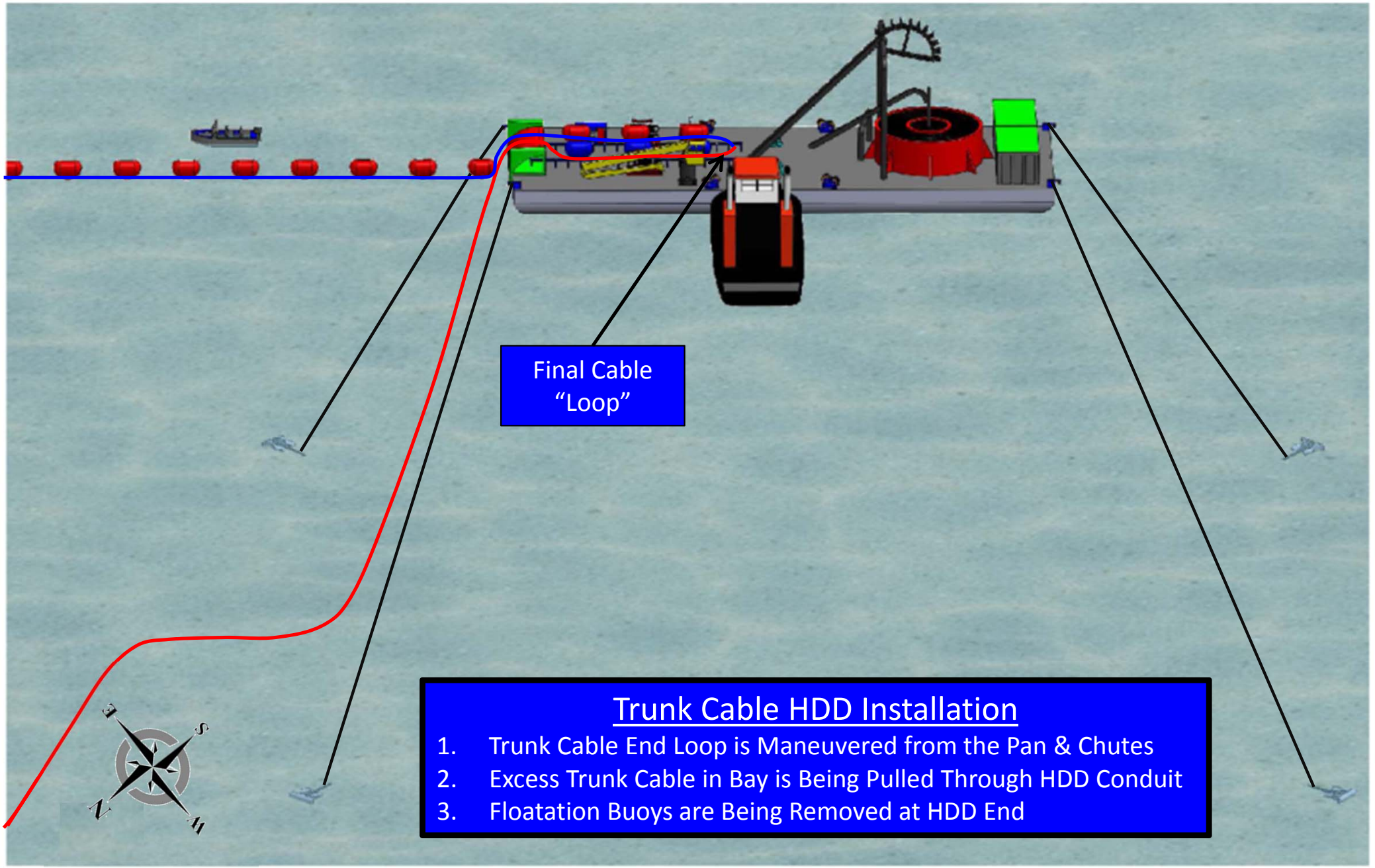
Trunk Cable HDD Installation

1. Assist Vessel Removes Floatation Buoys as Needed
2. Diver Monitors Trunk Cable Catenary & Minimum Bending Radius

Cable Lay Plan



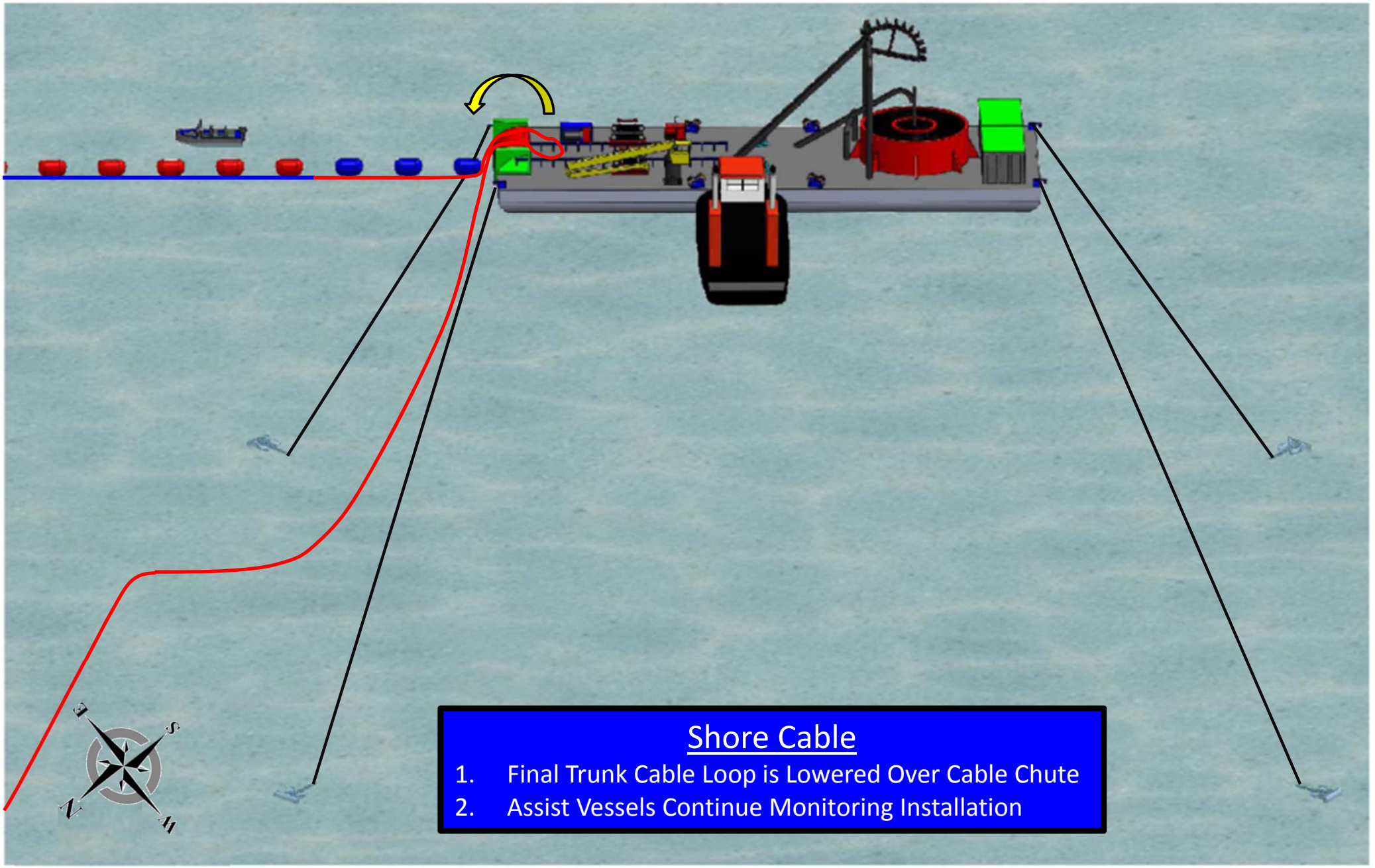
Cable Lay Plan



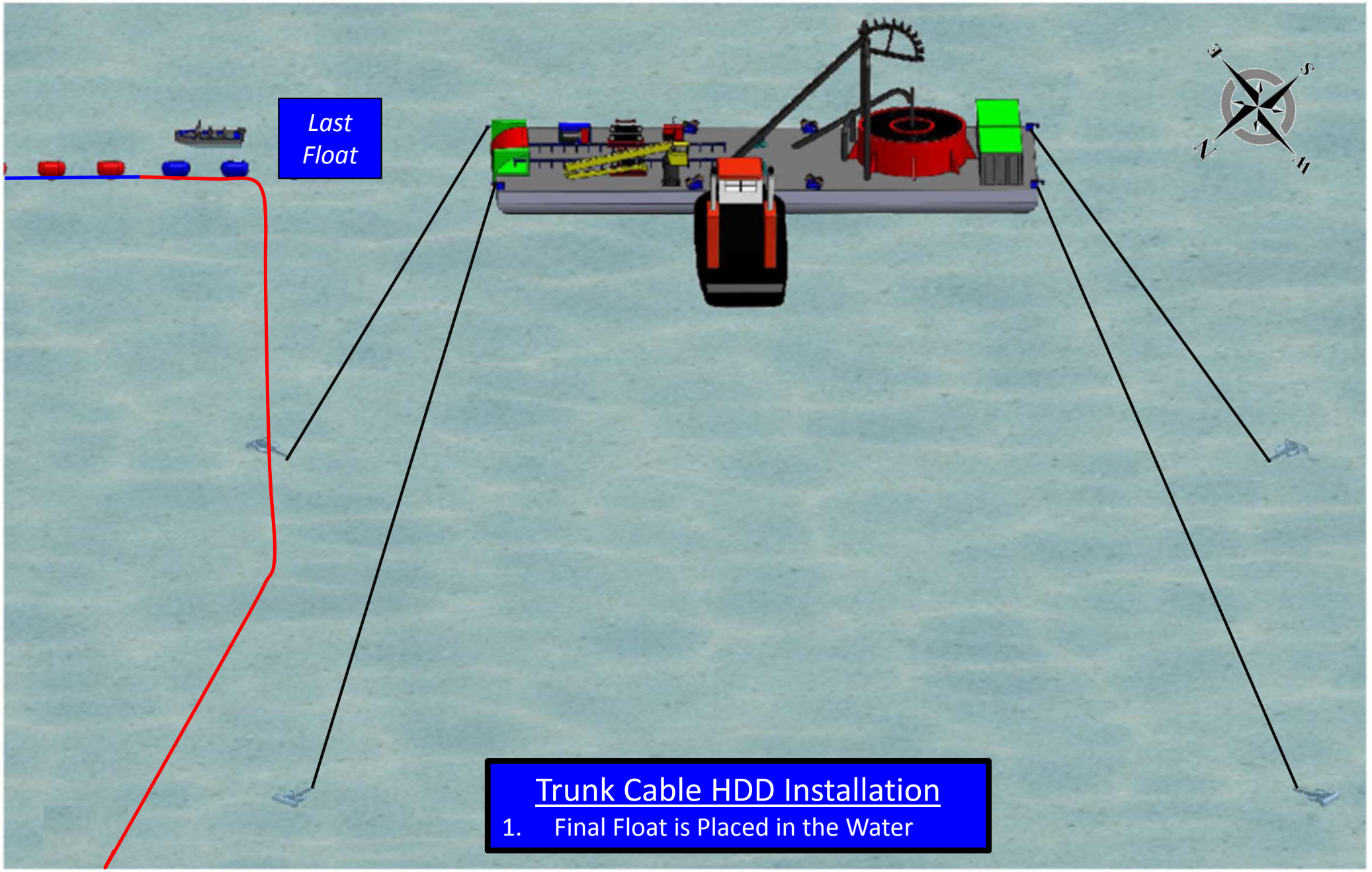
Trunk Cable HDD Installation

1. Trunk Cable End Loop is Maneuvered from the Pan & Chutes
2. Excess Trunk Cable in Bay is Being Pulled Through HDD Conduit
3. Floatation Buoys are Being Removed at HDD End

Cable Lay Plan

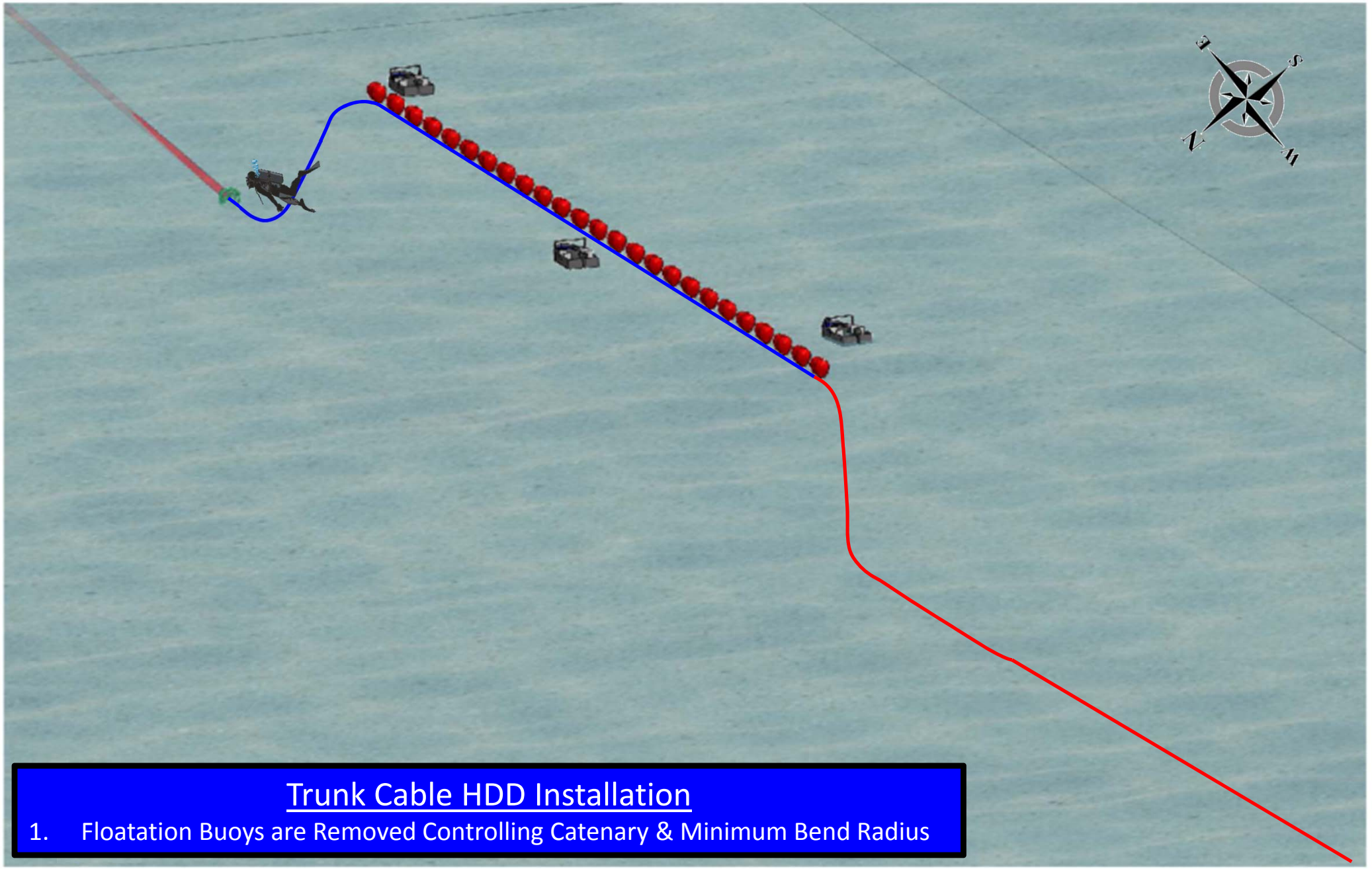


Cable Lay Plan

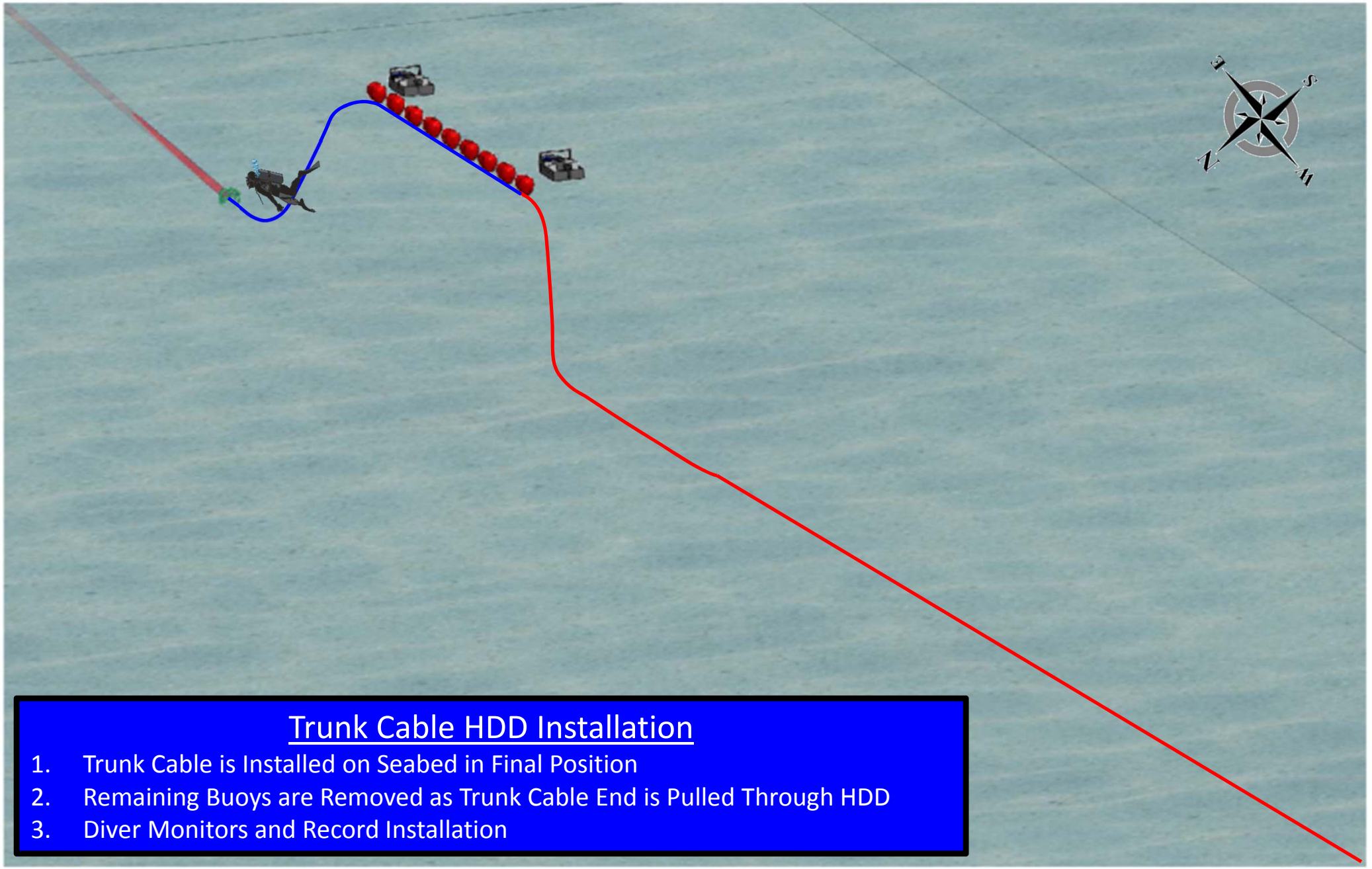


Cable Lay Plan

Cable Lay Plan



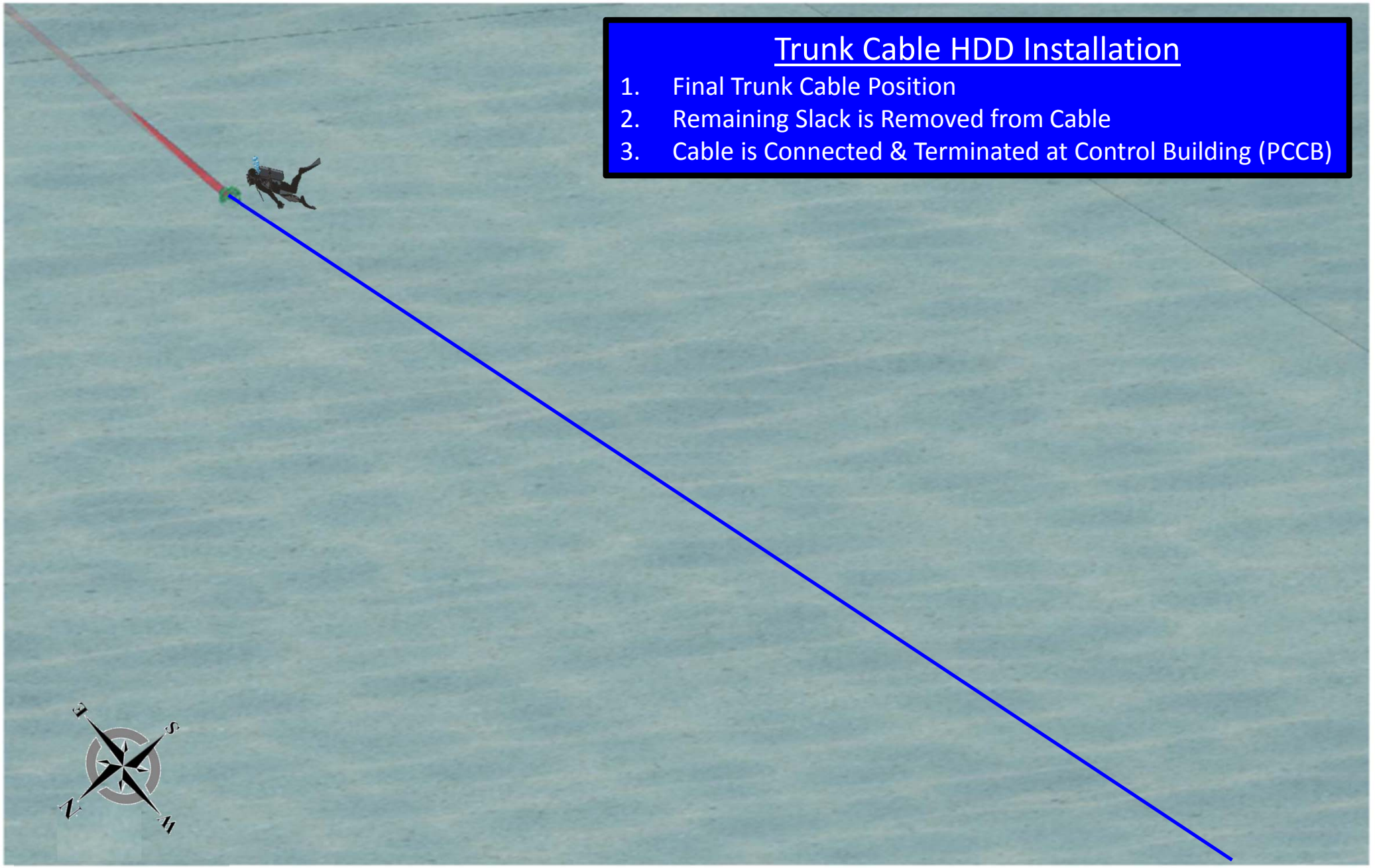
Cable Lay Plan



Trunk Cable HDD Installation

1. Trunk Cable is Installed on Seabed in Final Position
2. Remaining Buoys are Removed as Trunk Cable End is Pulled Through HDD
3. Diver Monitors and Record Installation

Cable Lay Plan



Cable Lay Plan

The Installation of West Turbine Trunk Cable Replicates the Procedure Shown.

Appendix C

TURBINE DEPLOYMENT STORYBOARD

Sound & Sea Technology
April 10, 2013

SnoPUD Tidal Energy Project

Tow Trialing & Turbine Deployment

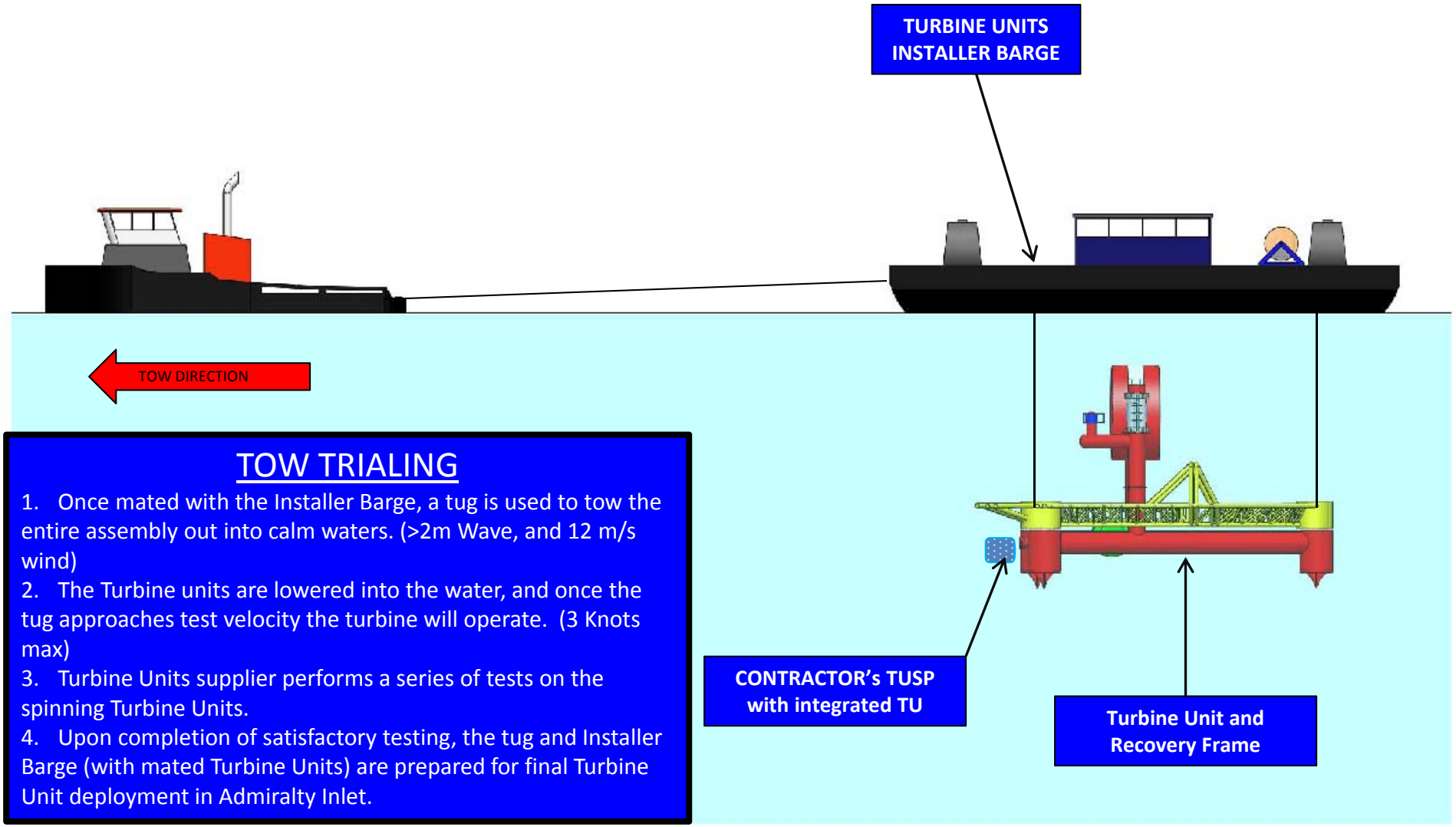
(By Others with CONTRACTOR observation)

April 10, 2013

Purpose: The purpose of this storyboard is to illustrate the conditions that the CONTRACTOR supplied TUSP, TU and associated equipment will be exposed to during the marine operations performed by the Turbine Units supplier.

TOW TRIALING

TOW TRIALING

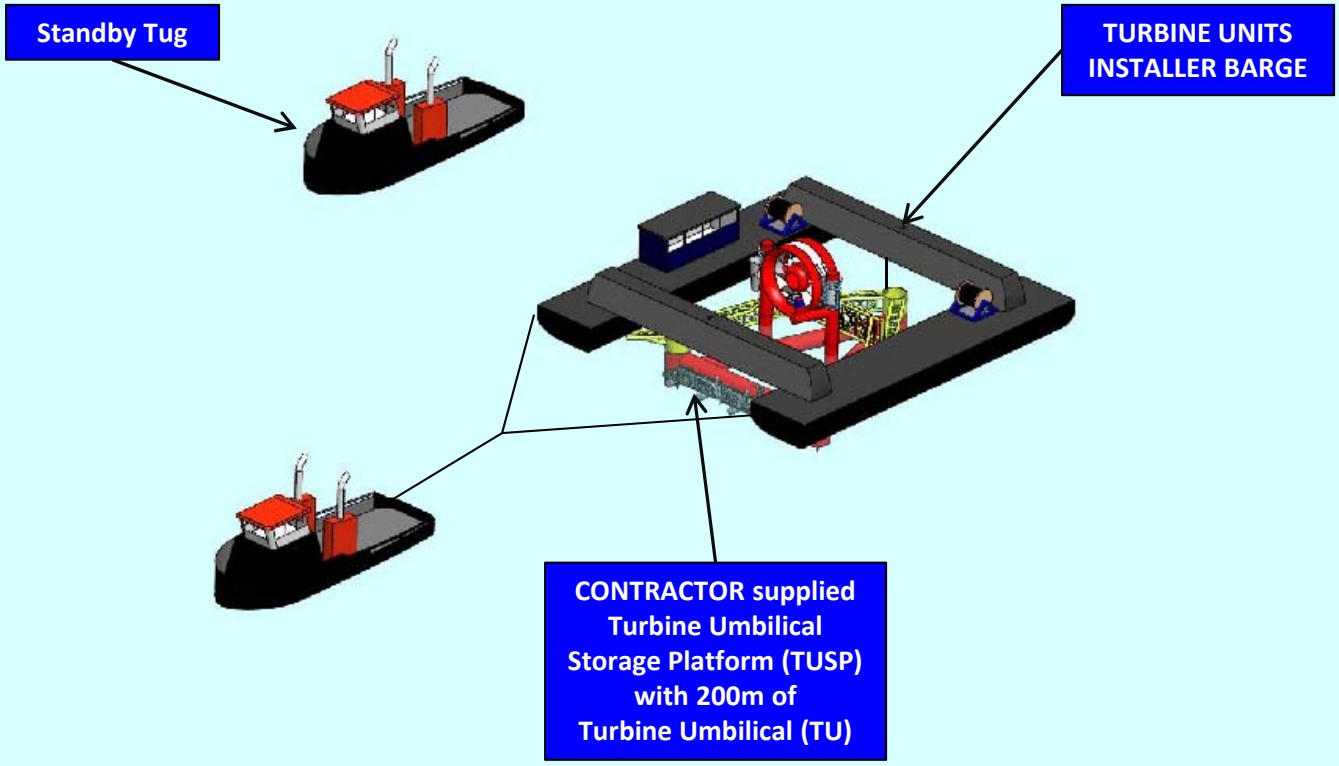


TOW TRIALING

1. Once mated with the Installer Barge, a tug is used to tow the entire assembly out into calm waters. (>2m Wave, and 12 m/s wind)
2. The Turbine units are lowered into the water, and once the tug approaches test velocity the turbine will operate. (3 Knots max)
3. Turbine Units supplier performs a series of tests on the spinning Turbine Units.
4. Upon completion of satisfactory testing, the tug and Installer Barge (with mated Turbine Units) are prepared for final Turbine Unit deployment in Admiralty Inlet.

TURBINE UNIT DEPLOYMENT

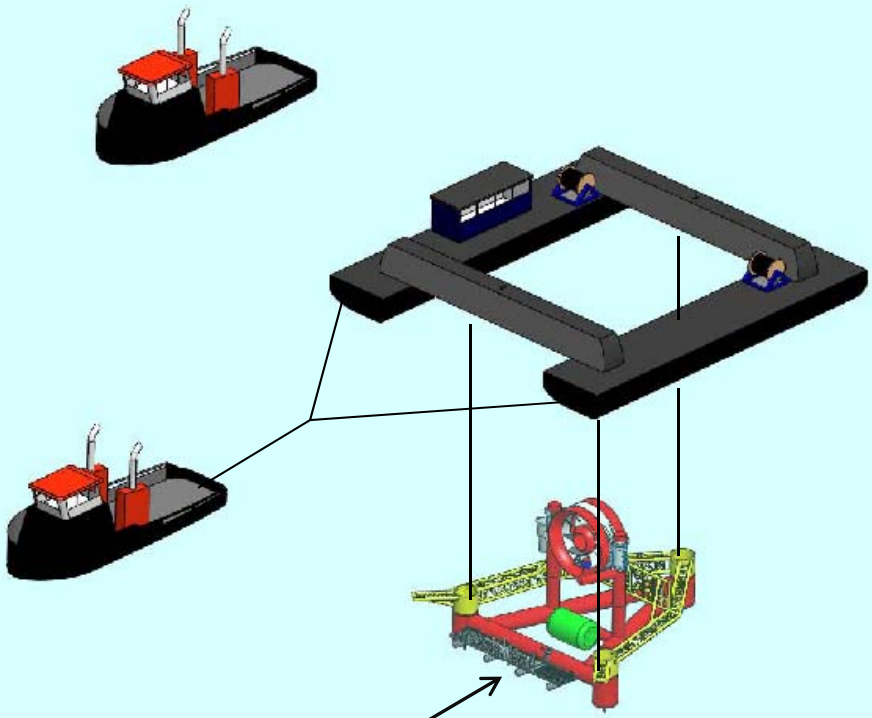
TURBINE UNIT DEPLOYMENT



TURBINE UNIT DEPLOYMENT

1. Tug tows the assembly to the Turbine Mobilization Site.
2. Upon arrival the tug performs a final positioning refinement while the crew aboard the Installer Barge prepares for deployment.

TURBINE UNIT DEPLOYMENT

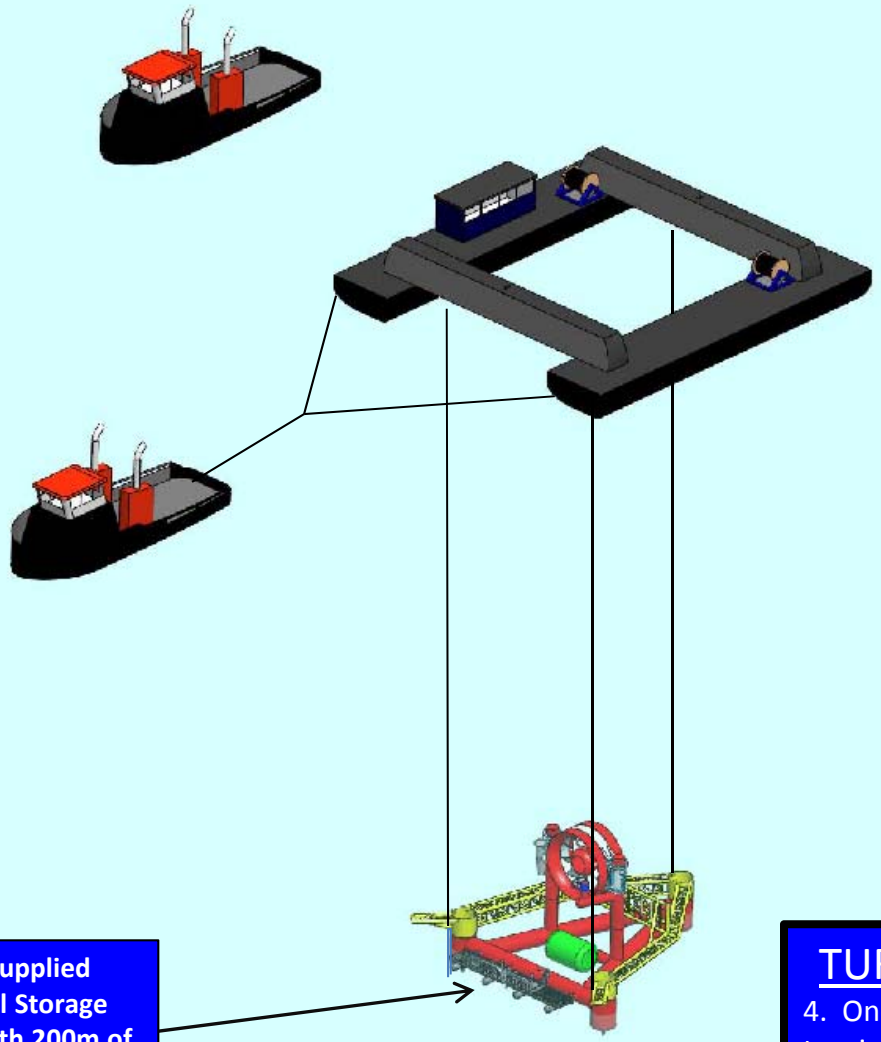


CONTRACTOR supplied Turbine Umbilical Storage Platform (TUSP) with 200m of Turbine Umbilical (TU)

TURBINE UNIT DEPLOYMENT

3. Crew onboard the Installer Barge lowers the Turbine Unit to the seafloor.

TURBINE UNIT DEPLOYMENT

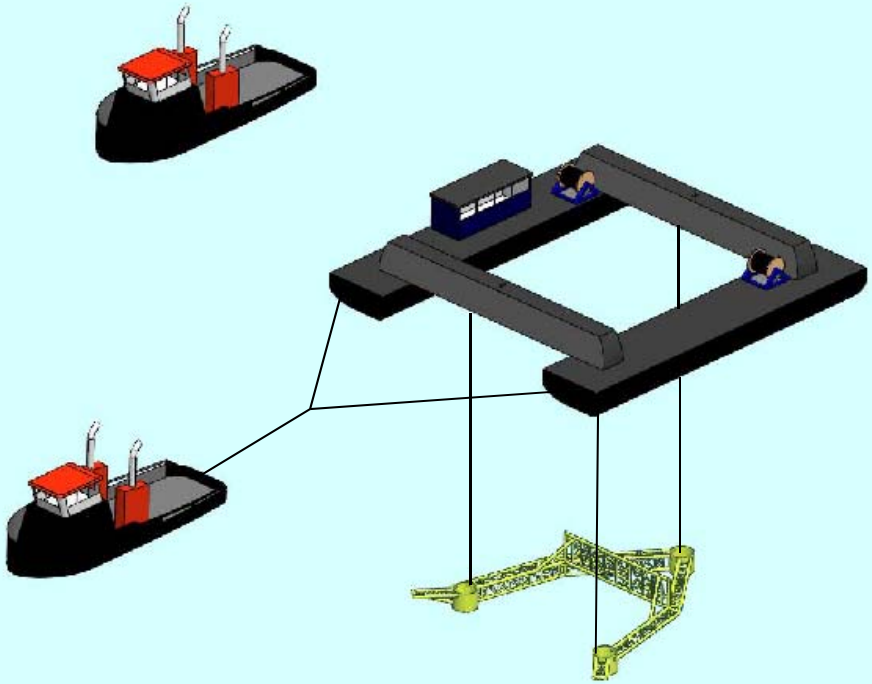


CONTRACTOR supplied Turbine Umbilical Storage Platform (TUSP) with 200m of Turbine Umbilical (TU)

TURBINE UNIT DEPLOYMENT

4. Once on the seafloor, crews slacken the tension on the winch cables until a series of checks are are performed

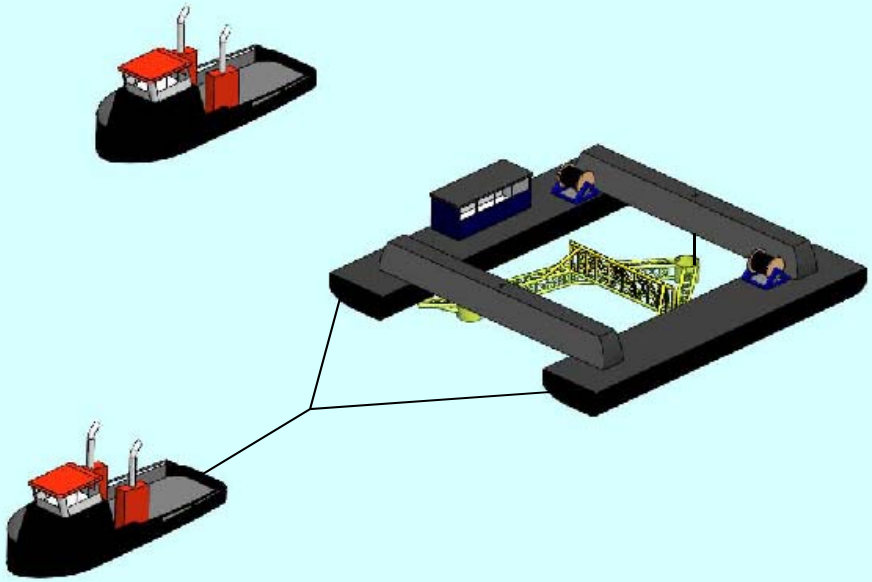
TURBINE UNIT DEPLOYMENT



TURBINE UNIT DEPLOYMENT

5. Upon successful check, the recovery frame is released from the Turbine Unit and brought back to mate with the Installer Barge.

TURBINE UNIT DEPLOYMENT



TURBINE UNIT DEPLOYMENT

6. Installer Barge and recovery frame are returned to the quayside.

Appendix D1

CABLE CONNECTION STORYBOARD

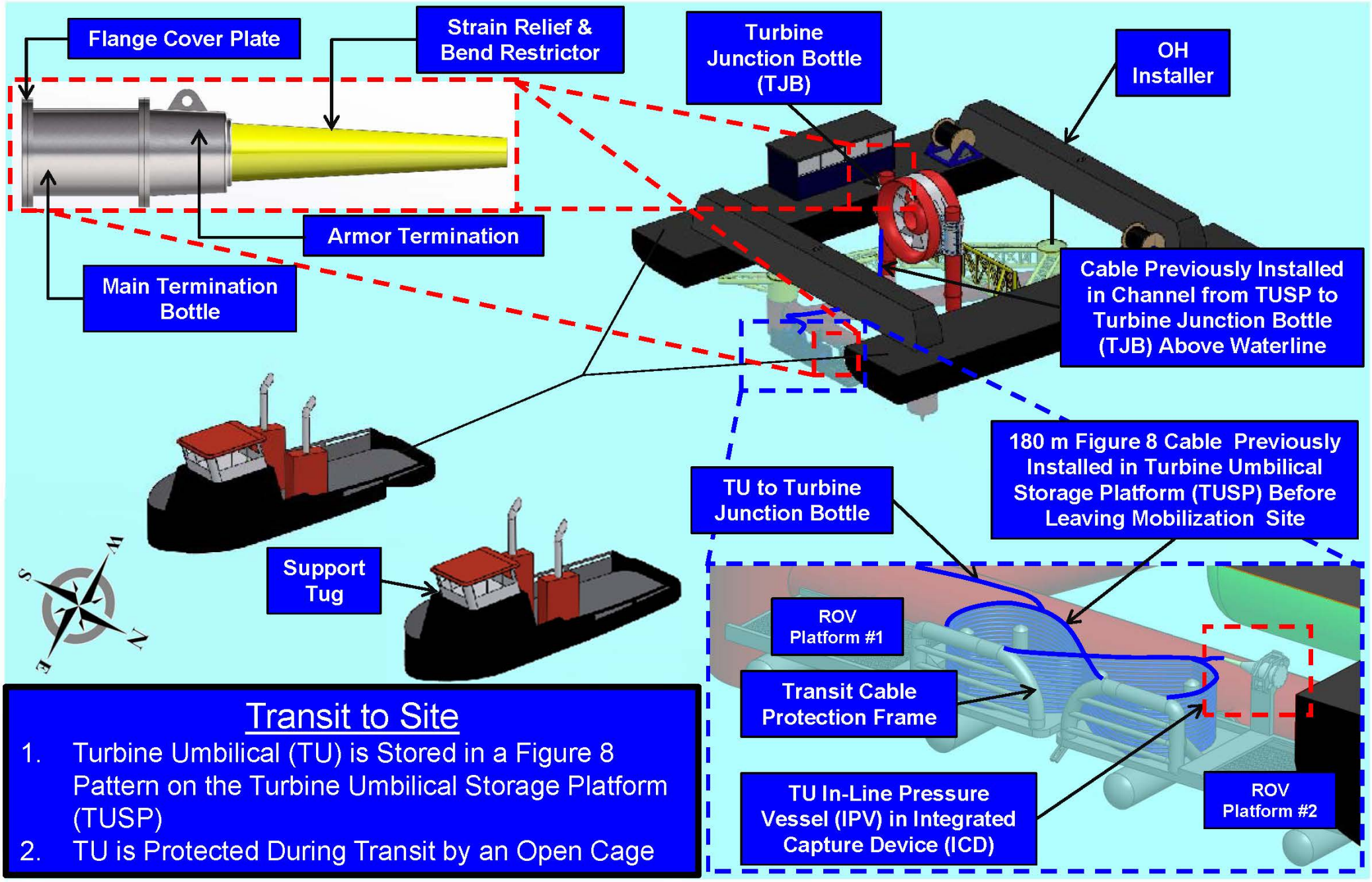
Sound & Sea Technology
March 23, 2013

Cable Connection Plan (CCP)

SnoPUD Tidal Energy Project

March 23, 2013

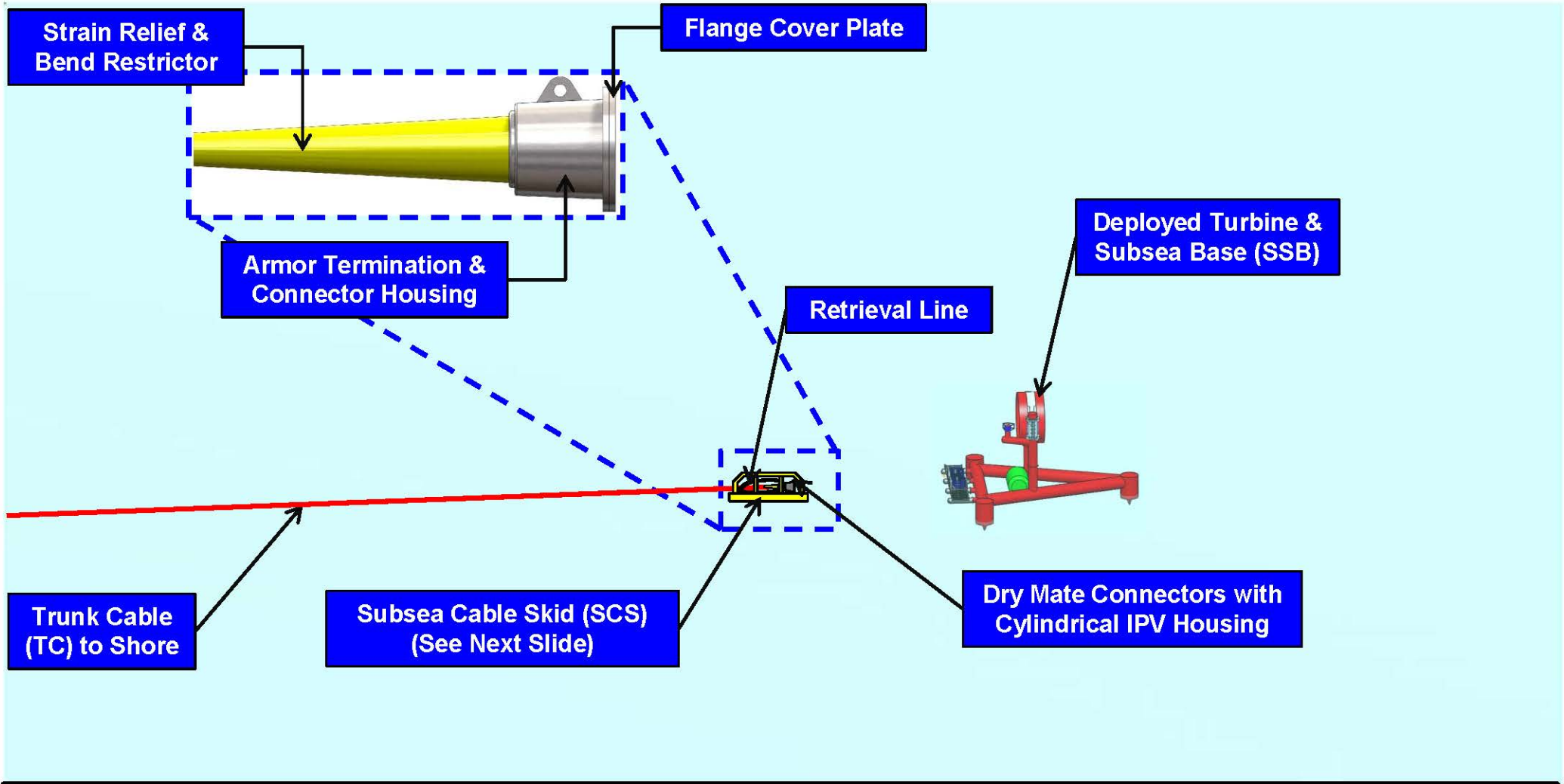
Cable Connection Plan



Transit to Site

1. Turbine Umbilical (TU) is Stored in a Figure 8 Pattern on the Turbine Umbilical Storage Platform (TUSP)
2. TU is Protected During Transit by an Open Cage

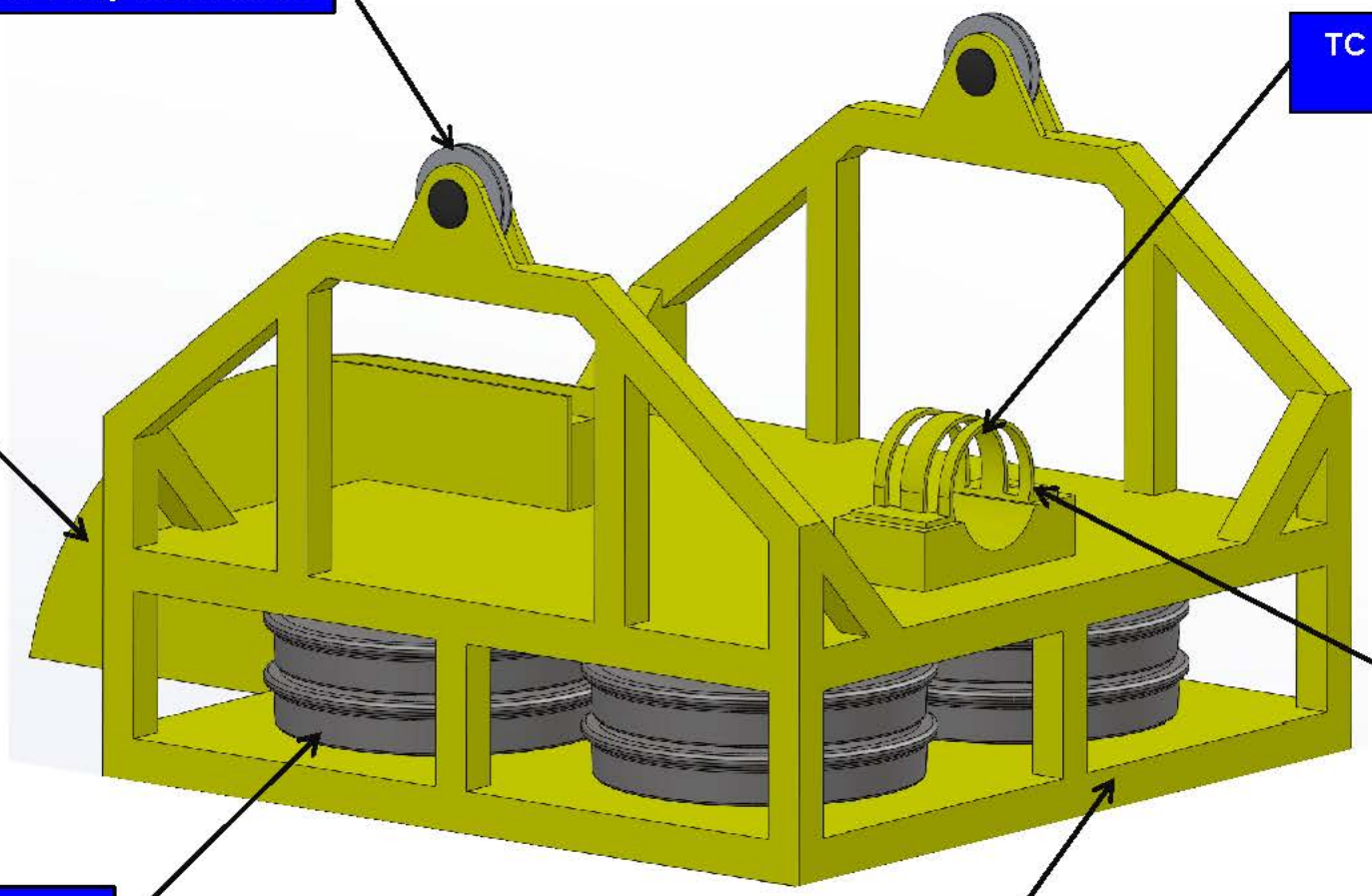
Cable Connection Plan



Turbine is Deployed

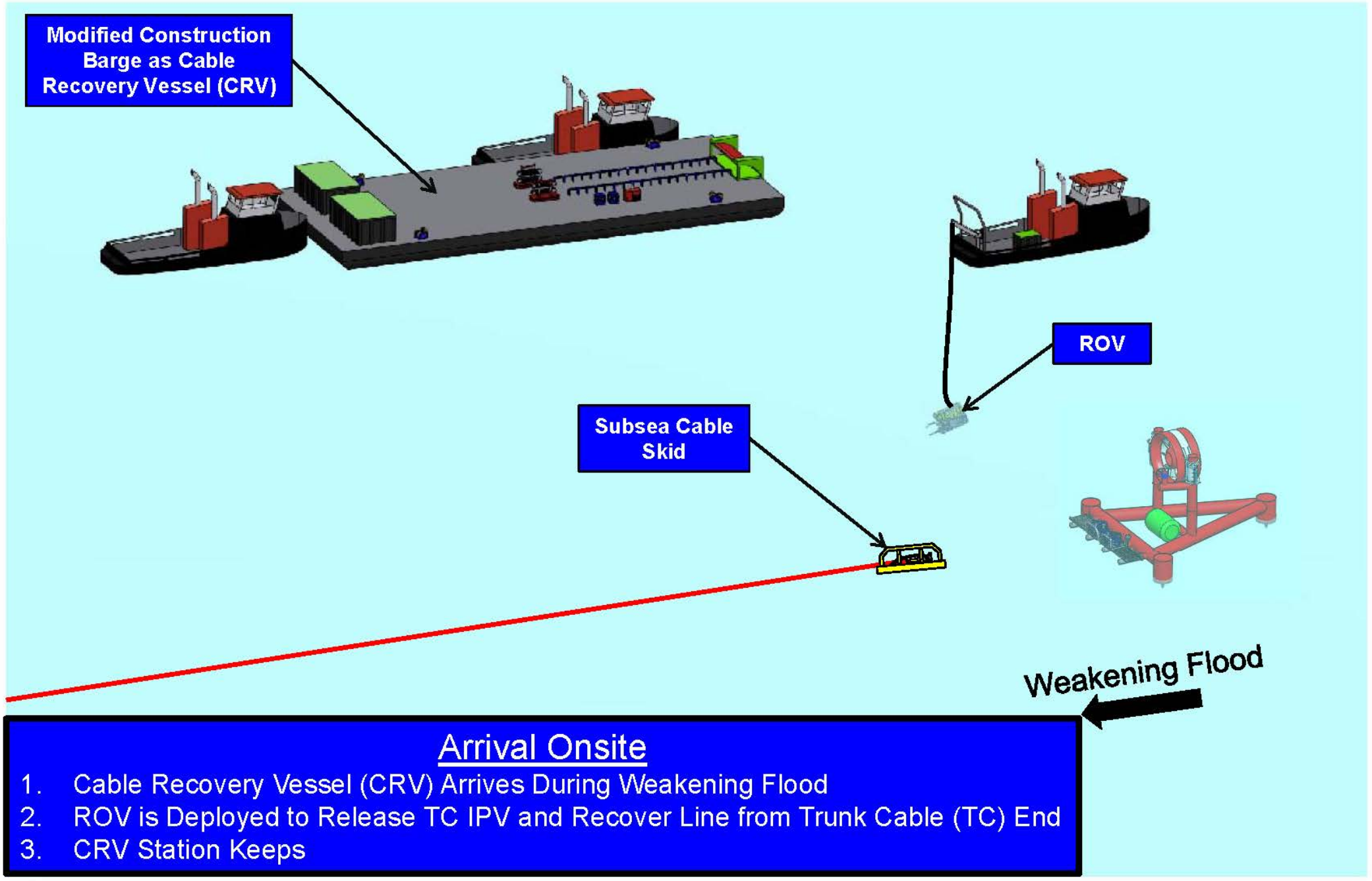
1. Main Export Cable is Previously Deployed on Subsea Cable Skid Near Turbine Site Before Deployment
2. Subsea Cable Skid Platform Secures Cable & TC In-Line Pressure Vessel (IPV) During Cable Lay
3. Turbine is Deployed ±5 Meters
4. Trunk Cable (TC) with Internally Protected Dry Mate Connectors and Strain Termination Secured on SCS.

Cable Connection Plan



Subsea Cable Skid (SCS) - Design Elements

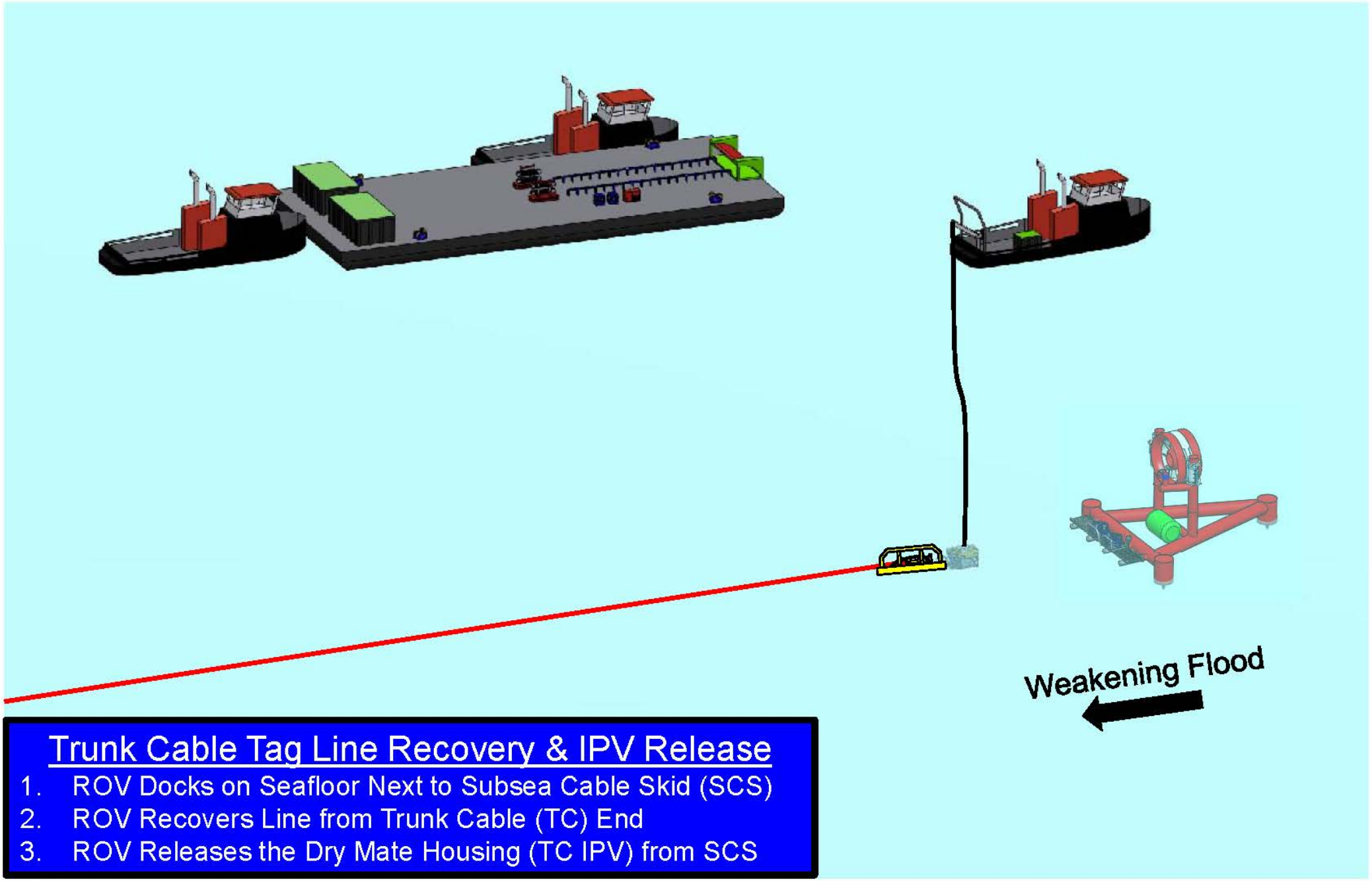
Cable Connection Plan



Arrival Onsite

1. Cable Recovery Vessel (CRV) Arrives During Weakening Flood
2. ROV is Deployed to Release TC IPV and Recover Line from Trunk Cable (TC) End
3. CRV Station Keeps

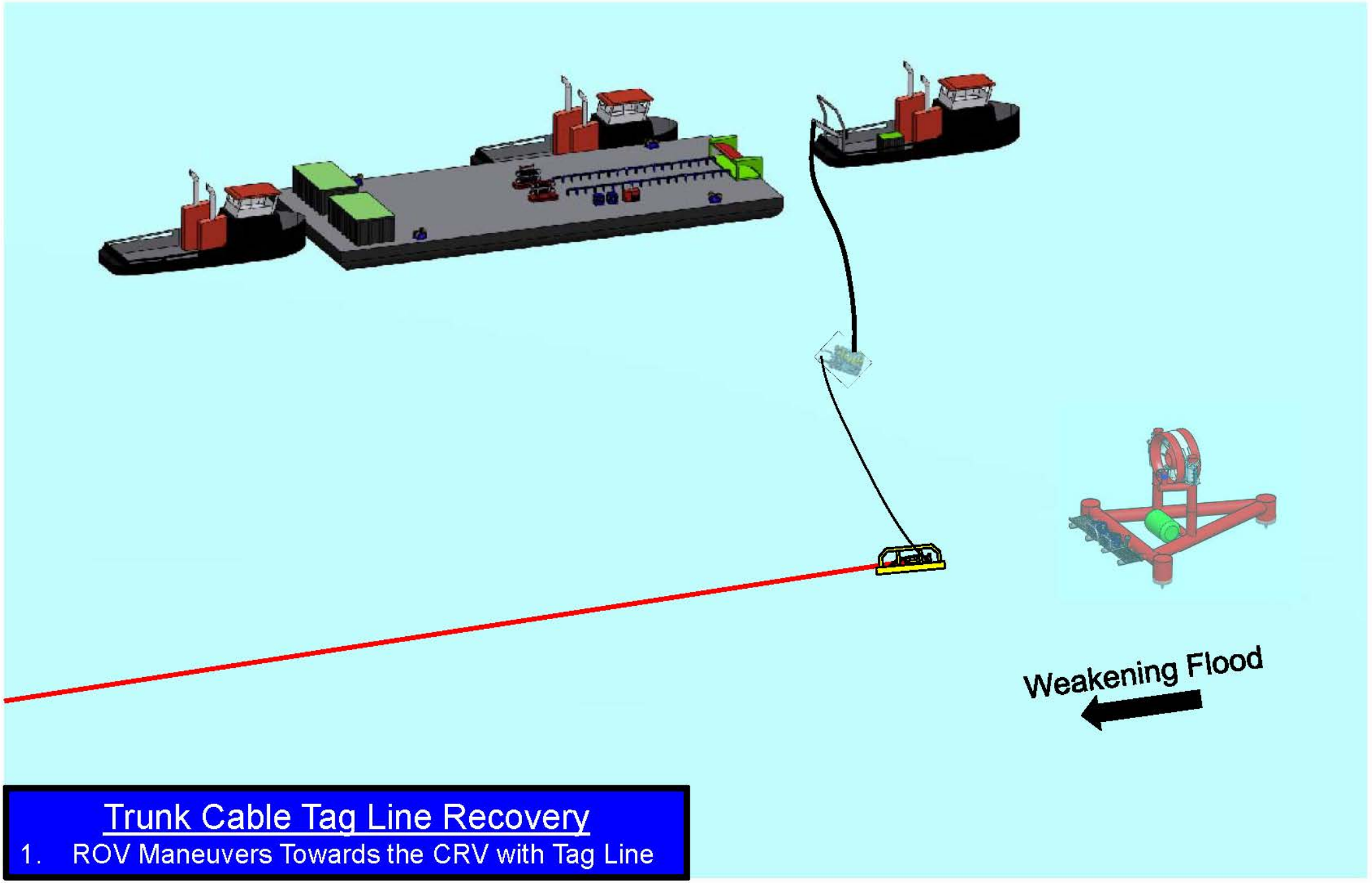
Cable Connection Plan



Trunk Cable Tag Line Recovery & IPV Release

1. ROV Docks on Seafloor Next to Subsea Cable Skid (SCS)
2. ROV Recovers Line from Trunk Cable (TC) End
3. ROV Releases the Dry Mate Housing (TC IPV) from SCS

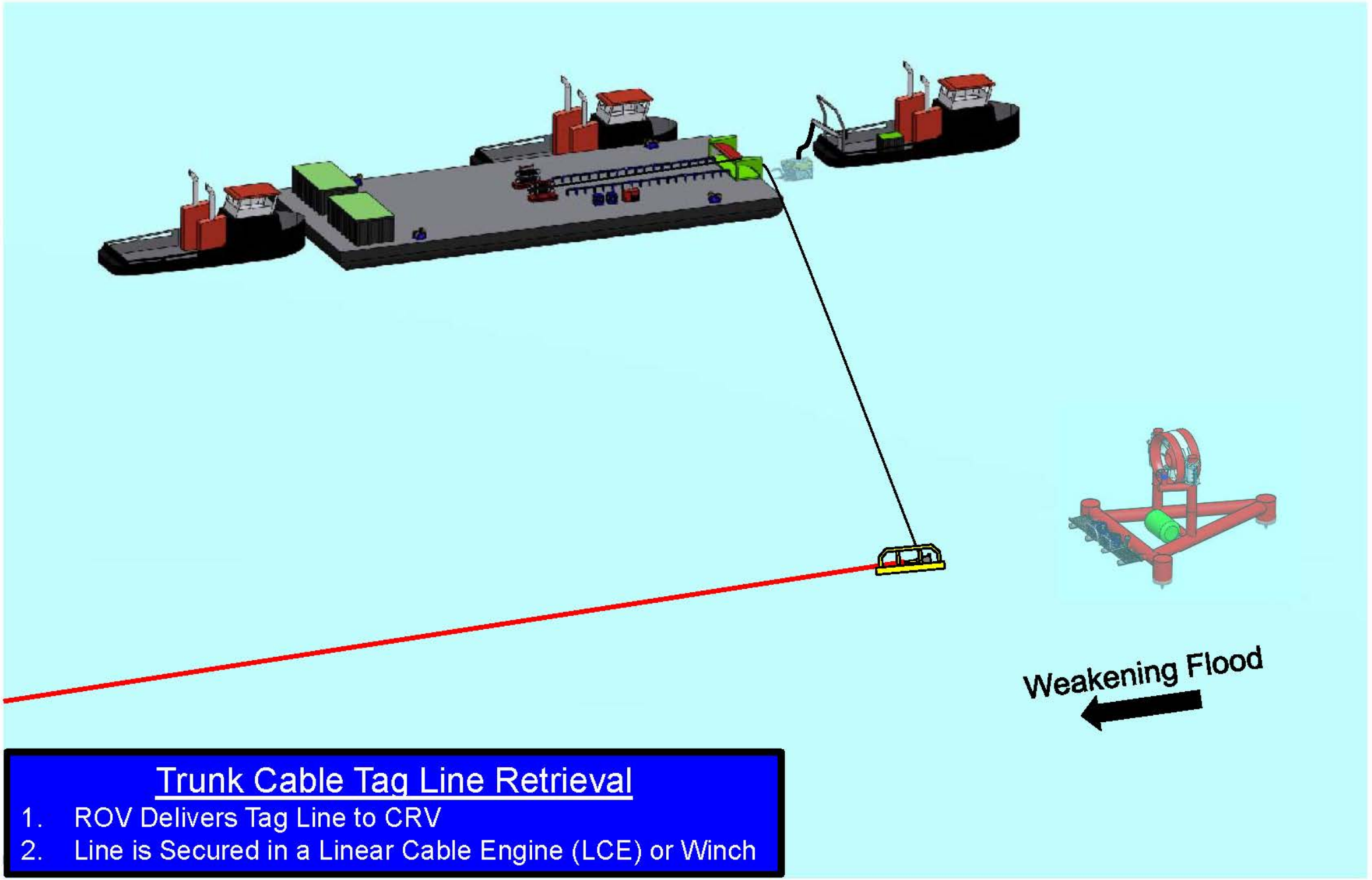
Cable Connection Plan



Trunk Cable Tag Line Recovery

1. ROV Maneuvers Towards the CRV with Tag Line

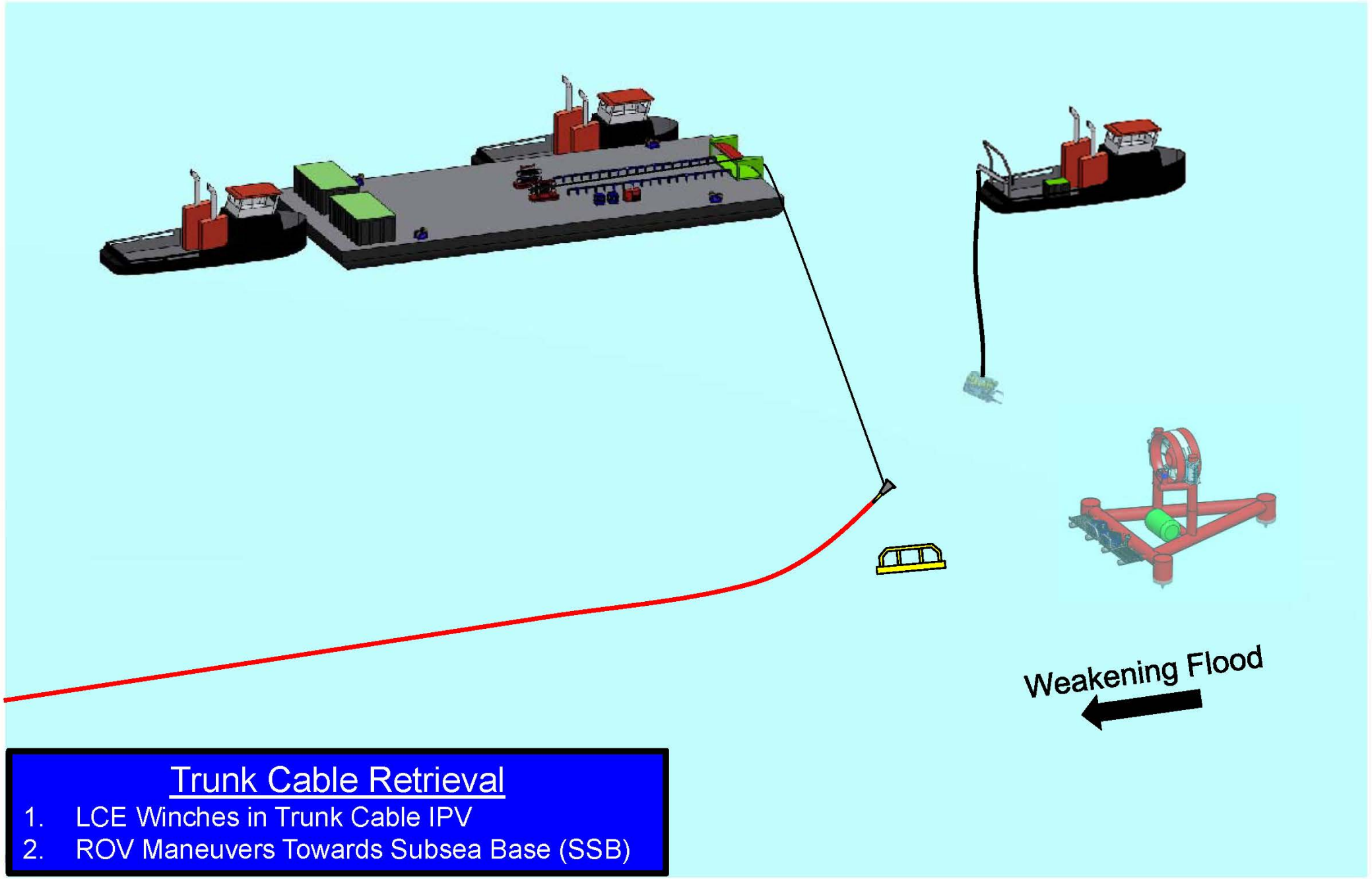
Cable Connection Plan



Trunk Cable Tag Line Retrieval

1. ROV Delivers Tag Line to CRV
2. Line is Secured in a Linear Cable Engine (LCE) or Winch

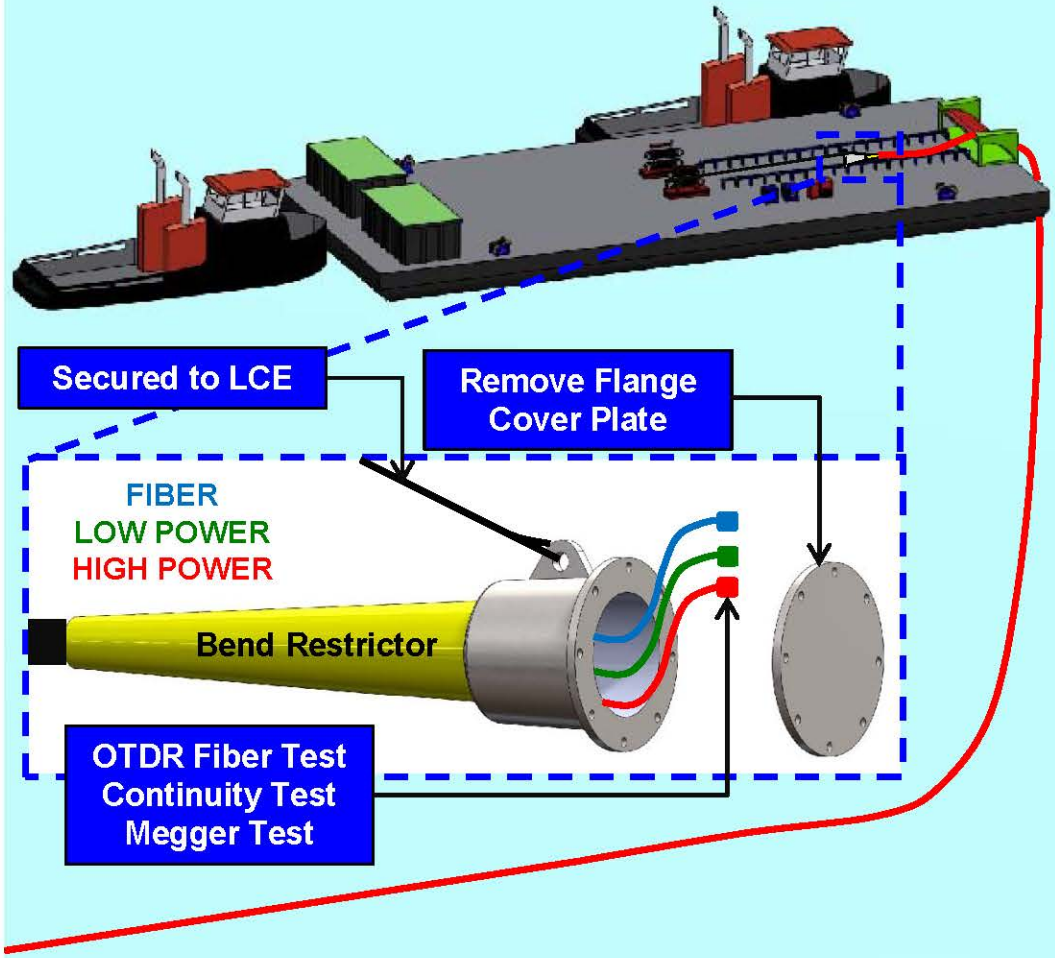
Cable Connection Plan

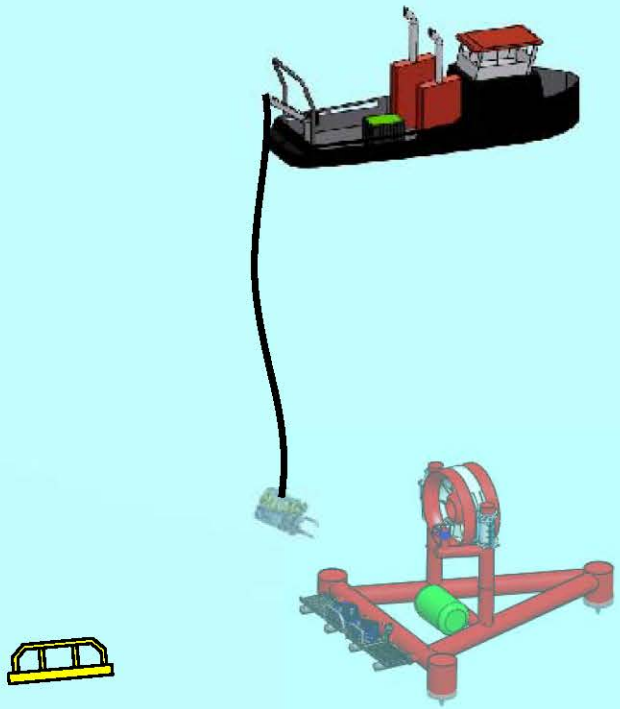


Trunk Cable Retrieval

1. LCE Winches in Trunk Cable IPV
2. ROV Maneuvers Towards Subsea Base (SSB)

Cable Connection Plan



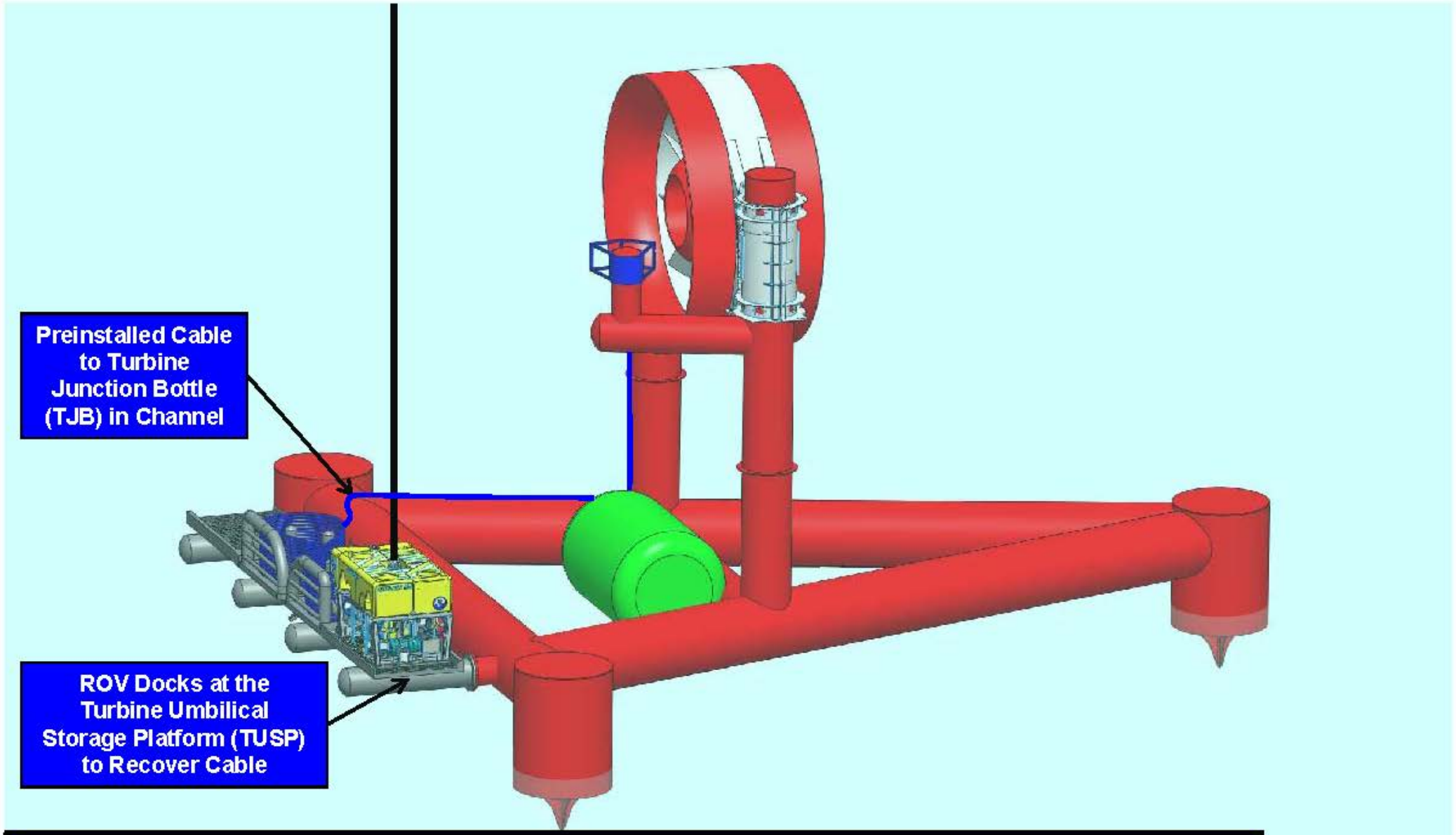


Weakening Flood

Trunk Cable Retrieval & Testing

1. The Trunk Cable IPV End is Secured Onboard the CRV
2. System Health Check is Performed on Trunk Cable using Dry Mate Connectors
3. Subsea Cable Skid Remains on Seafloor for Maximum of 60 days

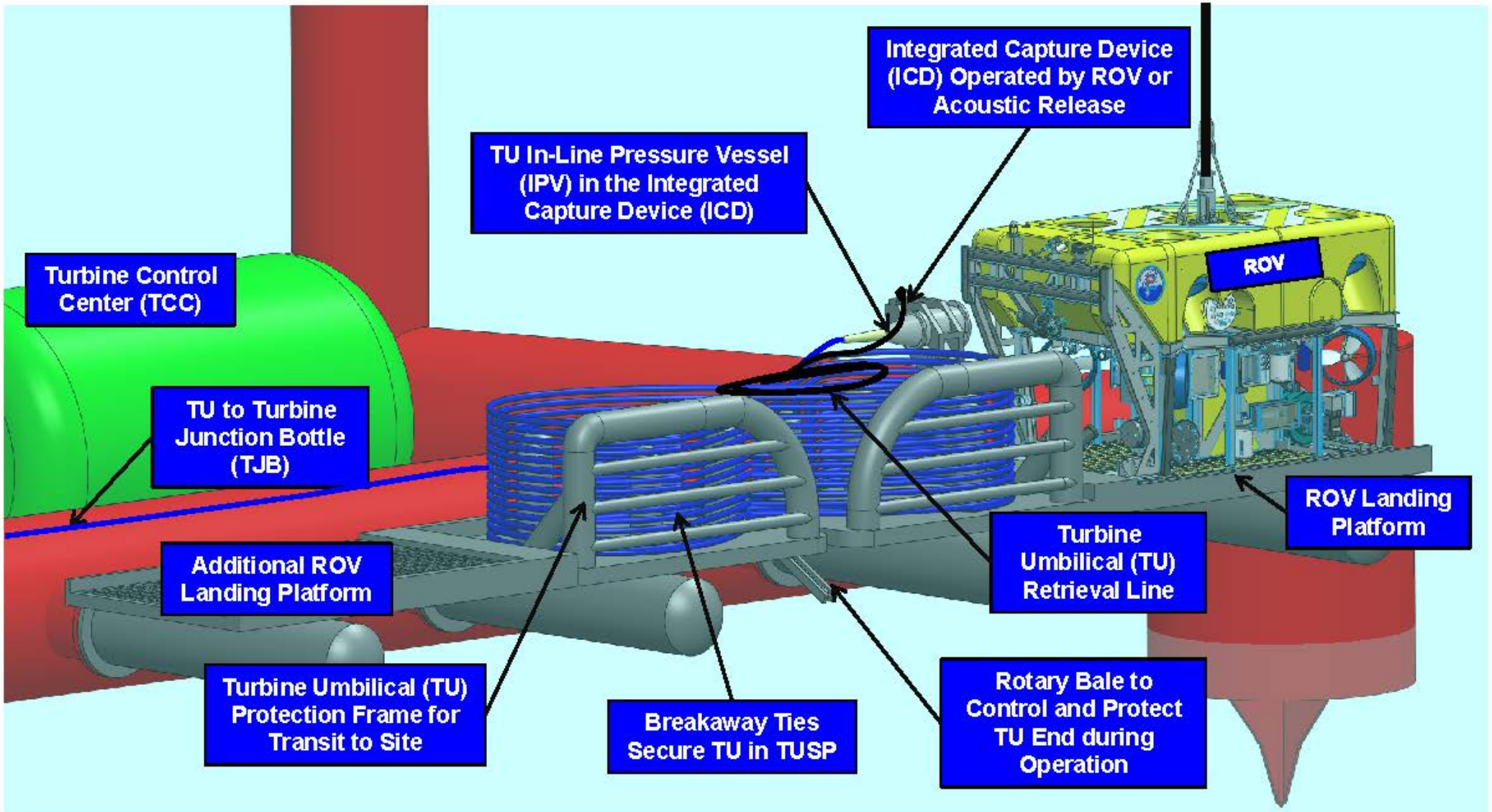
Cable Connection Plan



Turbine Umbilical (TU) Tag Line Retrieval

1. ROV Docks on the Turbine Umbilical Storage Platform (TUSP) at the Subsea Base (SSB)

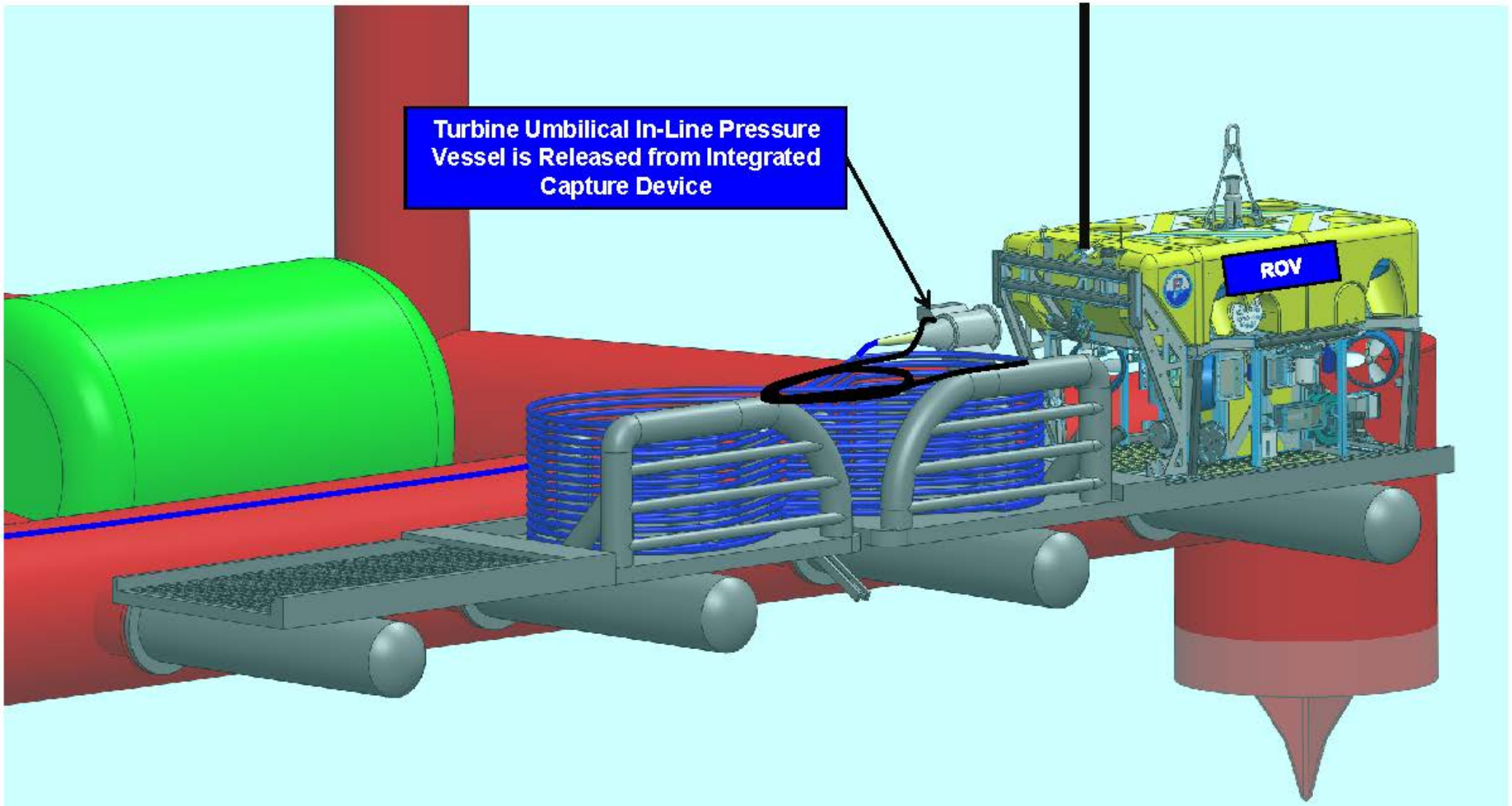
Cable Connection Plan



Turbine Umbilical (TU) Tag Line Retrieval

1. ROV Secures itself to the Turbine Umbilical Storage Platform (TUSP)
2. ROV Releases the TU IPV Integrated Capture Device (ICD)

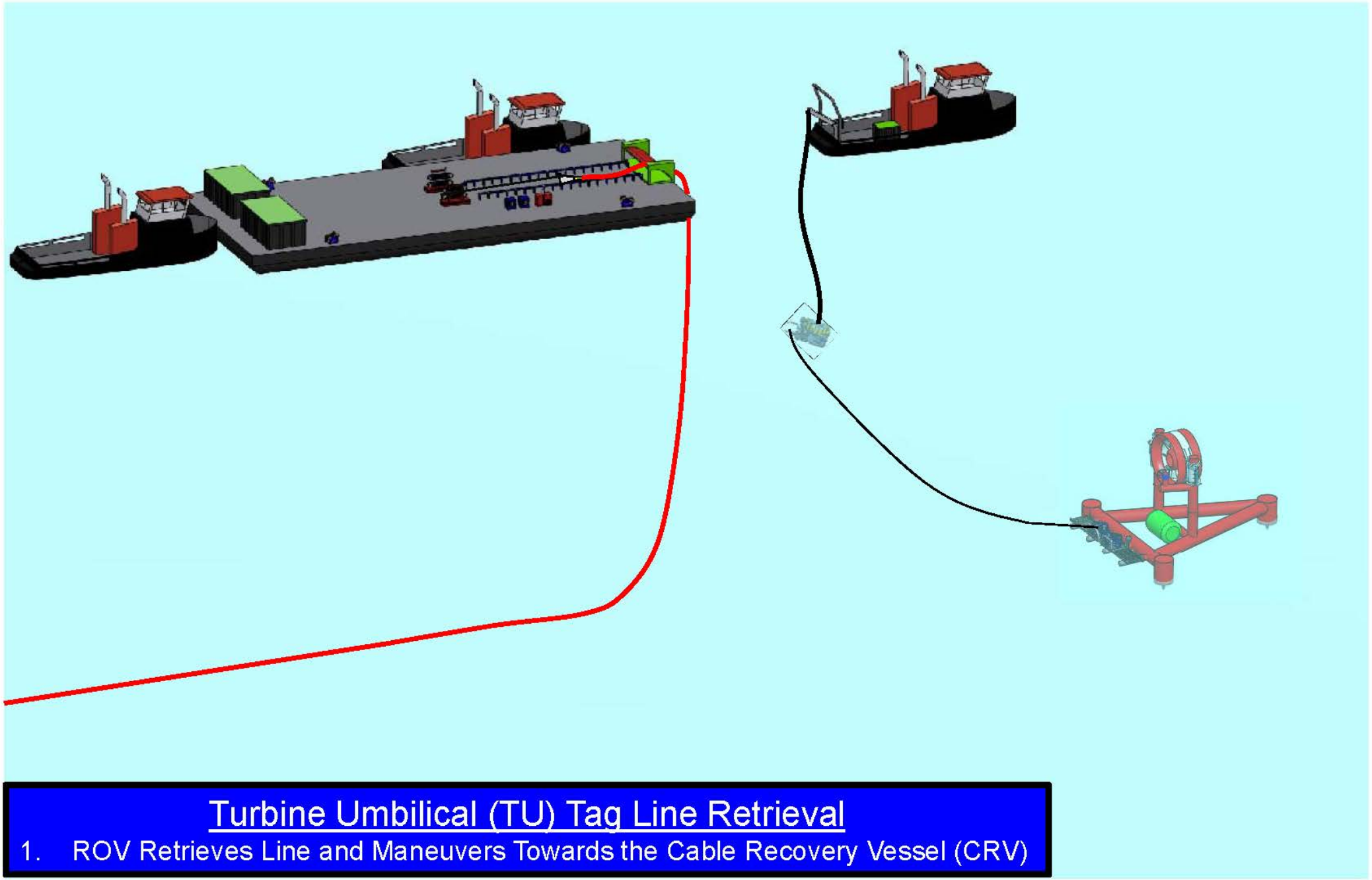
Cable Connection Plan



Turbine Umbilical (TU) Tag Line Retrieval

1. ROV Recovers a Tag Line from the Turbine Umbilical In-Line Pressure Vessel (TU IPV) on the TUSP

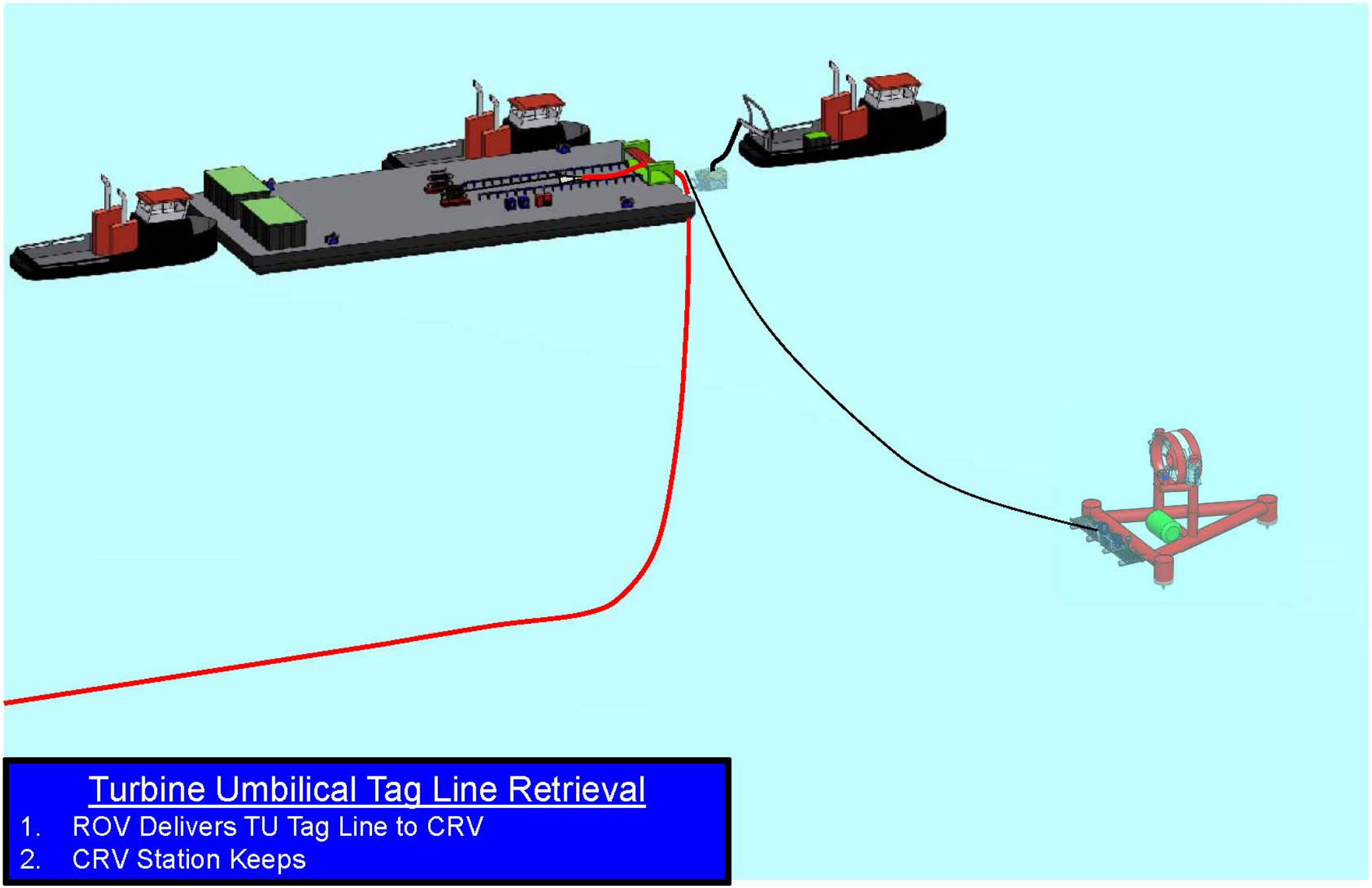
Cable Connection Plan



Turbine Umbilical (TU) Tag Line Retrieval

1. ROV Retrieves Line and Maneuvers Towards the Cable Recovery Vessel (CRV)

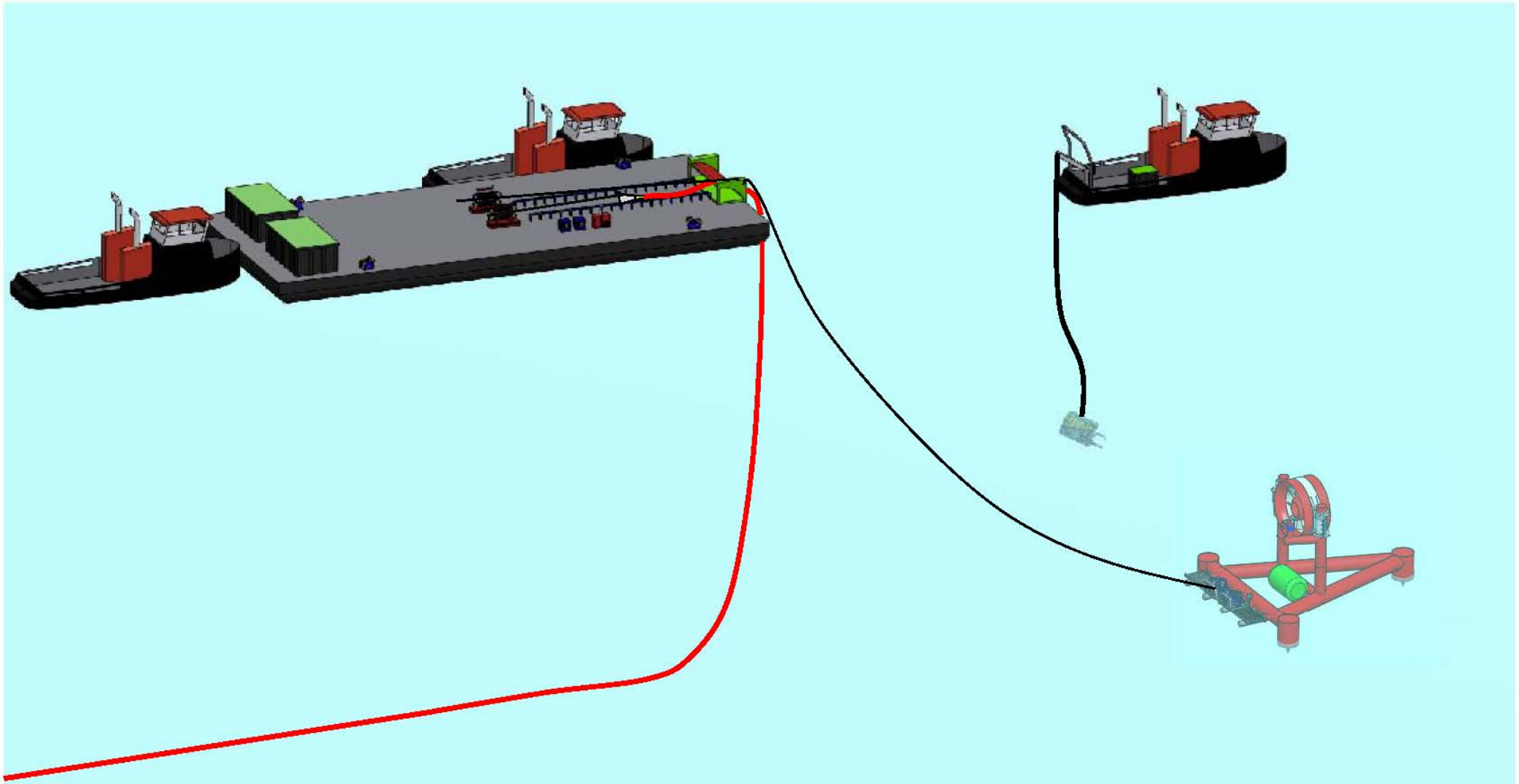
Cable Connection Plan



Turbine Umbilical Tag Line Retrieval

1. ROV Delivers TU Tag Line to CRV
2. CRV Station Keeps

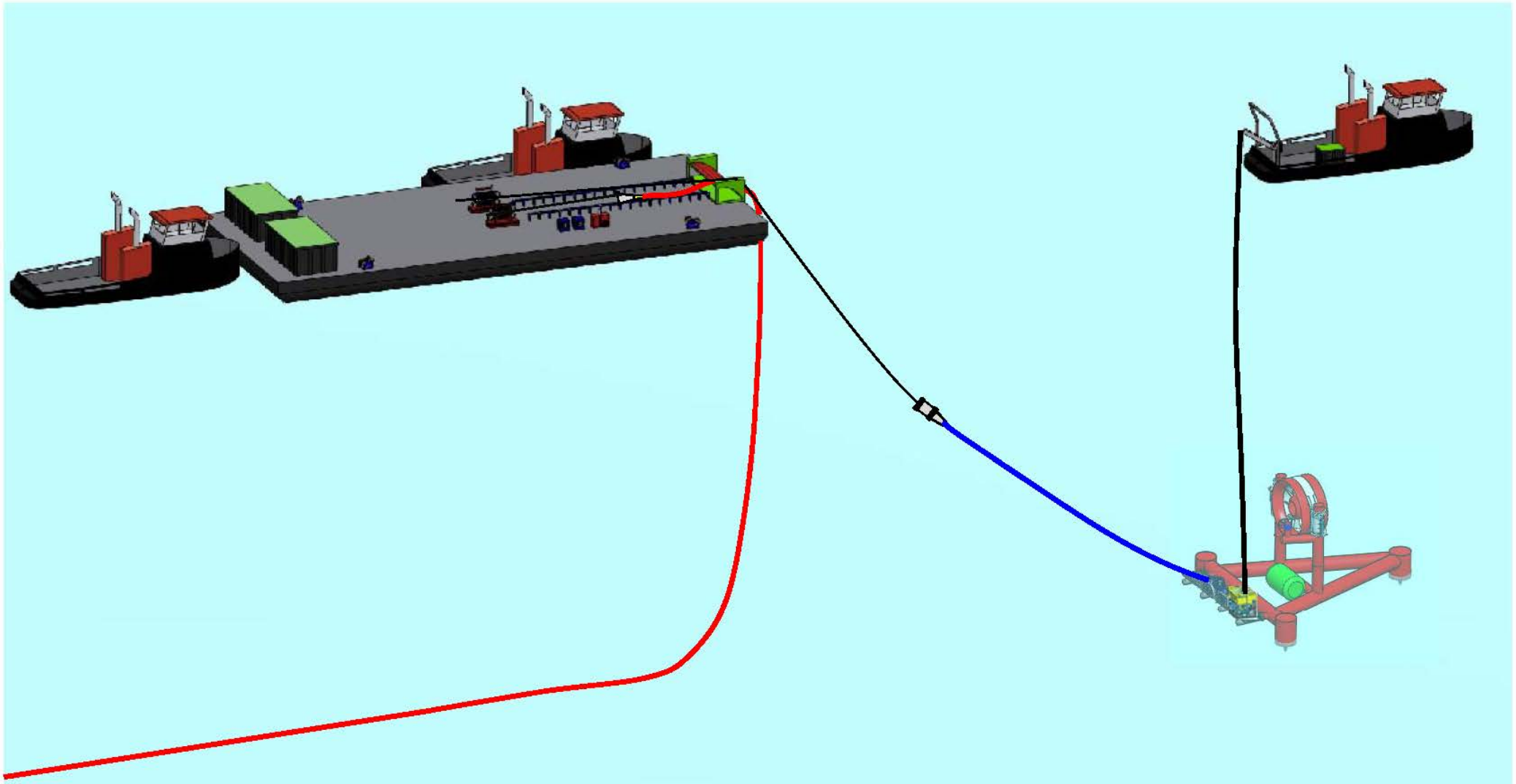
Cable Connection Plan



Turbine Umbilical (TU) Retrieval

1. TU Tag Line is Secured in LCE or Onboard Winch
2. ROV Maneuvers Back Towards Subsea Base (SSB) to Monitor Recovery

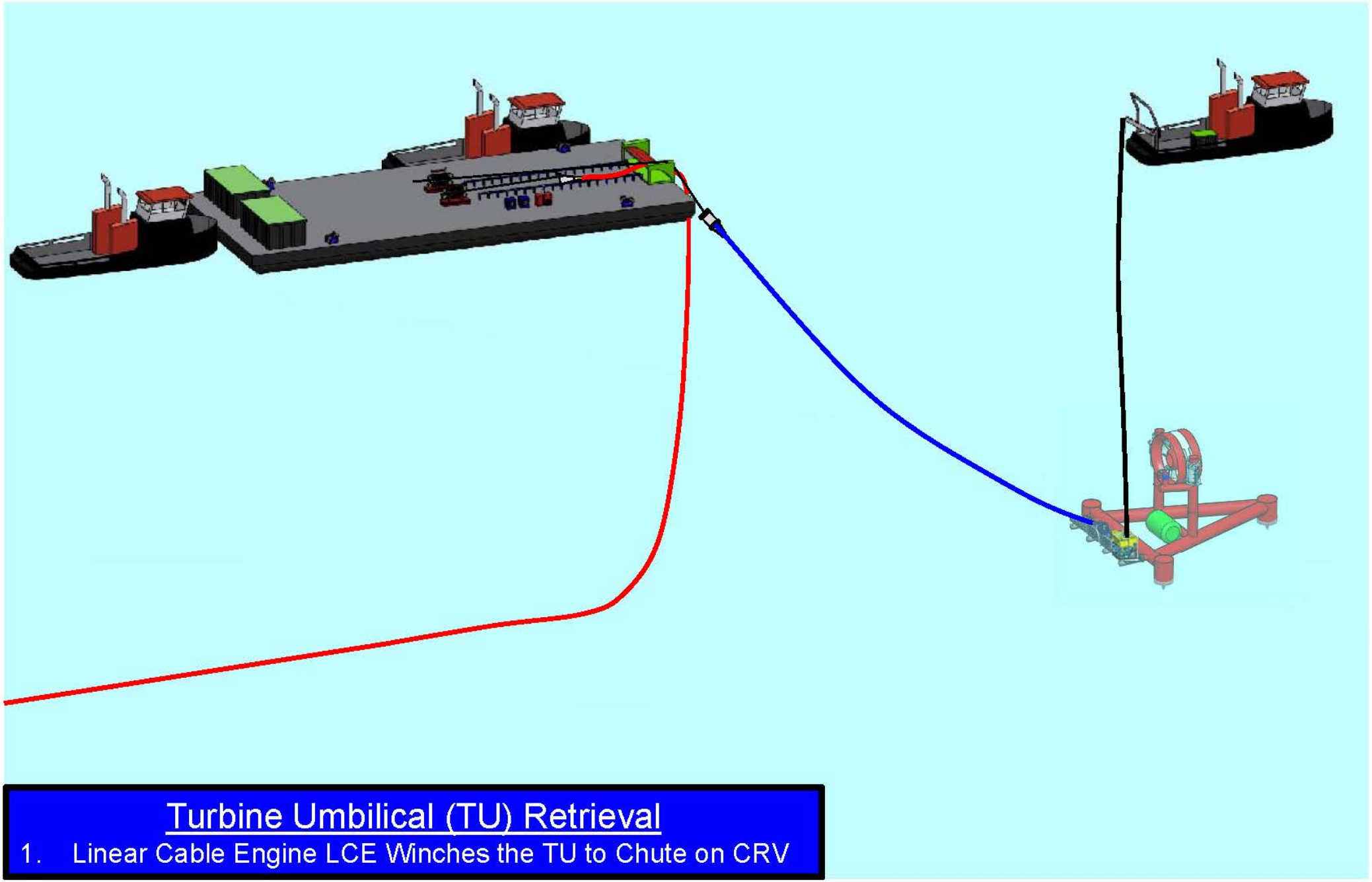
Cable Connection Plan



Turbine Umbilical (TU) Retrieval

1. LCE Winches Turbine Umbilical Towards CRV
2. ROV Docks on the TUSP at the Subsea Base (SSB) & Monitors the TU Recovery

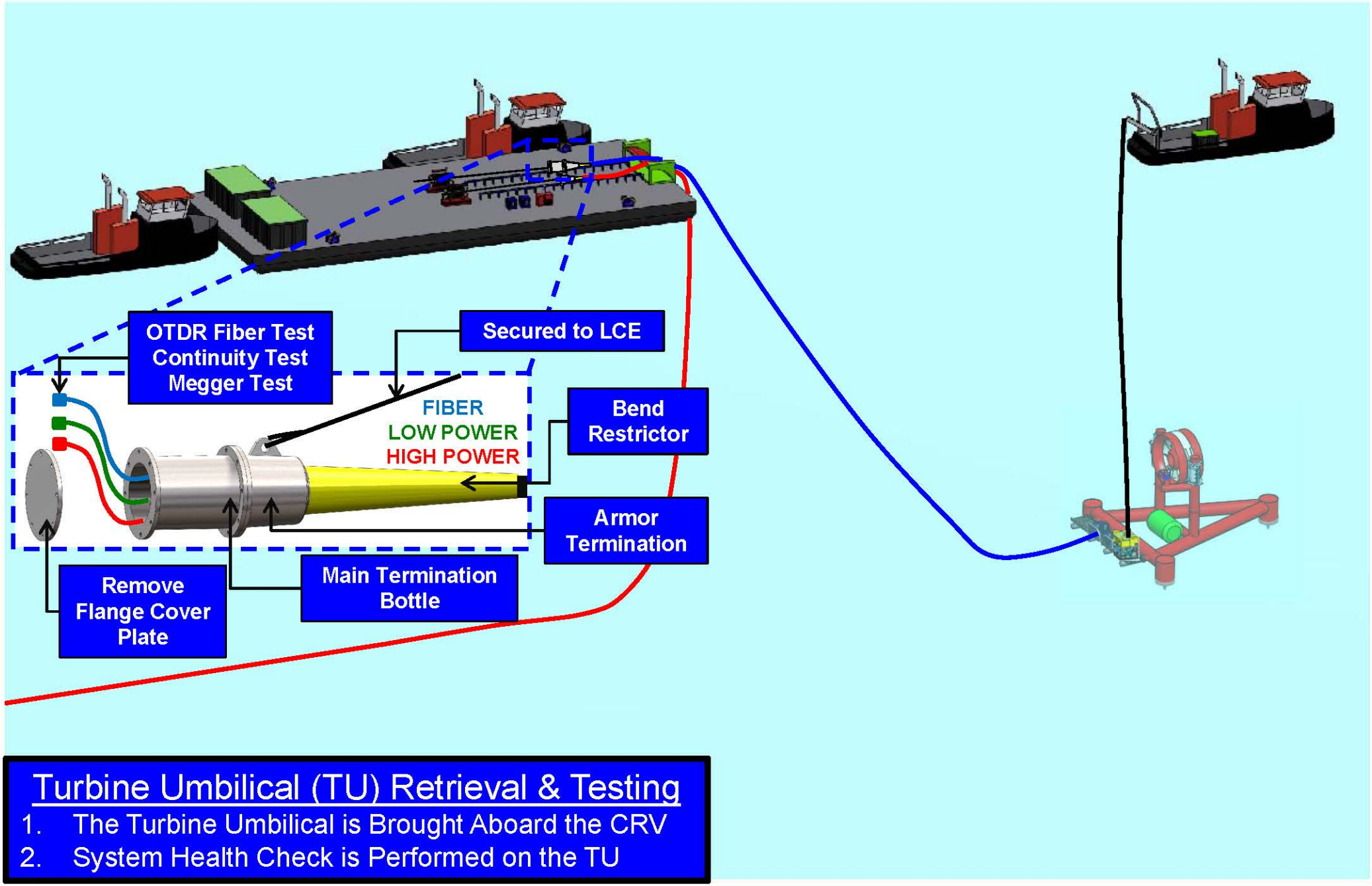
Cable Connection Plan



Turbine Umbilical (TU) Retrieval

1. Linear Cable Engine LCE Winches the TU to Chute on CRV

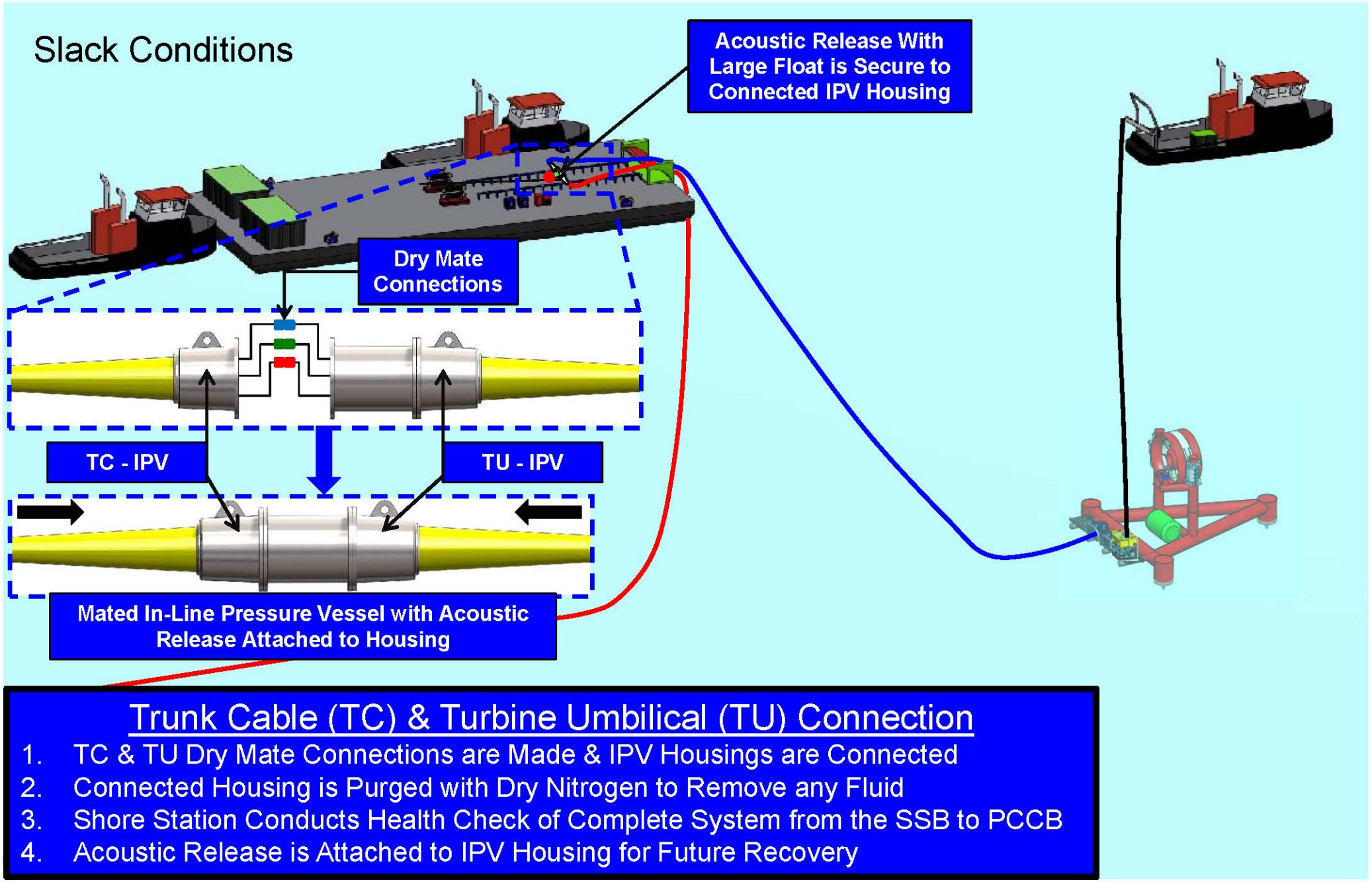
Cable Connection Plan



Turbine Umbilical (TU) Retrieval & Testing

1. The Turbine Umbilical is Brought Aboard the CRV
2. System Health Check is Performed on the TU

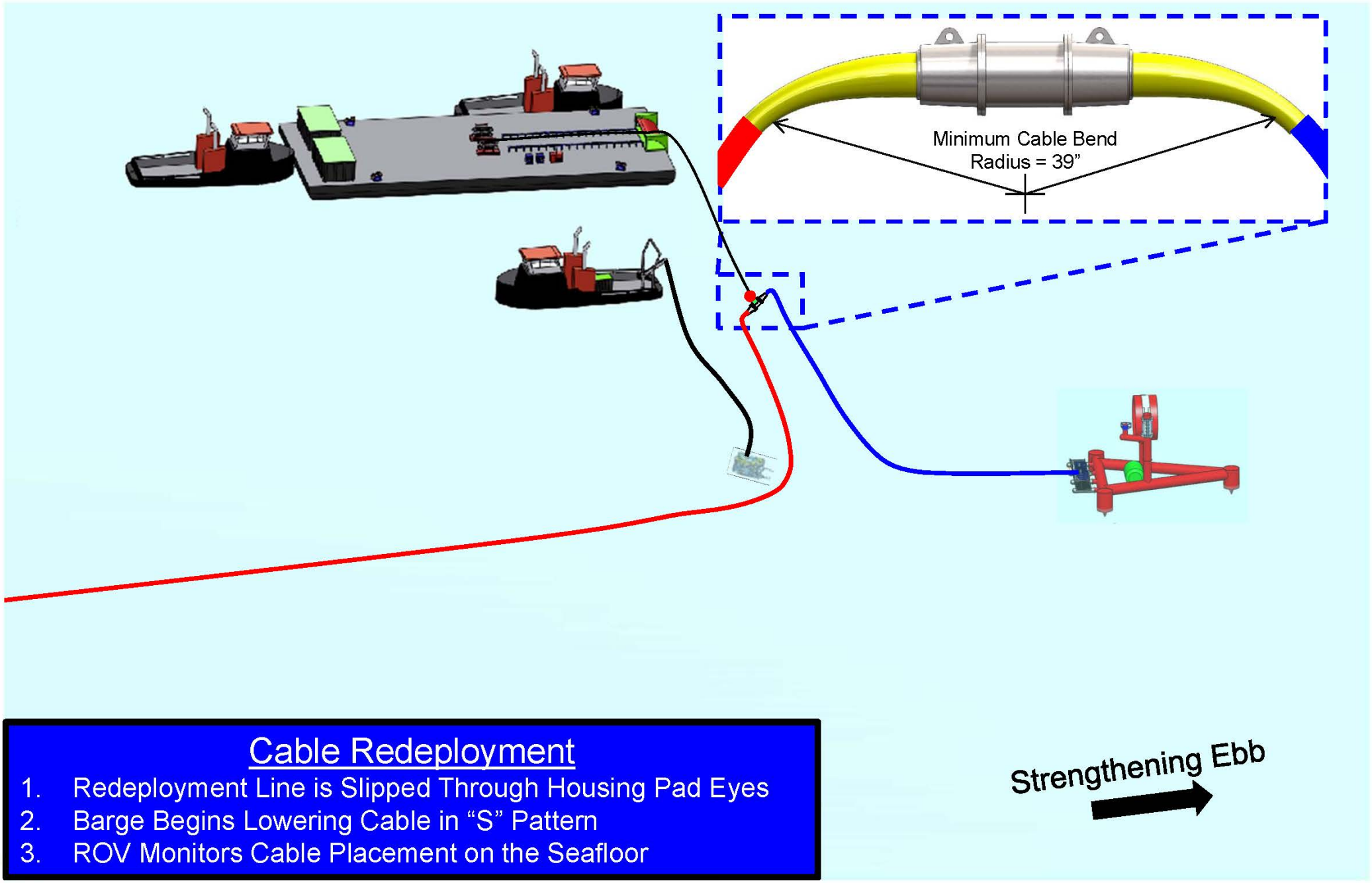
Cable Connection Plan



Trunk Cable (TC) & Turbine Umbilical (TU) Connection

1. TC & TU Dry Mate Connections are Made & IPV Housings are Connected
2. Connected Housing is Purged with Dry Nitrogen to Remove any Fluid
3. Shore Station Conducts Health Check of Complete System from the SSB to PCCB
4. Acoustic Release is Attached to IPV Housing for Future Recovery

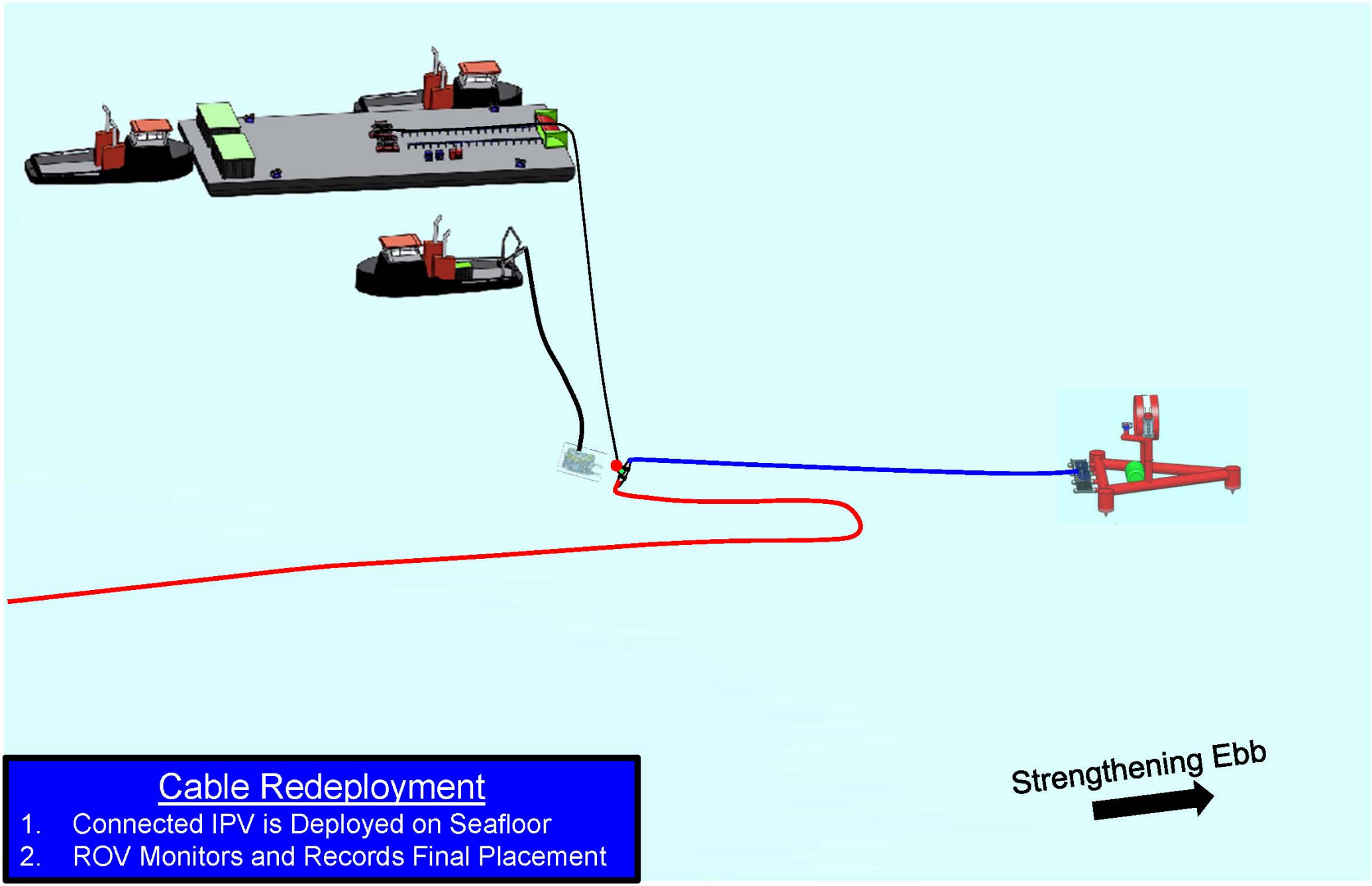
Cable Connection Plan



Cable Redeployment

1. Redeployment Line is Slipped Through Housing Pad Eyes
2. Barge Begins Lowering Cable in “S” Pattern
3. ROV Monitors Cable Placement on the Seafloor

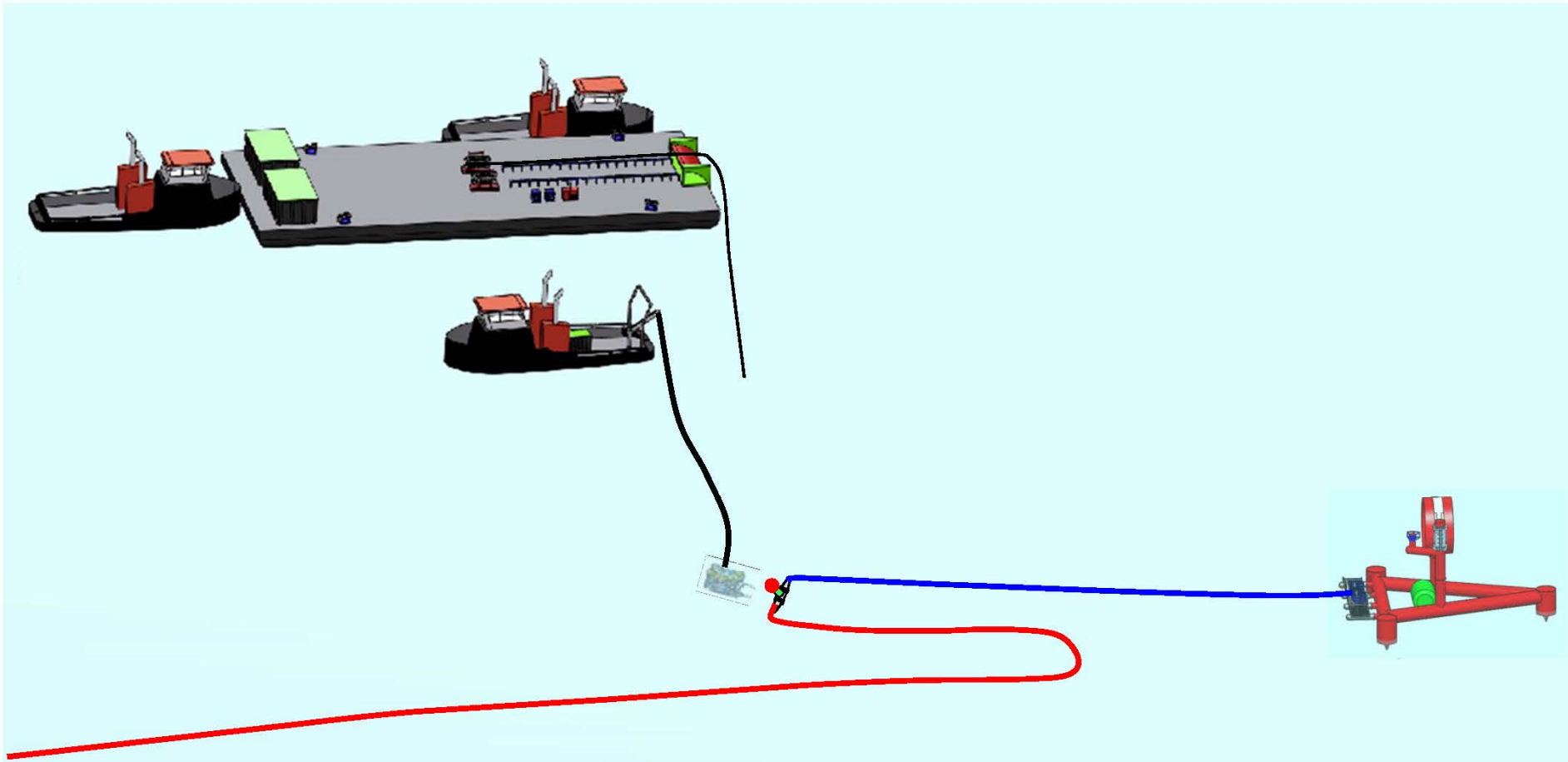
Cable Connection Plan



Cable Redeployment

1. Connected IPV is Deployed on Seafloor
2. ROV Monitors and Records Final Placement

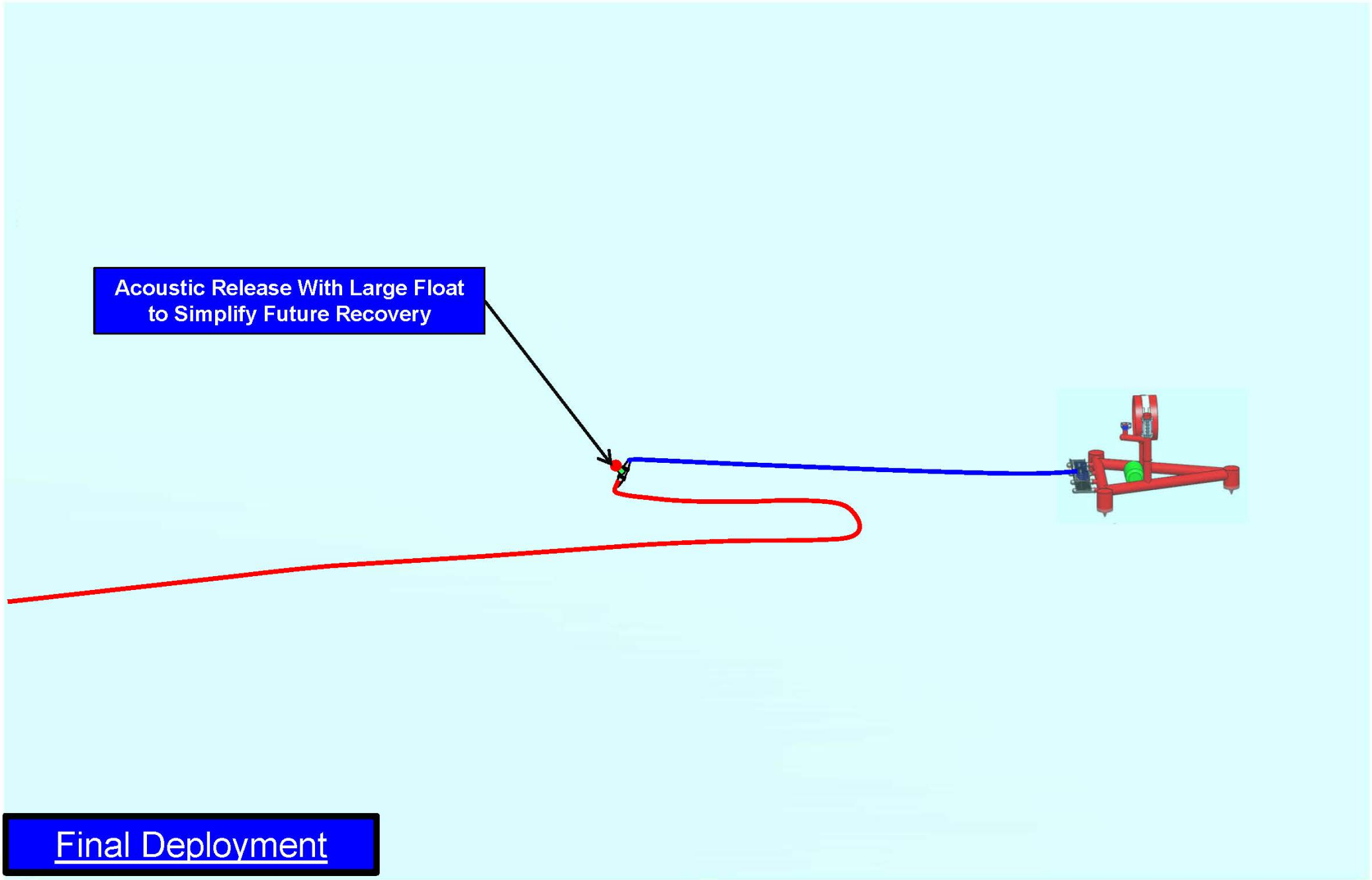
Cable Connection Plan



Cable Redeployment

1. Deployment Line is Retracted

Cable Connection Plan



Final Deployment

Cable Connection Plan

Process is Duplicated for West Turbine

Recovery Process Reverses Deployment

Appendix D2

RECOVERY & REDEPLOYMENT STORYBOARD

Sound & Sea Technology
December 8, 2013

SnoPud Tidal Energy Project

Recovery & Redeployment Plan (RRP)
December 8, 2013

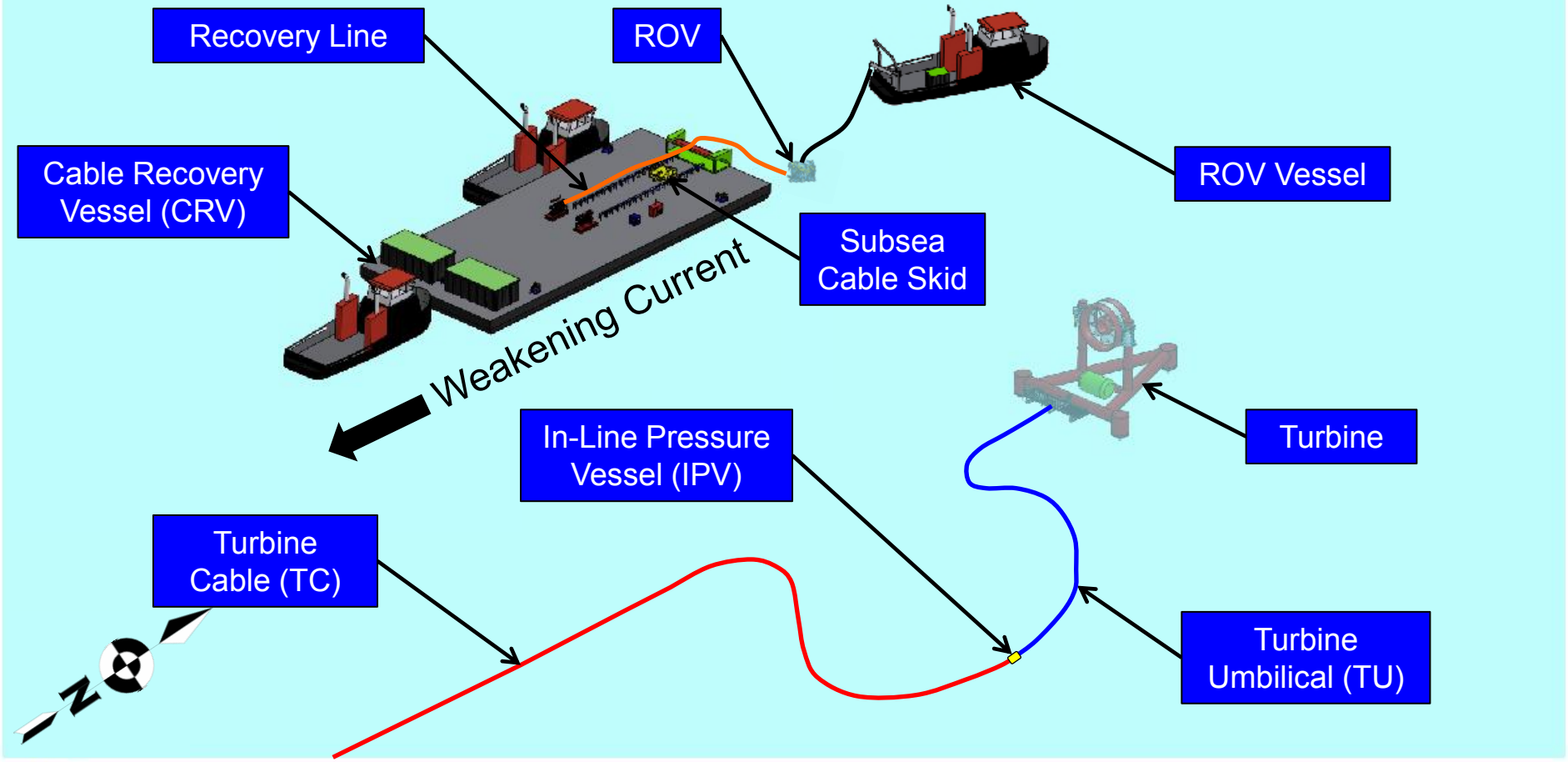
Note: Unless otherwise noted the CONTRACTOR is responsible for completing the events detailed in the following RRP.

Removal of the AMP the day prior.

Recovery & Redeployment Plan (RRP)

Arrival Onsite

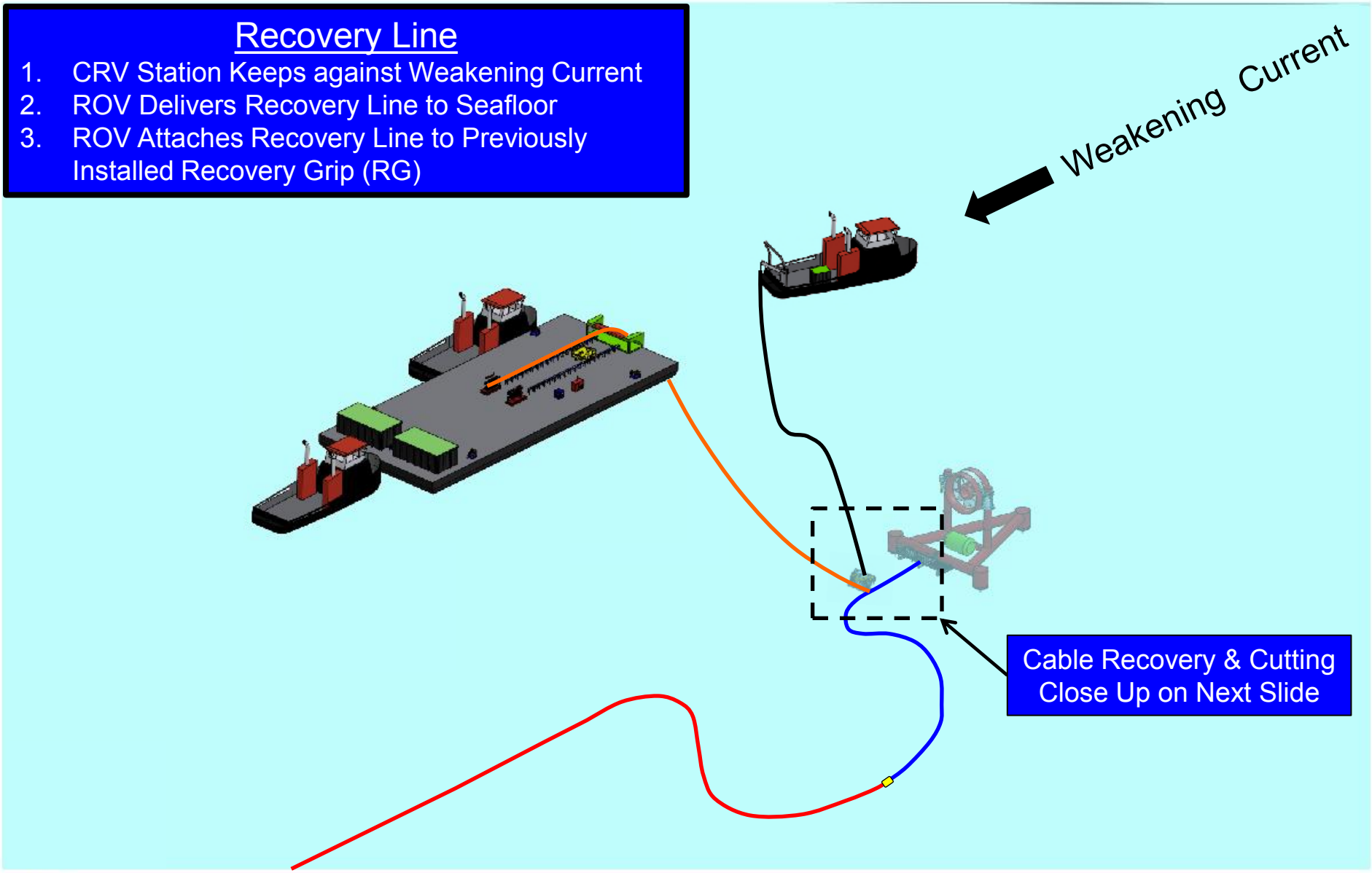
1. AMP is Removed, System is Formally Shutdown, Removing all Energy from the Cables (District)
2. Cable Recovery Vessel (CRV) Arrives at the End of a Weakening Current
3. Support Vessel Deploys ROV with Cable Cutting Tool
4. ROV Maneuvers towards the CRV to Receive Winch Line



Recovery & Redeployment Plan (RRP)

Recovery Line

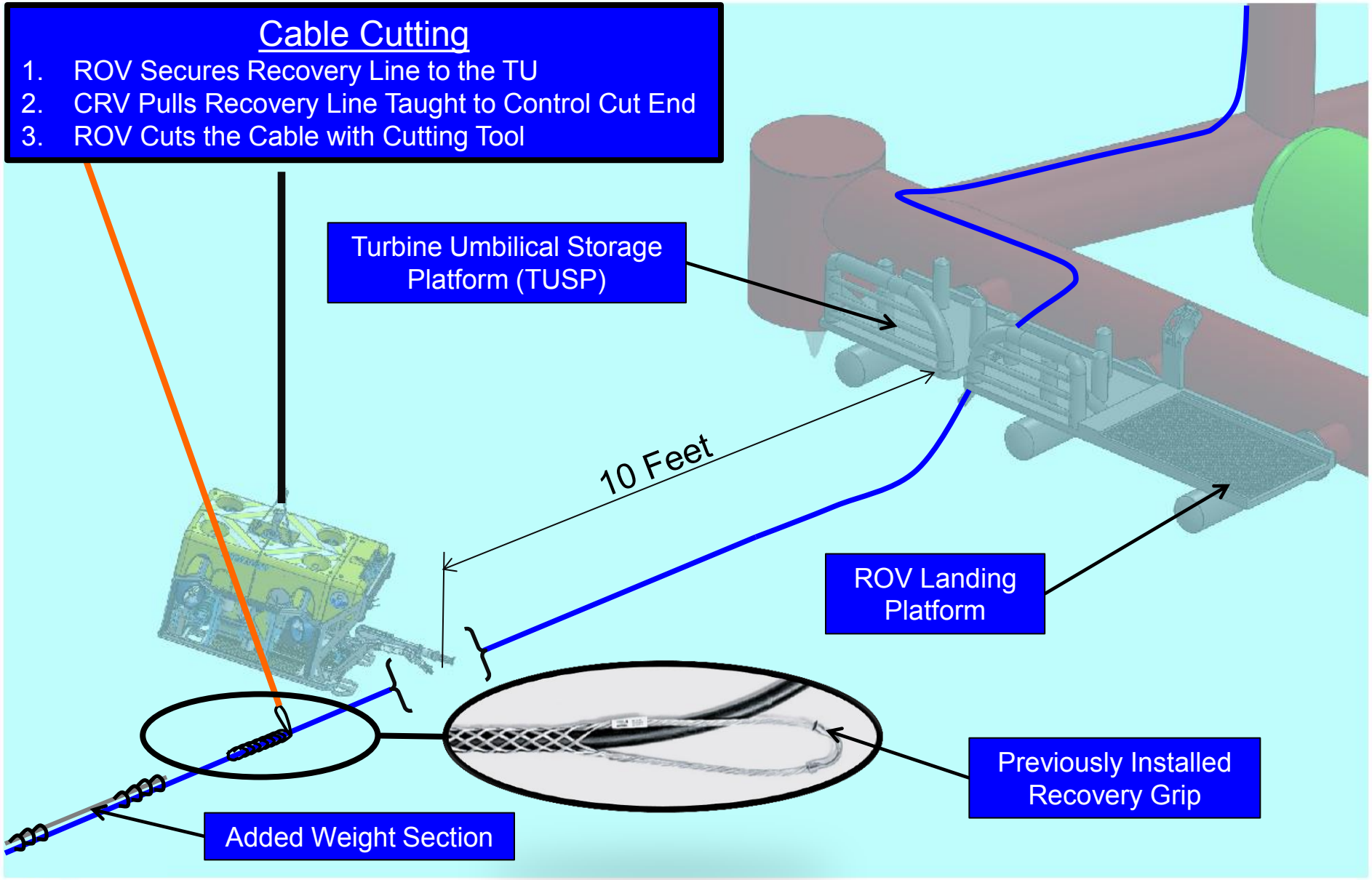
1. CRV Station Keeps against Weakening Current
2. ROV Delivers Recovery Line to Seafloor
3. ROV Attaches Recovery Line to Previously Installed Recovery Grip (RG)



Recovery & Redeployment Plan (RRP)

Cable Cutting

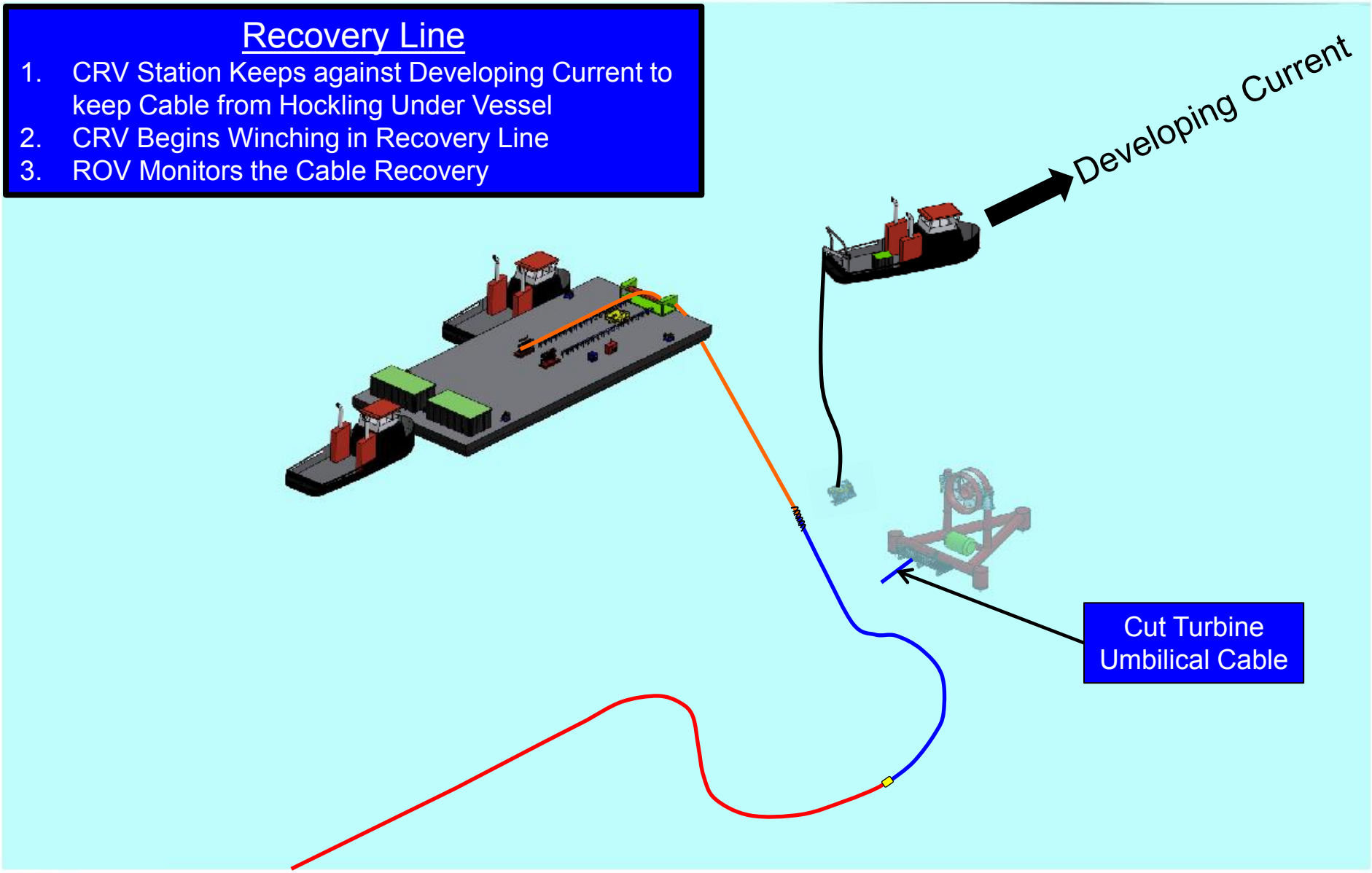
1. ROV Secures Recovery Line to the TU
2. CRV Pulls Recovery Line Taught to Control Cut End
3. ROV Cuts the Cable with Cutting Tool



Recovery & Redeployment Plan (RRP)

Recovery Line

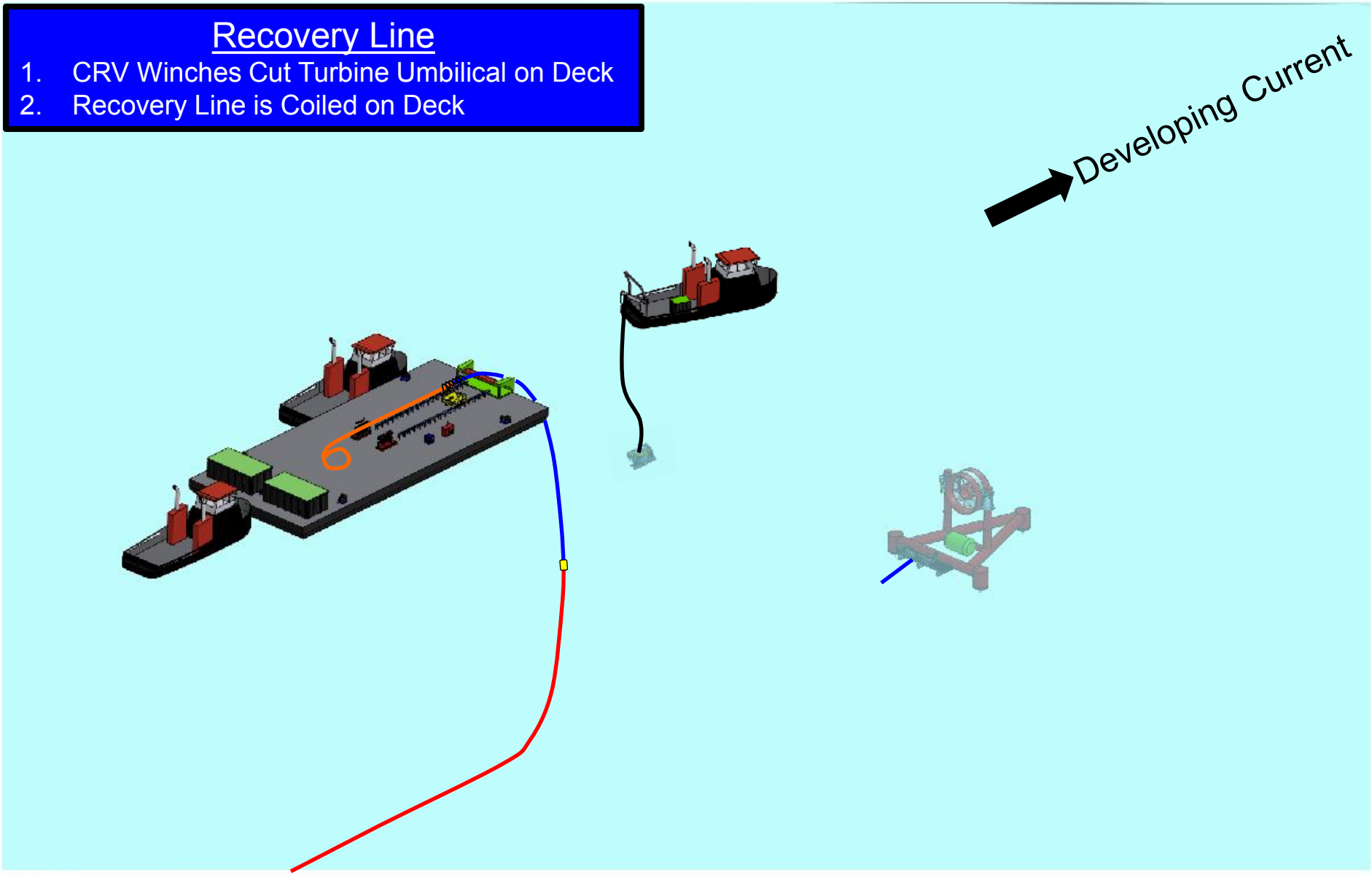
1. CRV Station Keeps against Developing Current to keep Cable from Hockling Under Vessel
2. CRV Begins Winching in Recovery Line
3. ROV Monitors the Cable Recovery



Recovery & Redeployment Plan (RRP)

Recovery Line

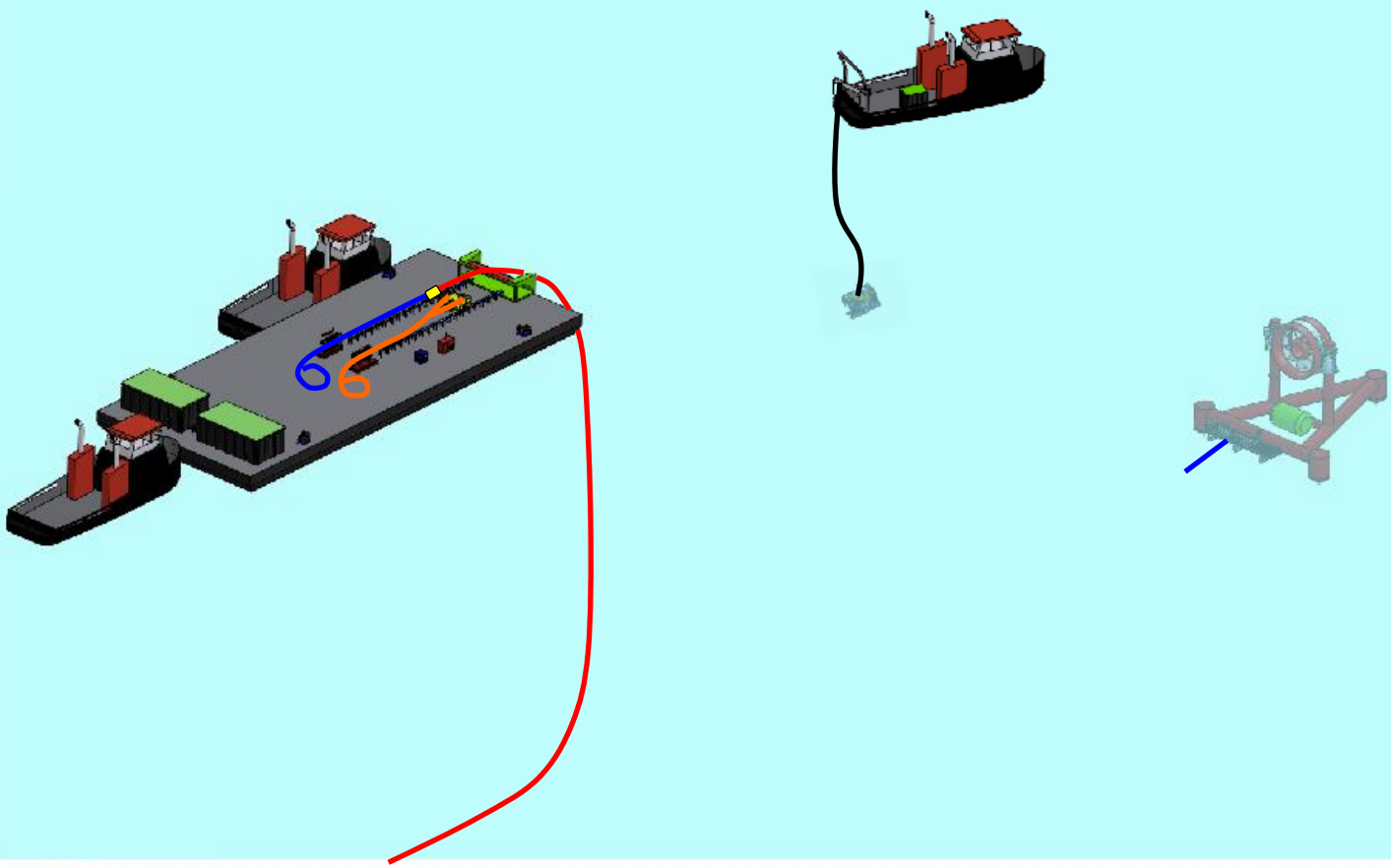
1. CRV Winches Cut Turbine Umbilical on Deck
2. Recovery Line is Coiled on Deck



Recovery & Redeployment Plan (RRP)

In-Line Pressure Vessel

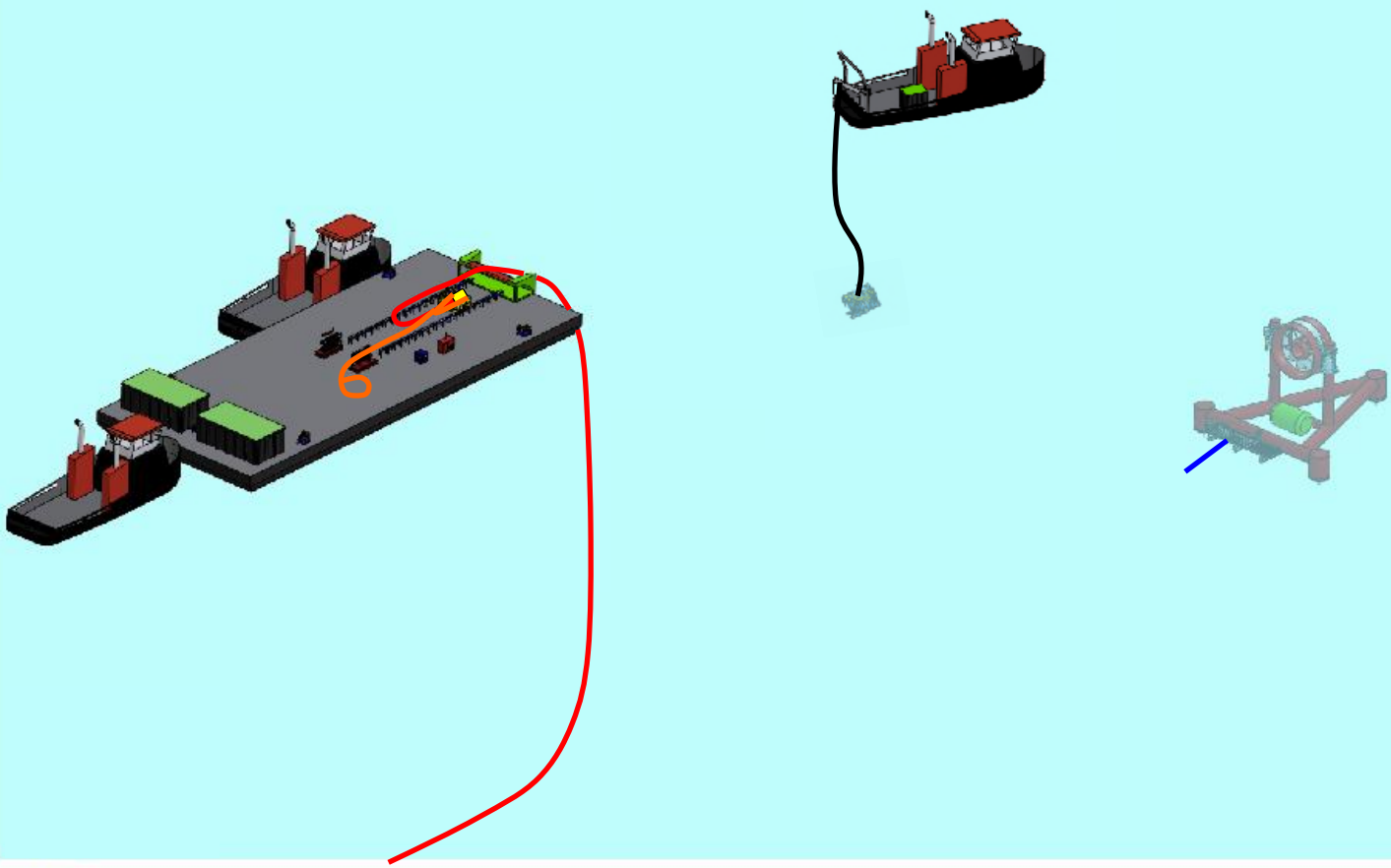
1. CRV Backs Down the Cable Alignment Path
2. CRV Winches IPV on Deck
3. Cable is Held in the Linear Traction Engine
4. ROV Maintains Position for Redeployment of IPV
5. Recovery Line is Secured to the Subsea Cable Skid



Recovery & Redeployment Plan (RRP)

Subsea Cable Skid (SCS)

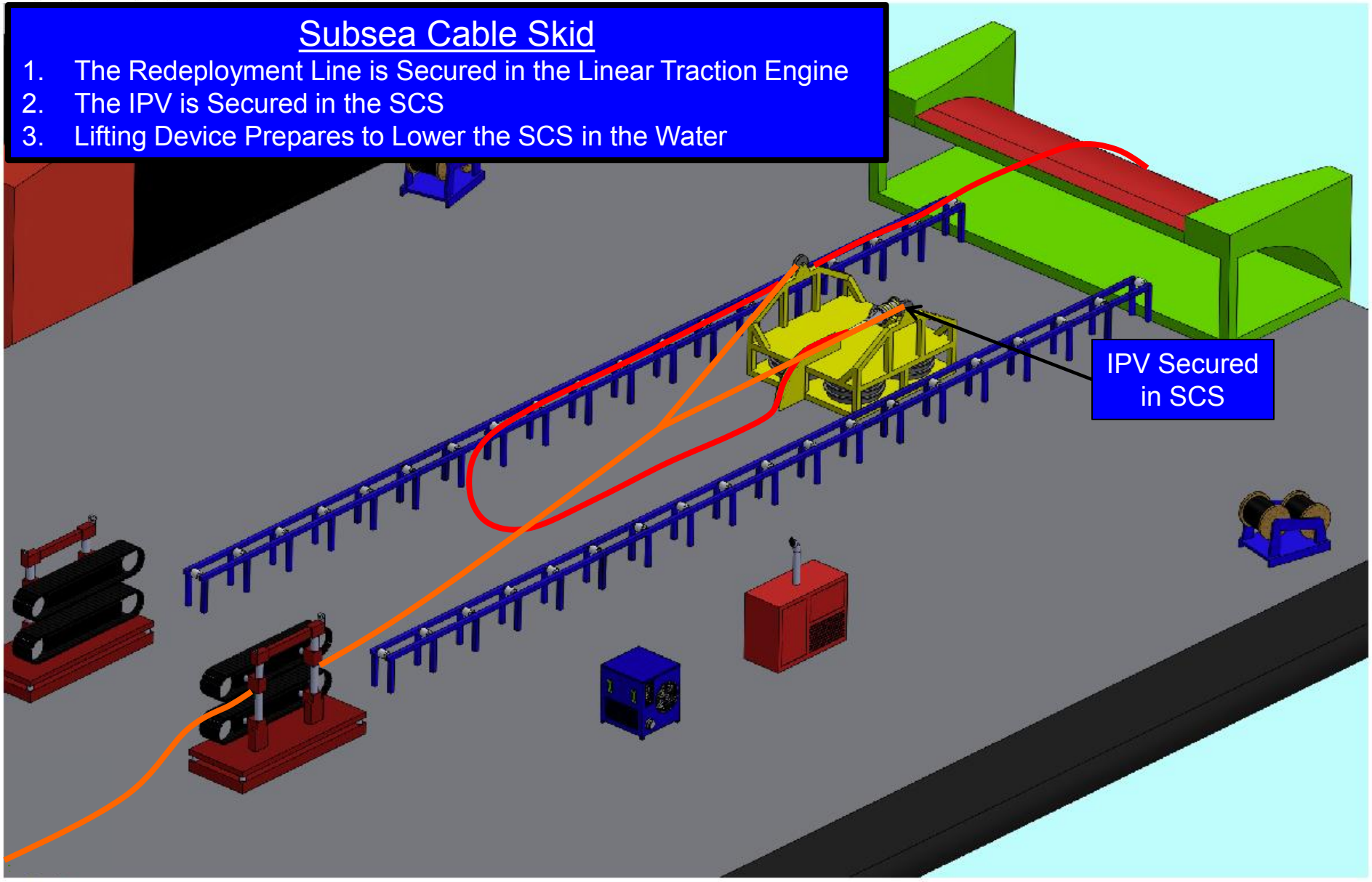
1. Additional Trunk Cable is Pulled Aboard and Secured
2. The IPV is Opened and the TU is Disconnected
3. Confidence Loops are Installed on the TC Connectors
4. The IPV is Capped and Purged with Dry Nitrogen
5. System Health Check is Preformed on the TC



Recovery & Redeployment Plan (RRP)

Subsea Cable Skid

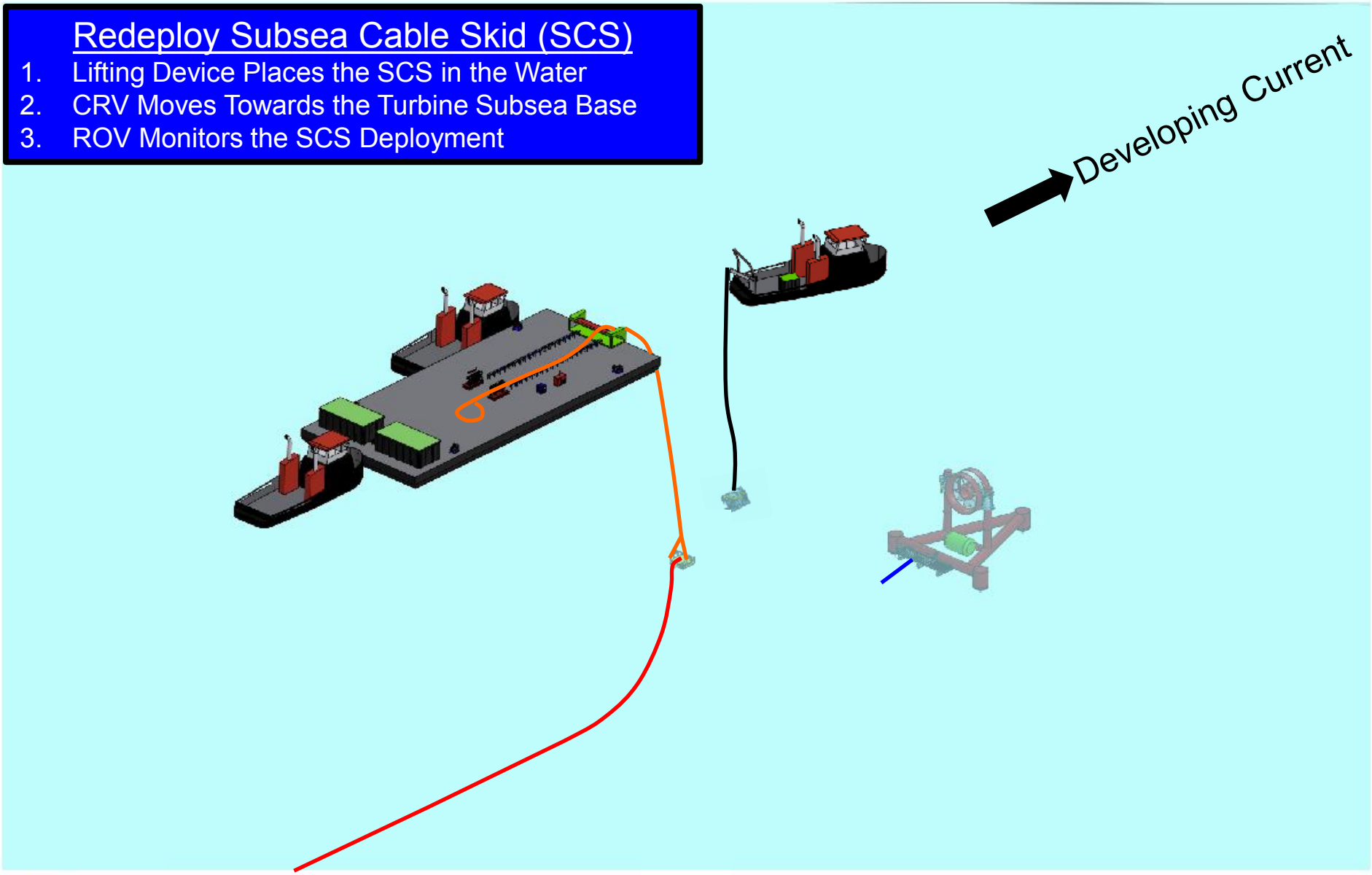
1. The Redeployment Line is Secured in the Linear Traction Engine
2. The IPV is Secured in the SCS
3. Lifting Device Prepares to Lower the SCS in the Water



Recovery & Redeployment Plan (RRP)

Redeploy Subsea Cable Skid (SCS)

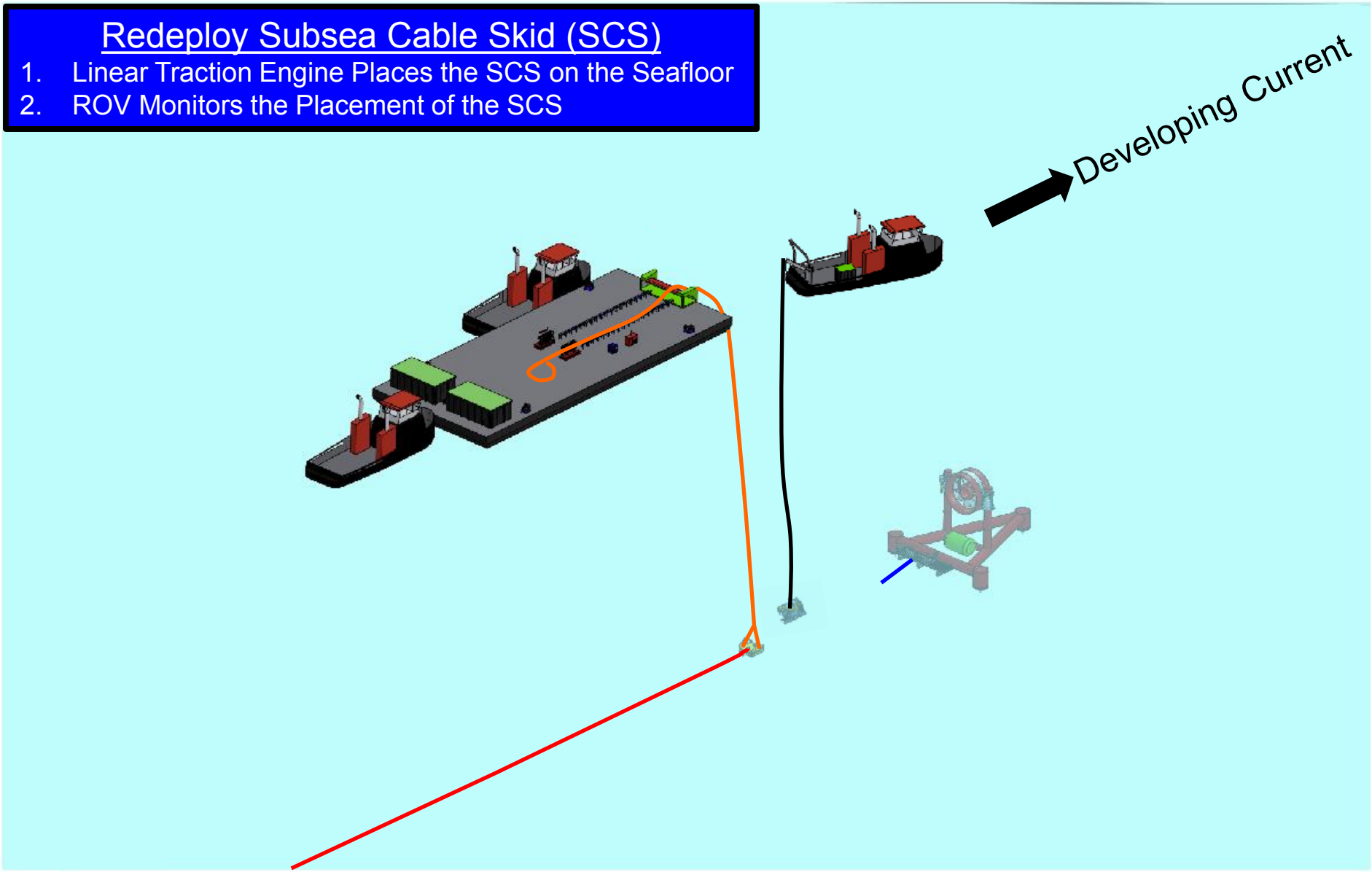
1. Lifting Device Places the SCS in the Water
2. CRV Moves Towards the Turbine Subsea Base
3. ROV Monitors the SCS Deployment



Recovery & Redeployment Plan (RRP)

Redeploy Subsea Cable Skid (SCS)

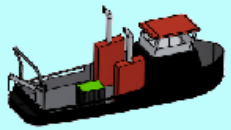
1. Linear Traction Engine Places the SCS on the Seafloor
2. ROV Monitors the Placement of the SCS



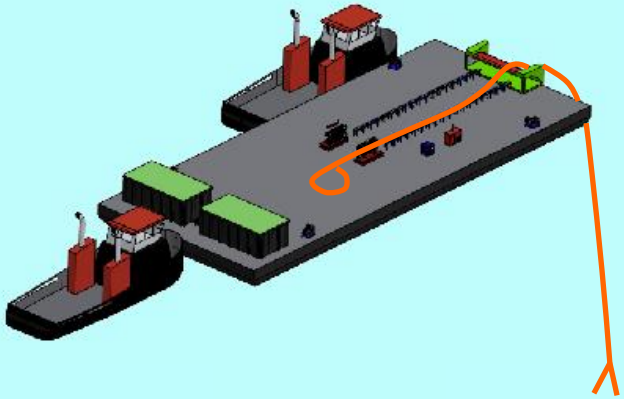
Recovery & Redeployment Plan (RRP)

Redeploy Subsea Cable Skid (SCS)

1. Linear Traction Engine Retracts the Redeployment Line
2. ROV Leaves the Deployment Site



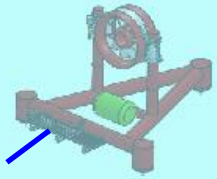
Developing Current

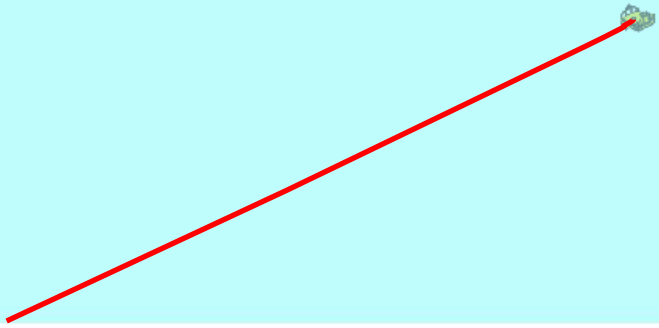


Recovery & Redeployment Plan (RRP)

Recover Turbine

1. SCS is Placed on Seafloor
2. CRV and ROV Vessel Leave Site
3. Turbine is Ready for Recovery by OpenHydro
4. Entire Operation to this Slide is Designed to 24 Hours Maximum
5. Installer Barge is in Transit to the Site (OpenHydro)

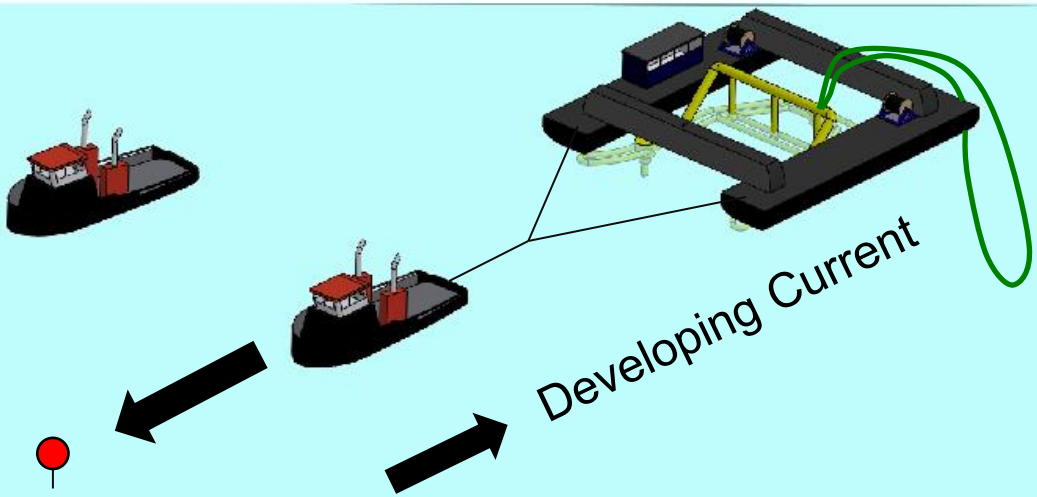


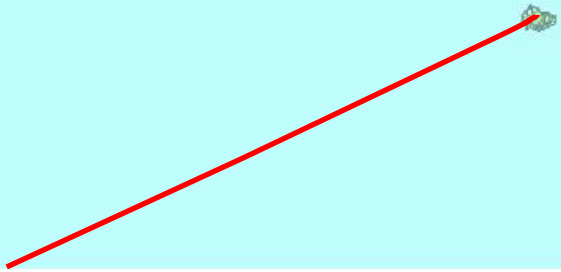


Recovery & Redeployment Plan (RRP)

Recover Turbine (OpenHydro)

1. Installer Barge Arrives Onsite
2. Second Tug Supports Recovery



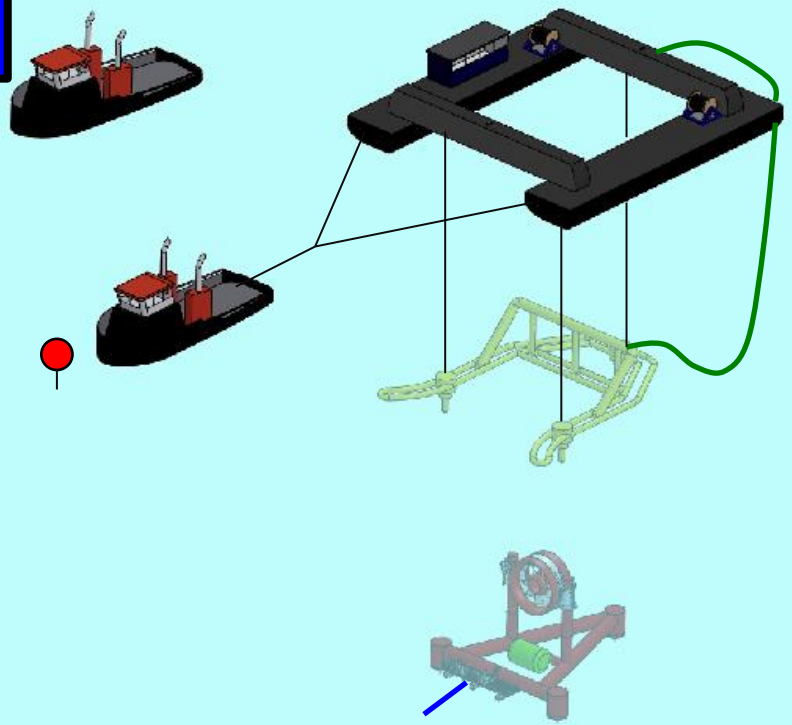


For Information Only
Not in Contract

Recovery & Redeployment Plan (RRP)

Recover Turbine (OpenHydro)

1. Installer Barge Lowers Recovery Frame
2. Support Tug Monitors Recovery

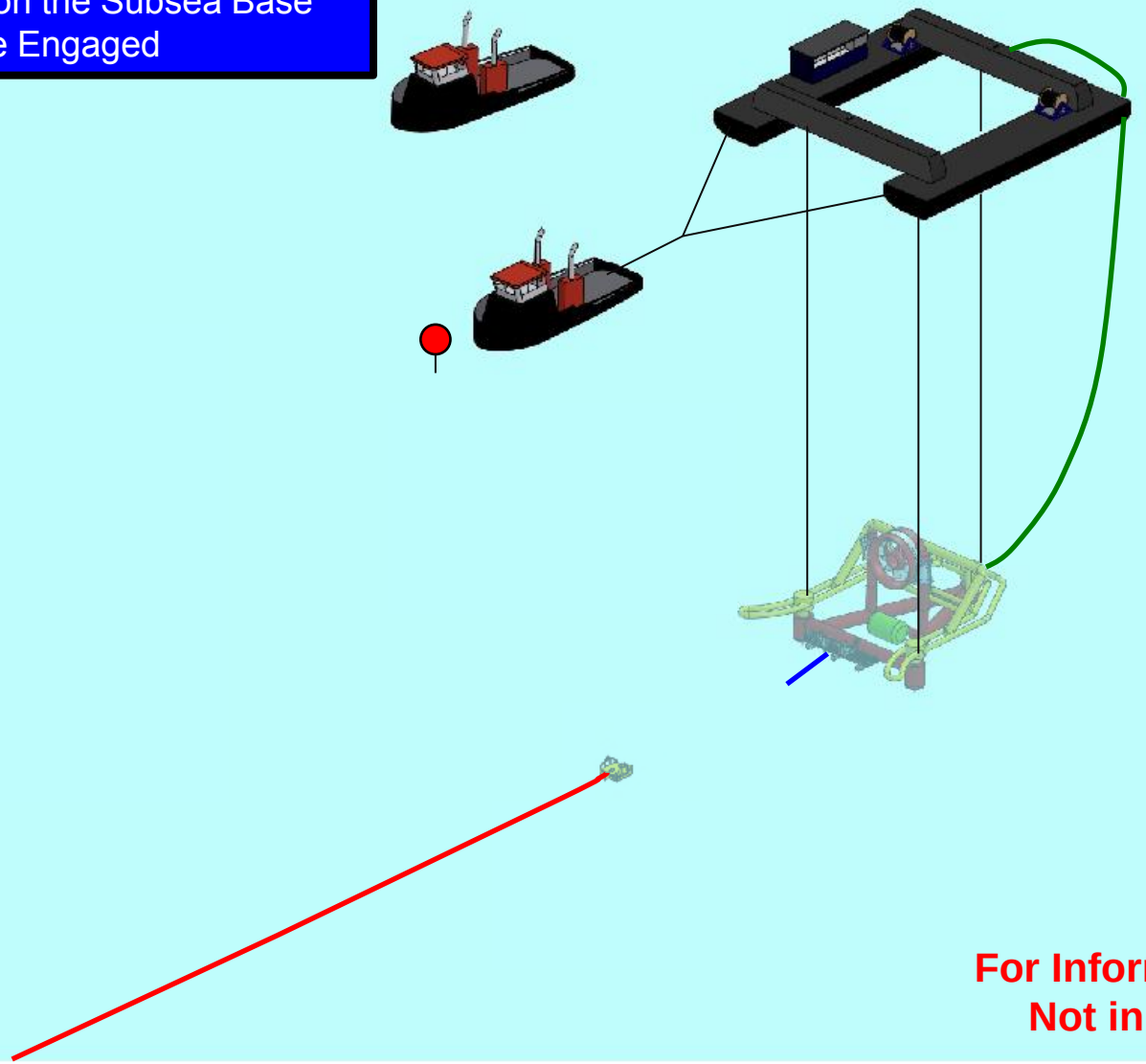


For Information Only
Not in Contract

Recovery & Redeployment Plan (RRP)

Recover Turbine (OpenHydro)

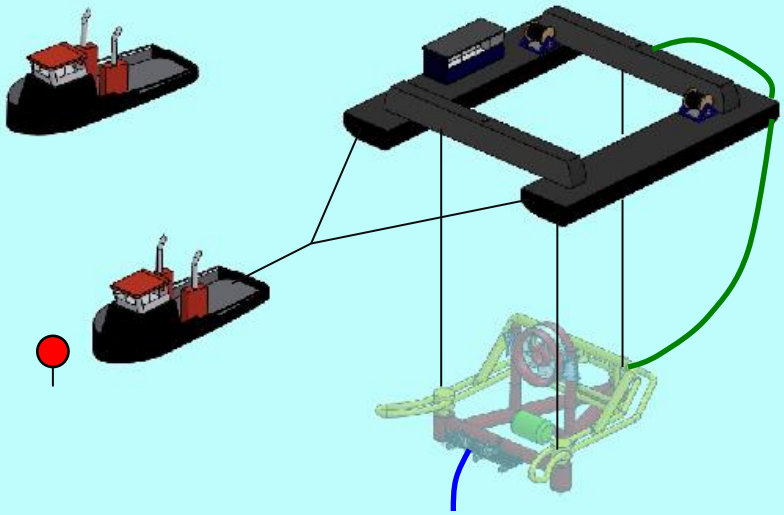
1. Frame is Placed on the Subsea Base
2. The Lift Locks are Engaged

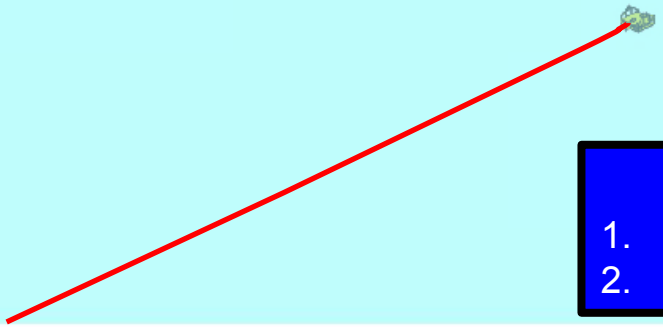


For Information Only
Not in Contract

Recovery & Redeployment Plan (RRP)

For Information Only
Not in Contract



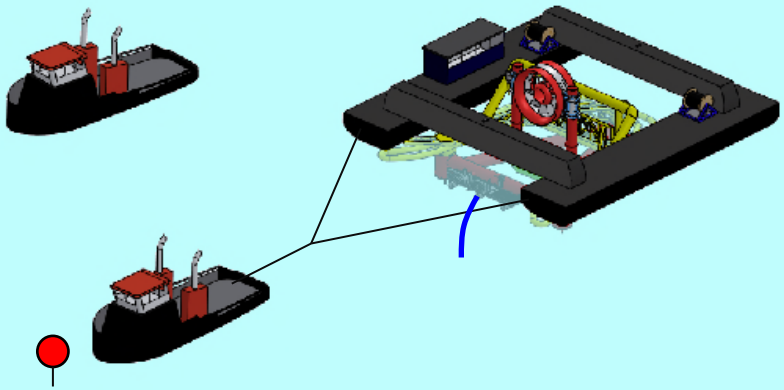


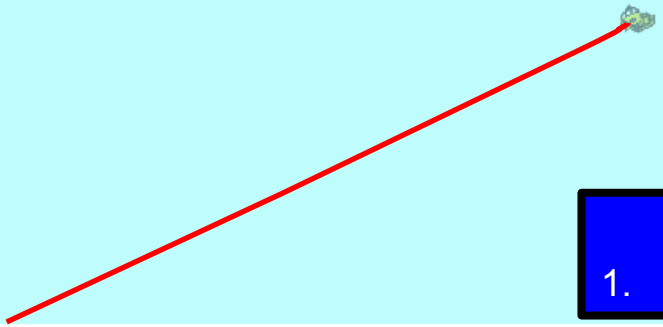
Recover Turbine (OpenHydro)

1. The Turbine is Lifted towards the Surface
2. The TU Cable Hangs Below the Subsea Base

Recovery & Redeployment Plan (RRP)

For Information Only
Not in Contract



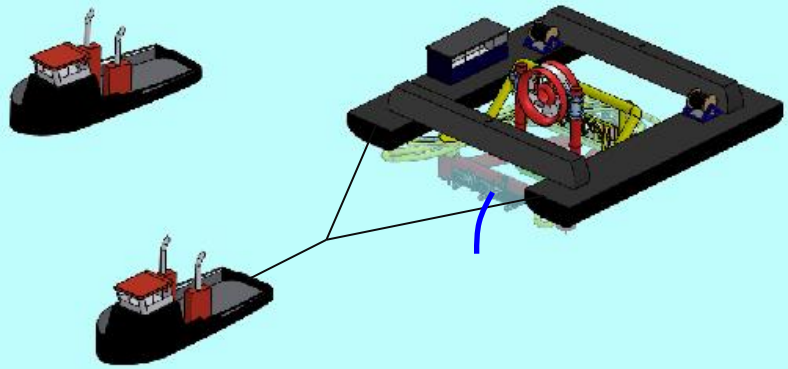


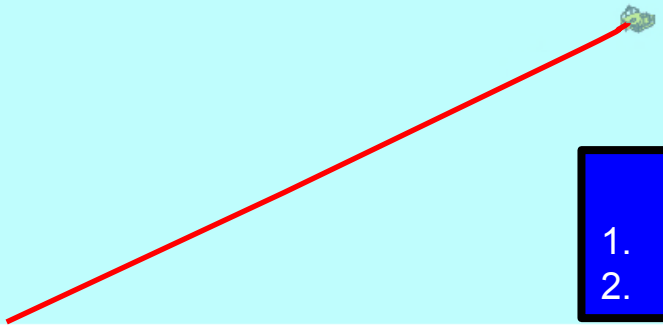
Recover Turbine (OpenHydro)

1. The Turbine is Secured in the Installer Barge

Recovery & Redeployment Plan (RRP)

For Information Only
Not in Contract

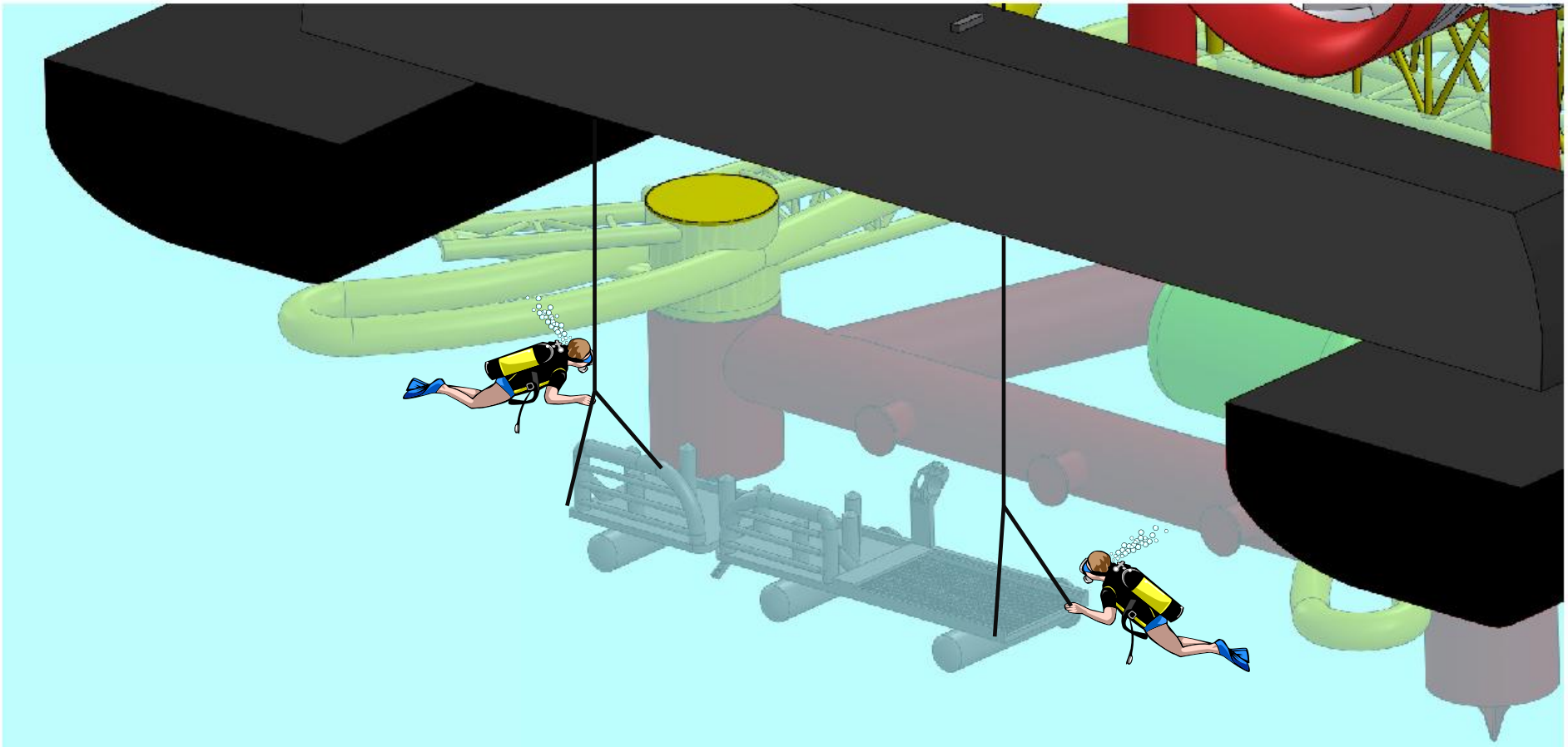




Recover Turbine (OpenHydro)

1. The Recovered Turbine Leaves the Site
2. The Installer Barge Navigates to the Quayside

Recovery & Redeployment Plan (RRP)

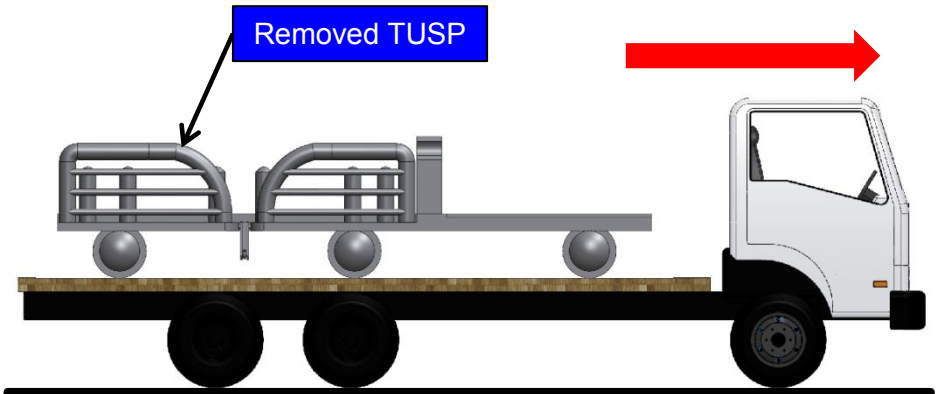


Quayside Work (OpenHydro)

1. The Turbine is Docked at the Quayside
2. The TUSP is Removed from the Subsea Base and Loaded on a Contractor Supplied Truck

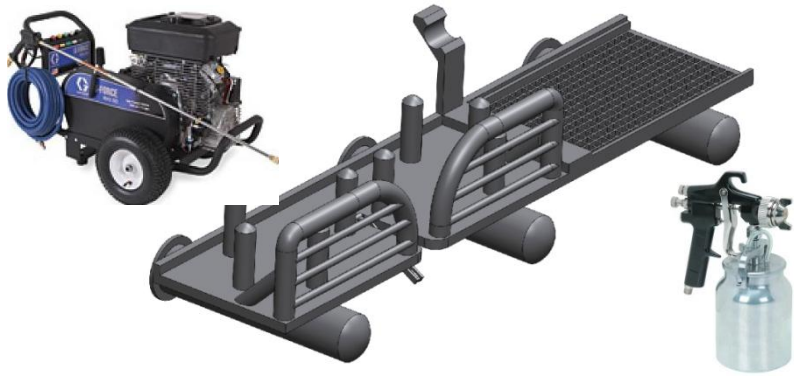
For Information Only
Not in Contract

Recovery & Redeployment Plan (RRP)



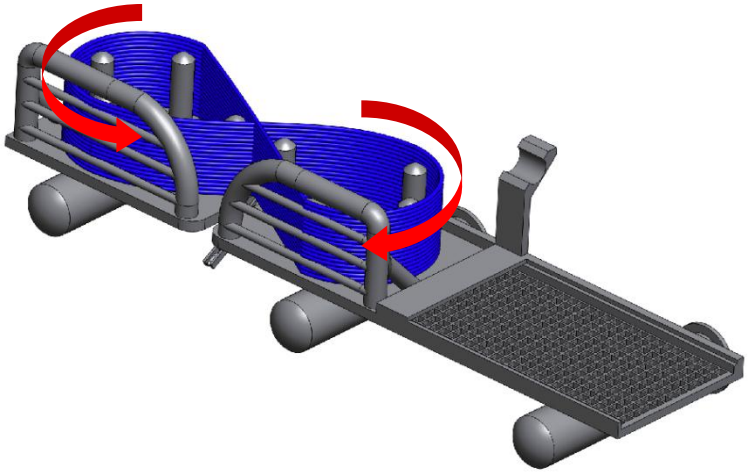
TUSP Removal

1. TUSP Lifted Out from the Quayside (OpenHydro)
2. TUSP Loaded on to Contractor Supplied Truck (OpenHydro)
3. TUSP is Transported to Contractor's Facility (Contractor)



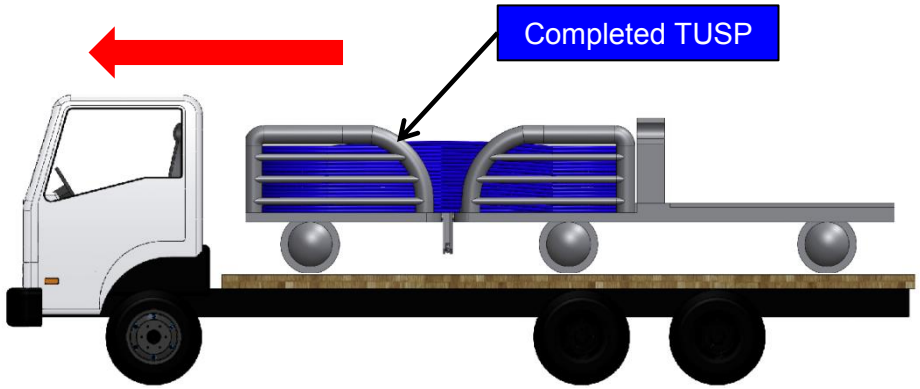
TUSP Reconditioning (Contractor)

1. All Debris from Use is Cleaned from the TUSP
2. If Required, any Repairs to the TUSP are Completed.
3. The TUSP is Painted to meet Original Specifications



Turbine Umbilical (TU) Integration (Contractor)

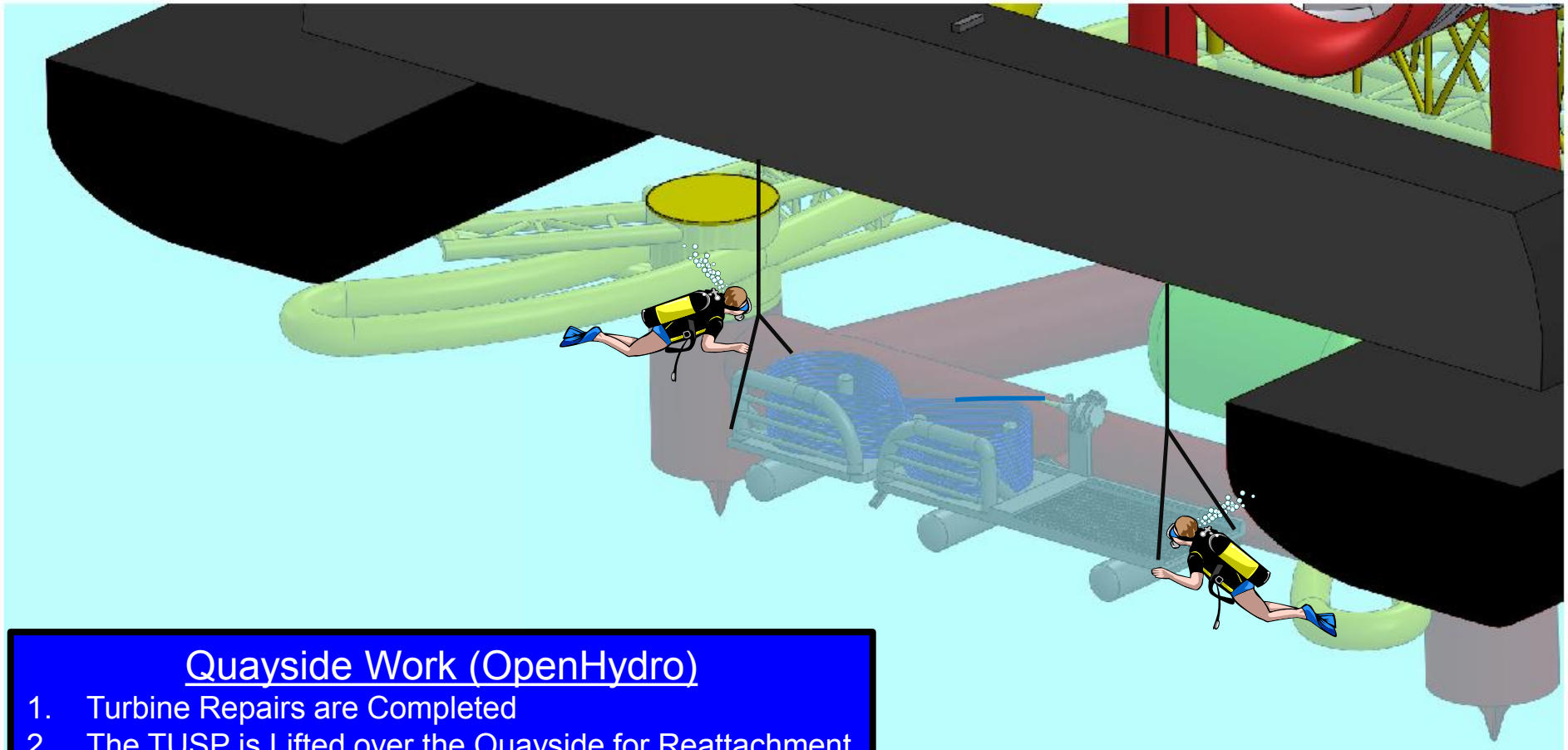
1. Spare TU is Integrated into the TUSP using Methods Consistent with the Methods utilized in the First Deployment and Cable Connection Series.



Reconditioned TUSP (Contractor)

1. Contractor Returns the Reconditioned TUSP to the Quayside
2. Contractor Coordinates Delivery with OpenHydro

Recovery & Redeployment Plan (RRP)



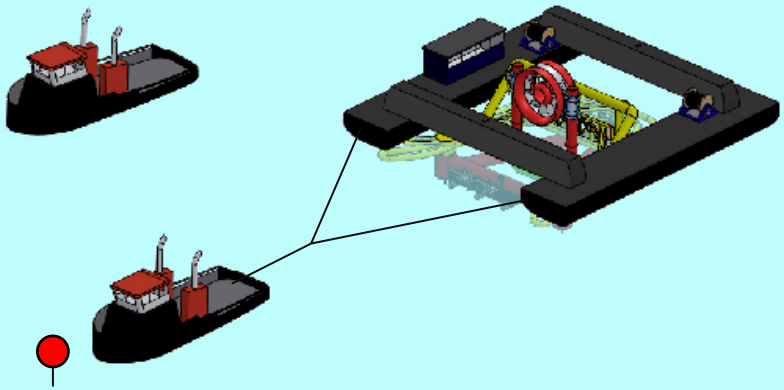
Quayside Work (OpenHydro)

1. Turbine Repairs are Completed
2. The TUSP is Lifted over the Quayside for Reattachment
3. Divers Reattach the TUSP to the Subsea Base
4. Reattach TU to Subsea Base and Perform Dry-mate Connections at the Turbine Junction Bottle
5. Final Preparations are Completed for Redeployment
6. Contractor to Observe OpenHydro Crews while they Perform the Tasks above.

For Information Only
Not in Contract

Recovery & Redeployment Plan (RRP)

For Information Only
Not in Contract



Redeploy Turbine

1. The Installer Barge Transits to the Deployment Site

Recovery & Redeployment Plan (RRP)

OpenHydro Performs Turbine Deployment Plan per the procedures outlined in the original Contract Documents

Then….

Recovery & Redeployment Plan (RRP)

Contractor Performs the Cable Connection Plan per the procedures outlined in the original Contract Documents

Recovery & Redeployment Plan (RRP)

Repeat this Entire Process for the Other Turbine (as Required)

Appendix E

MATERIALS AND EQUIPMENT SUPPLY MATRIX

APPENDIX-E
Materials and Equipment Supply Matrix

	Equipment	QTY	CONTRACTOR	DISTRICT	Description	Notes
1	Turbine Units	2		**FI**	Turbine, Subsea Base, TCC, all assoiated wiring (except the TJB, TU and TUSP)	Delivered to the sea floor
2	Cantelever for AMP	2		**FI**	Integrated cantelever and associated wiring from the TCC for the Docking Station associated with the UW's monitoring system Adaptive Monitoring Package (AMP)	By others
3	Docking Station	2		**FI**	The Docking Station is the custom-designed interface between the Turbine Unit's TCC and the AMP, which will also inteface with the retrieval system designed for periodic recovery via ROV.	BY others
4	Adaptive Monitoring Package (AMP)	3		**FI**	Adaptive Monitoring Package shall be secured to the docking Station	BY others with limited coordination by CONTRACTOR
5	Turbine Juncuion Bottle (TJB)	2	**FO**	**IO**	Pressure vessel containing dry connections within, also equiped with a flange plate containing connectors for inferface with OH wiring from the TCC and associated connectors	DISTRICT to fasten to Subsea Base and perform connection. CONTRACTOR to coordinate, assist and observe all testing to the CONTRACTOR's satisfaction.
6	Turbine Umbilical (TU)	2	**FO**	**IO**	200 meter length of marine cable connecting the Turbines from the TJB to the Trunk Cable(TC)	2-spare TUs provided in this contract. DISTRICT to fasten TU to Subsea Base. CONTRACTOR to observe installation and all testing to the CONTRACTOR's satisfaction.
7	In-line Pressure Vessel (IPV)	2	**FI**		Pressure vessel containing dry connections within; completes the connection between TU and TC	
8	Turbine Umbilical Storage Platform (TUSP)	2	**FO**	**IO**	Platform design to store the TU and facilitate the marine operations necessary to connect the TU the the TC.	Delivered to DISTRICT at Turbine Mobilization Site (Turbine) for installation by OH
9	Trunk Cable (TC)	2	**FI**		Marine cable to be extended from the connection with the turbine along the cable route, through the HDD and to the shore switch Vault	
10	HDD Conduit(s)	2	**FI**		Conduit(s) installed via Horizontal Directional Drilling. Conduits shall convey the cables from the 19-meter depth contour to the shoreline	CONTRACTOR's choice to install 1 or 2 conduits to meet project requirements
11	Shore Switch Vault	1	**IO**	**FO**	The vault that receives the marine trunk cable, provides shutoff capability and transfers the transmission of all electrical currents to individual terrestrial cables.	CONTRACTOR to receive from delivery truck and install per contract plans and specifications
12	Fiber termination Cabinet	1	**FI**		Outdoor cabinet for splicing fiber, mounted to a 4x4" post	Fiber shall pass through the switch vault from the Turbine Units and be spliced in this location
13	Low-Voltage termination cabinet	1	**FI**		Outdoor cabinet for splicing the low-voltage elements. Cabinet to be mounted to a 4x4" post	Low Voltage shall pass through the switch vault from the Turbine Units and be spliced in this location
14	Custom Transformers	2	**IO**	**FO**	Custom designed transformers for preparing tidal energy for the DEN battery storage system	CONTRACTOR to receive from delivery truck and install per contract plans and specifications
15	Site Conduits	TBD	**FI**		All site conduits required to meet the project needs	As indicatded in the plans and specs
16	Power Conditioning and Control Building (PCCB) and furnishings	1	**FI**		Everything except specific exclusions (equipment specifically identified as DEN on the contract plans) including but not limited to: foundation, structure, electrical wiring, electrical panels, security wiring, communications wiring, conduits, cable trays, flood protection, doors, lighting, HVAC equipment, communication racks.	As indicatded in the plans and specs
17	Power Control and Conditioning Equipment	1	**IO**	**FO**	All the equipment that receives the power from the Turbine Units (after the transformers), stores it to batteries and prepares it for grid connection (excluding any conduits and wiring outside the cabinets)	As indicatded in the plans and specs. Cabinets DEN-1 through DEN-11 together with 14 battery cabinets and associated batteries. CONTRACTOR to receive from delivery truck and install per contract plans and specifications
18	Grid Connection equipment	1	**FI**		All equipment required on the contract plans for connection to the local grid, between the DEN #11 Cabinet to the grid point of connection.	
19	Site Furnishings	1	**FI**		All site furnishings on the contract plans	

FI = Furnish and Install
FO = Furnish Only
IO = Install Only

Notes:

1) The purpose of this Appendix is to provide a high-level overview of the CONTRACTOR's and DISTRICT's materials and equipment responsibilities for the project.

2) In the event a conflict arise between this Appendix and the Contract Plans and Specifications, the Contract Plans and Specifications shall govern.

Appendix F

GEOTECHNICAL REPORT (ONSHORE)

Landau Associates
Geotechnical Report
Admiralty Inlet Pilot Tidal Project
Island County, Washington

February 13, 2013

Geotechnical Report
Admiralty Inlet Pilot Tidal Project
Island County, Washington

February 13, 2013

Prepared for

Snohomish County PUD No. 1
Snohomish County, Washington

LANDAU ASSOCIATES
950 Pacific Avenue, Suite 515
Tacoma, WA 98402
(253) 926-2493

TABLE OF CONTENTS

		Page
1.0	INTRODUCTION	1-1
	1.1 SCOPE OF SERVICES	1-1
	1.2 PROJECT UNDERSTANDING	1-2
2.0	EXISTING CONDITIONS	2-1
	2.1 SURFACE CONDITIONS	2-1
	2.2 GEOLOGIC SETTING	2-1
	2.3 SUBSURFACE SOIL CONDITIONS	2-3
	2.4 GROUNDWATER	2-4
	2.5 SEISMIC SURVEY	2-4
3.0	CONCLUSIONS AND RECOMMENDATIONS	3-1
	3.1 SITE GRADING	3-1
	3.1.1 Wet Weather Considerations	3-1
	3.1.2 Site Preparation Activities	3-1
	3.1.3 Structural Fill	3-2
	3.1.4 Backfill and Compaction Requirements	3-3
	3.1.5 Temporary and Permanent Slopes	3-3
	3.2 FOUNDATIONS	3-3
	3.2.1 Seismic Design Considerations	3-3
	3.2.2 Subgrade Preparation	3-5
	3.2.3 Foundation Support	3-5
	3.2.4 Resistance to Lateral Loads	3-5
	3.2.5 Foundation Drainage Considerations	3-6
	3.2.6 Slab-On-Grade Floors	3-6
	3.3 PAVEMENT	3-7
	3.4 HORIZONTAL DIRECTION DRILLING	3-7
4.0	DOCUMENT REVIEW AND CONSTRUCTION OBSERVATIONS	4-1
5.0	USE OF THIS REPORT	5-1
6.0	REFERENCES	6-1

FIGURES

Figure	Title
1	Vicinity Map
2	Site Plan

APPENDICES

Appendix	Title
A	Field Explorations and Laboratory Testing
B	Downhole Seismic Survey

1.0 INTRODUCTION

This report presents the results of our field investigation and provides geotechnical engineering conclusions and recommendations for the proposed Snohomish County PUD No. 1 Admiralty Inlet Pilot Tidal Project located in Island County, Washington. The purpose of this study was to complete a subsurface investigation to characterize soil and groundwater conditions at the site and develop geotechnical conclusions and recommendations for design and construction of the proposed control building located at 13254 State Route (SR) 20, Coupeville, Washington and the proposed horizontal directional drilling (HDD) bore for the offshore tidal turbines cable.

The general project location is shown on the Vicinity Map (Figure 1). Figure 2 presents the Site and Exploration Plan, which shows the general configuration of the project area, some of the surrounding site features, and the approximate location of the borings completed for this study. Appendix A presents a description of the field exploration and a summary log of conditions observed in the exploration completed for this study. A description of the geotechnical laboratory testing and laboratory test results is also included in Appendix A. Results of the downhole seismic survey are presented in Appendix B.

This report has been prepared based on information provided by Snohomish County PUD, Sound and Sea Technology, and Lawhead Architects; our review of readily available subsurface information; the results of the explorations completed for this project; our familiarity with geologic conditions in the vicinity of the project area; and our experience on similar projects.

1.1 SCOPE OF SERVICES

Landau Associates was contracted by Sound and Sea Technology to provide geotechnical engineering services to support the project. Our services were provided in accordance with the May 10, 2011 purchase order (P.O. 11001593) and general terms and conditions. Our scope of services for this portion of the project included the following specific services:

- Compiling and reviewing available geotechnical and geologic information in the project vicinity.
- Advancing three exploratory borings to characterize subsurface soil and groundwater conditions at the site. One of the borings was advanced to a depth of about 100 feet (ft) below the ground surface (BGS) using a track-mounted rotosonic drill rig. The other two borings were advanced to a depth of about 21½ ft BGS using a truck-mounted auger drill rig.
- Logging each soil unit observed in the exploratory boring and recording pertinent information, including soil sample depths, stratigraphy, soil engineering characteristics, and groundwater occurrence.
- Installing a 3-inch diameter Schedule 40 PVC casing in the 100-ft rotosonic boring and conducting a downhole geophysics survey to determine shear wave velocities in the subsurface soil.

- Conducting laboratory testing in accordance with American Society of Testing and Materials (ASTM) standards including natural moisture content determinations, grain size analyses, and Atterberg Limits tests on selected samples from the explorations.
- Performing engineering analyses and developing geotechnical engineering conclusions and recommendations for the proposed improvements.
- Preparing and submitting this written report summarizing our findings, conclusions, and geotechnical engineering recommendations for the project. This report includes:
  - Discussion of soil and groundwater conditions at the site
  - Recommendations for site earthwork including clearing, grubbing, and stripping; import fill requirements; fill placement and compaction criteria; subgrade preparation for foundations, slabs, and pavement areas; and design asphalt pavement sections for parking and driving areas
  - Recommendations for foundation support of the structures including seismic design considerations per 2009 International Building Code (IBC; ICC 2009), foundation preparation, maximum allowable soil bearing pressure, minimum footing sizes (continuous and column footings), minimum depth of burial (frost depth), and resistance to lateral loads (passive earth pressure and friction coefficient)
  - Estimated short-term and long-term settlements of foundations
  - Recommendations for slab-on-grade floor including subgrade preparation, and underslab drainage requirements
  - Foundation drainage considerations
  - Horizontal directional drilling (HDD) considerations.

1.2 PROJECT UNDERSTANDING

The project consists of a constructing a new control building to house the electrical equipment associated with tidal turbine power generation and installing a conduit by means of HDD from the shore to an offshore exit point to accommodate bringing the sea floor cable from the tidal turbine generators through the near shore area.

The proposed control building will be constructed about 80 ft south of SR 20 and consist of a single-story, wood-framed structure. Figure 2 shows the proposed location of the control building. The size of the control building is planned to be 24 ft by 30 ft in plan dimensions. The structure will be supported by conventional spread footing foundations with a concrete slab-on-grade floor with a finished floor elevation of 12 ft. The foundations will be structurally tied together. A 20 by 30 ft concrete pad will be constructed immediately south of the control building to house batteries. The concrete pad will have a finished floor elevation of 11.0 ft. A new gravel drive will provide access to the control building from SR 20.

The proposed HDD bore is planned to be 665 ft [203 meters (m)] in length with an exit point on the sea floor at a depth of about 60 ft (18.3 m) below sea level. The HDD entry point is located on private

property on Admiralty Bay about 50 ft north of the Ordinary High Water (OHW) line. The location of the proposed entry point is shown on Figure 2. The conduit is planned to consist of DR 9 or 11 high density polyethylene (HDPE) pipe. The HDPE pipe will be fused in sections on the beach, floated out to sea and pulled back through the bore to shore.

2.0 EXISTING CONDITIONS

The following sections describe the existing surface and subsurface conditions. Soil conditions described are based on those observed during completion of field explorations on March 29, 2012, as modified by laboratory testing results.

2.1 SURFACE CONDITIONS

The site of the proposed tunnel entrance and control building is located on Whidbey Island, on a strip of land between Admiralty Bay and Crockett Lake. The site property is privately owned, with adjacent private properties to the east and west. The property is bordered on the north by SR 20 and on the south by Admiralty Bay. The topography of the site is relatively flat, generally fluctuating between 5 and 7 feet in elevation. The ground surface in the vicinity of the proposed control building is covered with grass, while the ground surface over much of the rest of the site is covered with coarse gravel. An existing residential structure is located about 100 ft west of the proposed control building.

2.2 GEOLOGIC SETTING

The Snohomish County PUD's tidal turbine project is located within the Puget Sound Lowland physiographic province, a north-south trending structural basin located between the Olympic Mountains to the west and the Cascade Mountains to the east. The structural basin is a result of regional tectonic activity including the subduction of the Juan de Fuca oceanic plate beneath the North American plate. In the general project area, depth to bedrock is estimated to range from about 1150 to 2600 ft (350 to 790m) below sea level (Polenz et al. 2005) and is overlain by a complex series of unlithified glacial and non-glacial sediments. A series of generally east-west trending (active) faults subdivide the Puget Sound basin into smaller blocks and basins, and these faults cut both bedrock and unconsolidated sediment units. One of these faults, the northwest-southeast trending Southern Whidbey Island Fault, cuts the project area (Polenz et al. 2005).

The recent geologic history and shallow geologic conditions are the result of the succession of at least six continental glaciations that advanced into the Puget Sound Lowlands over the last 2 million years. The purpose of describing these glaciations is that sedimentary deposits that have been overridden by thick glacial ice are typically highly consolidated, which influences the engineering behavior of the soils.

The continental glaciers advanced into the Puget Sound Lowlands from southern British Columbia, and ice spanned the lowlands from the Cascade Mountains to the Olympic Mountains and blocked the inlet to Puget Sound (Admiralty Inlet) and the Strait of Juan de Fuca, creating a large lake in

which fine-grained lacustrine sediments (clay and silt) were deposited. As the ice sheet advanced southward, a sand and gravel unit was deposited (advance outwash unit) above the fine-grained lacustrine unit. The ice sheet subsequently advanced over the sand and gravel, depositing the characteristic glacial till unit, consolidating underlying sediments, and scouring significant meltwater channels at the base of the glacier. In the project area, ice thickness during the most recent glaciations may have been up to about 3,900 to 4,300 ft (1,200 to 1,300 m; Thorsen 1980). Generally, the ice sheets advanced just beyond Olympia, Washington located at the southern extent of present day Puget Sound. As the climate warmed, the ice became stagnate and melted, depositing ice-entrained sediment over the landscape in some areas as an unsorted blanket and alluvial deposits from recessional meltwater. Post-glacial erosional processes further modified the landscape and deposited non-glacial sediments in the lowlands during interglacial periods. Each successive glaciation had a similar depositional sequence and also partially eroded the existing ground surface, both eroding and depositing a fresh sequence of glacial sediment over the landscape. The resulting stratigraphy is a very complex sequence of glacial and non-glacial sediments.

The latest glaciation that advanced into the Puget Sound Region, known as the Vashon Stade of the Fraser Glaciation, occurred approximately 20,000 to 11,000 years before present and had a significant effect on the present day landscape. During the Vashon glacial advance, as the ice front advanced over the advance outwash deposits, the Vashon glacial till was deposited, and meltwater flowing beneath the ice sheet significantly eroded the outwash material along with some of the previously deposited sediments, creating generally north-south trending, deep subglacial drainage channels. Puget Sound, Hood Canal, Lake Washington, and the Snohomish/Snoqualmie River Valley are examples of remnants of these deep subglacial water channels. As the ice retreated, the ice front stalled near present day Coupeville (Polenz et al. 2005), which is located about 6 miles (10 kilometers) north of the study area. Polenz et al. (2005) suggests that the historic (post-Vashon Stade) relative sea level was at least 216 to 229 ft (66.5 to 69.8 m) above present day sea level based on deposits of clay, silt, and sparse gravel of glaciomarine origin to about 220 ft (67.1 m) above present day sea level. Floating ice in the form of berg and shelf covered much of the area, and entrained sediment from the floating ice deposited glaciomarine drift on the seafloor over much of the project vicinity. With the retreat of glacial ice, the land surface rebounded, lifting the portions of the glaciomarine drift above present day sea level. In the project vicinity, the glaciomarine drift is often underlain by glacial till and/or other Vashon-age deposits.

According to Polenz et al. (2005), subsurface deposits in the immediate vicinity of the project are mapped as relatively recent beach deposits. In the project area, beach deposits are post-glacial deposits, consisting primarily of sand, gravel, and cobbles that are locally well sorted. Deposits are typically loose, with the larger (gravel and cobble) sized particles being well rounded. Beach deposits are typically a mix of locally derived glacial and non-glacial sediment from shoreline bluffs and underlying sediment and (or)

carried in by longshore drift. Due to the loose and granular nature, this unit typically exhibits high permeability and low to moderate shear strength.

In the project area, glaciomarine drift is mapped north and west of Crockett Lake, which is located north of the project area. Glaciomarine drift is described as consisting of clayey to silty diamicton with variable sand and gravel content and often contains marine shells. Glaciomarine drift typically exhibits low to very low permeability and low shear strength.

Soil conditions observed in the borings advanced for this project are generally consistent with the mapped geology. Beach deposits were observed throughout the depths explored in borings B-2 and B-3 (21½ ft BGS) and to a depth of about 64 ft BGS in boring B-1. North of Crockett Lake, the surface of the glaciomarine drift plain slopes downward to the south at about 2 to 3 percent. This would place the top of the glaciomarine drift at the project site about 60 to 70 ft BGS.

2.3 SUBSURFACE SOIL CONDITIONS

Subsurface conditions in the project area were explored by advancing and sampling three exploratory borings on March 29, 2012. The borings are labeled B-1, B-2, and B-3, the approximate locations of which are shown on Figure 2. Boring B-1 was advanced to about 100 ft BGS with a track-mounted rotosonic drill rig. Borings B-2 and B-3 were each advanced to a depth of about 21½ ft BGS with a truck-mounted, hollow-stem auger drill rig. All three borings were advanced by Major Drilling, Inc. of Pacific, Washington under subcontract to Landau Associates. A discussion of the field exploration program with an edited log of the exploratory borings and a discussion of the geotechnical laboratory test procedures and test results are presented in Appendix A.

Beach deposits were encountered in boring B-1 to a depth of about 64 ft BGS. Glaciomarine drift was encountered below the beach deposits throughout the remaining depths explored (100 ft BGS). The beach deposits were observed to consist of medium dense, coarse gravel (0 to 2½ ft) underlain by about ½ ft of medium dense silty sand. Below the thin silty layer we encountered medium dense, sandy gravel or medium dense, very gravelly, sand to a depth of about 50 ft BGS. From about 50 to 62½ ft BGS, dense very gravelly sand was observed. A transitional zone of sand and silt was encountered between 62½ and 64 ft BGS. Below the sand we observed medium stiff to stiff silty clay (64 to 84 ft) transitioning to medium stiff to stiff silt (84 to 90 ft). From 90 to 100 ft BGS we observed ½- to 3-ft thick layers of interbedded stiff silt and medium dense very fine sand.

In general, subsurface conditions encountered in the borings B-2 and B-3 consists of about ½ ft of topsoil over granular beach deposits. Neither boring penetrated through the beach deposits. In boring B-2, the beach deposits were observed to consist of loose to medium dense, coarse gravel to a depth of about 4 ft BGS. Below the coarse gravel, we observed medium dense gravelly sand (4 to 7 ft), medium dense

sandy gravel (7 to 11 ft), and very dense sand with gravel (11 to 21½ ft). We observed similar conditions in boring B-3, with the beach deposit consisting of loose to medium dense, coarse gravel to a depth of about 2 ft BGS. Below the coarse gravel, we observed medium dense sandy gravel (2 to 9½ ft) and medium dense gravelly sand (9½ to 21½ ft) with a very dense section of gravelly sand from about 15 to 17 ft BGS.

2.4 GROUNDWATER

Groundwater was encountered at the time of drilling (March 29, 2012) at about 6 ft BGS in boring B-1, 7 ft BGS in boring B-2, and 6½ ft BGS in boring B-3. The groundwater is at about the water level in Admiralty Bay to the south. Given the clean, granular nature of the soil and the proximity of the site to Admiralty Bay, groundwater levels are not expected to fluctuate seasonally at the location. However, changing tides, long-term precipitation patterns, and unanticipated subsurface conditions could cause the groundwater level to vary by up to a few feet from that observed at the time of drilling.

2.5 SEISMIC SURVEY

On March 30, 2012, Major Drilling, Inc. of Pacific, Washington installed a 3-inch, Schedule 40 PVC casing in boring B-1 to allow for post-construction shear-wave velocity measurements. On April 2, 2012, Global Geophysics of Monroe, Washington performed a downhole shear wave survey in the casing. Detailed seismic survey results are presented in Appendix B. The average shear wave velocity in the Beach Deposit portion of the hole (about 0 to 63 ft BGS), when corrected for overburden pressure, was calculated to be about 590 ft per second (fps). The average shear wave velocity in the Glaciomarine Drift (about 63 to 83 ft BGS), when corrected for overburden pressure, was calculated to be about 640 fps.

3.0 CONCLUSIONS AND RECOMMENDATIONS

Based on conditions observed in the explorations, construction of the project appears feasible using standard construction means and methods. With proper preparation, the site soil should provide adequate support for foundations and slab-on-grade floors. Geotechnical conclusions and recommendations are presented for site grading, foundations, new pavement, and tunneling.

3.1 SITE GRADING

Site grading is expected to consist of removal of the topsoil from within the control building area; minor cuts and fills to establish planned site grades; foundation excavation; and subgrade preparation for foundation, floor slabs, and pavements.

3.1.1 WET WEATHER CONSIDERATIONS

Site preparation activities, as well as other earthwork-related construction, will be influenced by weather conditions. The medium dense sand and gravel below the topsoil is expected to have a moderate to low sensitivity to moisture. Unprotected site soil, in either a compacted or uncompacted state, can degrade in the presence of water and construction traffic. If subgrade soil becomes loosened or disturbed, additional excavation to expose undisturbed soil and replacement with properly compacted structural fill will be required.

To limit the potential for wet weather construction impacts, we recommend that site earthwork occur during the relatively dry portion of the year (early summer to early fall). Completing earthwork activities outside of this normal construction window could lead to an increase in construction costs due to repair of disturbed areas and moisture conditioning (drying) of onsite material.

3.1.2 SITE PREPARATION ACTIVITIES

Site preparation activities are expected to consist of removing the existing topsoil from within the footprint of the control building area and from within paved areas. Based on conditions observed in the borings, the topsoil is anticipated to be about 6-inches thick. The removed topsoil could be spread or stockpiled elsewhere on the property at the direction of the property owner or disposed of at an approved offsite location. All incidental excavations associated with site preparation activities should be backfilled in accordance with the recommendations presented in Sections 0 and 3.1.4 of this report.

Prior to placing structural fill to establish planned site grades, the exposed subgrade should be cleaned of any debris and loose and/or disturbed soil. The prepared subgrade surface should be in a firm and non-yielding condition. The prepared subgrade should be proof-rolled in the presence of a qualified

geotechnical or civil engineer with a loaded dump truck, large self-propelled vibrating roller, or equivalent piece of equipment to check for the presence of soft and/or disturbed areas. Soft and/or disturbed subgrades should be repaired by either overexcavating the disturbed soil and replacing it with compacted structural fill meeting the requirements in Section 0 of this report, or by scarifying or moisture-conditioning (aerating) the disturbed soil (weather permitting) and recompacting. Repaired subgrades should be recompacted in accordance with Section 3.1.4 of this report.

3.1.3 STRUCTURAL FILL

Structural fill is defined as material needed to establish planned subgrade elevations within the building limits. The suitability of excavated soil or imported soil for use as structural fill will depend on the gradation and moisture content of the soil when it is placed. As the amount of fines increases, the soil becomes increasingly sensitive to small changes in moisture content and adequate compaction becomes more difficult to achieve. Soil containing more than about 5 percent fines cannot consistently be compacted to a dense, non-yielding condition when the water content is greater than about 2 to 3 percent above optimum moisture content. Optimum moisture content is the moisture content at which the greatest compacted dry density can be achieved. The onsite soil is anticipated to have a very low percentage of fines, making it more tolerant of moisture contents in excess of the optimum.

Based on its present natural moisture content, the near-surface soil is near its optimum moisture content for compaction and could be suitable for use as structural fill provided suitable weather conditions prevail; however, some moisture conditioning (wetting or drying) should be anticipated. The soil below a depth of about 6½ ft is below the water table and should not be utilized as structural fill.

If the onsite soil cannot be utilized as fill, or if additional fill material is needed to establish planned subgrade elevations, import fill will be necessary. Import fill should consist of granular material, either naturally occurring or processed and shall meet the following gradation requirements:

Sieve Size	Percent Passing
4 -inch	99 – 100
2-inch	75 – 100
No. 4	50 – 80
No. 40	30 max
No. 200	7.0 max

If wet weather construction is anticipated, the amount of fines (material passing a U.S. No. 200 sieve) should not exceed 5 percent, by dry weight, based on a wet sieve analysis of that portion passing the ¾-inch sieve.

3.1.4 Backfill and Compaction Requirements

Structural fill should be placed in relatively horizontal lifts of 8 to 10 inches, loose measure, and each lift compacted to at least 95 percent of the ASTM D 1557 maximum dry density. The maximum dry density and optimum moisture content should be determined by the ASTM D 1557 test procedure.

3.1.5 Temporary and Permanent Slopes

Based on soil conditions encountered in our explorations, appropriate configurations for temporary excavations less than 10 vertical ft in height in the absence of groundwater seepage would be 1½H:1V (horizontal to vertical). If groundwater seepage is present (anticipated below about 6½ ft), it should be expected to cause an unstable condition in the temporary excavation, necessitating flatter slopes, shoring, or construction dewatering.

Temporary excavation slopes should be protected by covering with plastic sheeting, straw, or other means to prevent erosion. Also, construction, maintenance, and design of temporary excavation slopes should be the sole responsibility of the contractor. All local, state, and federal safety codes should be followed. The contractor should monitor all temporary cuts during excavation for any evidence of instability. If instability is detected, the contractor should flatten the temporary excavation slopes or install temporary shoring. The contractor should also implement measures to prevent surface water runoff from entering excavations.

Permanent cut or fill slopes should be no steeper than 2H:1V, and should be provided with erosion protection, as recommended above, and be reseeded or revegetated as soon as practical.

3.2 FOUNDATIONS

The following sections provide geotechnical engineering conclusions and recommendations for foundation design for the control building. Recommendations are provided for seismic design, foundations, slab-on-grade floors, below-grade walls, and drainage considerations.

3.2.1 Seismic Design Considerations

The Pacific Northwest is seismically active and the site could be subject to ground shaking from a moderate to major earthquake during the design life of the structure. Consequently, earthquake shaking should be anticipated during the design life of the project, and the proposed control structure should be designed to resist earthquake loading using the appropriate design methodology.

Seismic design of the proposed control building will be in accordance with the 2009 IBC (ICC 2009). The near-surface soil at the site is liquefiable. According to the 2009 IBC, the liquefiable soil profile that underlies the site classifies as Site Class F, per Table 1613.5.2. For Site Class F soil profiles,

the 2009 IBC requires that the Site Coefficients, F_a and F_v, be determined in accordance with the *Minimum Design Loads of Buildings and Other Structures* (ASCE 7-05) published by the American Society of Civil Engineers (ASCE 2006).

According to Section 11.4.7 of ASCE 7-05, a dynamic site response analysis is required to determine the site coefficients, F_a and F_v, for Site Class F and for structures with periods of vibration greater than 0.5 seconds. At the time this report was prepared, the period of vibration for the control building had not been determined. If the control building has a period of vibration less than or equal to 0.5 seconds, Section 20.3.1 of ASCE 7-05 allows for the site coefficients to be equal to the site coefficients if the project site were not susceptible to liquefaction. In the absence of liquefaction, the site would classify as Site Class E (Soft Soil Profile).

For Site Class E, the following spectral response accelerations for a 2 percent probability of exceedance in 50 years (USGS 2011) should be used to determine the design response spectrum per Figure 11.4-1 (ASCE 2006):

Spectral Response Acceleration for 0.2-second period (S_S):	126% of gravity (1.26g)
Spectral Response Acceleration for a 1-second period (S_1):	125% of gravity (1.25g)

A value of 0.90 should be used for site coefficient F_a, and 2.40 for site coefficient, F_v. The design peak horizontal ground acceleration ($0.40S_{DS}$) for the site should be taken as 0.34g.

Groundwater at the site is at a depth of about 6½ ft BGS. Loose to medium dense granular soil underlies the site to a depth of about 64 ft. Using the methodology described in Idriss and Boulanger (2008), about 75 percent of the granular soil in the upper 64 ft of the soil column was found to have a high likelihood of liquefaction during the design a seismic event. The consequences of liquefaction include settlement and possible lateral spreading of the foundation. Lateral spreading could result in lateral displacement of the structure and potentially large differential settlements. Differential lateral movement between foundation elements could result in cracking and distortion, and possible partial collapse of the structure due to ground shaking. Utilities could be damaged and/or sheared off as a result of ground shaking and/or differential settlement.

Ground modification to mitigate the liquefaction potential is likely cost prohibitive given the size and function of the proposed structure. In our opinion, the most cost-effective method would be to structurally tie individual foundation elements and floor slabs together which would allow the building to settle as a unit. Structurally-tied foundation elements would also limit differential settlements across the building as a result of liquefaction-induced ground subsidence and lateral spreading. Flexible utility connections should also be provided at the exterior of the structure to reduce impacts to utilities.

3.2.2 SUBGRADE PREPARATION

Based on the results of our field exploration program, loose to medium dense beach deposits consisting of gravel with trace sand and silt are expected to be present at the foundation level of the proposed structure. The gravel will be difficult to compact to a dense and unyielding surface. Therefore, we recommend that the upper 12 inches of native material be overexcavated and replaced with structural fill meeting the requirements of Section 3.1.3 of this report. Structural fill should be compacted to at least 95 percent of the maximum dry density as determined by the ASTM D 1557 test procedure. The exposed foundation subgrade should be observed by a qualified geotechnical engineer to check that the subgrade has been properly prepared. Prior to pouring the concrete, foundation-bearing surfaces should be free of all loose soil and water.

3.2.3 FOUNDATION SUPPORT

All continuous and isolated spread footings should have minimum widths of 18 inches and 24 inches, respectively, and should be founded a minimum of 12 inches below the lowest adjacent final grade for frost protection. Assuming the above foundation support criteria are satisfied, continuous or isolated spread footings for the proposed structure may be proportioned using a maximum net allowable soil bearing pressure of 2,000 pounds per square foot. The allowable bearing pressure includes a factor of safety of at least 3 on the calculated ultimate bearing capacity. The term "Net Allowable Bearing Pressure" refers to the pressure that can be imposed on the soil at foundation level resulting from the total of all dead plus live loads (including snow loads), exclusive of the weight of the footing or any backfill placed above the footing. The maximum allowable bearing pressure may be increased by ⅓ for short-term transient loadings, such as wind or earthquakes.

Settlement of shallow foundations depends on the foundation size and bearing pressure, as well as the strength and compressibility characteristics of the underlying bearing soil. Assuming foundation construction is accomplished as previously recommended, we estimate that settlement of continuous or isolated spread footings will be less than 1 inch. Differential settlement between similarly loaded foundation elements may be assumed to be about ½ inch or less. Differential settlements between adjacent heavily-loaded and lightly-loaded foundations or between footings underlain by different subgrade soils would be greater. It is estimated that most of the settlement, as described above, will occur during construction as loads are applied. Post-construction settlements should be negligible.

3.2.4 RESISTANCE TO LATERAL LOADS

Resistance to lateral loads may be assumed to be provided by friction acting on the base of footings and floor slabs, and by passive lateral earth pressures acting against the sides of footings. An

ultimate coefficient of sliding resistance of 0.50, applied to the vertical dead loads only, may be used to compute frictional resistance. For design purposes, the passive resistance of undisturbed, medium to very dense native soil or well-compacted fill placed against the sides of foundations may be considered equivalent to a fluid with a density of 250 pounds per cubic foot. The upper 1 ft of passive resistance should be neglected in design if not covered by pavement or floor slabs. The value for coefficient of sliding resistance does not include a factor of safety, and the value for the foundation passive earth pressure has been reduced by a factor of 2.0 to limit deflections to less than 1 percent of the embedded depth.

3.2.5 Foundation Drainage Considerations

Although the near-surface soil is relatively free draining, we recommend providing foundation drainage for all below-grade floor slabs. The foundation drainage system should consist of a minimum 4-inch diameter, smooth-walled, heavy-duty, minimum Schedule 80 PVC perforated pipe (with the perforations placed downward) in a minimum 12-inch thick envelope of 1-inch minus drain gravel. The drain gravel should completely surround the perforated drainpipe and be completely surrounded by a non-woven geotextile material such as Mirafi® 140N or equivalent. The top of the perforated pipe should be no higher than the top of the adjacent footing. The foundation drains should discharge to the site storm drainage system. We recommend that all below-grade walls be coated with a waterproofing compound.

The ground surface around the buildings should be properly graded to direct stormwater runoff away from the building. Surface water should not be allowed to pond and infiltrate into the ground surface near the building. Roof drainage should not be introduced into footing drains, but should be discharged directly to the stormwater system or other appropriate outlet by means of a tight line.

3.2.6 Slab-On-Grade Floors

Assuming that the building pads were constructed in accordance with the recommendations provided in Section 3.2.2 of this report, floors for the proposed structure may be constructed as slab-on-grade. Prior to placing the drainage material, the slab subgrade should be scarified as necessary, moisture conditioned to near optimum moisture content, and recompacted to at least 95 percent of the maximum dry density as determined by the ASTM D 1557 test procedure. The resulting slab subgrade should be firm and unyielding. The prepared surface should be checked by a qualified geotechnical engineer for any loose and/or disturbed areas. If detected, these areas should be further compacted as recommended above, or overexcavated and replaced with structural fill in accordance with Section 0 and 3.1.4 of this report.

For interior spaces, a minimum of 4 inches of clean, free-draining material, such as 3/4-inch minus washed gravel, should be placed beneath slab-on-grade floors to act as a capillary break. If moisture penetration through the slab is of concern, the use of a vapor barrier between the prepared subgrade and capillary break layer should be considered to minimize vertical transport of vapor through the slab while allowing moisture within the slab to escape through both the top and bottom during curing.

3.3 PAVEMENT

Provided the subgrade is prepared as recommended in Section 3.1.2 of this report, the existing site soil will provide suitable support for new pavements and gravel surfacing. The proposed paving section for the asphalt apron extending from SR 20 onto the site consist of 2 inches of asphalt pavement over 2 inches of Crushed Surfacing Top Course (CSTC), over 6 inches of Gravel Base. The gravel surface area section consists of 2 inches of CSTC over 4 inches of gravel base. These pavement sections should be adequate provided the subgrade prepared as recommended in Section 3.1.2 of this report.

Asphalt concrete should consist of Hot-Mix Asphalt Class ½-inch and meet the requirements in Section 5-04 of the Washington State Department of Transportation (WSDOT) *Standard Specifications for Roadway, Bridge, and Municipal Construction* (2012 WSDOT *Standard Specifications*; WSDOT 2012). The asphalt binder should be PG58-22. Crushed surfacing top course material should meet the gradation requirements in Section 9-09.3(9) of the 2012 WSDOT *Standard Specifications* and be placed in accordance with Section 4-04 of the 2012 WSDOT *Standard Specifications*. Gravel Base should meet the requirements in Section 9-09.10 of the 2012 WSDOT *Standard Specifications*. Crushed surfacing and gravel base should be compacted to at least 95 percent of the maximum dry density as determined by the ASTM D 1557 test procedure.

3.4 HORIZONTAL DIRECTION DRILLING

Based on conditions encountered in the boring B-1 completed at about the entry location of the HDD bore and our understanding of the project geologic setting, it is our opinion that it is feasible to construct the proposed offshore cable conduit by means of HDD.

Soil conditions along the proposed bore path outside are expected to generally consist of clean, granular sand and gravel (beach deposits) to about 64 ft BGS (elevation -59 ft). Below a depth of about 64 ft BGS, the soil transitions to fine-grained silt with varying amounts of clay and fine sand (glaciomarine drift). Based on our understanding of the regional geologic setting, we expect that the contact between the granular beach deposits and glaciomarine drift to slope gently downward to the south. Drop stones ranging from pebble-size to boulders several feet in diameter are often present within the glaciomarine drift deposits.

Based on our understanding of the geology in the project area and the general depositional environment, wood may be present within the beach deposits. If encountered, wood is expected to range in size from small discrete pieces to potential logs. Randomly disturbed cobbles and small boulders may also be present along the bore bath.

4.0 DOCUMENT REVIEW AND CONSTRUCTION OBSERVATIONS

Landau Associates recommends that we review the geotechnical-related portions of the plans and specifications for the proposed project in advance of project bidding. The purpose of the review is to verify that the recommendations presented in this geotechnical report have been properly interpreted and implemented in the design and specifications.

We recommend that monitoring, testing, and consultation be provided during construction to confirm that the conditions encountered are consistent with those indicated by our explorations, to provide expedient recommendations should conditions be revealed during construction that differ from those anticipated, and to evaluate whether geotechnical-related activities comply with project plans and specifications and the recommendations contained in this report. Such geotechnical-related activities include observation of the prepared subgrade, observation of foundations for buildings and retaining walls, compaction testing of structural fill and wall backfill, observation of any prepared pavement subgrade, observation of the horizontal directions drilling operations, and other geotechnical-related earthwork activities. The purpose of these services would be to observe compliance with the design concepts, specifications and recommendations of this report, and in the event subsurface conditions differ from those anticipated before the start of construction, provide revised recommendations appropriate to the conditions revealed during construction. Landau Associates would be pleased to provide these services for you.

5.0 USE OF THIS REPORT

This report was prepared for the exclusive use of Sounds and Sea Technology and Snohomish County PUD for specific application to the proposed control building and HDD bore located at 13254 SR 20 near Coupeville, Washington. The use by others, or for purposes other than intended, is at the user's sole risk. The findings, conclusions, and recommendations presented herein are based on our understanding of the project, review of available geotechnical and geologic information in the project vicinity, and on subsurface conditions observed during explorations completed on March 29, 2012 and downhole seismic survey completed on April 2, 2012. Within the limitations of scope, schedule, and budget, the conclusions and recommendations presented in this report were prepared in accordance with generally accepted geotechnical engineering principles and practices in the area at the time the report was prepared. We make no other warranty, either express or implied.

There may be some variation in subsurface soil and groundwater conditions at the site, and the nature and extent of the variations may not become evident until construction. Accordingly, a contingency for unanticipated conditions should be included in the construction budget and schedule. We should be contacted if variations in subsurface conditions are encountered during construction.

We appreciate the opportunity to provide geotechnical services on this project and look forward to assisting you during the bidding and construction phases. If you have any questions or comments regarding the information contained in this report, or if we may be of further service, please call.

LANDAU ASSOCIATES, INC.

Joshua D. Elliott, P.E.
Senior Staff Geotechnical Engineer

Edward J. Heavey, P.E.
Principal

2-13-13

JDE/EJH/jrc

6.0 REFERENCES

ASCE. 2006. *Minimum Design Loads for Buildings and Other Structures*. American Society of Civil Engineers.

ICC. 2009. *2009 International Building Code*. International Code Council.

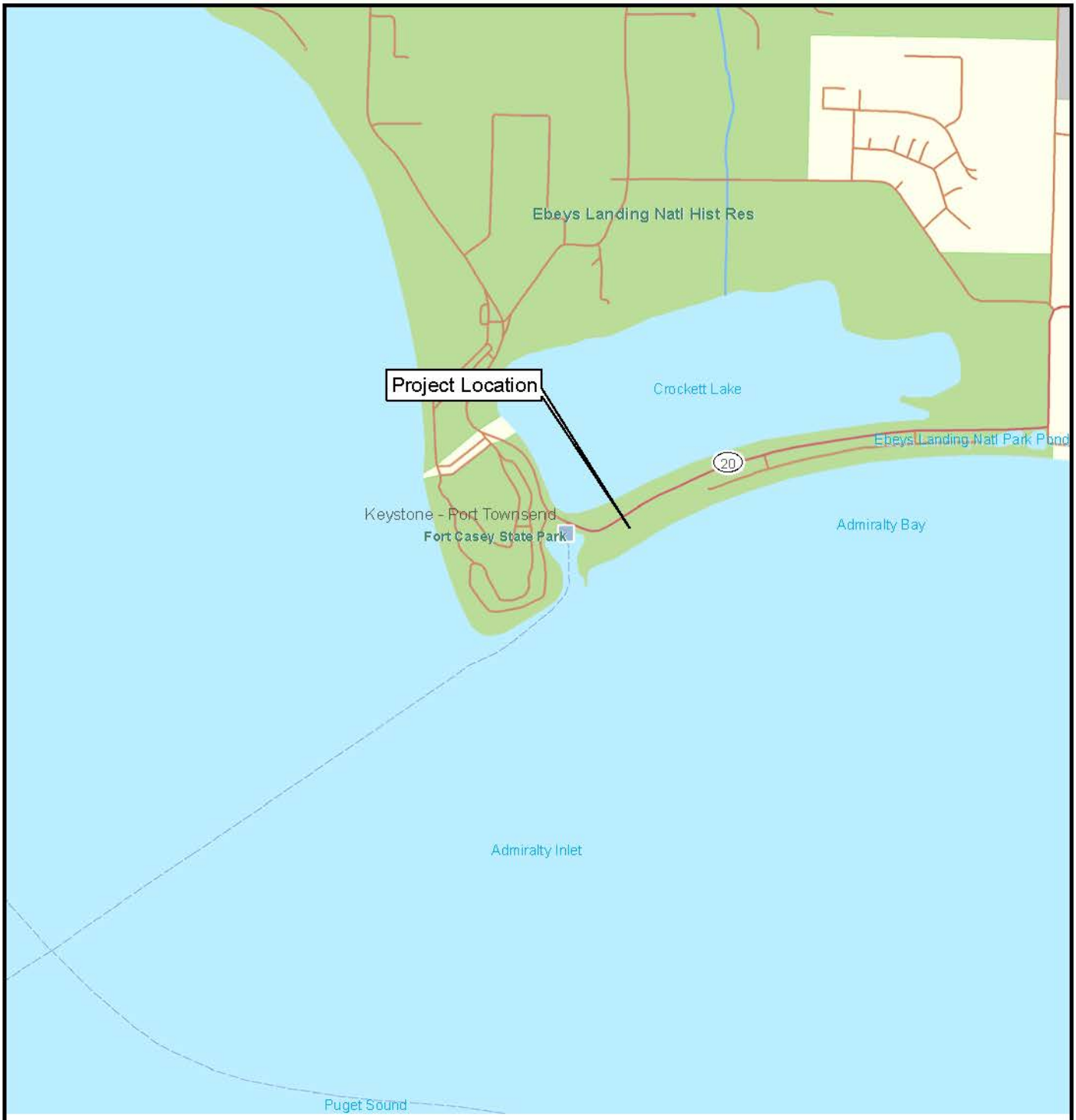
Idriss, I.M., and Boulanger, R.W. 2008. *Soil Liquefaction During Earthquakes*. Earthquake Engineering Research Institute.

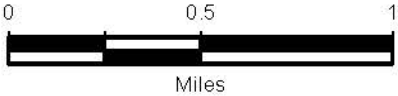
Polenz, M., et. al. 2005. *Geologic Map of the Coupeville and Part of the Port Townsend North 7.5 Minute Quadrangles, Island County Washington.* Washington Division of Geology and Earth Resources, Geologic Map GM-58, scale 1:24,000.

Thorson, R. M. 1980. *Ice-sheet Glaciation of the Puget Lowland, Washington, during the Vashon Stade (late Pleistocene)*. Quaternary Research. v. 13, no. 3. p. 303-321.

USGS. 2011. *Earthquake Ground Motion Parameters Software Program.* Version 5.1.0.

WSDOT. 2012. *Standard Specifications for Road, Bridge, and Municipal Construction.* Washington State Department of Transportation.





Data Source: ESRI 2008

LANDAU ASSOCIATES

Snohomish County PUD No. 1 Admiralty Inlet Pilot Tidal Project Island County, Washington	**Vicinity Map**	Figure 1

Legend

B-1 Approximate Boring Location and Designation

0 75 150

Scale in Feet

Note

1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Image Source: Google Earth Pro <April 19, 2012>

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Snohomish County PUD No. 1
Admiralty Inlet Pilot Tidal Project
Island County, Washington

Site and Exploration Plan

Figure 2

LANDAU ASSOCIATES, INC. | V:\1262\001\010.011\Figure 2_S&E Plan.dwg (A) "Figure 2" 2/12/2013

APPENDIX A

Field Explorations and Laboratory Testing

APPENDIX A
FIELD EXPLORATIONS AND LABORATORY TESTING

Subsurface conditions at the site were explored on March 29, 2012. The exploration program consisted of advancing and sampling three exploratory borings (B-1, B-2, and B-3). Boring B-1 was advanced to about 100 ft BGS with a track-mounted rotosonic drill rig near the HDD entrance, and borings B-2 and B-3 were advanced to about 21½ ft with a truck-mounted hollow-stem auger drill rig in the vicinity of the proposed control building at the approximate locations illustrated on the Site and Exploration Plan (Figure 2). Major Drilling, Inc. of Pacific, Washington advanced all three borings under subcontract to Landau Associates. The explorations were located approximately in the field by hand-taping from features referenced on a site plan provided by Lawhead Architects. The ground surface elevations at the exploratory boring locations were interpolated from the same site plan provided by Lawhead Architects.

The field exploration program was coordinated and monitored by a Landau Associates geotechnical engineer, who also obtained representative soil samples, maintained a detailed record of the observed subsurface soil and groundwater conditions, and described the soil encountered by visual and textural examination. Each representative soil type observed in our exploratory borings was described using the soil classification system shown on Figure A-1, in general accordance with American Society for Testing and Materials (ASTM) D 2488, *Standard Recommended Practice for Description of Soils (Visual-Manual Procedure)*. Logs of the exploratory borings are presented on Figures A-2 through A-4. These logs represent our interpretation of subsurface conditions identified during the field exploration program. The stratigraphic contacts shown on the logs represent the approximate boundaries between soil types; actual transitions may be more gradual. The soil and groundwater conditions depicted are only for the specific dates and locations reported and, therefore, are not necessarily representative of other locations and times. A further discussion of the soil and groundwater conditions observed is contained in the text portion of this report.

Disturbed samples of the soil encountered from the boring were obtained at 2½ foot intervals in borings B-2 and B-3 using a 1.5-inch inside diameter Standard Penetration Test split-spoon sampler. The sampler was driven up to 18 inches (or a portion thereof) into the undisturbed soil ahead of the auger bit with a 140-pound automatic hammer, falling a distance of approximately 30 inches. The number of blows required to drive the sampler for the final 12 inches (or portion thereof) of soil penetration, is noted on the boring logs adjacent to the appropriate sample notation. Upon completion of drilling and sampling, the borehole was decommissioned in general accordance with the requirements of the Washington Administrative Code (WAC) 173-160.

Continuous, disturbed samples were acquired in boring B-1 during rotosonic drilling in 10-ft lengths identified as a "run." Each run was extruded from the core barrel in 2- to 5-ft core lengths. During rotosonic sampling, a 4-inch sample barrel was driven into the formation ahead of a 6-inch casing, the sample barrel was tripped out of the drill-hole, and material in the sampler was vibrated into a polyethylene sleeve. For rotosonic samples, the run length, recovered length, and measured interval are noted on the logs. Representative disturbed "grab" samples were taken from the core at regular intervals (approximately every 5 ft).

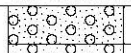
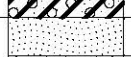
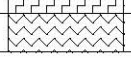
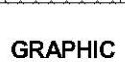
Natural moisture content determinations, sieve analyses, and Atterberg Limits tests were conducted in Landau Associates' laboratory on representative samples recovered from boring B-1 for the purpose of soil classification. Laboratory testing was performed in general accordance with the ASTM standard test procedures, which are described below. The samples were checked against the field log descriptions, which were updated where appropriate in general accordance with ASTM D 2487, Standard Test Method for Classification of Soils for Engineering Purposes.

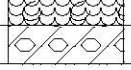
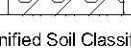
Natural moisture content determinations were performed on soil samples recovered from the borings in general accordance with ASTM D 2216. The natural moisture content is shown as W=xx (percent of dry weight) at the respective sample depth in the column labeled "Test Data" on the summary boring logs in Appendix A. Sieve analyses were performed on representative soil samples obtained from the borings in accordance with ASTM D 422, to provide an indication of the grain size distribution. The results are presented in the form of grain size distribution curves on Figures A-5 and A-6.

Atterberg limits tests were performed on representative soil samples obtained from the borings in accordance with ASTM D 4318 to provide an indication of the plasticity level of the fine grained soils encountered. Samples selected for Atterberg limits tests are designated with an "AL" in the column labeled "Test Data" on the summary boring logs (Figures A-2 through A-4). The results of the Atterberg limits tests are presented in graphical and tabular form on Figure A-7.

Vane shear and pocket penetrometer tests were performed on representative samples from the fine-grained portion of the rotosonic core. These tests were performed in Landau Associates' Tacoma office on April 6, 2012. Vane shear testing was performed in general accordance with ASTM D 2573. Although samples collected via rotosonic coring are disturbed, the samples tested were relatively intact and thought to provide an approximation of the in-situ undrained soil strength. The results of these tests are presented on the summary boring logs.

Soil Classification System

MAJOR DIVISIONS			GRAPHIC SYMBOL	USCS LETTER SYMBOL[1]	TYPICAL DESCRIPTIONS [2][3]
COARSE-GRAINED SOIL (More than 50% of material is larger than No. 200 sieve size)	GRAVEL AND GRAVELLY SOIL (More than 50% of coarse fraction retained on No. 4 sieve)	CLEAN GRAVEL (Little or no fines)		GW	Well-graded gravel; gravel/sand mixture(s); little or no fines
				GP	Poorly graded gravel; gravel/sand mixture(s); little or no fines
		GRAVEL WITH FINES (Appreciable amount of fines)		GM	Silty gravel; gravel/sand/silt mixture(s)
				GC	Clayey gravel; gravel/sand/clay mixture(s)
	SAND AND SANDY SOIL (More than 50% of coarse fraction passed through No. 4 sieve)	CLEAN SAND (Little or no fines)		SW	Well-graded sand; gravelly sand; little or no fines
				SP	Poorly graded sand; gravelly sand; little or no fines
		SAND WITH FINES (Appreciable amount of fines)		SM	Silty sand; sand/silt mixture(s)
				SC	Clayey sand; sand/clay mixture(s)
FINE-GRAINED SOIL (More than 50% of material is smaller than No. 200 sieve size)	SILT AND CLAY (Liquid limit less than 50)			ML	Inorganic silt and very fine sand; rock flour; silty or clayey fine sand or clayey silt with slight plasticity
				CL	Inorganic clay of low to medium plasticity; gravelly clay; sandy clay; silty clay; lean clay
				OL	Organic silt; organic, silty clay of low plasticity
	SILT AND CLAY (Liquid limit greater than 50)			MH	Inorganic silt; micaceous or diatomaceous fine sand
				CH	Inorganic clay of high plasticity; fat clay
				OH	Organic clay of medium to high plasticity; organic silt
	HIGHLY ORGANIC SOIL			PT	Peat; humus; swamp soil with high organic content

OTHER MATERIALS	GRAPHIC SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS
PAVEMENT		AC or PC	Asphalt concrete pavement or Portland cement pavement
ROCK		RK	Rock (See Rock Classification)
WOOD		WD	Wood, lumber, wood chips
DEBRIS		DB	Construction debris, garbage

Notes:
1. USCS letter symbols correspond to symbols used by the Unified Soil Classification System and ASTM classification methods. Dual letter symbols (e.g., SP-SM for sand or gravel) indicate soil with an estimated 5-15% fines. Multiple letter symbols (e.g., ML/CL) indicate borderline or multiple soil classifications.
2. Soil descriptions are based on the general approach presented in the Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), outlined in ASTM D 2488. Where laboratory index testing has been conducted, soil classifications are based on the Standard Test Method for Classification of Soils for Engineering Purposes, as outlined in ASTM D 2487.
3. Soil description terminology is based on visual estimates (in the absence of laboratory test data) of the percentages of each soil type and is defined as follows:

Primary Constituent:	> 50% - "GRAVEL," "SAND," "SILT," "CLAY," etc.
Secondary Constituents:	> 30% and ≤ 50% - "very gravelly," "very sandy," "very silty," etc.
	> 15% and ≤ 30% - "gravelly," "sandy," "silty," etc.
Additional Constituents:	> 5% and ≤ 15% - "with gravel," "with sand," "with silt," etc.
	≤ 5% - "with trace gravel," "with trace sand," "with trace silt," etc., or not noted.

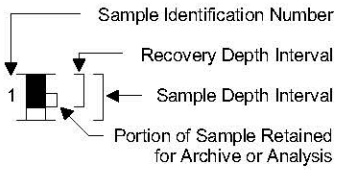
4. Soil density or consistency descriptions are based on judgement using a combination of sampler penetration blow counts, drilling or excavating conditions, field tests, and laboratory tests, as appropriate.

Drilling and Sampling Key

SAMPLER TYPE

Code	Description
a	3.25-inch O.D., 2.42-inch I.D. Split Spoon
b	2.00-inch O.D., 1.50-inch I.D. Split Spoon
c	Shelby Tube
d	Grab Sample
e	Single-Tube Core Barrel
f	Double-Tube Core Barrel
g	2.50-inch O.D., 2.00-inch I.D. WSDOT
h	3.00-inch O.D., 2.375-inch I.D. Mod. California
i	Other - See text if applicable
1	300-lb Hammer, 30-inch Drop
2	140-lb Hammer, 30-inch Drop
3	Pushed
4	Vibrocore (Rotosonic/Geoprobe)
5	Other - See text if applicable

SAMPLE NUMBER & INTERVAL



Field and Lab Test Data

Code	Description
PP = 1.0	Pocket Penetrometer, tsf
TV = 0.5	Torvane, tsf
PID = 100	Photoionization Detector VOC screening, ppm
W = 10	Moisture Content, %
D = 120	Dry Density, pcf
-200 = 60	Material smaller than No. 200 sieve, %
GS	Grain Size - See separate figure for data
AL	Atterberg Limits - See separate figure for data
GT	Other Geotechnical Testing
CA	Chemical Analysis

Groundwater

▽ Approximate water level at time of drilling (ATD)
▼ Approximate water level at time other than ATD

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Snohomish County PUD No. 1
Admiralty Inlet Pilot Tidal Project
Island County, Washington

Soil Classification System and Key

Figure A-1

B-1

LAI Project No: 1262001.010

Drilling Method: Rotosonic
Ground Elevation (ft): 12
Drilled By: Major Drilling
Logged By: JDE Date: 03/29/12

Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	Test Data	Graphic Symbol	USCS Symbol	Soil Profile
0	10	S-1					GP	Gray, medium to coarse GRAVEL (medium dense, moist) **(BEACH DEPOSITS)**
		S-2			W = 6 GS		SM	Brown, silty, very gravelly, fine to coarse SAND (medium dense, moist)
5	5	Run 1	f4					No Recovery
10	0	S-3					SP	Gray, fine to coarse SAND with gravel (medium dense, wet)
							GP	Gray, sandy, fine to coarse GRAVEL (medium dense, wet)
		S-4			W = 3 GS			
15	-5	Run 2	f4					No Recovery
20	-10	S-5			W = 9 GS		SP	Gray, very gravelly, fine to coarse SAND (medium dense, wet)
								No Recovery
25	-15	Run 3	f4					
30	-20	S-6			W = 9 GS		SP	Gray, very gravelly, fine to coarse SAND (medium dense, wet)
								No Recovery
35								

Groundwater: 6.0 ft ATD

Moisture Content (%): Plastic Limit 20 — Liquid Limit 80 (20, 40, 60, 80)
▲ SPT N-Value ▲ (△ Non-Standard N-Value △): 10, 20, 30, 40
× Fines Content (%) ×: 20, 40, 60, 80

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1262001.01 4/25/12 Y:\1262\001.010\TDRILLING (03_29_12)\1262001.010 GINT GPJ SOIL BORING LOG WITH GRAPH

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Snohomish County PUD No. 1
Admiralty Inlet Pilot Tidal Project
Island County, Washington

Log of Boring B-1

Figure A-2 (1 of 3)

B-1

LAI Project No: 1262001.010

Drilling Method: Rotosonic
Ground Elevation (ft): 12
Drilled By: Major Drilling
Logged By: JDE Date: 03/29/12

Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	Test Data	Graphic Symbol	USCS Symbol	Groundwater	Moisture Content (%) / SPT N-Value / Fines Content (%)
35		Run 4	f4						No Recovery
40	-25						SP		Gray, very gravelly, fine to coarse SAND (medium dense, wet)
	-30	S-7							No Recovery
45		Run 5	f4						
	-35								
50		S-8			W = 8 GS		SP		Gray, very gravelly, fine to coarse SAND (dense, wet)
	-40								
55		Run 6	f4						
	-45	S-9							No Recovery
60							SP		Gray, gravelly, fine to coarse SAND with frequent shell fragments (dense, wet)
	-50	S-10			W = 15 GS				
		S-11					SW/ MH		SAND/SILT transitional zone, abundant white shells up to 3.5" across (medium dense/stiff, wet)
65		Run 7	f4				CL/ CH		Gray, silty CLAY with trace sand (medium stiff to stiff, moist to wet) **(GLACIOMARINE DRIFT)**
	-55	VS-1			TV=0.35 PP=1.00 W = 36 AL				
		S-12							
70									

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1262001.01 4/25/12 Y:\1262\001.010\TDRILLING (03_29_12)\1262001.010 GINT GPJ SOIL BORING LOG WITH GRAPH

LANDAU ASSOCIATES

Snohomish County PUD No. 1
Admiralty Inlet Pilot Tidal Project
Island County, Washington

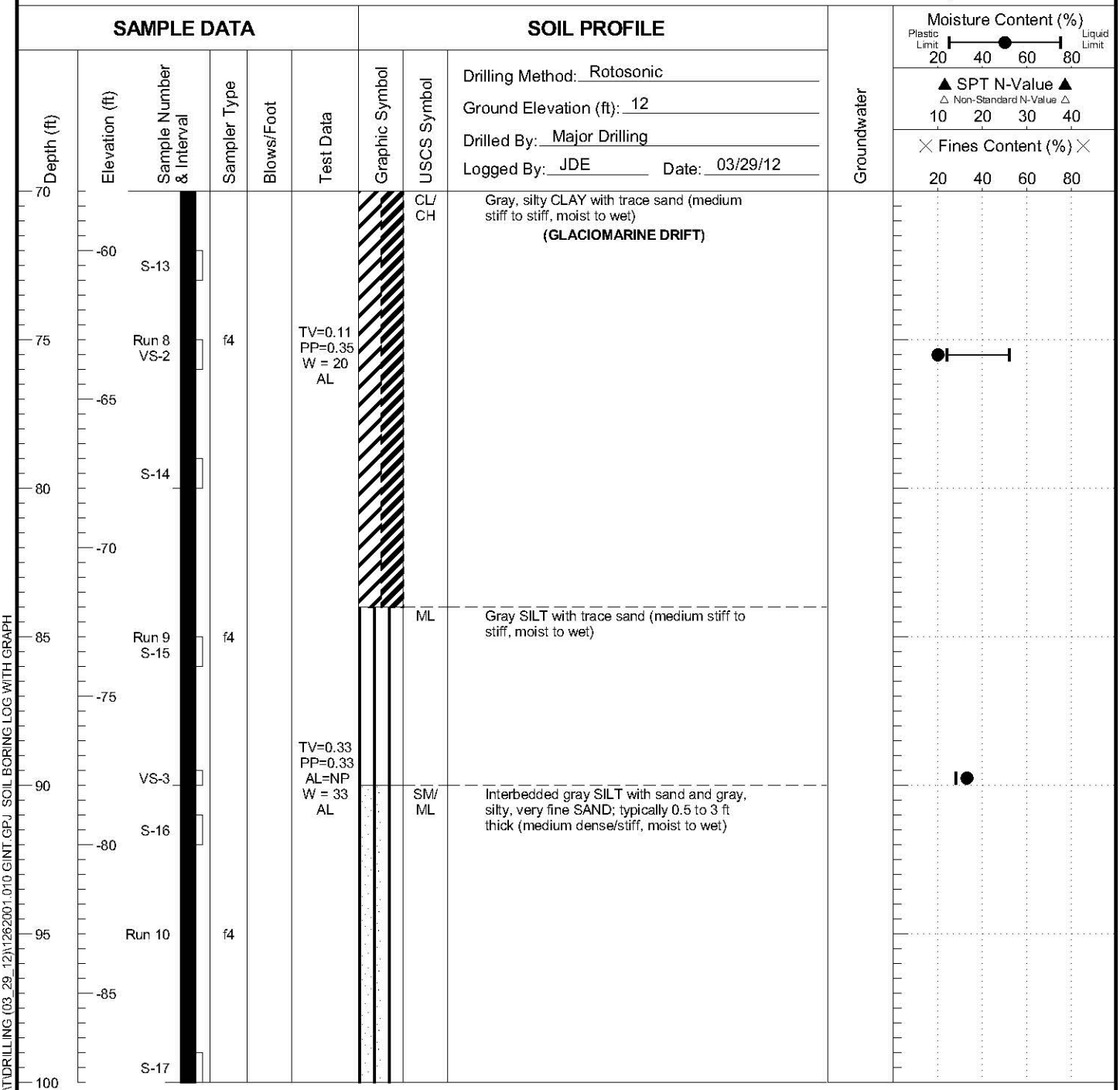
Log of Boring B-1

Figure A-2 (2 of 3)

B-1

LAI Project No: 1262001.010

Drilling Method: Rotosonic
Ground Elevation (ft): 12
Drilled By: Major Drilling
Logged By: JDE Date: 03/29/12



Boring Completed 03/29/12
Total Depth of Boring = 100.0 ft.

Seismic Casing Completed 03/30/12
Total Depth of Seismic Casing = 100.1 ft.

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1262001.01 4/25/12 Y:\1262\001.010\TDRILLING (03_29_12)\1262001.010 GINT GPJ SOIL BORING LOG WITH GRAPH

LANDAU ASSOCIATES

Snohomish County PUD No. 1
Admiralty Inlet Pilot Tidal Project
Island County, Washington

Log of Boring B-1

Figure
A-2
(3 of 3)

B-2

LAI Project No: 1262001.010

Drilling Method: Hollow-Stem Auger
Ground Elevation (ft): 9
Drilled By: Major Drilling
Logged By: JDE Date: 03/29/12

Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	Test Data	Graphic Symbol	USCS Symbol	Soil Profile	Groundwater
0							OL	Brown, sandy, organic SILT (soft to medium stiff, moist) (TOPSOIL)	
							GP	Gray, medium to coarse GRAVEL, rounded (medium dense, moist) (BEACH DEPOSITS)	
	5	S-1b S-1	d b2	17			SP	Brown, gravelly, medium to coarse SAND, trace roots (medium dense, moist)	
5		S-2	b2	14					
		S-3	b2	15			GP	Brown, sandy, fine to coarse GRAVEL, rounded (medium dense, wet)	▽ 7.0 ft ATD
	0								
10		S-4	b2	19			SP	Gray, medium to coarse SAND with gravel (very dense, wet)	
	-5	S-5	b2	50/ 3"					
15		S-6	b2	56			SP	Gray, fine to coarse SAND with gravel (very dense, wet)	
	-10	S-7	b2	56					
20		S-8	b2	19					
25									
30									
35									

Moisture Content (%)
Plastic Limit — Liquid Limit
20 40 60 80

▲ SPT N-Value ▲
△ Non-Standard N-Value △
10 20 30 40

× Fines Content (%) ×
20 40 60 80

50/3"
56
56

Boring Completed 03/29/12
Total Depth of Boring = 21.5 ft.

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1262001.01 4/25/12 Y:\1262\001.010\TDRILLING (03_29_12)\1262001.010 GINT GPJ SOIL BORING LOG WITH GRAPH

LANDAU ASSOCIATES

Snohomish County PUD No. 1
Admiralty Inlet Pilot Tidal Project
Island County, Washington

Log of Boring B-2

Figure
A-3

B-3

LAI Project No: 1262001.010

Drilling Method: Hollow-Stem Auger
Ground Elevation (ft): 9
Drilled By: Major Drilling
Logged By: JDE Date: 03/29/12

Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	Test Data	Graphic Symbol	USCS Symbol	Soil Profile
0	5	S-1	b2	11			OL	Brown, sandy, organic SILT (soft to medium stiff, moist) **(TOPSOIL)**
							GP	Gray, medium to coarse GRAVEL, rounded (loose, moist) **(BEACH DEPOSITS)**
5	0	S-2	b2	13			GP	Brown, sandy, fine to coarse GRAVEL, rounded (medium dense, moist)
		S-3	b2	19			SP	Gray, sandy, fine to medium GRAVEL, rounded (medium dense, wet)
10	-5	S-4	b2	13			SP	Gray, gravelly, fine to coarse SAND (medium dense, wet)
		S-5	b2	26				
15	-10	S-6	b2	62				Grades to very dense (15'-17')
		S-7	b2	28				
20		S-8	b2	23				
25								
30								
35								

Groundwater: ▽ 6.5 ft ATD

Moisture Content (%): Plastic Limit 20 — Liquid Limit 80

▲ SPT N-Value ▲ (△ Non-Standard N-Value △): 10 20 30 40

× Fines Content (%) ×: 20 40 60 80

62

Boring Completed 03/29/12
Total Depth of Boring = 21.5 ft.

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1262001.01 4/25/12 Y:\1262\001.010\TDRILLING (03_29_12)\1262001.010 GINT GPJ SOIL BORING LOG WITH GRAPH

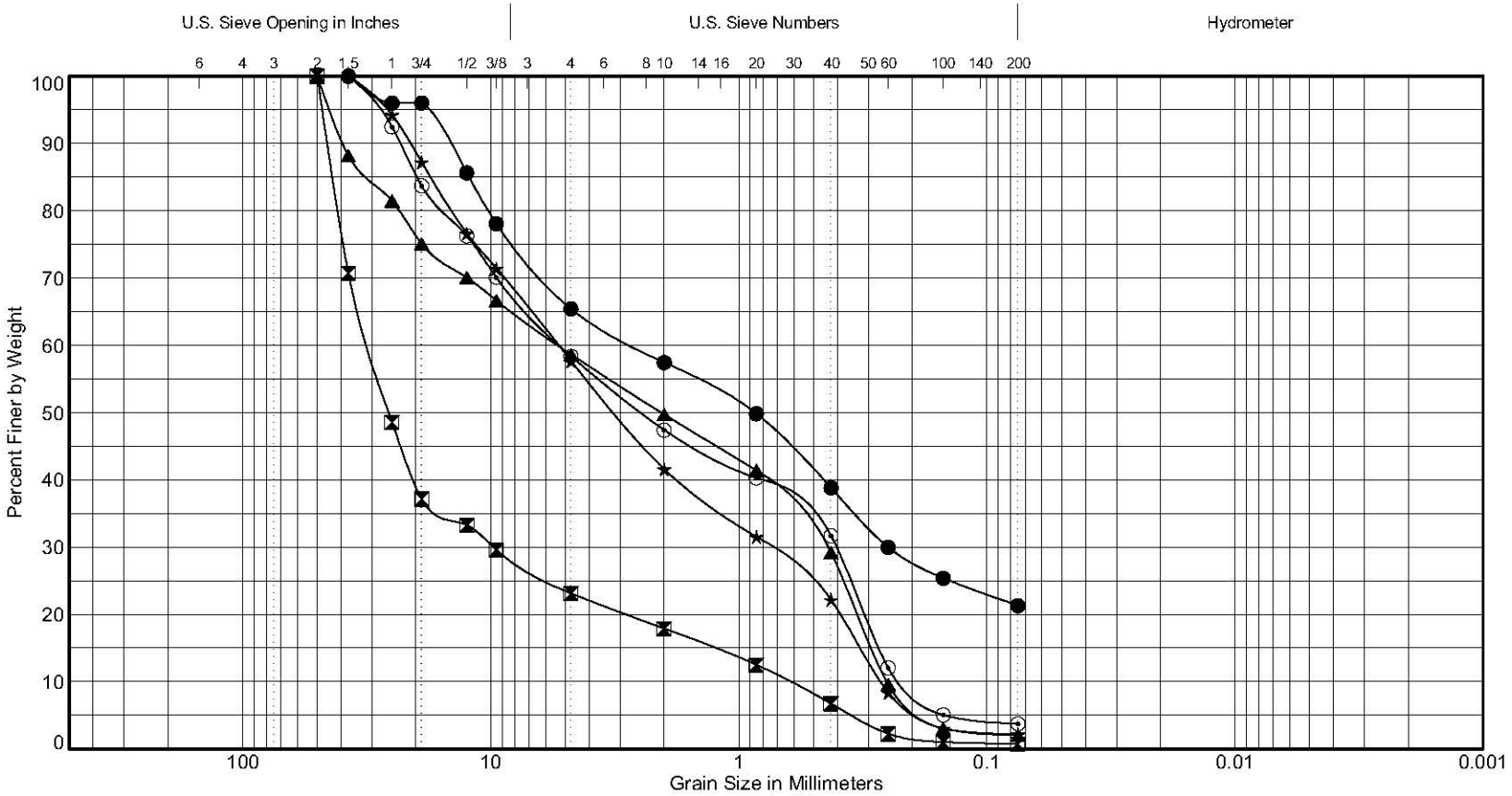
LANDAU ASSOCIATES

Snohomish County PUD No. 1
Admiralty Inlet Pilot Tidal Project
Island County, Washington

Log of Boring B-3

Figure A-4

1262001.01 4/25/12 Y:\1262\001.010\T\DRILLING (03_29_12)\1262001.010 GINT.GPJ GRAIN SIZE FIGURE



Cobbles	Gravel		Sand			Silt or Clay
	Coarse	Fine	Coarse	Medium	Fine	

Symbol	Exploration Number	Sample Number	Depth (ft)	Natural Moisture (%)	Soil Description	Unified Soil Classification
●	B-1	S-2	2.7	6	Silty, very gravelly, fine to coarse SAND	SM
⊠	B-1	S-4	13.0	3	Sandy, fine to coarse GRAVEL	GP
▲	B-1	S-5	22.0	9	Very gravelly, fine to coarse SAND	SP
★	B-1	S-6	31.0	9	Very gravelly, fine to coarse SAND	SP
⊙	B-1	S-8	50.1	8	Very gravelly, fine to coarse SAND	SP

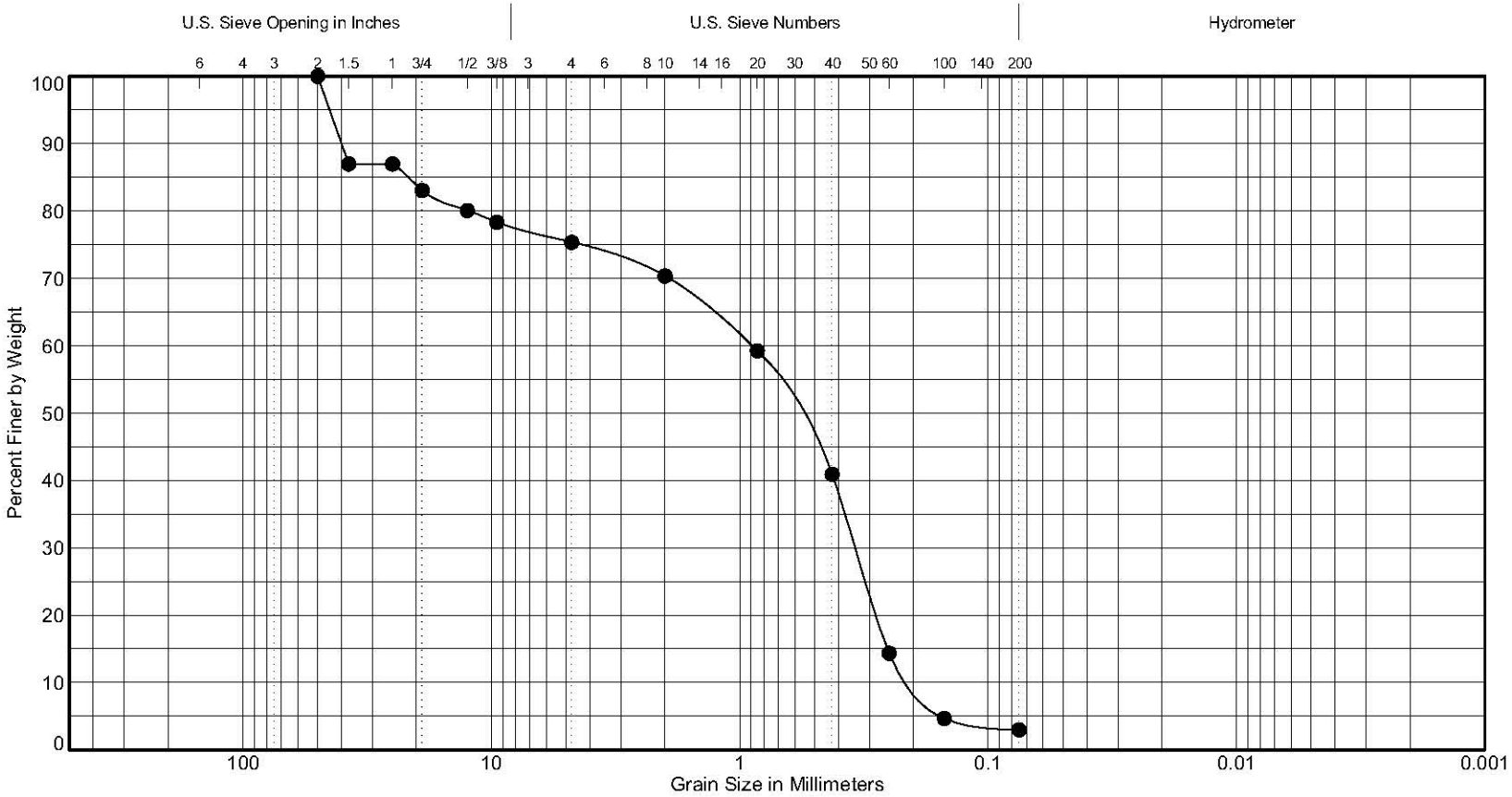
LANDAU ASSOCIATES

Snohomish County PUD No. 1
Admirality Inlet Pilot Tidal Project
Island County, Washington

Grain Size Distribution

Figure
A-5

1262001.01 4/25/12 Y:\1262\001.010\T\DRILLING (03_29_12)\1262001.010 GINT.GPJ GRAIN SIZE FIGURE

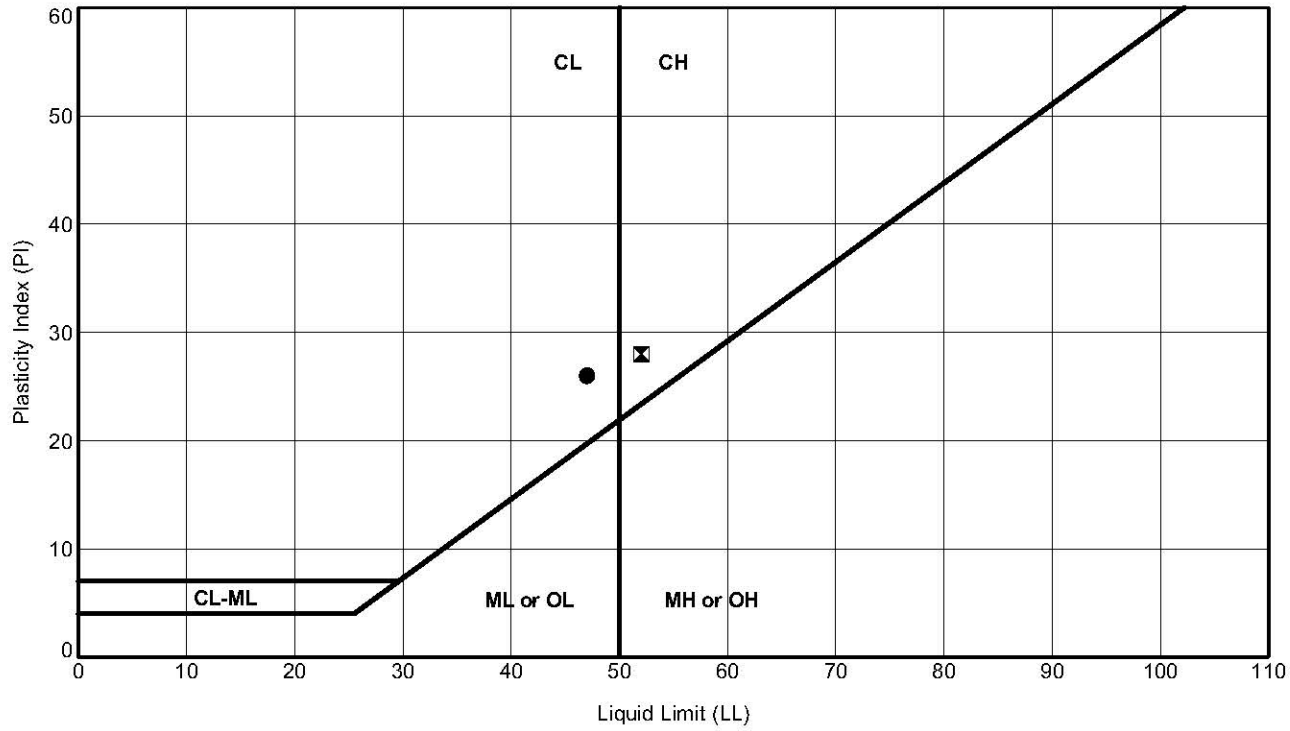


Cobbles	Gravel		Sand			Silt or Clay
	Coarse	Fine	Coarse	Medium	Fine	

Symbol	Exploration Number	Sample Number	Depth (ft)	Natural Moisture (%)	Soil Description	Unified Soil Classification
●	B-1	S-10	61.0	15	Gravelly, fine to coarse SAND with frequent shell fragments	SP

LANDAU ASSOCIATES

Snohomish County PUD No. 1 Admiralty Inlet Pilot Tidal Project Island County, Washington	Grain Size Distribution	Figure A-6



ATTERBERG LIMIT TEST RESULTS

Symbol	Exploration Number	Sample Number	Depth (ft)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Natural Moisture (%)	Soil Description	Unified Soil Classification
●	B-1	VS-1	66.0	47	21	26	36	Silty CLAY with trace sand	CL/CH
⧓	B-1	VS-2	75.0	52	24	28	20	Silty CLAY with trace sand	CL/CH

ASTM D 4318 Test Method

1262001.01 4/25/12 Y:\1262\001.010\TVDRILLING (03_29_12)\1262001.010 GINT.GPJ ATTERBERG LIMITS FIGURE

LANDAU ASSOCIATES

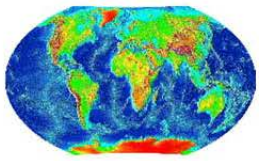
Snohomish County PUD No. 1
Admiralty Inlet Pilot Tidal Project
Island County, Washington

Plasticity Chart

Figure
A-7

APPENDIX B

Downhole Seismic Survey



Global Geophysics
16651 White Mountain Road SE
Monroe, WA 98272
Tel: 425-890-4321
Fax: 360-805-0259

April 8, 2012 Our Ref.: 102-0115.000

Landau Associates, Inc.
950 Pacific Avenue, Suite 515
Tacoma, WA 98402

Attention: Mr. Edward Heavey

RE: REPORT ON THE SUSPENSION LOGGING FOR THE SNOHOMISH COUNTY PUD TIDAL TURBINE PROJECT LOCATED AT 13254 STATE ROUTE (SR) 20 COUPEVILLE, WASHINGTON

Global Geophysics conducted borehole suspension logging survey in borehole B1 to obtain s-wave and p-wave velocities at 13254 State Route (SR) 20, Coupeville, WA. The following paragraphs describe the method and result.

METHODOLOGY AND INSTRUMENTATION

Suspension Logging

Suspension soil velocity measurements were performed using the suspension PS logging system, manufactured by OYO Corporation, and their subsidiary, Robertson Geologging. This system directly determines the average velocity of a 3.3 feet high segment of the soil column surrounding the boring of interest by measuring the elapsed time between arrivals of a wave propagating upward through the soil column. The receivers that detect the wave, and the source that generates the wave, are moved as a unit in the boring producing relatively constant amplitude signals at all depths.

The suspension system probe consists of a combined reversible polarity solenoid horizontal shear wave source (SH) and compressional-wave source (P), joined to two biaxial receivers by a flexible isolation cylinder. The separation of the two receivers is 3.28 feet, allowing average wave velocity in the region between the receivers to be determined by inversion of the wave travel time between the two receivers. The total length of the probe as used in these surveys is 21 feet. The probe receives control signals from, and sends the receiver signals to, instrumentation on the surface via an armored 4-conductor cable. The cable is wound onto the drum of a winch and is used to support the probe. Cable travel is measured to provide probe depth data, using a 1.3-foot circumference sheave fitted with a digital rotary encoder. The entire probe is suspended in the boring by the cable, therefore, source motion is not coupled directly to the boring walls; rather, the source motion creates a horizontally propagating impulsive pressure wave in the fluid filling the boring and surrounding the

source. This pressure wave is converted to P and SH-waves in the surrounding soil and rock as it passes through the casing and grout annulus and impinges upon the wall of the boring. These waves propagate through the soil and rock surrounding the boring, in turn causing a pressure wave to be generated in the fluid surrounding the receivers as the soil waves pass their location.

In operation, a distinct, repeatable pattern of impulses is generated at each depth as follows:
1. The source is fired in one direction producing dominantly horizontal shear with some vertical compression, and the signals from the horizontal receivers situated parallel to the axis of motion of the source are recorded.
2. The source is fired again in the opposite direction and the horizontal receiver signals are recorded.
3. The source is fired again and the vertical receiver signals are recorded. The repeated source pattern facilitates the picking of the P and SH-wave arrivals; reversal of the source changes the polarity of the SH-wave pattern but not the P-wave pattern.

RESULTS

The calculated S-wave and P-wave velocities from B1 are presented in table below.

Depth (ft)	S-wave velocity (ft/s)	P-wave velocity (ft/s)
7	326	
9	321	
11	577	
13	484	
15	538	
17	643	
19	590	
21	663	
23	649	5045
25	564	5045
27	687	4825
29	671	5205
31	677	4969
33	740	5376
35	705	5376
37	581	5468
39	705	5205
41	649	4825
43	684	4969

45	594	4753
47	602	5205
49	528	5127
51	458	4897
53	858	5963
55	544	5655
57	589	5963
59	676	5963
61	751	5560
63	649	4897
65	918	5291
67	846	5655
69	877	5291
71	820	5205
73	974	5560
75	713	5127
77	687	5045
79	615	4431
81	776	4753
83	707	5205

LIMITATIONS OF THE GEOPHYSICAL METHODS

Global geophysics services are conducted in a manner consistent with the level of care and skill ordinarily exercised by other members of the geophysical community currently practicing under similar conditions subject to the time limits and financial and physical constraints applicable to the services. Suspension logging is remote sensing geophysical methods that may not detect all subsurface conditions. In general, the errors in the calculated velocities are about ±15 % of the true velocities. The calculated shear wave velocities at this borehole may not represent the soil conditions of the whole development site.

Sincerely,

Global Geophysics

John Liu, Ph.D., R.G.
Principal Geophysicist

Appendix G

GEOPHYSICAL INVESTIGATION (OFFSHORE)

Golder Associates
Final Report
Geophysical Investigation for Admiralty Inlet Turbine Project

September 2011

Final Report

Geophysical Investigation for Admiralty Inlet Turbine Project

Prepared for:
Snohomish PUD
Public Utility District No.1 of Snohomish County
2320 California Street

September 2011

A world of capabilities delivered locally

Golder Associates

11393037100cv01.indd

REPORT

GEOPHYSICAL INVESTIGATION FOR ADMIRALTY INLET TURBINE PROJECT

Submitted To: Snohomish PUD
Public Utility District No. 1 of Snohomish County
2320 California Street
Everett, WA 98201

Submitted By: Golder Associates Inc.
18300 NE Union Hill Road, Suite 200
Redmond, WA 98052 USA

September 6, 2011

Project No. 113-93037

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Table of Contents

1.0 INTRODUCTION 1
2.0 SURVEY OBJECTIVE 1
3.0 INSTRUMENTATION 1
3.1 Navigation 1
3.2 Bathymetry 1
3.3 Datums 2
3.4 Sub bottom Profiler and Seismic Reflection Systems 2
3.5 Survey Coverage 2
4.0 ANALYSIS OF GEOPHYSICAL DATA 3
5.0 INTERPRETED RESULTS 5
5.1 Turbine Site 5
5.2 Cable Corridor 5
6.0 CLOSING 9

List of Figures

Figure 1 Geophysical Instrumentation

List of Maps

Map 1 Trackline Map
Map 2 Bathymetric Contours
Map 3 Bathymetric Image 50 cm Resolution
Map 4 Bathymetric Image and Contours
Map 5 Sidescan Sonar Mosaic
Map 6 Subbottom Profiler Sediment Isopach
Map 7 Seismic Reflection Sediment Isopach

1.0 INTRODUCTION

This letter report summarizes the results of the geophysical investigation for the proposed Admiralty Inlet turbine project. The information presented in this report will be used by others to assist in evaluating and interpreting the geology at the turbine site and for selecting a route from shore to the site for the power cable. Further interpretation of the geology and geotechnical attributes at the site will be based on soil samples that are to be obtained in a subsequent subsurface investigation.

2.0 SURVEY OBJECTIVE

The purpose of the marine precision bathymetric and geophysical survey was to obtain information for selecting potential cable routes from shore to the turbine sites and assist in evaluating surface and subsurface geologic conditions at the turbine sites. The geophysical data are to be used as an aide to characterize seafloor material and to estimate the thickness of the sediment on the seafloor at the proposed site and along the proposed power cable corridors. This geophysical data will also be used to develop a geotechnical investigation program or an optional geophysical investigation that would include multichannel analysis of seismic waves (MASW).

3.0 INSTRUMENTATION

The geophysical data were acquired with a suite of instruments that, with the exception of the sidescan sonar, were deployed and operated simultaneously. The following is a brief discussion of the instruments and the shipboard configuration of the instruments is illustrated on Figure 1.

3.1 Navigation

The position of the survey vessel was determined using a Coda F180 inertial navigation system with differential global positioning system (DGPS) utilizing a Coast Guard beacon located at Whidbey Island. The DGPS was interfaced with the geophysical instruments including the echosounder, graphic recorders, and QPS QINSy digital acquisition systems. QPS QINSy was used to provide real-time data acquisition, quality assurance tools and data file storage during the survey. The position of the survey vessel, planned and completed tracklines and navigation parameters including speed, heading and cross-track error were displayed in real-time on multiple monitors. This made it possible for the helmsman to navigate the survey vessel along the planned survey transects.

3.2 Bathymetry

The bathymetric data were acquired with a R2 Sonic 2024 multibeam operating at the 400 kHz frequency. Vessel heading, heave, pitch and roll were recorded from an inertial navigation sensor to correct the multibeam swath bathymetry for vessel attitude. Sound velocity casts were taken at the beginning of each day and every two hours to record the speed of sound through the water column. The data was used to apply refraction corrections to the multibeam.

Bathymetric post processing was performed with Caris Hips version 7. Soundings were corrected for vessel attitude and beam refraction and cleaned of erroneous data. The final soundings were created with a data binning process that reports the average value of all soundings within a given cell. The cell center is used as the X and Y coordinate. Smaller bin sizes preserve the accuracy of the surface better but result in very large and difficult to manage datasets. A larger bin size will produce smaller datasets but may smooth the surface with undesired affects. One and two meter binned data sets were provided for this project

3.3 Datums

The horizontal datum is NAD83, UTM Zone 10, meters. The vertical datum is Mean Lower Low Water (MLLW) datum, holding the NOS Tidal Benchmark "R 257 1944" at Tide Station 9444900 in Port Townsend. Vertical positions were corrected with the GEOID09 geoid model. Post Processed Kinematic (PPK) GPS was used to refine the final horizontal and vertical vessel positioning holding Continuously Operating Reference Station (CORS) Whidbey Island 5 as the reference station. PPK positioning was applied to the multibeam only to improve the real-time DGPS vessel positioning accuracy from approximately one meter to better than 10 centimeters (cm).

3.4 Sub bottom Profiler and Seismic Reflection Systems

The need for high-resolution data in fine to medium-grained sediment and subsurface penetration in coarse-grained material required the use of two acoustic systems that had different output characteristics.

A 3.5 kilohertz (kHz) sub bottom profiler (SBP) system was used to provide high-resolution information on the thickness of fine-grained sediment. The high-resolution data were displayed in real-time on a graphic recorder, and archived on a digital acquisition system. The graphic recorder and digital acquisition system were interfaced with the navigation system to provide real-time fiducials or event marks on the archived and printed data.

A low frequency acoustic system (800 Hz to 2000 Hz) was used to acquire deeper subsurface reflection data. The data were displayed in real-time on a thermal graphic recorder and archived on a digital recorder. The display recorder and digital system were interfaced with the GPS navigation system and received an event mark, tagged to vessel position, every 30 seconds.

3.5 Survey Coverage

The bathymetric and seismic data were acquired simultaneously on a series of parallel transects (Map 1). In the turbine area, the transects were oriented NE-SW spaced at an interval of 30 feet (10 m). In the proposed cable corridor area the NS and EW transects were spaced at an interval of 150 feet (50 m).

The sidescan sonar data were acquired after completing the bathymetric and seismic survey on two transects that ran approximately down the center of the proposed cable corridor area (Map 1)

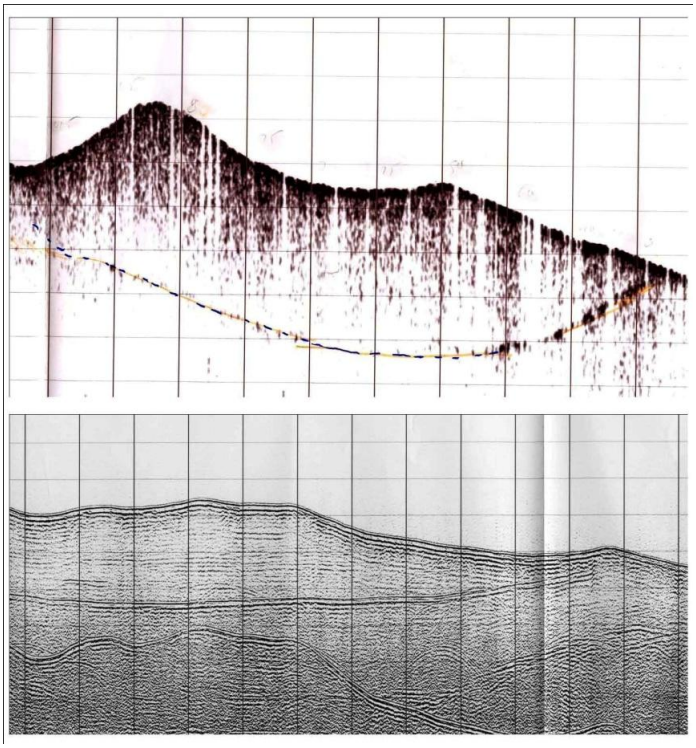
4.0 ANALYSIS OF GEOPHYSICAL DATA

The seismic reflection and subbottom field records and the processed data were analyzed to provide a qualitative classification of stratigraphy, based on seismic characteristics, and to determine the thickness of unconsolidated sediment and/or depth to an interpreted acoustically-hard material or reflector. In addition, an effort was made to identify subsurface features that suggested the presence of potential geohazards or anomalous geologic conditions such as buried channels, submarine landslides and potential faults and the presence of large boulders.

Stratigraphic classification, based on seismic reflection data, uses the principal of seismic facies analysis. This method identifies various reflection patterns observed in the data (e.g., reflection free, uniform horizontal reflectors, discontinuous reflectors, chaotic reflectors, hyperbolic reflectors, multiple reflections etc.) and then assumes a particular pattern is characteristic of a particular type of sediment, geology or depositional environment. For example a reflector pattern (geophysical facies) on the record comprised of continuous, thin layers suggests fine-grained sediment deposited in a low energy environment such as lake or deep-water deposits. The subbottom example shown in the image below would be an example of this type of reflection pattern and interpretation. Sediments deposited in a high-energy environment, or that may be more consolidated than overlying material, usually produce very strong reflections (dark layers on the records) and the reflectors are often discontinuous. Areas of no subsurface penetration, with a dark reflection pattern, or numerous multiple reflections, represent acoustically-hard material such as bedrock or over-consolidated glacial and interglacial deposits. Large boulders produce hyperbolic reflections; upside down U shaped patterns.

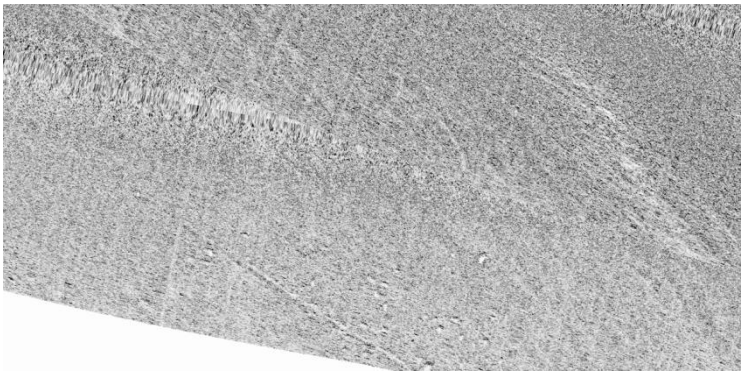
Examples of the geophysical acoustic data obtained during this survey are shown in the figure below. The upper image is from the subbottom profiler (SBP) and shows a relatively thick deposit of what is interpreted to be fine-grained sediment. It is relatively acoustically transparent. This material was probably deposited in a glacial lake or in a quiet water marine environment. Each division is 20 feet (approximately 7 m) and the deposit has a maximum thickness of 70 feet (approximately 23 m). This data example is not in the turbine area.

The lower image is from the seismic reflection system that achieved considerably more subsurface penetration than the SBP system. The fine-grained deposits discussed above can be seen on this image as well as thin, horizontally layered interbeds within the deposit. Each division is 40 feet (approximately 13 m) on this image. On the right side of the image hyperbolic reflectors can be seen suggesting the presence of boulders and possibly an over-consolidated glacial or interglacial deposit. The relative dark reflector on the left and towards the bottom of the image is a multiple reflection, or echo, of the seabed.



Example of subbottom profiler data (upper) and seismic reflection data (lower).

The sidescan sonar data were processed and the data from the two transects were combined to produce one image or a mosaic of the seabed along the proposed cable corridor.



Example of sidescan sonar mosaic. Linear feature along the bottom of the image is one of the communication cables that pass through the survey area.

5.0 INTERPRETED RESULTS

5.1 Turbine Site

The water depth in the region of the proposed turbine sites ranged from 45 to 70 m (Maps 2, 3 and 4). Based on previous studies using underwater video the bottom conditions in the area of the proposed turbine site are reported to consist of coarse-grained sediment including cobbles and boulders with interstitial clay. In addition, a number of very large boulders were observed on the multibeam bathymetric data and the sidescan sonar image as well as a section of one of the communication cables that pass through the area (Map 5). The largest of the boulders has an estimated weight of 8 million kilograms (kg) and the smaller ones are estimated to weigh approximately 45,000 to 60,000 kg (Map 3). These boulders are interpreted to be glacial erratics, dropped from the ice over 10,000 years ago. The do not appear to have settled into the seabed but do show evidence of a scour moat surrounding them.

An accurate thickness of the cobble pavement is difficult to determine but it estimated to range between 1 and 2 m. Unfortunately the gravel and cobbles on the seabed scatters the acoustic energy and therefore a distinct, continuous contact between the surficial layer and the underlying material cannot be easily identified.

In the south-west corner of the area the material on the seabed contains fine to medium-grained material, identified on the subbottom profiler data, that is up to 12 m thick (Map 6). In the remainder of the area the surficial and underlying material are interpreted to be coarse-grained and are possibly semi-consolidated (Map 7). There are also hyperbolic features and discontinuous reflectors in these underlying materials suggesting that small cobbles, gravel etc. are entrained within the deposit.

The deepest reflector mapped, 30 to 40 m below the seabed, is interpreted to be the top of over-consolidated glacial or interglacial deposits. The surface of this unit is irregular in shape, and there are numerous hyperbolic reflections indicating the presence of boulders. The seismic characteristic of this unit is typical of glacial till observed in other glacial environments.

5.2 Cable Corridor

The seabed along the proposed cable corridor ranged in depth from 2 m, at the landing site, to 60 m in the area of the turbine sites (Maps 2-4). The gradient of the seabed is approximately 1:100 going south from the landing site to the bottom of the slope. Going westward from this point to the turbine site the seabed gradient is also approximately 1:100. However, there are several changes in elevation of the seabed, such as depressions with 5 to 10 m of relief that are crossed in this direction.

The sidescan sonar data detected a number of large cobbles and boulders as well as evidence of seabed scour that are probably produced by the high currents in the area. There was no evidence of debris or

cultural artifacts on the seabed with the exception of evidence for one of the communication cables near the turbine site.

The subbottom profiler (SBP) detected a surficial layer of what is interpreted to be fine to medium-grained, unconsolidated sediment along most of the corridor (Map 6). On the slope these material were generally less than 5 m in thickness. However, in one area, in deeper water, these sediments are up to 30 m in thickness in what is a relatively deep basin.

As expected the seismic reflection system was able to achieve considerably greater subsurface penetration than the SBP system. On the slope these sediment, interpreted to contain medium to coarse grained material, ranged in thickness from 5 to 30 m. No subsurface penetration could be achieved beneath this material and it appears that the underlying unit is an over consolidated glacial till.

In the area of the basin containing the fine-grained sediment mapped with the SBP the maximum sediment thickness, including fine and medium grained material is 70 m. This material is underlain by what it interpreted to be an over-consolidated glacial deposit containing large boulders.

6.0 CLOSING

We trust the foregoing is satisfactory for your current needs. If you should have any questions or comments, please contact the under signed.

Richard Sylwester, LG, LEG
Associate, Geophysicist

David P. Findley, LG, LEG
Associate, Engineering Geologist

RS/DPF/km

FIGURE

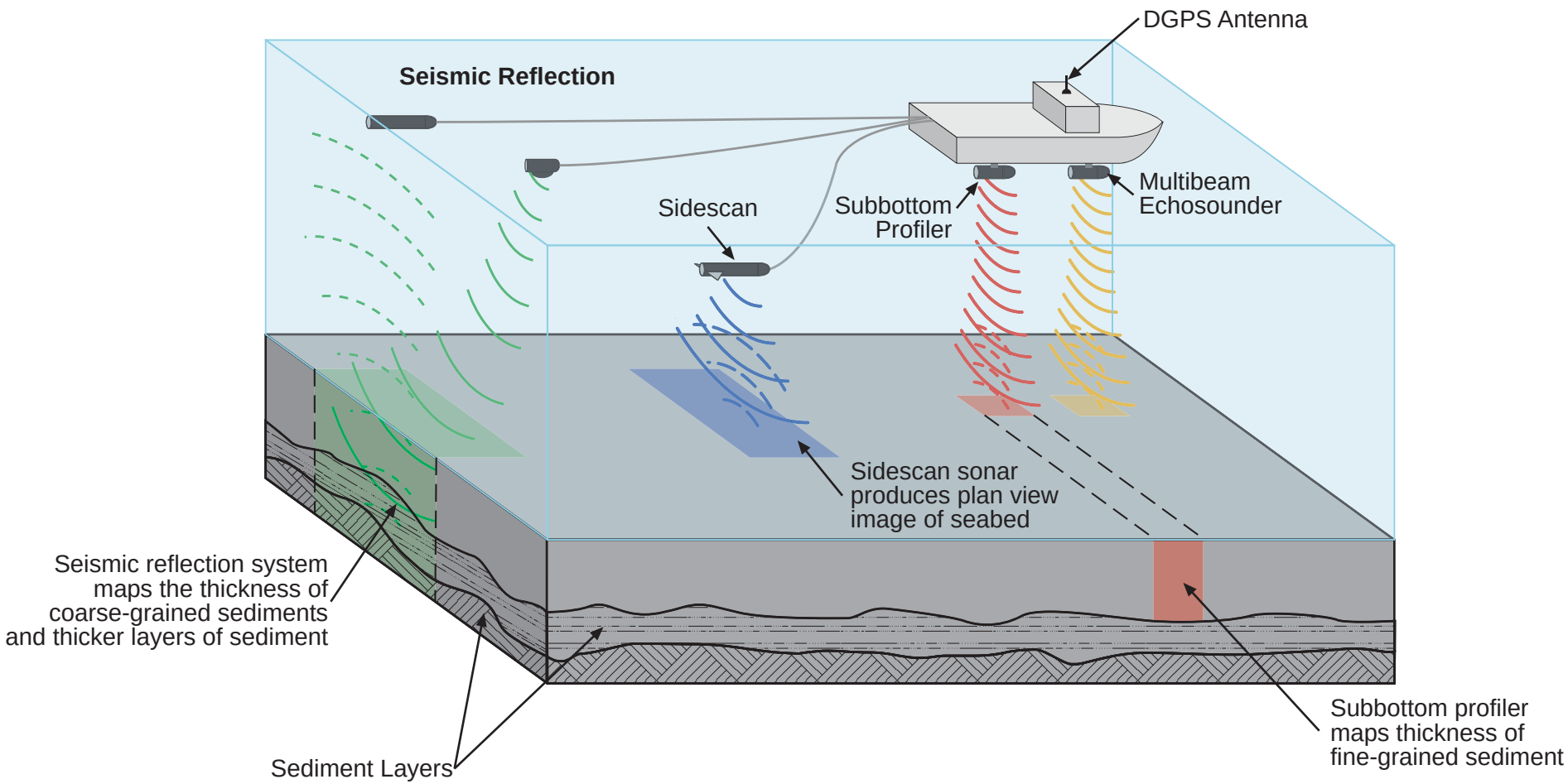
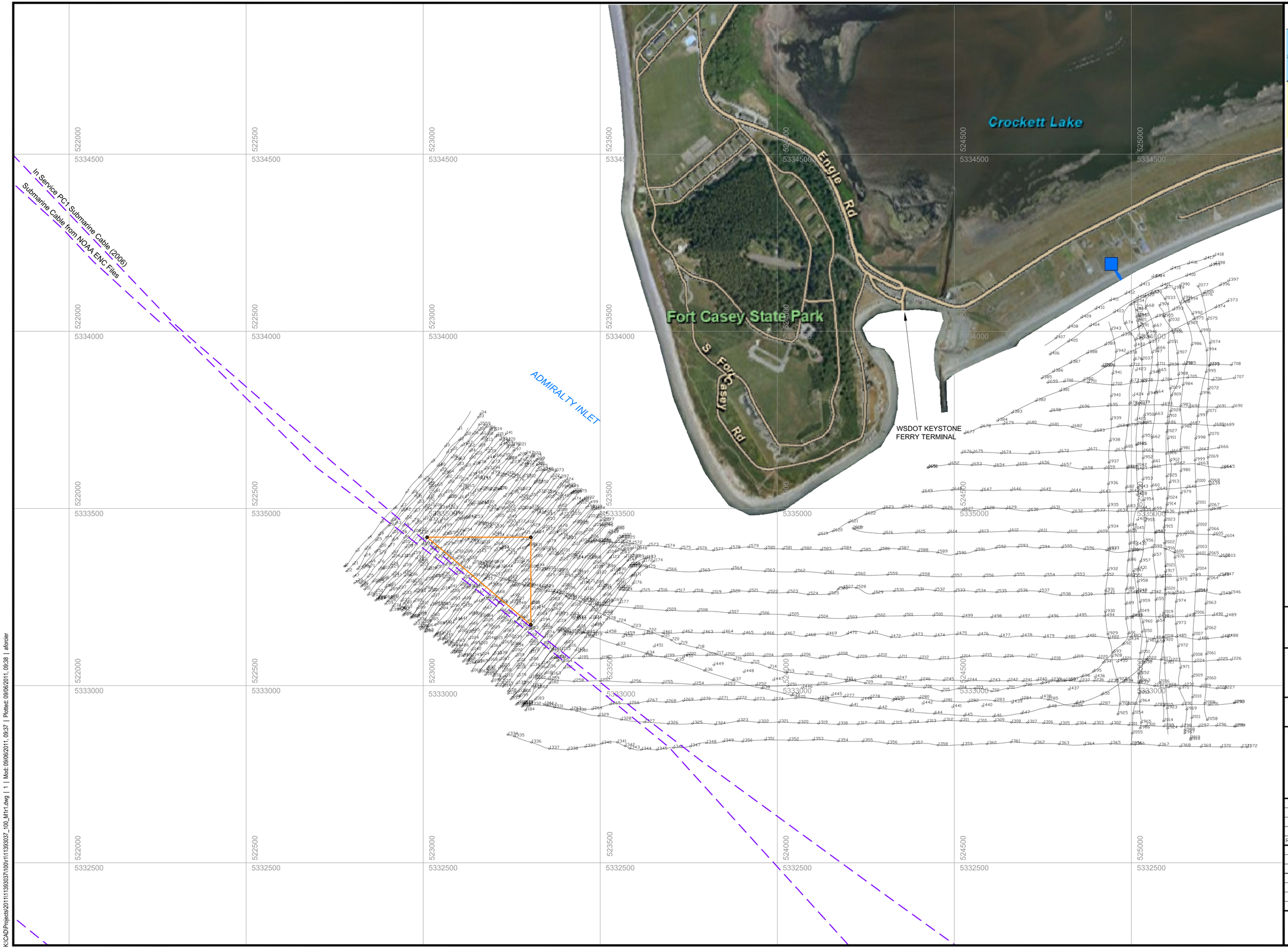


FIGURE **1**

GEOPHYSICAL INSTRUMENTATION

SNOPUD/ADMIRALTY INLET TIDAL/WA

MAPS



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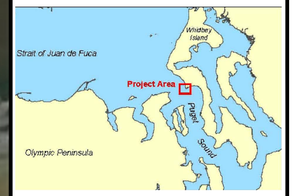
KEY MAP



LEGEND

360 TRACK LINE AND EVENT NUMBER

PROPOSED DEPLOYMENT AREA

0 50 100 150 200 250
SCALE (METERS)

NOTES

1. LOCATION OR POSITIONS OF SUBMARINE CABLES BASED ON NOAA ENC.

INSTRUMENTATION

Navigation	Coda F180 Inertial System
Bathymetry	R2 Sonic 2024, 400 kHz
Sidescan Sonar	Edgetech Model 4200
Subbottom Profiler	Datasonic Model 5000
Seismic Reflection	AAE Model CSP 1500
Digital Acquisition	Sony 204 DAS

GEODETIC PARAMETERS

Horizontal Datum	NAD 83, UTM Zone 10, meters
Vertical Datum	MLLW
Tidal BM	R 257 1944, TS 9444900

Golder Associates
GOLDER ASSOCIATES INC.
18300 NE UNION HILL ROAD, SUITE 200
REDMOND, WA USA 98052-3333
TEL: (425) 883-0777
FAX: (425) 882-5498

SUBMITTED TO:
SNOHOMISH COUNTY PUD PUBLIC UTILITY DISTRICT NO. 1

PROJECT:
SNOPUD/ADMIRALTY INLET TURBINE/WA

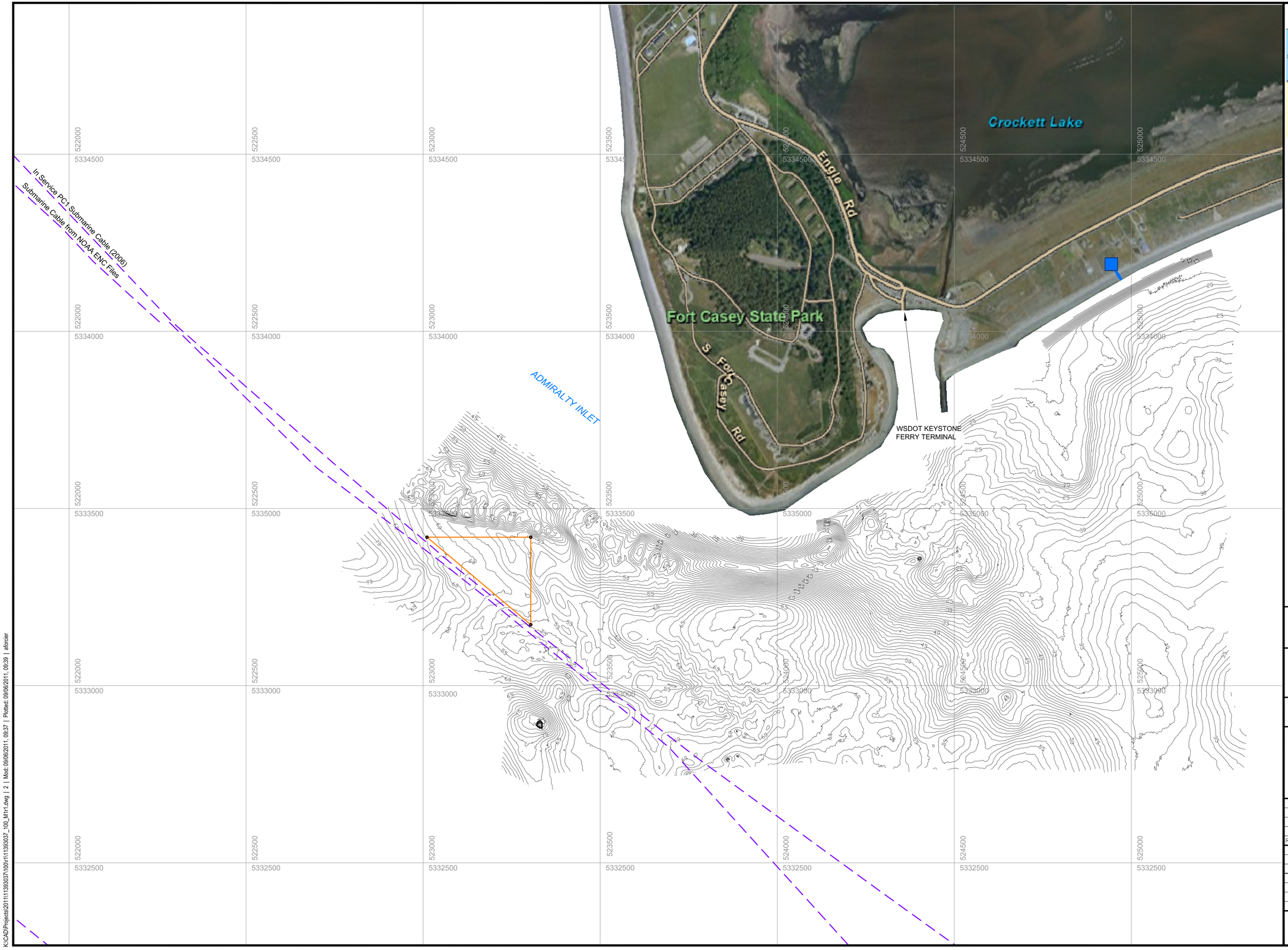
TITLE:

TRACKLINE MAP

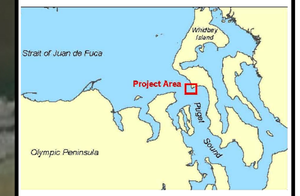
REV	DATE	REVISION DESCRIPTION	SIGNED
1	9-1-11	FINAL	DS

PROJECT No.	113-93037	
FILE No.	113-93037_100_M1r1.dwg	
REV. 1	SCALE	AS SHOWN
DESIGN	DS	09-01-2011
CADD	ACF	09-01-2011
CHECK	DS	09-01-2011
REVIEW	DF	09-01-2011

MAP 1



KEY MAP



LEGEND

20 BATHYMETRIC CONTOUR 1.0 m C.I.

PROPOSED DEPLOYMENT AREA

0 50 100 150 200 250
SCALE (METERS)

NOTES

1. LOCATION OR POSITIONS OF SUBMARINE CABLES BASED ON NOAA ENC.

INSTRUMENTATION

Navigation	Coda F180 Inertial System
Bathymetry	R2 Sonic 2024, 400 kHz
Sidescan Sonar	Edgetech Model 4200
Subbottom Profiler	Datasonic Model 5000
Seismic Reflection	AAE Model CSP 1500
Digital Acquisition	Sony 204 DAS

GEODETIC PARAMETERS

Horizontal Datum	NAD 83, UTM Zone 10, meters
Vertical Datum	MLLW
Tidal BM	R 257 1944, TS 9444900

Golder Associates
GOLDER ASSOCIATES INC.
18300 NE UNION HILL ROAD, SUITE 200
REDMOND, WA USA 98052-3333
TEL: (425) 883-0777
FAX: (425) 882-5498

SUBMITTED TO:
SNOHOMISH COUNTY PUD PUBLIC UTILITY DISTRICT NO. 1

PROJECT:
SNOPUD/ADMIRALTY INLET TURBINE/WA

TITLE:
BATHYMETRIC CONTOURS

REV	DATE	REVISION DESCRIPTION	SIGNED
1	9-1-11	FINAL	DS

PROJECT No.		113-93037
FILE No.		113-93037_100_M1r1.dwg
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DESIGN	DS	09-01-2011
CADD	ACF	09-01-2011
CHECK	DS	09-01-2011
REVIEW	DF	09-01-2011

MAP 2

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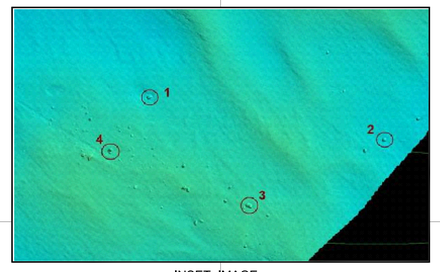

INSET IMAGE
(NOT TO SCALE)

Obj. #	Depth (m)	Height (m)	Length (m)	Width (m)	Weight (kgs)
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2	56	1.16	3.9	3.7	46,000
3	52	1.15	6.2	3.3	64,705
4	52	1.28	3.8	2.7	79,600

In Service PC1 Submarine Cable (2006)
Submarine Cable from NOAA ENC Files

ADMIRALTY INLET

Crockett Lake

Engle Rd

Fort Casey State Park

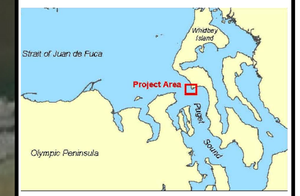
S Fort Casey Rd

WSDOT KEYSTONE
FERRY TERMINAL

SEE INSET 1

Obj. #	Depth (m)	Height (m)	Length (m)	Width (m)	Weight (kg)
5	72	20	12	11	8,000,000

KEY MAP



LEGEND

PROPOSED DEPLOYMENT AREA

DEPTH IN METERS
0-20
20-40
40-60
60-70

0 50 100 150 200 250
SCALE (METERS)

NOTES

1. LOCATION OR POSITIONS OF SUBMARINE CABLES BASED ON NOAA ENC.

INSTRUMENTATION

Navigation	Coda F180 Inertial System
Bathymetry	R2 Sonic 2024, 400 kHz
Sidescan Sonar	Edgetech Model 4200
Subbottom Profiler	Datasonic Model 5000
Seismic Reflection	AAE Model CSP 1500
Digital Acquisition	Sony 204 DAS

GEODETIC PARAMETERS

Horizontal Datum	NAD 83, UTM Zone 10, meters
Vertical Datum	MLLW
Tidal BM	R 257 1944, TS 9444900

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FAX: (425) 882-5498

SUBMITTED TO:
SNOHOMISH COUNTY PUD
PUBLIC UTILITY DISTRICT NO. 1

PROJECT:
SNOPUD/ADMIRALTY INLET TURBINE/WA

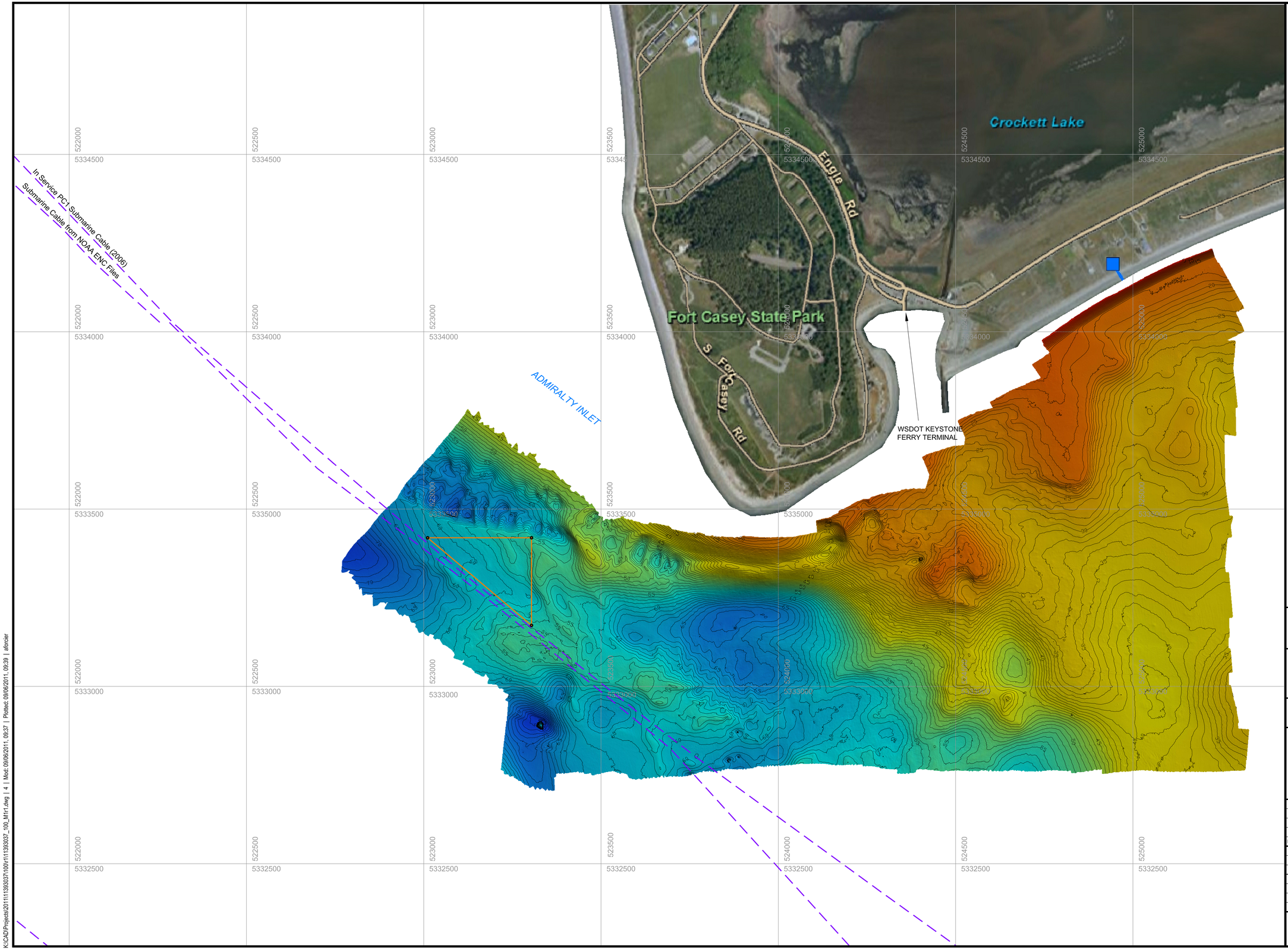
TITLE:
BATHYMETRIC IMAGE 50 cm RESOLUTION

REV	DATE	REVISION DESCRIPTION	SIGNED
1	9-1-11	FINAL	DS

PROJECT No.	113-93037
FILE No.	113-93037_100_M1r1.dwg
REV. 1	SCALE AS SHOWN
DESIGN	DS 09-01-2011
CADD	ACF 09-01-2011
CHECK	DS 09-01-2011
REVIEW	DF 09-01-2011

MAP 3

K:\CAD\Projects\2011\113933037\100\r1\113393037_100_M1r1.dwg | 3 | Mod: 09/06/2011, 09:37 | Plotted: 09/06/2011, 09:39 | aforcier



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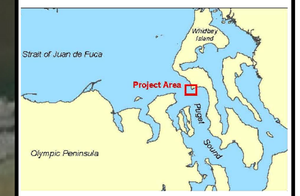

LEGEND

20 BATHYMETRIC CONTOUR 1.0 m C.I.

PROPOSED DEPLOYMENT AREA

0 50 100 150 200 250
SCALE (METERS)

NOTES

1. LOCATION OR POSITIONS OF SUBMARINE CABLES BASED ON NOAA ENC.

INSTRUMENTATION

Navigation	Coda F180 Inertial System
Bathymetry	R2 Sonic 2024, 400 kHz
Sidescan Sonar	Edgetech Model 4200
Subbottom Profiler	Datasonic Model 5000
Seismic Reflection	AAE Model CSP 1500
Digital Acquisition	Sony 204 DAS

GEODETIC PARAMETERS

Horizontal Datum	NAD 83, UTM Zone 10, meters
Vertical Datum	MLLW
Tidal BM	R 257 1944, TS 9444900

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SUBMITTED TO:
SNOHOMISH COUNTY PUD
PUBLIC UTILITY DISTRICT NO. 1

PROJECT:
SNOPUD/ADMIRALTY INLET TURBINE/WA

TITLE:

BATHYMETRIC IMAGE AND CONTOURS

REV	DATE	REVISION DESCRIPTION	SIGNED
1	9-1-11	FINAL	DS

PROJECT No.	113-93037	
FILE No.	113-93037_100_M1r1.dwg	
REV. 1	SCALE	AS SHOWN
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CADD	ACF	09-01-2011
CHECK	DS	09-01-2011
REVIEW	DF	09-01-2011

MAP 4

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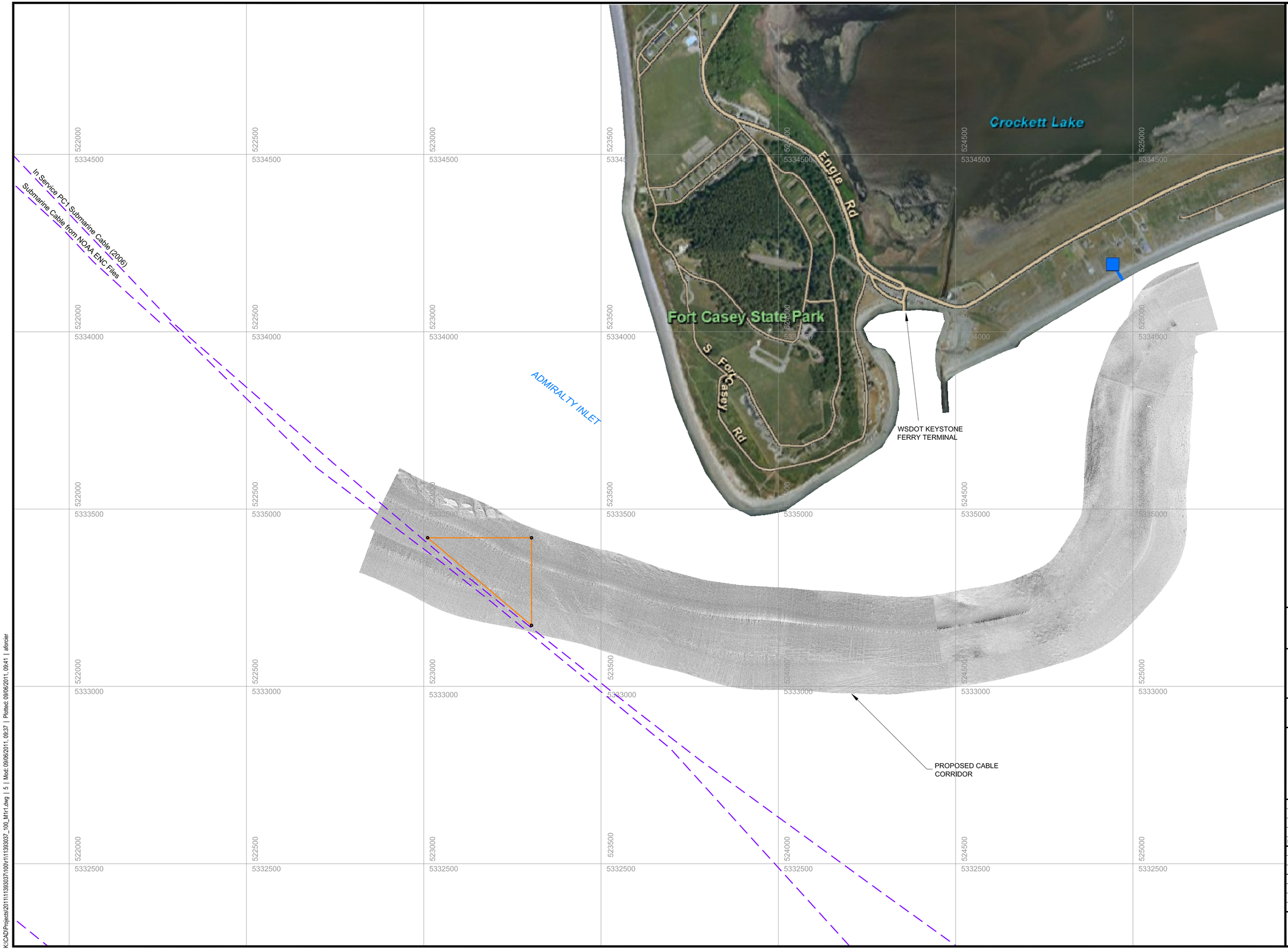

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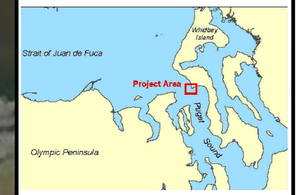

LEGEND

PROPOSED DEPLOYMENT AREA

0 50 100 150 200 250
SCALE (METERS)

NOTES

1. LOCATION OR POSITIONS OF SUBMARINE CABLES BASED ON NOAA ENC.

INSTRUMENTATION

Navigation	Coda F180 Inertial System
Bathymetry	R2 Sonic 2024, 400 kHz
Sidescan Sonar	Edgetech Model 4200
Subbottom Profiler	Datasonic Model 5000
Seismic Reflection	AAE Model CSP 1500
Digital Acquisition	Sony 204 DAS

GEODETIC PARAMETERS

Horizontal Datum	NAD 83, UTM Zone 10, meters
Vertical Datum	MLLW
Tidal BM	R 257 1944, TS 9444900

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SUBMITTED TO:

SNOHOMISH COUNTY PUD PUBLIC UTILITY DISTRICT NO. 1

PROJECT:

SNOPUD/ADMIRALTY INLET TURBINE/WA

TITLE:

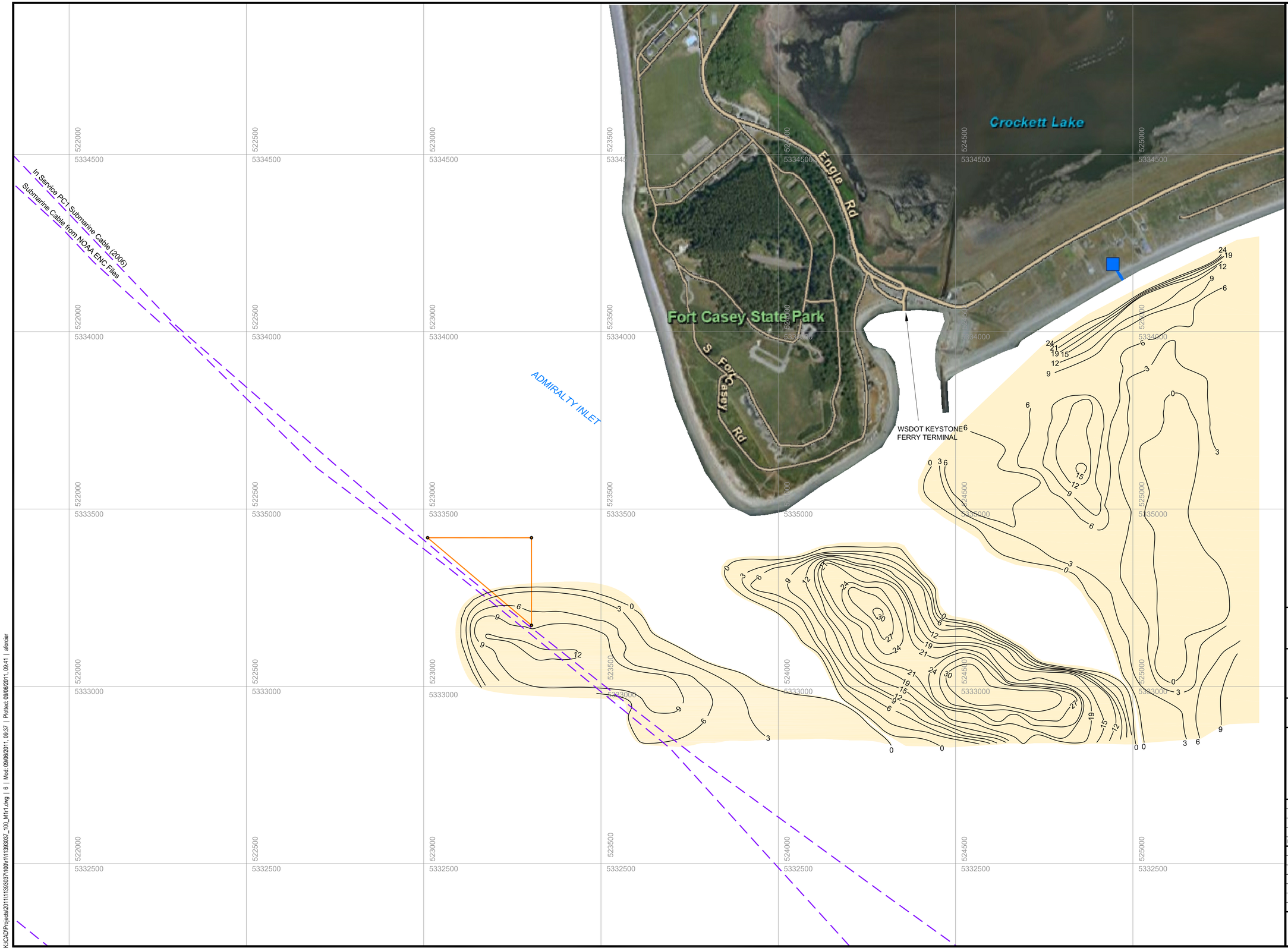
SIDESCAN SONAR MOSAIC

REV	DATE	REVISION DESCRIPTION	SIGNED
1	9–1–11	FINAL	DS

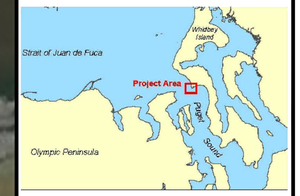
PROJECT No.		113–93037
FILE No.		113–93037_100_M1r1.dwg
REV. 1	SCALE	AS SHOWN
DESIGN	DS	09–01–2011
CADD	ACF	09–01–2011
CHECK	DS	09–01–2011
REVIEW	DF	09–01–2011

MAP 5

K:\CAD\Projects\2011\11393037\100\r1\113393037_100_M1r1.dwg | 5 | Mod: 09/06/2011, 09:37 | Plotted: 09/06/2011, 09:41 | aforcier



KEY MAP



LEGEND

—12— SEDIMENT THICKNESS CONTOUR 3m C.I.

PROPOSED DEPLOYMENT AREA

INTERPRETED STRATIGRAPHY FINE TO MEDIUM GRAINED UNCONSOLIDATED SEDIMENT

0 50 100 150 200 250
SCALE (METERS)

NOTES

1. LOCATION OR POSITIONS OF SUBMARINE CABLES BASED ON NOAA ENC.

INSTRUMENTATION

Navigation	Coda F180 Inertial System
Bathymetry	R2 Sonic 2024, 400 kHz
Sidescan Sonar	Edgetech Model 4200
Subbottom Profiler	Datasonic Model 5000
Seismic Reflection	AAE Model CSP 1500
Digital Acquisition	Sony 204 DAS

GEODETIC PARAMETERS

Horizontal Datum	NAD 83, UTM Zone 10, meters
Vertical Datum	MLLW
Tidal BM	R 257 1944, TS 9444900

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SUBMITTED TO:
SNOHOMISH COUNTY PUD PUBLIC UTILITY DISTRICT NO. 1

PROJECT:
SNOPUD/ADMIRALTY INLET TURBINE/WA

TITLE:

SUB BOTTOM PROFILER SEDIMENT ISOPACH

REV	DATE	REVISION DESCRIPTION	SIGNED
1	9–1–11	FINAL	DS

PROJECT No.	113–93037	
FILE No.	113–93037_100_M1r1.dwg	
REV. 1	SCALE	AS SHOWN
DESIGN	DS	09–01–2011
CADD	ACF	09–01–2011
CHECK	DS	09–01–2011
REVIEW	DF	09–01–2011

MAP 6

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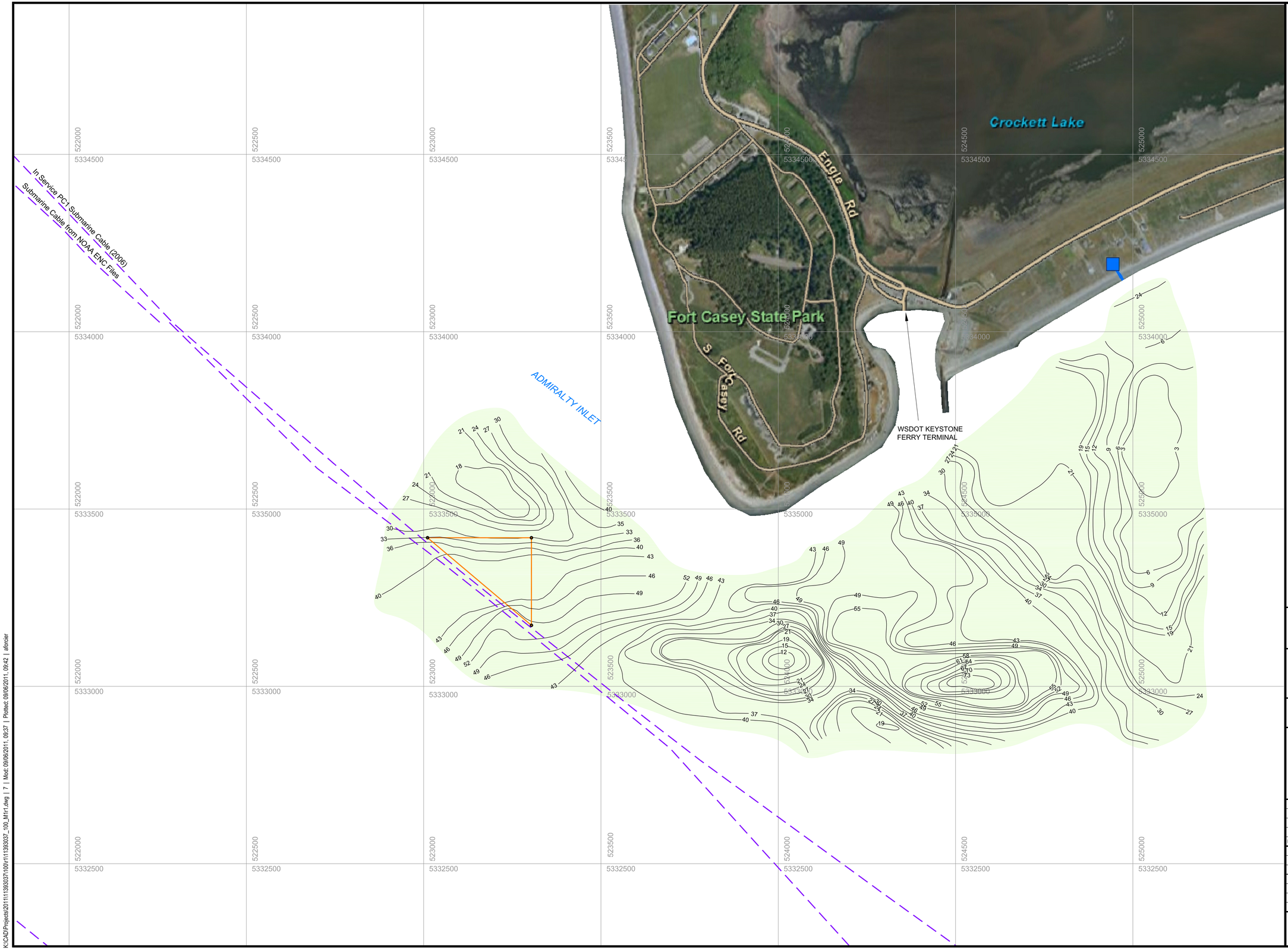

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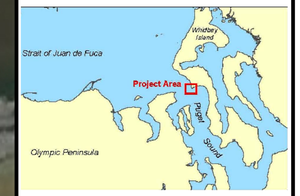

LEGEND

—12— SEISMIC REFLECTION SEDIMENT CONTOURS 3 m C.I.

PROPOSED DEPLOYMENT AREA

INTERPRETED STRATIGRAPHY MEDIUM TO COARSE-GRAINED SEDIMENT

0 50 100 150 200 250
SCALE (METERS)

NOTES

1. LOCATION OR POSITIONS OF SUBMARINE CABLES BASED ON NOAA ENC.

INSTRUMENTATION

Navigation	Coda F180 Inertial System
Bathymetry	R2 Sonic 2024, 400 kHz
Sidescan Sonar	Edgetech Model 4200
Subbottom Profiler	Datasonic Model 5000
Seismic Reflection	AAE Model CSP 1500
Digital Acquisition	Sony 204 DAS

GEODETIC PARAMETERS

Horizontal Datum	NAD 83, UTM Zone 10, meters
Vertical Datum	MLLW
Tidal BM	R 257 1944, TS 9444900

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SUBMITTED TO:
SNOHOMISH COUNTY PUD PUBLIC UTILITY DISTRICT NO. 1

PROJECT:
SNOPUD/ADMIRALTY INLET TURBINE/WA

TITLE:

SEISMIC REFLECTION SEDIMENT ISOPACH

REV	DATE	REVISION DESCRIPTION	SIGNED
1	9–1–11	FINAL	DS

PROJECT No.		113–93037
FILE No.		113–93037_100_M1r1.dwg
REV. 1	SCALE	AS SHOWN
DESIGN	DS	09–01–2011
CADD	ACF	09–01–2011
CHECK	DS	09–01–2011
REVIEW	DF	09–01–2011

MAP 7

K:\CAD\Projects\2011\113393037\100\r1\113393037_100_M1r1.dwg | 7 | Mod: 09/06/2011, 09:37 | Plotted: 09/06/2011, 09:42 | aforcier

At Golder Associates we strive to be the most respected global group of companies specializing in ground engineering and environmental services. Employee owned since our formation in 1960, we have created a unique culture with pride in ownership, resulting in long-term organizational stability. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees now operating from offices located throughout Africa, Asia, Australasia, Europe, North America and South America.

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Golder Associates

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Appendix H

GEOLOGICAL SETTING TECHNICAL MEMO (OFFSHORE)

Landau Associates
Technical Memorandum
Preliminary Geological Characterization Proposed Tidal Turbine Site
Island County, WA

September 6, 2011

TECHNICAL MEMORANDUM

LANDAU ASSOCIATES
ENVIRONMENTAL | GEOTECHNICAL | NATURAL RESOURCES

TO: Larry Armbruster, Project Manager, Sound and Sea Technology
Kim Moore, P.E., Eric Schneider, P.E., and Craig Collar, P.E., Snohomish County PUD

FROM: Edward J. Heavey, P.E. and Brian F. Butler, L.Hg.

DATE: September 6, 2011

RE: PRELIMINARY GEOLOGIC CHARACTERIZATION
PROPOSED TIDAL TURBINE SITE
ISLAND COUNTY, WASHINGTON

This memorandum presents our preliminary understanding of geologic conditions in the vicinity of the location of the proposed Snohomish County Public Utility District No. 1 (Snohomish County PUD) Admiralty Inlet Tidal Turbine site. This memorandum supports ongoing geotechnical engineering design discussions between Snohomish County PUD and OpenHydro Group Ltd related to pilot scale tidal turbine deployment. Our interpretation of the expected geologic conditions at the turbine sites is based on the nearby mapped surface geology, correlation to depositional environments, nearby upland well logs, the results of recent geophysical investigations in the project area, an August 9, 2011 cruise to sample the seafloor at the proposed turbine sites, and our past experience in the upland near the project area. As additional geologic information regarding seafloor conditions becomes available from future investigations, the understanding of geologic conditions will need to be reviewed and modified as appropriate.

REGIONAL GEOLOGIC SETTING

The Snohomish County PUD's tidal turbine project is located within the Puget Sound Lowland physiographic province, a north-south trending structural basin located between the Olympic Mountains to the west and the Cascade Mountains to the east. The structural basin is a result of regional tectonic activity including the subduction of the Juan de Fuca oceanic plate beneath the North American plate. In the general project area, depth to bedrock is estimated to range from about 1150 to 2600 feet (ft) [350 to 790 meters (m)] below sea level (Polenz et al. 2005) and is overlain by a complex series of unlithified glacial and non-glacial sediments. A series of generally east-west trending (active) faults subdivide the Puget Sound basin into smaller blocks and basins, and these faults cut both bedrock and unconsolidated sediment units. One of these faults, the northwest-southeast trending Southern Whidbey Island Fault, cuts the project area (Polenz et al. 2005).

The recent geologic history and shallow geologic conditions are the result of the succession of at least six continental glaciations that advanced into the Puget Sound Lowlands over the last 2 million

years. The purpose of describing these glaciations is that sedimentary deposits that have been overridden by thick glacial ice are typically highly consolidated, which influences the engineering behavior of the soils.

The continental glaciers advanced into the Puget Sound Lowlands from southern British Columbia, and ice spanned the lowlands from the Cascade Mountains to the Olympic Mountains and blocked the inlet to Puget Sound (Admiralty Inlet) and the Strait of Juan de Fuca, creating a large lake in which fine-grained lacustrine sediments (clay and silt) were deposited. As the ice sheet advanced southward, a sand and gravel unit was deposited (advance outwash unit, in front of the advancing glacier) above the fine-grained lacustrine unit. The ice sheet subsequently advanced over the sand and gravel, depositing the characteristic glacial till ice-contact unit, consolidating underlying sediments, and scouring significant melt-water channels at the base of the glacier. In the project area, ice thickness during the most recent glaciations may have been up to about 3,900 to 4,300 ft (1,200 to 1,300 m; Thorsen 1980). Generally, the ice sheets advanced just beyond Olympia, Washington located at the southern extent of present day Puget Sound. As the climate warmed, the ice stagnated and melted, depositing ice-entrained sediment over the landscape in some areas as an unsorted blanket and alluvial deposits from recessional melt water. Post-glacial erosional processes further modified the landscape and deposited non-glacial sediments in the lowlands during interglacial periods. Each successive glaciation had a similar depositional sequence and also partially eroded the existing ground surface, both eroding and depositing a fresh sequence of glacial sediment over the landscape. The resulting stratigraphy is a very complex sequence of glacial and non-glacial sediments.

The latest glaciation that advanced into the Puget Sound Region, known as the Vashon Stade of the Fraser Glaciation, occurred approximately 20,000 to 11,000 years before present (ybp) and had a significant effect on the present day landscape. During the Vashon glacial advance, as the ice front advanced over the advance outwash deposits, the Vashon glacial till was deposited, and melt water flowing beneath the ice sheet significantly eroded the outwash material along with some of the previously deposited sediments, creating generally north-south trending, deep subglacial drainage channels. Puget Sound, Hood Canal, Lake Washington, and the Snohomish/Snoqualmie River Valley are examples of remnants of these deep subglacial water channels. As the ice retreated, the ice front stalled near present day Coupeville (Polenz et al. 2005), which is located about 6 miles (10 km) north of the study area. Polenz et al. (2005) suggest that the historic (post-Vashon Stade) relative sea level was at least 216 to 229 ft (66.5 to 69.8 m) above present day sea level based on deposits of clay, silt, and sparse gravel of glaciomarine origin to about 220 ft (67.1 m) above present day sea level. Floating ice in the form of berg and shelf covered much of the area, and entrained sediment from the floating ice deposited glaciomarine drift on the seafloor over much of the project vicinity. With the retreat of glacial ice, the land surface

rebounded, lifting the portions of the glaciomarine drift above present day sea level. In the project vicinity, the glaciomarine drift is often underlain by glacial till and/or other Vashon-age deposits.

Movement of water through the relatively narrow and shallow Admiralty Inlet during the semi-diurnal tidal cycle results in strong tidal currents. These currents are an important mechanism for sediment transport in the project area. The project area is distant from major rivers that would supply sediment; accordingly, the major source of sediment contributed to the project area is likely from erosion of the shoreline and bluffs along the west side of Whidbey Island. Sediment from bluff erosion accumulates on the shelf and submarine slopes along the west side of Whidbey Island. In areas where submarine slope gradients are steep, occasional slumps and slides occur that deliver sediments to the deeper seafloor. Earthquake activity may also trigger slumps and slides on the steep submarine slopes. These factors shape project area geomorphology.

PROJECT SITE INFORMATION FROM REMOTE METHODS

Our interpretation of the expected geologic conditions at the turbine site is based on correlation to the mapped nearby surface geology (Polenz et al. 2005), understanding of depositional environments, nearby upland well logs obtained from the Washington State Department of Ecology (Ecology) website (Ecology website 2011), the results of sea floor geophysical investigations in the project area (Fugro 2009; Golder Associates 2011; Sound and Sea Technology 2010), and our past experience in the vicinity of the project area.

Fugro completed a bathymetric survey and preliminary geophysical survey in 2009 (Fugro 2009). Sound and Sea Technology completed a remotely operated vehicle (ROV) video survey of the proposed turbine deployment area in 2010 (Sound and Sea Technology 2010). Golder completed a seismic reflection survey of the turbine site and a 2011 memorandum *Preliminary Geophysical Interpretation at the Turbine Site* (Golder Associates 2011). Golder Associates included two interpreted cross sections (Figures 1 and 2) with geophysical units interpreted based on similar geophysical properties. Map 1 and Figures 1 and 2 from the Golder Associates memorandum are included in this memorandum.

Golder Associates identifies the uppermost geophysical unit on the sea floor at tidal turbine locations T1A and T2A (Map 1, and Figures 1 and 2, Golder Associates 2011) to consist of a gravel-cobble material or “pavement”. The unit has been described based on the ROV video survey completed in 2010 (Sound and Sea Technology 2010) as well-rounded, cobblestones and pebbles, locally ranging in size down to gravel-pebble cover and up to a boulder-cobble mix, with scattered boulders. Golder Associates also identified boulders in the project area, including a number of very large boulders observed on the multibeam bathymetric data. The largest of these has an estimated weight of 10,000 tons (9.1 kilotonnes) and the smaller ones are estimated to weigh approximately 30 to 80 tons (0.03 to 0.07

kilotonnes). These boulders are interpreted to be glacial erratics, dropped from the ice over 10,000 years ago. The boulders appear to have not settled into the seabed, but do show evidence of a scour moat around them. Some finer-grained material such as sand and organic shell debris is present in the interstices of the gravel-cobble deposit, but only as a minor constituent. The thickness of this unit is not known, but evidence from vessel and barge anchoring operations described subsequently indicates the unit is most likely relatively thin. Recent seismic reflection studies completed by Golder Associates (2011) indicate that the unit is about 3 to 6 ft (1 to 2 m) thick in the vicinity of the proposed turbine site. The gravel-cobble pavement layer is likely a deposit formed by erosion of finer-grained fractions of granular deposits by strong tidal currents.

The Golder Associates (2011) *Preliminary Geophysical Interpretation* included two cross sections (Figures 1 and 2) that present geophysical units interpreted based on similar geophysical properties. In the southern portion of the turbine site, beneath the surface gravel-cobble pavement, Golder Associates interpreted a layer to consist of fine-grained material, largely clay and sand. The unit is shown as green on Golder Associates Figures 1 and 2 (See Golder Associates Map 1 for the locations of the cross sections shown on Figures 1 and 2). This unit is up to approximately 10 ft (3.3 m) thick in the southern portion of the survey area and extends to the northeast approximately to turbine location T2A (Figure 2). The material does not appear to be present beneath turbine location T1A (Figure 1). Golder Associates reports that there are small hyperbolic features and discontinuous reflectors suggesting the presence of some cobbles and gravel within the deposit. Based on the mapped terrestrial geology and Golder Associates' interpretation of the geophysical data, this layer may be a remnant of a glaciomarine drift unit. The cobbles, gravel, etc. within the deposit may be dropstones from the floating ice. Based on correlation to nearby terrestrial exposures of glaciomarine deposits, our experience with similar units, and understanding of the depositional environment, the fine-grained material is likely soft to medium stiff in consistency. This clay unit interpretation is consistent with reports that during vessel and barge anchoring operations at the time of the 2010 ROV survey (Sound and Sea Technology 2010), gray silty clay was one of the soil types noted on project vessel anchors. The exact locations where this occurred were not recorded.

Below the surface gravel-cobble pavement unit and the interpreted clay-sand unit, Golder Associates interprets a relatively thick geophysical unit of sand, gravel, cobbles, and boulders. This unit is approximately 100 to 130 ft (30 to 40 m) thick (Golder Associates Figures 1 and 2, purple color). Based on the nearby mapped terrestrial geology (Polenz et al. 2005) and Golder Associates' interpretation of the geophysical data, this layer may be similar to the (post-Vashon Stade) Partridge Gravel unit mapped north of the turbine site. The thickness of the unit is consistent with the mapped terrestrial

deposits. The surface gravel-cobble pavement may have been formed in part by erosion of the finer sand matrix material leaving behind a lag deposit of the larger clasts.

The deepest interpreted geophysical unit, 100 to 130 ft (30 to 40 m) below the seabed, is interpreted by Golder Associates to be the top of overconsolidated glacial or interglacial deposits (Golder Associates Figures 1 and 2, blue color). Golder Associates interprets the seismic characteristic of this unit to be typical of heavily overconsolidated deposits observed in other post-glacial environments.

On August 9, 2011, several attempts were made to sample the seafloor conditions in the vicinity of the two turbine sites, T1A and T2A. In general, the sampling attempts were unsuccessful and no new information regarding the seafloor conditions was obtained. The following briefly summarizes the explorations attempts.

At site T1A, two attempts were made to obtain samples of the bottom sediment using a 4-inch diameter, 500 pound, core barrel sampler. In general, the core barrel was unable to successfully penetrate the cobble layer, returning only small samples of fine gravel.

Six attempts were made to obtain samples of the bottom sediment using a 500-lb. 4-inch diameter core barrel sampler at T2A. The corer failed to deploy four times due to what appeared to be interference with the sampling release mechanism by strong currents at the seafloor. As with Site T1A, the core barrel was unable to successfully penetrate the cobble layer and returned only small samples of fine gravel.

The impact force of the sampler hitting the bottom was estimated assuming that the sampler had reached terminal velocity at impact. The impact velocity was conservatively estimated to be about 16.6 ft/sec (5.1 m/s). Since a small amount of sample was returned, it was assumed that the sampler penetrated approximately 6 inches (0.15 m) into the bottom on impact or to about the level of the catcher basket at the end of the shoe. Therefore, it was estimated that the sampler struck the bottom with a force of about 4,055 pounds (18,040 N). The outside diameter of the sampler is about 4 inches (0.10 m). Given the relatively small sampler diameter, it is expected that most of the impact force dissipates within a depth of 1 to 2 ft (0.3 to 0.6 m) below the bottom.

A chain bag sampler (CBS) tow was attempted at site T1A. The tow resulted in collection of a single large quartize cobble, about 5”x 6”x 8” in dimension. The CBS sieve mesh is too large to retain any small (gravel-pebble-small cobble) sediments. The bottom of the CBS is flat and appeared to ride over the top of the cobble layer. The CBS system was found to be of little value in this environment.

At site T1A, an attempt was made to drag a purpose-built, four-bladed, anchor across the seabed with the intent that the blades would dig into the sub-bottom and bring up a sample of fine soil such as clay that may be present beneath the cobble layer. The anchor was weighted down using approximately 12 feet of heavy chain. The anchor tow was unsuccessful in obtaining soil samples. The blades were visibly abraded by dragging across the rocky bottom, but no material was recovered.

SUMMARY

Based on ROV observations, geophysical data, and geologic data, the turbine site is overlain with a 3- to 6-ft (1 to 2 m) thick gravel-cobble pavement. Based on observations and our experience with similar depositional environments, the deposit is likely in a loose to medium dense condition. In the southern portion of the turbine area, the gravel-cobble pavement appears to be underlain by up to 10 ft (3.3 m) of fine-grained material, possibly part of a glaciomarine drift clay unit. Based on correlation to nearby terrestrial deposits and our experience with similar depositional environments, the fine-grained material is likely soft to medium stiff in consistency. The sand, gravel, cobble, and boulder unit beneath the gravel-cobble pavement over the central and northern portion of the turbine site is interpreted to be recessional outwash that extends to about 100 to 130 ft (30 to 40 m) below the sea floor. Based on correlation to similar terrestrial deposits and the depositional environment, the deposit is likely in a medium dense to dense condition.

The sub-seafloor conditions interpreted from geophysical data are relatively uniform below proposed tidal turbine location T1A. The interpreted sub-seafloor conditions at location T2A indicate that two units with different geotechnical engineering properties are present, and that geophysical data suggest that more uniform conditions are present toward the northeast. We suggest that consistent geotechnical properties are an important factor in refining tidal turbine site selection. As additional geologic information regarding seafloor conditions becomes available from upcoming investigations, the understanding of geologic conditions and associated geotechnical engineering properties will be revised as appropriate.

USE OF THIS TECHNICAL MEMORANDUM

This memorandum was prepared for the exclusive use of Sound and Sea Technology and Snohomish County PUD for the Admiralty Inlet Tidal Energy Project located in Island County, Washington. The use by others, or for purposes other than intended, is at the user's sole risk. The findings, conclusions, and recommendations presented herein are based on our understanding of the project and our review of available geologic and geophysical information in the project area. Within the limitations of scope, schedule, and budget, the conclusions presented in this memorandum were prepared in accordance with generally accepted geologic and geotechnical engineering principles and practices in the area at the time the memorandum was prepared. We make no other warranty, either express or implied.

If you have any questions or comments regarding the information contained in this memorandum, or if we may be of further service, please call.

REFERENCES

Ecology website. 2011. Washington State Well Log Viewer. http://apps.ecy.wa.gov/welllog/MapSearch/viewer.htm?left=1104935&right=1115774&top=1042087&bottom=1035059&sessionid=715679135. Accessed on July 21.

Fugro. 2009. *Bathymetric and Geophysical Survey Site Characterizations Admiralty Inlet Pilot Tidal Project*. Prepared for Snohomish County PUD. September 23.

Golder Associates. 2011. *Preliminary Geophysical Interpretation at the Turbine Site*. Prepared for Snohomish County PUD. July 26.

Polenz, M., S.L. Slaughter, and G.W. Thorsen. 2005. *Geologic Map of the Coupeville and Part of the Port Townsend North 7.5-minute Quadrangles, Island County, Washington*. Washington Division of Geology and Earth Resources. Geologic Map GM-58. June.

Sound and Sea Technology. 2010. *Geological Summary, Snohomish Public Utilities District Admiralty Inlet Tidal Energy Project Site*. Prepared for Snohomish County PUD. December 18.

Thorson, R. M. 1980. *Ice-sheet Glaciation of the Puget Lowland, Washington, during the Vashon Stade (late Pleistocene)*. Quaternary Research. v. 13, no. 3. p. 303-321.

EJH/BFB/rgm

ATTACHMENTS

Golder Associates Map 1 and Figures 1 and 2 (Golder 2011)

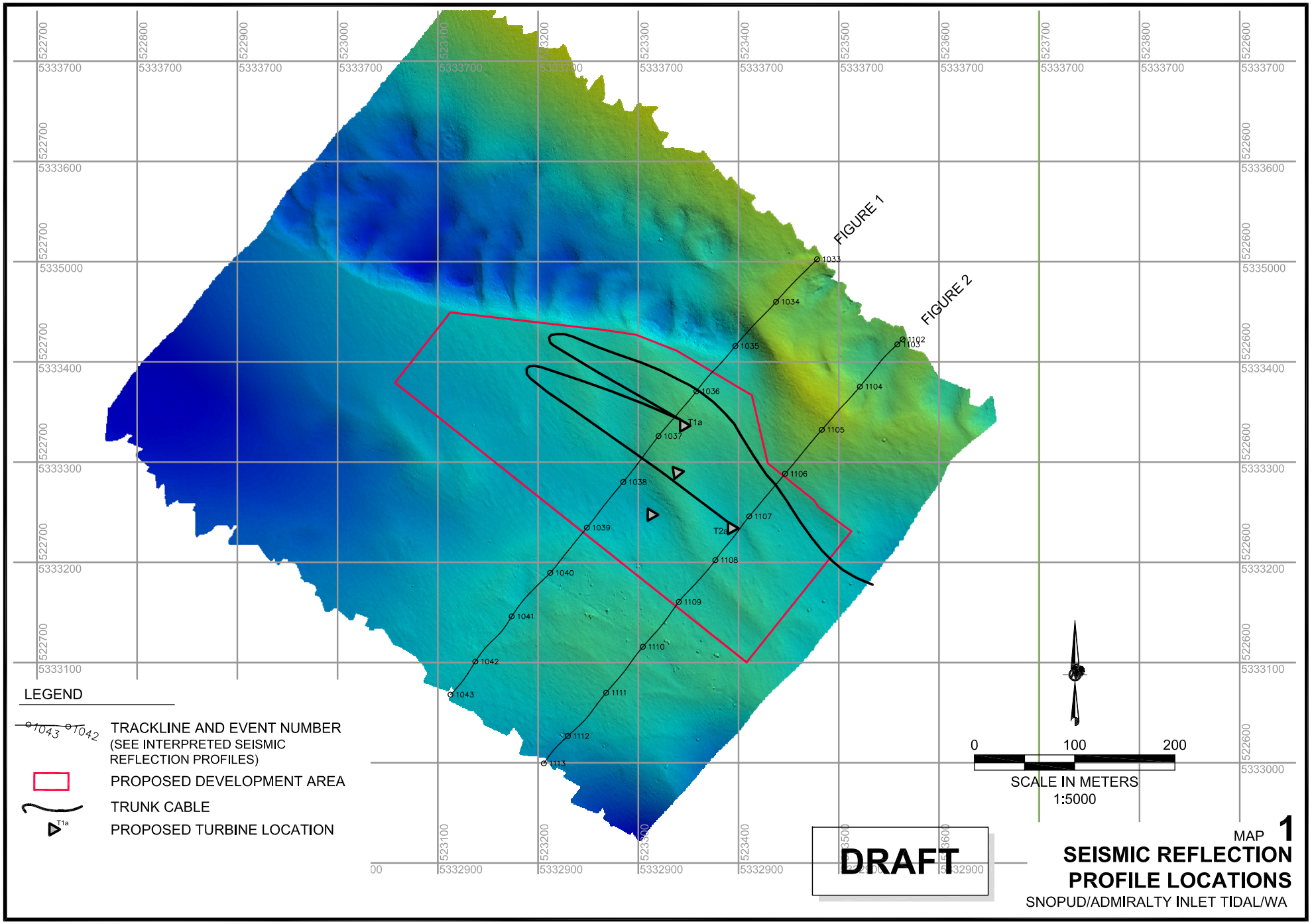
FIGURE 1
FIGURE 2
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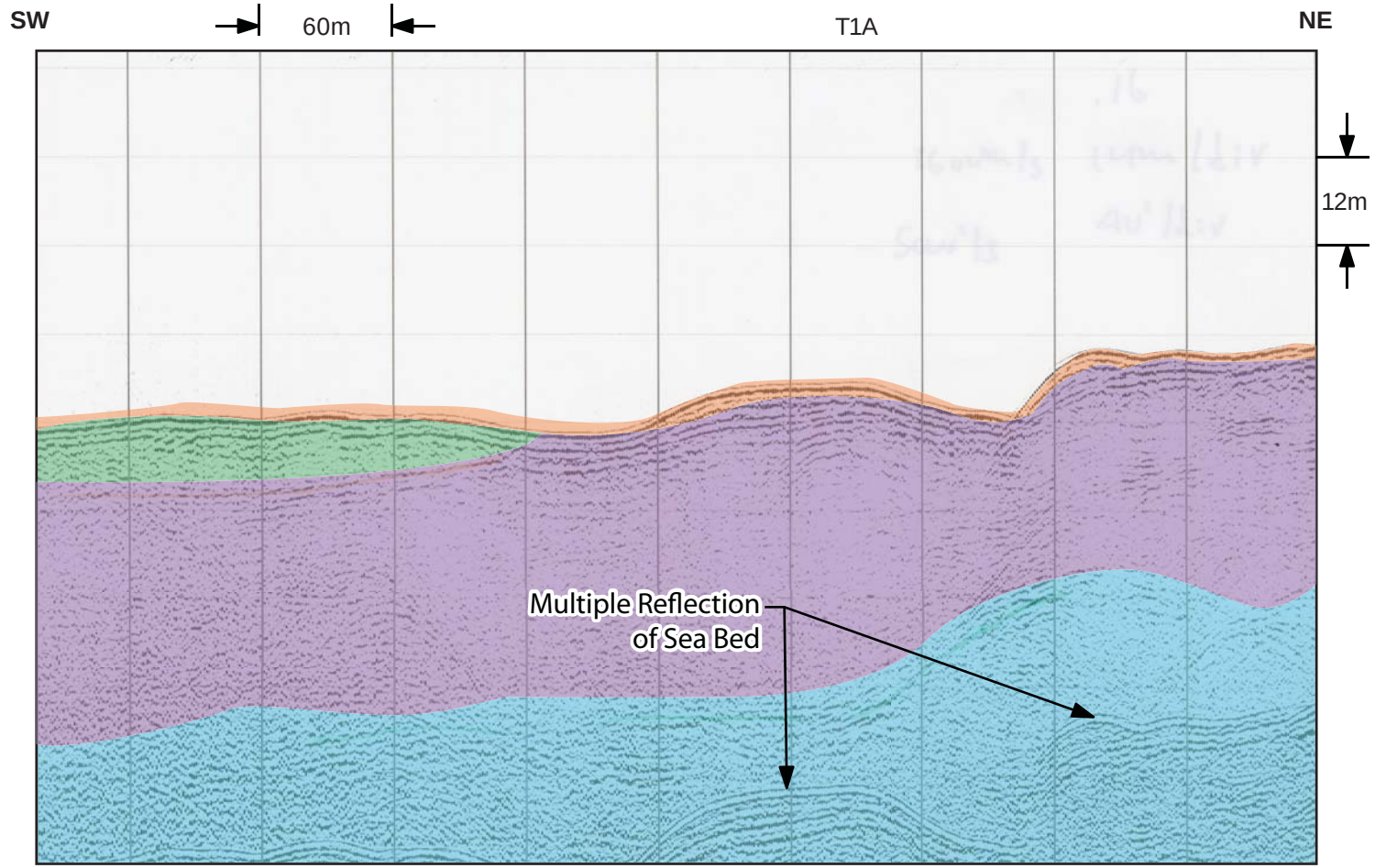
T1a
T2a
LEGEND
TRACKLINE AND EVENT NUMBER (SEE INTERPRETED SEISMIC REFLECTION PROFILES)
PROPOSED DEVELOPMENT AREA
TRUNK CABLE
PROPOSED TURBINE LOCATION
0
100
200
SCALE IN METERS
1:5000
DRAFT
MAP 1
SEISMIC REFLECTION PROFILE LOCATIONS
SNOPUD/ADMIRALTY INLET TIDAL/WA



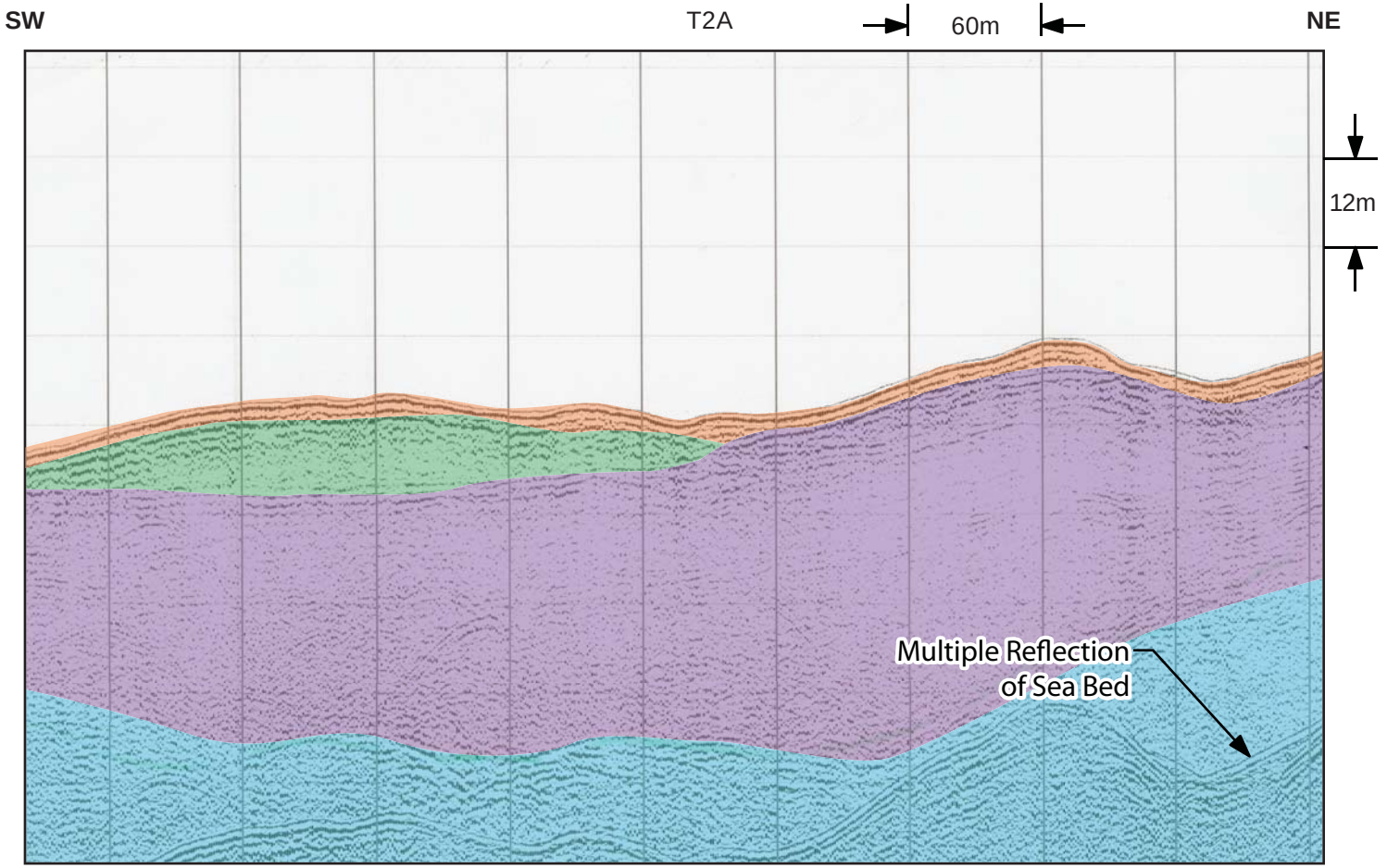
LEGEND

- Gravel Pavement
- Clay, Sand
- Sand, Gravel, Cobbles, Boulders
- Over Consolidated Glacial Material

FIGURE **1**

INTERPRETED SEISMIC REFLECTION PROFILE

SNOPUD/ADMIRALTY INLET TIDAL/WA



LEGEND

- Gravel Pavement
- Clay, Sand
- Sand, Gravel, Cobbles, Boulders
- Over Consolidated Glacial Material

FIGURE **2**

INTERPRETED SEISMIC REFLECTION PROFILE

SNOPUD/ADMIRALTY INLET TIDAL/WA

Appendix I

SUMMARY OF SITE CONDITIONS

Admiralty Inlet Site Characteristics

1 Introduction

The purpose of this memorandum is to provide an overview of the characteristics of current flows in Admiralty Inlet, as they may pertain to operations in the vicinity of the District's tidal energy demonstration project. This is not intended as a comprehensive description of tidal currents in the project area and the examples shown here should be taken as illustrative, rather than representative of "typical" conditions that will be encountered during operations. In general, the marine environment in northern Admiralty Inlet is extremely energetic and marine operations should be carefully planned to ensure success. For example, truly "slack" water rarely occurs over more than a small fraction of the water column for periods longer than several minutes. Surface currents in northern Admiralty Inlet can exceed 3.5 m/s and are generated by the narrowing of the channel between Point Wilson and Admiralty Head and decreased water depth over the broad sill connecting the two points. Near Admiralty Head, water depth decreases further and, in combination with the flow acceleration around the headland, results in locally strong, turbulent currents.

2 Source of Data

Current characteristics presented in this overview are drawn from a record collected at 48.1529^{o} N, -122.6862^{o} W. This is the approximate location of the one of the two turbines in the array. This site is slightly more energetic than the other turbine site and provides a conservative estimate for operations plans. Data were collected by a Nortek Continental (470 kHz) Doppler profiler deployed on the seabed for seven months from November 2011 – May 2012 in approximately 55 m of water. Over this time period, there are no indications of significant movement of the profiler by tidal currents. Data were collected in 1 m vertical bins and horizontal velocities have a Doppler uncertainty of 0.053 m/s.

3 Current Characteristics

The characteristics of currents in Admiralty Inlet are described in this section, separated by time scales of likely interest: daily, fortnightly, and seasonal. Turbulence and predictability are then briefly discussed.

3.1 Daily Variations

The current regime in Admiralty Inlet is classified as mixed, mainly semidiurnal, in that there are two ebbs and floods each day of unequal strength. In other words, the progression is from greater ebb to greater flood to lesser flood to lesser ebb, as shown in Figure 1. These data have been smoothed to a five minute average to minimize the influence of turbulence and are representative of mean flow conditions. The proximity of Admiralty Head strongly influences the currents. While the site is not within the eddy that forms to either side of the headland on ebb or flood (most pronounced on ebb), the vorticity produced by these eddies does affect mean flow conditions in the turbine area. This is manifested as perturbations from a classical sinusoidal representation of tidal currents with magnitudes of up to 1 m/s and durations on the order of fifteen minutes. An example of this is the "double peak" seen in Figure 1 during the greater flood.

The distribution of cycle durations (period) and peak velocities for ebb and flood tides observed during the seven month deployment are shown in Figure 2. While the average ebb or flood tide lasts for 6

Admiralty Inlet Site Characteristics

hours, variations of ± 2 hours are to be expected, and, occasionally, much shorter or longer tidal cycles can occur. Peak ebb currents are, in general, stronger than peak flood currents. While ebb tides with peak currents weaker than 1 m/s are uncommon, these do occur with relatively high frequency for flood tides. Consequently, if strong currents are likely to be problematic for operations, targeting lesser flood tides may provide up to several hours of operating time on station.

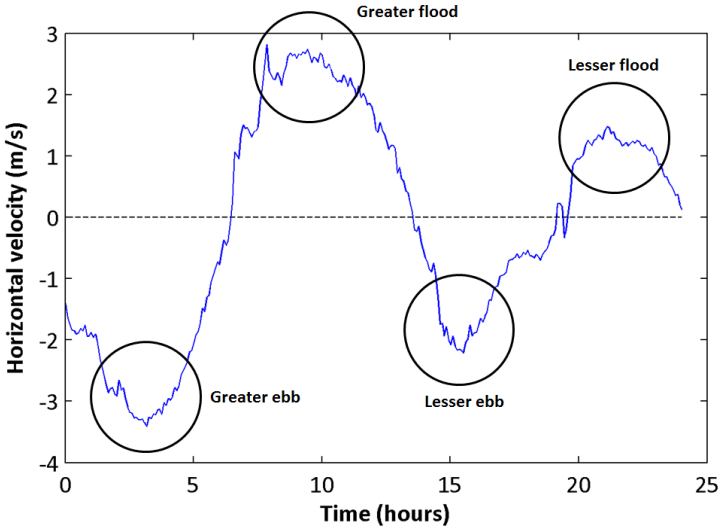


Figure 1 – Diurnal inequality in Admiralty Inlet (10 m above seabed)

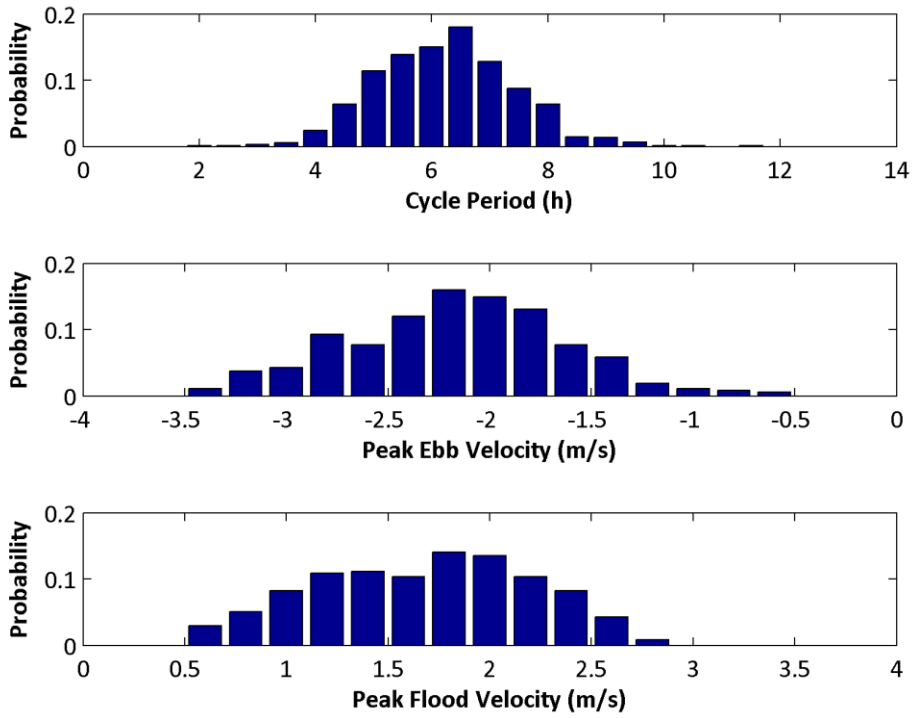


Figure 2 – Tidal cycle properties (10 m above seabed)

Figure 3 shows variations in current velocity and direction between the near-surface and hub-height of the turbines (10 m) over the same period as shown in Figure 1. In general, the velocity difference

Admiralty Inlet Site Characteristics

between surface and hub height is on the order of 0.5 m/s or lower, though around slack water, variations can exceed 1 m/s. The phase mismatch between seabed and surface depends on the position within the tidal cycle, with surface or seabed leading/lagging the other. In some cases, the reversal of the currents may be up to an hour apart between seabed and surface. In general, the direction of currents at hub-height is on the order of 20 degrees offset from surface currents, though significantly higher offsets (exceeding 100 degrees) should be expected around slack water. As previously mentioned, “slack” water does not occur uniformly throughout the water column and the combination of velocity and direction phase differences between surface and seabed during the turning of the tide may complicate operations. Note, in contrast, that the direction and velocity difference between the lesser flood for this particular cycle is limited, with velocity differences less than 0.1 m/s and phase differences less than 15 degrees. In other words, it may be more feasible to conduct operations once the tide has firmly “set” to either ebb or flood.

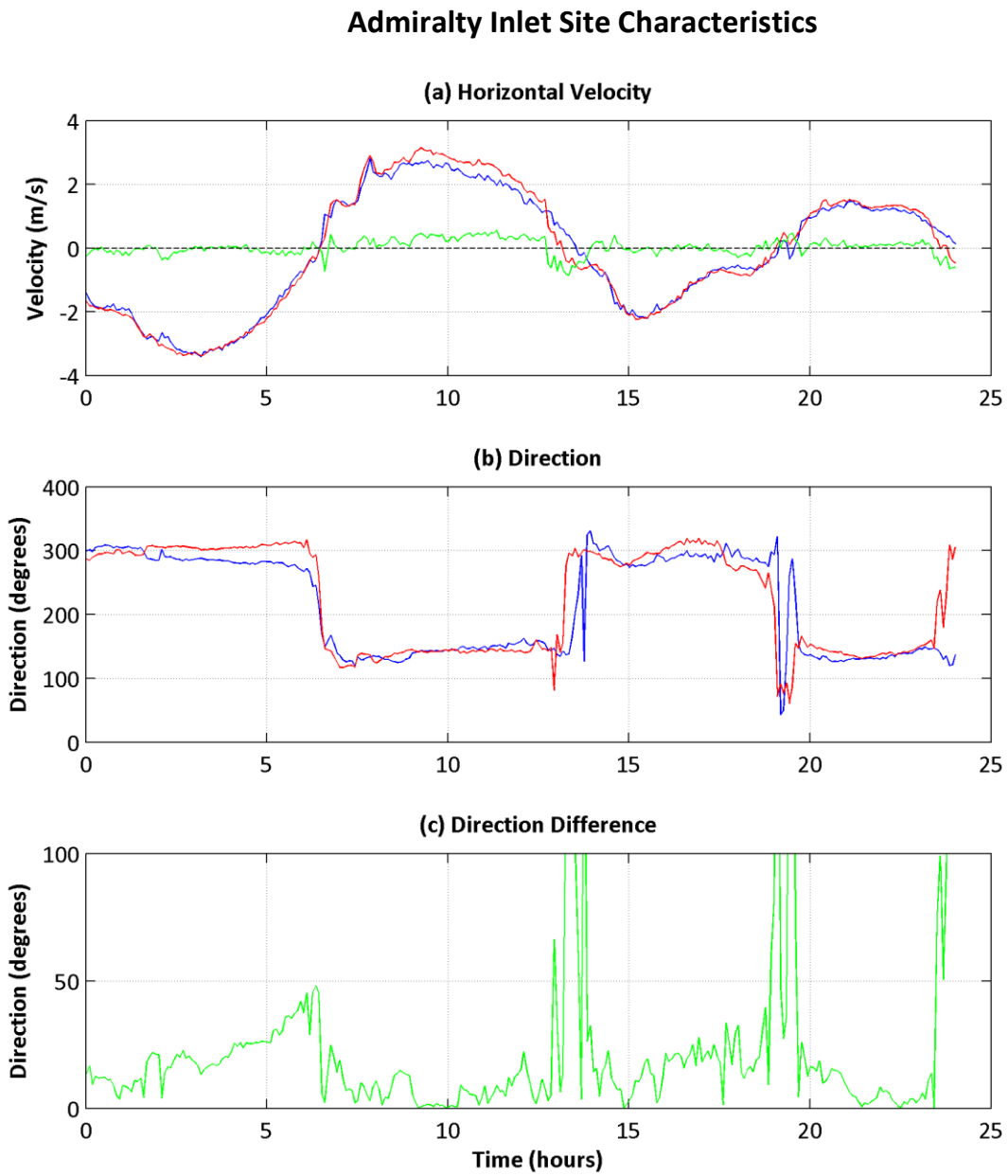


Figure 3 – Depth variations in current velocity and direction. (a) Horizontal velocity, (b) Direction (degrees true), (c) Direction difference between hub height (10 m above seabed) and near-surface. Blue line is hub-height (10 m), red line is near-surface (-10 m from surface), and green line is difference between the two.

As shown in Figure 3 and Figure 4, directional variation within a tidal cycle can be significant. Further, the current is not truly rectilinear, meaning that rather than passing through an entirely slack period (zero north and east velocity), the current velocity achieves a local minimum (usually less than 0.5 m/s) as the direction rotates between ebb and flood.

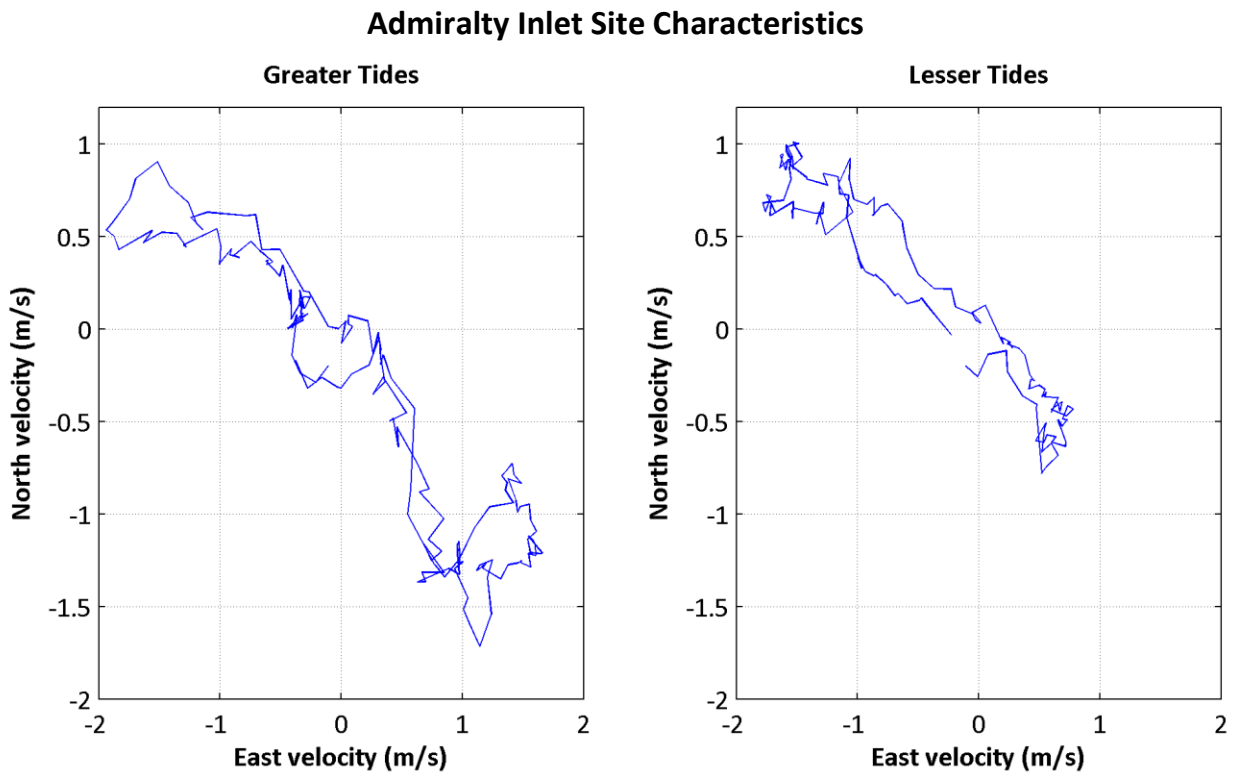


Figure 4 – Tidal ellipse during greater and lesser tides (10 m above seabed)

3.2 Fortnightly Variations

The predominant tidal periodicity beyond the daily diurnal inequality is the fortnightly progression from neap (weak currents) to spring (strong currents) as the gravitational forcing from the sun and moon moves in and out of phase. Figure 5 shows the fortnightly progression of tidal current velocity over the 14.8 day neap-spring cycle. Note that while the intensity of the greater tides is much diminished during the neap period, the intensity of lesser tides is relatively consistent and flood tides of moderate strength (i.e., less than 1 m/s peak currents) occur during both neap and spring periods.

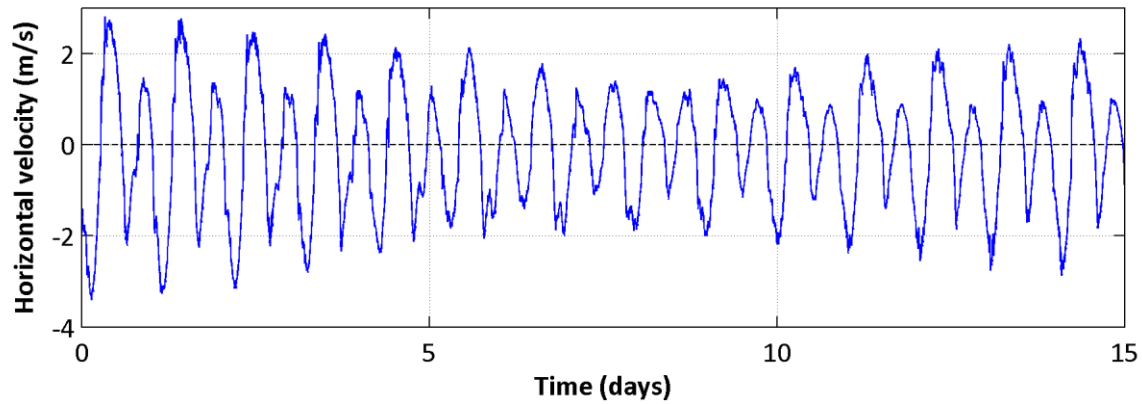


Figure 5 – Fortnightly variation in current velocity (10 m above seabed)

Admiralty Inlet Site Characteristics

3.3 Seasonal Variations

In addition to the neap-spring periodicity, there are longer-term tidal current intensity variations, such as the apogean-perigean cycle (absolute strongest currents in June and December, absolute weakest in March and September). The variations are lower amplitude than the neap-spring cycle, but can be operationally significant.

There are also seasonal variations in non-tidal currents. First, during winter months, sea states of 2-3 are common in northern Admiralty Inlet, which may complicate operations, depending on vessel stability. However, the site is relatively sheltered from the Straits of Juan de Fuca and significant swell is unlikely directly off of Admiralty Head. Second, during periods with large volumes of fresh water run-off (snow melt in the spring, storms in the late fall), stratification will establish residual currents, with a net outflow near the surface and net inflow near the seabed. The magnitude of the residual currents rarely exceeds 0.2 m/s throughout the water column during the winter and spring, as shown in Figure 6. During periods with higher run-off, residual currents may approach 0.4 m/s at both the surface and seabed.

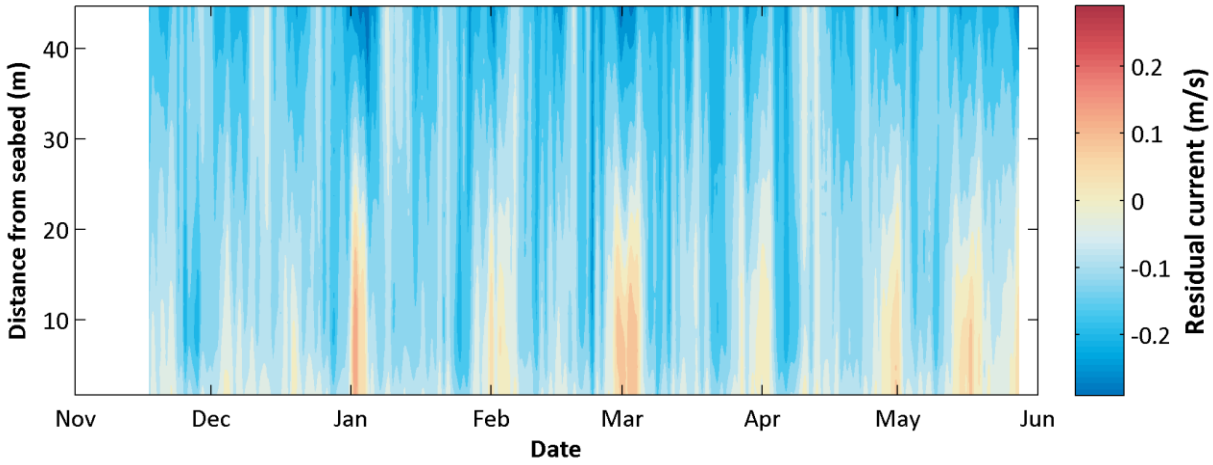


Figure 6 – Variation in residual currents with season and depth

3.4 Turbulence

In all figures to this point, data have been ensemble averaged to minimize the contribution of turbulence. Turbulence may be thought of as a perturbation to the mean flow and alters the direction and magnitude of current velocity in a stochastic (i.e., unpredictable) manner. Variations in direction and magnitude are correlated, with the highest intensity turbulent eddies increasing velocity by up to 50% relative to the mean flow and altering direction by up to 50 degrees. These are extreme cases and, more generally, velocity fluctuations are around 10% and directional variations around 5 degrees. During field operations, current fluctuations of at least ±0.5 m/s relative to the mean flow are likely to be encountered, regardless of mean flow conditions. The time scales for these variations will range from less than a second to longer than a minute.

Admiralty Inlet Site Characteristics

3.5 Current Predictions

The combination of turbulence and proximity to the headland reduces the accuracy of the NOAA current predictions for this region of Admiralty Inlet[1]. In general, the peak current magnitude predicted by NOAA is too low by a factor of two (near-surface) and the timing of peak and slack events may be as much as an hour removed from reality.

NOAA current predictions should be consulted to identify periods of generally favorable currents (i.e., lesser flood tides), but should be assumed to under-predict velocities and have timing errors.

The District and its consultants are working to develop improved predictions for this region of Admiralty Inlet and can provide provisional current predictions upon request for the purposes of planning field operations. These methods are exploratory in nature (the asymmetries in direction and magnitude between ebb and flood lead to particular challenges in harmonic prediction) and should be used as a compliment to, rather than replacement of, NOAA current predictions.

Within the general area of the demonstration project (i.e., distances to 1 km), there are large-scale gradients in current intensity and direction. These are hypothesized to be the result of flow separation around Admiralty Head. At any moment in time, differences in mean currents on the order of 0.1 m/s exist over spatial scales as short as 100 m and more pronounced gradients occur over spatial scales on the order of several hundred meters. Consequently, the accuracy of any current predictions is likely to degrade within 100-200 m of the specific site for which the prediction was made.

4 Conclusion

The characteristics that make northern Admiralty Inlet an attractive site for tidal power generation also complicate field operations in support of the demonstration project. The easiest time to operate on station is during the summer months (long days, limited wave activity), on lesser floods during neap tides. The timing of these events can be determined qualitatively from NOAA current predictions and refined using site-specific predictions available from the District's consultants.

[1] NOAA is re-surveying currents throughout Puget Sound over the coming years, which should improve the accuracy of predictions as time goes on.

Appendix J

2012 ROV CABLE-ROUTE SURVEY

The following are included in this appendix:

1. *Northwest Underwater Construction LLC*
   Tidal Energy Project: ROV Inspection Report Prepared for: Sound & Sea Technology
   July 25, 2012

2. *Attachment (1): ROV Survey Log*

3. *Time Stamp Sheets of Cable Route Footage (Sheets 1-10)*

4. *PDF images of cable route corresponding with sheets 2-10 above.*

Note:

i. *The DISTRICT has DVD copies of all the ROV footage (9+ hours in total) available for prospective bidders. These will be available at the scheduled pre-bid conferences and upon special request.*
ii. *To avoid confusion, please note that DVD numbers **DO NOT** correspond with the sheet numbers included herein.*

September 26, 2012

Eric Schneider, P.E.
Principal Engineer, Generation Division
Snohomish Public Utility District
PO Box 1107
Everett, WA 98206-1107

Re: Northwest Underwater Construction, LLC ROV Survey

Dear Mr. Schneider:

On August 11 - 13, 2012, Northwest Underwater Construction conducted a remotely-operated vehicle (ROV) video survey of the seabed in Admiralty Inlet and Admiralty Bay in support of the Snohomish Public Utilities District Tidal Energy Project. The principle product from this survey is the ROV video footage, hand-delivered to the District under separate cover on 27 August 2012. The enclosed NUC report and attached SST survey timeline are provided for your information.

Seafloor Conditions

Admiralty Bay: Cable Route

Within Admiralty Bay, the sea floor sediment of the eastern (shallow) half of the cable route appears to be predominantly coral- and algae-covered pebbles and cobblestones. Visibility in the inner Admiralty Bay section was hampered by abundant presence of organic debris in the water. The easternmost end of the cable route, in water depths from about 17 to 25 meters, is heavily vegetated by short, feathery algae. The bottom is too obscured to confirm the mix of sediment grain sizes without hands-on (diver) examination, but there is little evidence seen in the ROV footage of any fine sediment along this sector of the RPL. Large patches of algae attached to rocks cover much of the sea floor. It is reasonably level, but humpy.

As requested by the District, this shallow segment of the cable route was checked for evidence of geoduck clams; none was found, although there is no question there are other types of clams in the area. There is much organic litter between the cobbles and pebbles of the seabed, and a large portion of the fragments are butter or Manila clamshells. A request had been made to look for eelgrass; there was none (neither eelgrass nor evidence thereof). It appears that the habitat in the depth range surveyed is both too deep and too turbulent (there is a strong tidal surge present, even in the bay) for the eelgrass to take hold. Eelgrass also requires a sandy bottom. There does not appear to be any sand on the sea floor along the cable route. The seabed here is all cobbles with a few minor patches of pebbles. Everything is covered by organic growth.

The deeper western half of the cable route RPL (route position list) from about the 30-meter contour on the east side of a large depression just west of the Port Townsend/Coupeville Ferry harbor is paved

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e-mail: admin@soundandsea.com

patches of pebbles and scattered boulders. A small but noteworthy boulder field, with probably a half-dozen 1 to 1-1.5 m rocks, and one 3 m by 1.5 m monster was encountered approximately due south of Admiralty Head. The boulders were marked on the navigation plot and a preliminary file was provided to the District by separate correspondence. There appears to be room for the cable route between the boulders, but the cable deployment through this sector (RPL nodes 12-14) will be a slow, careful process.

Turbine Deployment Site

Within the turbine deployment box, most of the survey lines appeared very uniform: large cobblestones predominate (12-16 cm), with scattered very large cobbles and small boulders (to 10-14 inches; few larger boulders were identified in the turbine box). Organic material obscures some of the sea floor; algae and barnacles primarily, but not as dense as in the bay.

The deployment site segment of the NUC survey is visually nearly identical to the video footage recorded during earlier Global Diving ROV surveys in the area. The surface is covered with a pavement of cobblestones across the entire span, with small patches of pebbles and scattered boulders, most in the ½ to 1 m range.

At the extreme north end of the deployment box on lines B12 and B13, there are patches of coarse sand and gravel (both in waves and flat shoals). The patches are relatively small – a few meters across, at least along the survey lines. Interestingly, the sand butts up against a zone of very large cobbles and relatively small (1/2 to 1 m) boulders. But as one moves closer into the box, the cobble size drops and few boulders of any size are seen inside the box. ***Note***: this area is immediately adjacent to the gravel wave zone downslope from Whidbey Island's coastline, and it may be that some of these boulders are not erratics deposited in situ but have rolled downslope from eroded coastal formations.

Summary of Seabed Conditions:

With very minor exceptions a fairly consistent cobblestone pavement is present throughout the deployment box and the entire cable route. At the extreme eastern end of the cable run into Admiralty Bay the cobbles are smaller and are interspersed with pebbles; and as noted above, there are sand patches and boulders in the north corner of the box, and a small boulder field (which includes large cobbles) just south of Admiralty Head. Other than those features, the entire area looks very uniform. Given the amount of side-to-side deviation of the ROV path during the survey, there is little reason to expect any significant variability in the seabed anywhere within the deployment box. There is more vegetation in the shallows of the bay, obscuring the bottom; more shell debris nearshore; and more barnacles out in the deeper water. But overall, it is a very predictable and consistent sedimentary environment.

Attachments

Sincerely,

Michael A. McCallister
CAPT USN/NOAA (Ret)
Sound & Sea Technology
425-293-2674

Enclosure (1) ROV SURVEY LOG
Enclosure (2) TIDAL ENERGY PROJECT: ROV INSPECTION REPORT dated July 25, 2012

Sound and Sea

Tidal Energy Project: ROV Inspection Report

Report Date:
July 25, 2012

Prepared For:
Larry Armbruster
Sound and Sea

Prepared By:
Northwest Underwater Construction, LLC (NUC)
NUC Project No. 112083

NORTHWEST UNDERWATER CONSTRUCTION, LLC.

800 NE. TENNEY RD., SUITE 110-111, VANCOUVER, WA 98685
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July 25, 2012

Larry Armbruster
Mobile: 206 595-5781
Sound & Sea Technology, Inc.
3507 Shelby Road
Lynnwood, WA 98087
425 743-1282
Fax 425 742-5643

RE: Tidal Energy Project

Mr. Armbruster,
Attached is our report summarizing the findings of the ROV inspection Northwest Underwater Construction, LLC performed at Admiralty Inlet adjacent to Fort Casey on Whidbey Island, Washington on July 11, 2012. Underwater video was recorded during the course of the project and a DVD copy is included with this report.

Should you have any questions and/or comments please feel free to contact me at the numbers and/or emails listed below. Thank you for allowing us to provide these services for you and we look forward to working with you again in the near future.

Sincerely,

Ryan Berg

Special Projects Manager
Northwest Underwater Construction, LLC
800 NE Tenney Road, Suite 110-111
Vancouver, WA 98685
(360)-695-5163 mobile
(866) 270-1114 office
(360)-993-5581 fax
rberg@nwuwconst.com

Introduction

Northwest Underwater Construction, LLC (NUC) performed a Remote Operated Vehicle (ROV) underwater video inspection on June 21, 2012 at Admiralty Inlet, adjacent to Fort Casey on Whidbey Island, Washington. The work was performed in general accordance with the Association of Diving Contractors International, Inc. (ADCI) *Consensus Standards for Commercial Diving and Underwater Operations* (6th Ed.), and applicable regulations from U.S. and Washington 29 CFR; Dir. CPL 02-00-151; 2011. The following presents our Work Scope, Methods, Findings and any recommendations for further work based on our observations.

Facility and Project Location

The tidal project ROV survey is to support precise site and cable route selection and environmental permitting for demonstrating two Open Hydro tidal energy turbines to be deployed in Admiralty Inlet adjacent to Fort Casey on Whidbey Island, Washington

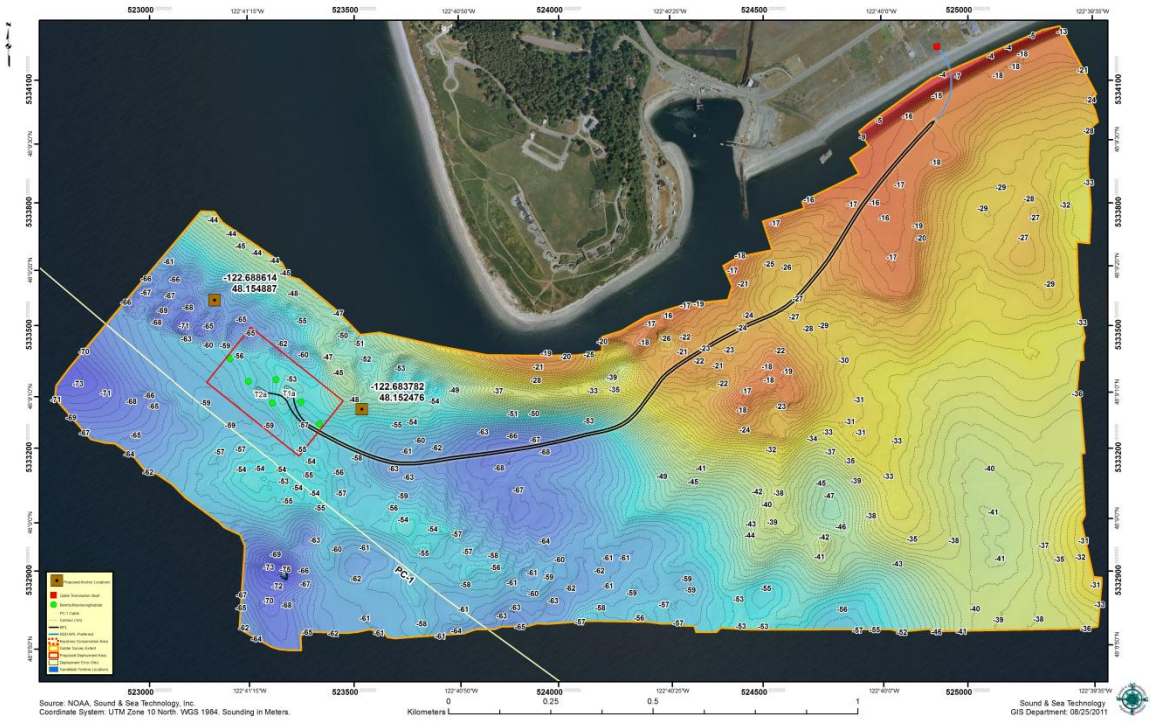

Figure 1: Proposed Turbine Site Locations and Cable Route (figure provided by Sound ad Sea)

Work Scope

Our scope of work for this project consisted of providing a four-person ROV and survey crew (one captain, one pilot, one surveyor and one tender) to conduct a ROV visual inspection of specific client-defined areas of the proposed turbine site (Figure 1). NUC mobilized a support vessel and a *Sub Atlantic* ROV system capable of generating video footage in DVD or USB format to the project site.

Inspection Methods

NUC set-up and launched the ROV system during live boat operations on the M/V Salvager to conduct a general bottom survey and document visually observed conditions of the proposed turbine site using an DVD-recordable underwater video system for subsequent viewing by the project ROV Supervisor, Ryan Berg, and Sound and Sea's field representative Michael McCallister. Three roughly parallel ROV track lines were run from the strart of the cable route to the off shore turbine location. (Please reference survey data). During the course of the ROV inspection, sonar data was acquired to visually inspect approximately 10 meters 360 degrees while the ROV swam the track lines. During the survey no anomalies where noted. The survey crew noted large boulders larger than 1 meter with a GPS mark on the Hypack Navigation Suite. Due to the water clarity and visibility the black and white low-lux camera was utilized to observe bottom conditions.

Both the sonar and ROV data was displayed real-time on a laptop computer and stored for post-processing and incorporation into the report using the Hypack software program. Written field notes were also recorded during the course of the survey and are summarized below. To view all of the recorded video footage, please refer to the DVD included with the report.

Inspection Findings

The bottom conditions

Bottom conditions:
NUC observed approximately 8 to 10-inches of river rock and scattered boulders covering the bottom along the cable route inspection. This was also noted in the proposed turbine location. During the ROV inspection there was very little bottom sediment observed. (please reference the survey data as boulders were marked in hypack)

For review of the entire video footage, please refer to the DVD provided with this report. NUC thanks you for your business and please don't hesitate to contact me should you have any questions, comments or require follow-up work on the project.

Sincerely,

Ryan Berg

Special Projects Manager
Northwest Underwater Construction, LLC
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Vancouver, WA 98685
(360)-695-5163 mobile
(866) 270-1114 office
(360)-993-5581 fax
rberg@nwuwconst.com

Reviewed by:
Brian Haug, Operations
brianh@nwuwconst.com

Attachment (1)
ROV SURVEY LOG

11 July 2012

1030: Met aboard NUC survey vessel R/V ***SALVAGER*** in Port Townsend harbor. Conducted mission briefing (R. Berg), site briefing (M. McCallister), safety briefing (NUC vessel skipper).
1100:1200: Equipment checkout and navigation baseline tests
1210: Underway
1255: Arrive Admiralty Bay, Puget Sound
1325: Deploy ROV
1340: Commence survey of cable route (Line #1 – from HDD daylight site westbound to turbine deployment "box")
1635: End cable route Line #1 at turbine deployment box
1640: Commence cable route Line #2 (from turbine deployment box eastbound to HDD daylight site)
1850: End cable route line 2 at HDD daylight site
1900: Recover ROV
1910 RTB Port Townsend
1945 Arrive harborside Port Townsend

12 July 2012

1030: Met aboard R/V ***SALVAGER*** in Port Townsend harbor.
1040: Underway
1125: Arrive Admiralty Bay
1125: Coordinate operations with Keystone ferry; maneuver to deploy site
1209: Deploy ROV
1216: Commence survey of cable route (Line #3W – from ferry landing westbound to turbine deployment "box")
1153: End cable route Line #3W at turbine deployment box
1358: Recover ROV to check thruster problem (cleared up en route to surface)
1413: ROV deployed at southeast end of line B2 ("B" for "deployment Box")
1422: Recover ROV; unable to get ROV to sea floor (current still too strong, despite predicted window)
1513: Redeploy ROV
1522: ROV on bottom
1523: Commence survey line B07
1528: End Line B07 (partial)
1530: Begin Line B06
1542: Line B06 complete
1544: Begin Line B05
1554: Line B05 complete
1555: Begin Line B04
1610: Line B04 complete

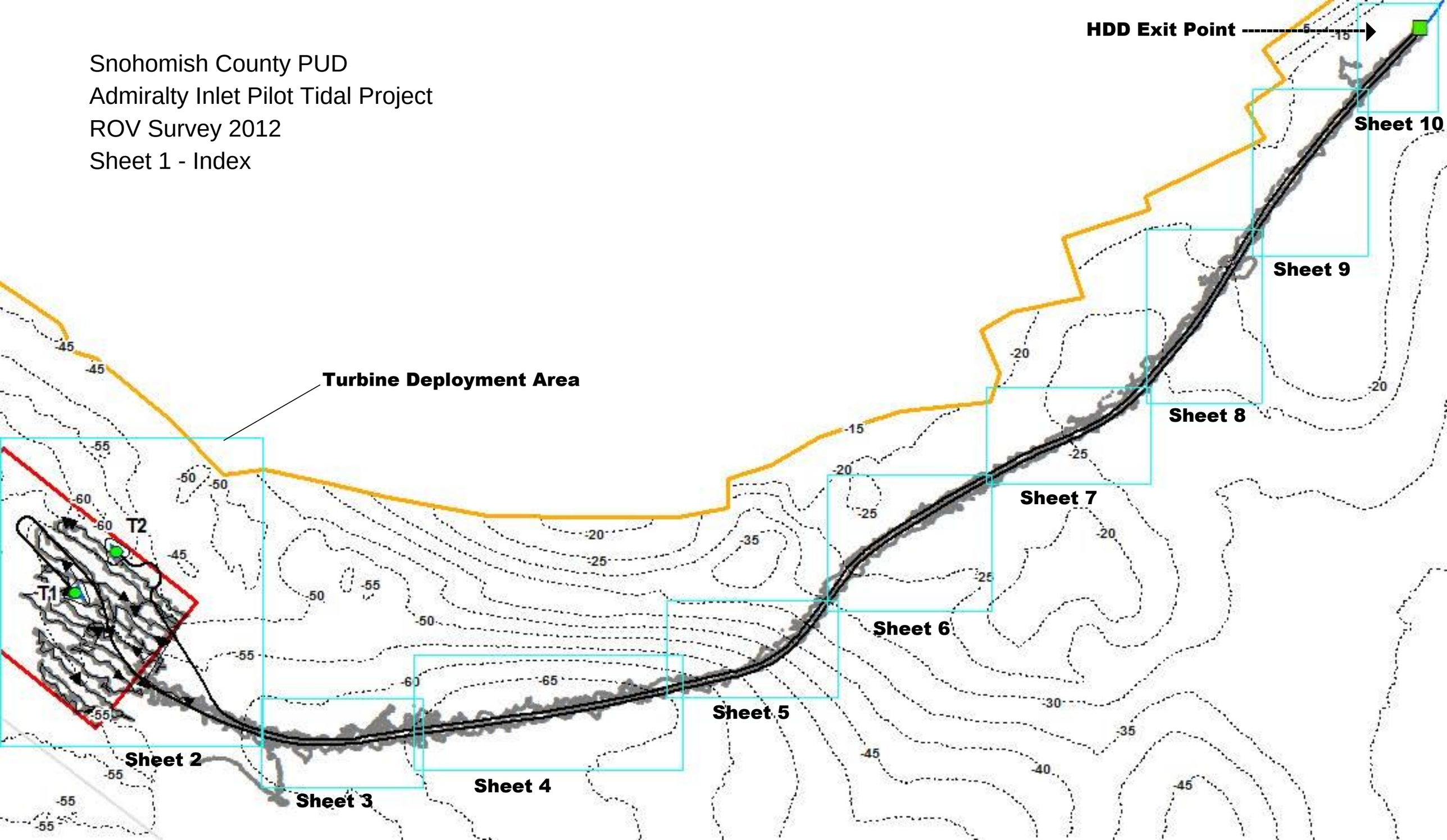
1610: Begin Line B03
1613: line B03 complete
1614: Begin Line B02
1624: Line B02 complete; heading back to finish Line B07
1630: Loss of power on vessel. Recover ROV and troubleshoot
1636: Problem identified as tripped breaker on generator distribution panel; reset breaker and reset all electronics
1703: Redeploy ROV
1705: ROV on bottom
1715: Begin line B08
1724: End Line B08 (partial)
1725: Begin Line B09
1744: Line B09 complete
1745: Begin Line B08 partial
1755: Line B08 complete
1755: Begin Line B07 partial
1801: Line B07 complete
1803: Begin Line B10
1813: Line B10 complete
1814: Begin Line B11
1824: Line B11 complete
1825: Begin Line B12
1828: USBL pole bracket weld broke, causing USBL system failure (no way to correctly position ROV).
1831: Set ROV on bottom and strapped USBL pole to side of vessel
1833: Begin recovery of ROV
1852: Secure from survey, RTB Port Townsend
1910: Arrive harborside Port Townsend

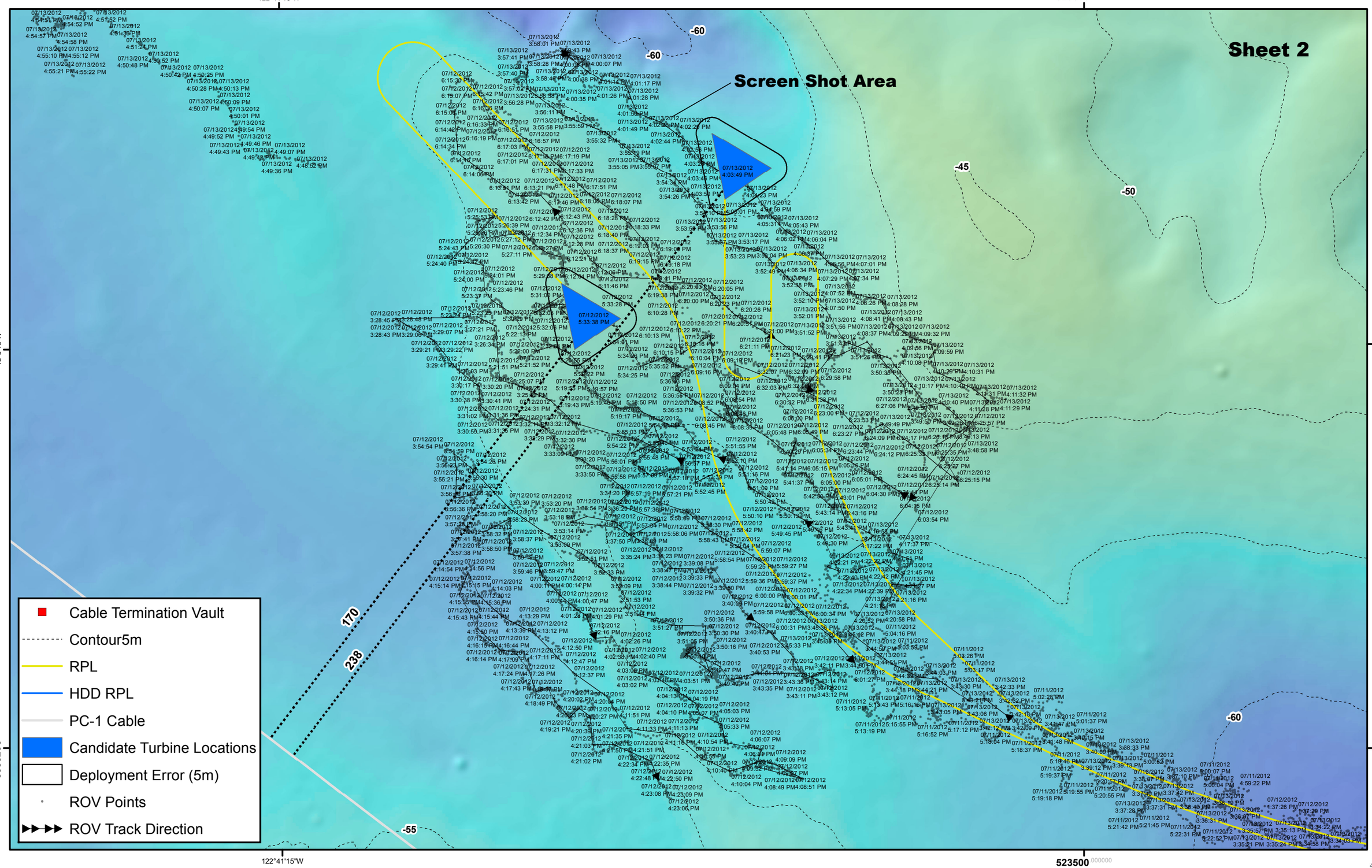
13 July 2012

0830-1200: Aluminum welding on board NUC survey vessel to repair USBL pole
1230: Met aboard R/V ***SALVAGER*** in Port Townsend harbor; delayed for weather
1300: Underway
1330: Arrive Admiralty Bay
1335: Coordinate operations with Keystone ferry; maneuver to deploy site; check systems
1349: Deploy ROV
1355: ROV on the bottom
1359: Commence survey of cable route (Line #1- 50 m segment remaining from 11 July)
1406: End segment, Cable Route Line #1. Line 1 complete.
1408: Begin center line Cable Route Line 3E
1503: Cable Route Line 3E complete, joined up with Cable Route Line 3W
1505: Recover ROV and transit
1527: Redeploy ROV
1534: Commence survey of short segment on west end of Cable Route Center Line (Line 3W) heading westbound to turbine deployment “box”

1546: End segment of Cable Route Line 3W; transit to box, Line B12
1548: Commence survey line B12
1556: End Line B12
1600: Begin Line B13
1611: Line B13 complete
1613: line B03 complete
1616: Begin survey segment along Cable Route laydown loop, southeast end of deployment box
1623: Search for UW Sea Spider
1624: Line B02 complete; heading back to finish Line B07
1642: Located Sea Spider, bearing 257, 24 m from UW reported deployment location; collected video of instrument package
1650: Commence survey of Cable Route laydown loop outside NW end of box
1655: Loop survey complete. All lines complete; end survey
1700: ROV on board
1705: RTB Port Townsend
1742: Arrive harborside Port Townsend

Snohomish County PUD
Admiralty Inlet Pilot Tidal Project
ROV Survey 2012
Sheet 1 - Index





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GIS Department: 10/12/2012

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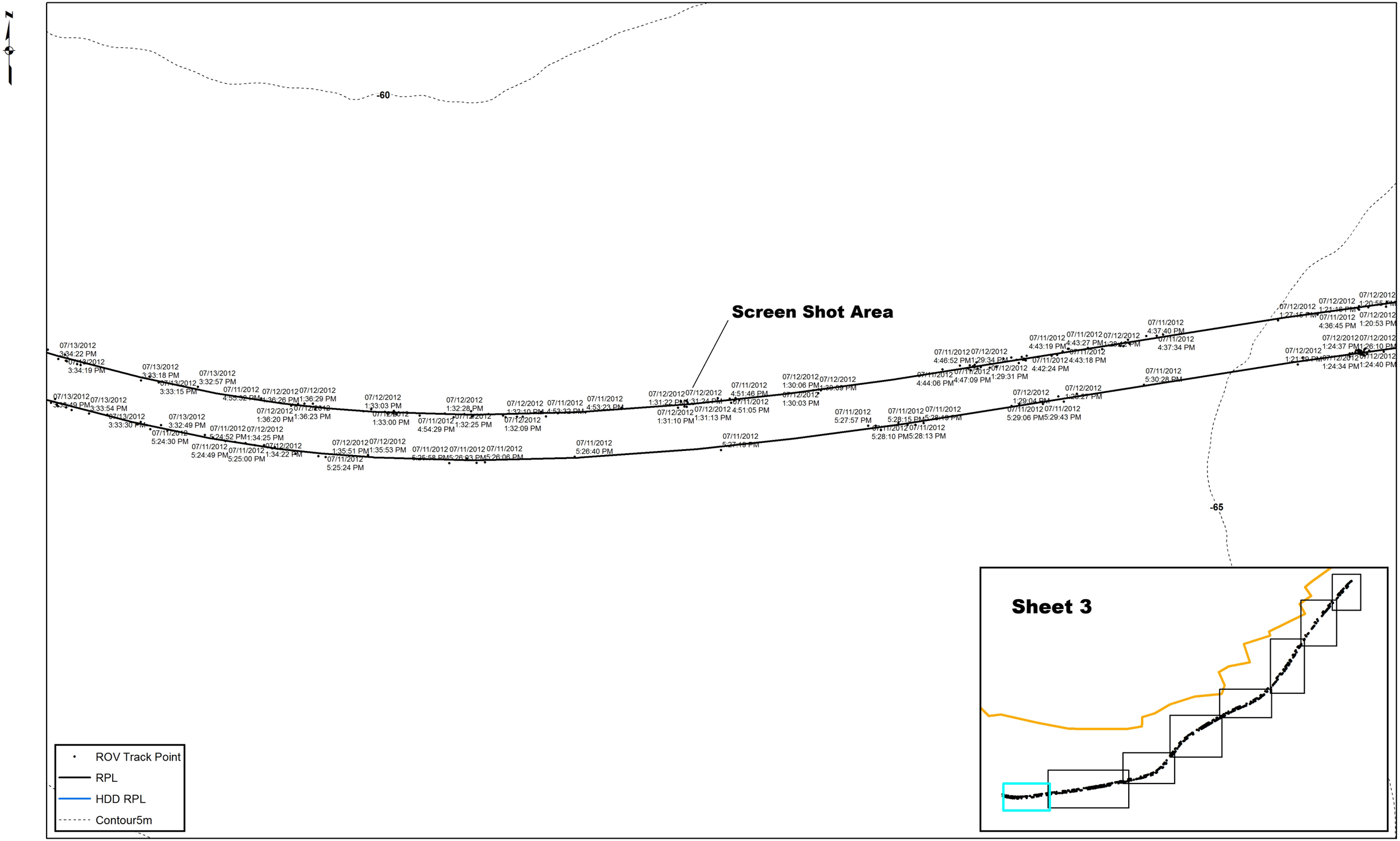

Source: Golder, Geo-visualization by Sound & Sea Technology, Inc.
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GIS Department: 05/21/2013

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Sheet 4

ROV Track Point

RPL

HDD RPL

Contour5m

Source: Golder, Geo-visualization by Sound & Sea Technology, Inc.
Coordinate System: UTM Zone 10 North. WGS 1984.

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Sheet 5

ROV Track Point
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HDD RPL
Contour5m

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Coordinate System: UTM Zone 10 North. WGS 1984.

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Depth in Meters

Sound & Sea Technology
GIS Department: 05/21/2013

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Sheet 6

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HDD RPL
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Depth in Meters

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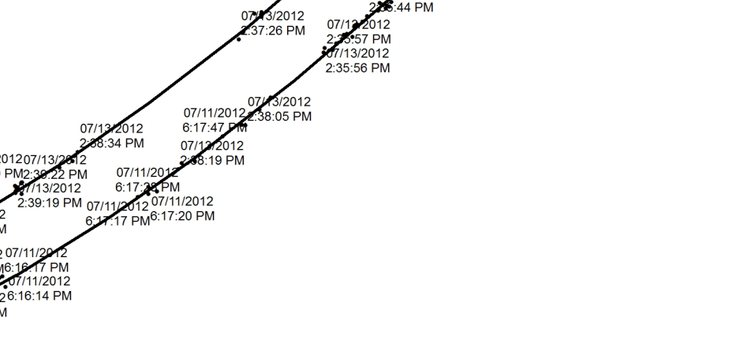

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Sheet 8

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RPL
HDD RPL
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Depth in Meters

Sound & Sea Technology
GIS Department: 05/21/2013

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Sound & Sea Technology
GIS Department: 05/21/2013

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Appendix K

FERC LICENSE CONDITIONS

While the final FERC license and associated Articles have yet to be issued as of 11/2/2014, the DISTRICT has enclosed the attached Environmental Assessment (EA) in lieu of the Final FERC License. The EA contains preliminary License Articles and closely represents what will be issued in the Final License. Should a material difference arise between the Articles in the EA and those issued with the final license, the DISTRICT recognizes this as a potential change condition.

20130809-3019 FERC PDF (Unofficial) 08/09/2013

UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

Public Utility District No. 1 of Snohomish County, Washington — Project No. 12690-005

ERRATA NOTICE

(August 9, 2013)

On August 9, 2013, the Commission issued notice of availability of the Final Environmental Assessment for the Admiralty Inlet Pilot Tidal Project No. 12690. The notice mistakenly says that comments should be filed within 30 days. The Commission does not solicit comments on a Final Environmental Assessment.

Kimberly D. Bose,
Secretary.

20130809-3019 FERC PDF (Unofficial) 08/09/2013

Document Content(s)

P-12690-005ErrataNotice.DOC.....1-1

UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

Public Utility District No. 1
of Snohomish County, Washington

Project No. 12690-005

NOTICE OF AVAILABILITY OF FINAL ENVIRONMENTAL ASSESSMENT

(August 9, 2013)

In accordance with the National Environmental Policy Act of 1969 and the Federal Energy Regulatory Commission's (Commission or FERC's) regulations, 18 CFR Part 380 (Order No. 486, 52 FR 47897), the Office of Energy Projects reviewed the Public Utility District No. 1 of Snohomish County, Washington's (Snohomish PUD) application for a 10-year license for the proposed Admiralty Inlet Pilot Tidal Project No. 12690, which would be located in Admiralty Inlet in Puget Sound, near the City of Port Townsend, in Island County, Washington, and has prepared a final environmental assessment (FEA) in cooperation with the U.S. Department of Energy (DOE/EA-1949). In the FEA, Commission staff analyzed the potential environmental effects of constructing and operating the project and concludes that licensing the project, with appropriate environmental protective measures, would not constitute a major federal action that would significantly affect the quality of the human environment.

A copy of the FEA is available for review at the Commission in the Public Reference Room or may be viewed on the Commission's web site at www.ferc.gov using the "eLibrary" link. Enter the docket number excluding the last three digits in the docket number field to access the document. For assistance, contact FERC Online Support at FERCOnlineSupport@ferc.gov or toll-free at 1-866-208-3676, or for TTY, 202-502-8659. A copy of the EA can also be found on DOE's Public Reading Room web site at http://www.eere.energy.gov/golden/NEPA_FEA_FONSI.aspx. Please reference DOE/EA-1949 in the National Environmental Policy Act, Documents section.

You may also register online at www.ferc.gov/docs-filing/esubscription.asp to be notified via email of new filings and issuances related to this or other pending projects. For assistance, contact FERC Online Support.

Any comments should be filed within 30 days from the date of this notice. Comments may be filed electronically via the Internet. See 18 CFR 385.2001(a)(1)(iii) and the instructions on the Commission's web site (http://www.ferc.gov/docs-filing/ferconline.asp) under the "eFiling" link. Commenters can submit brief comments up to 6,000 characters, without prior registration, using the eComment system at http://www.ferc.gov/docs-filing/ecomment.asp. You must include your name and contact

20130809-3010 FERC PDF (Unofficial) 08/09/2013

information at the end of your comments. For assistance, please contact FERC Online Support. Although the Commission strongly encourages electronic filings, documents may also be paper-filed. To paper-file, mail an original and five copies to: Kimberly D. Bose, Secretary, Federal Energy Regulatory Commission, 888 First Street, NE, Washington, DC 20426. Please affix Project No. 12711-005 to all comments.

For further information, contact Stephen Bowler by telephone at 202-502-6861 or by email at stephen.bowler@ferc.gov.

Kimberly D. Bose,
Secretary.

20130809-3010 FERC PDF (Unofficial) 08/09/2013

FINAL ENVIRONMENTAL ASSESSMENT

FOR HYDROPOWER LICENSE

Admiralty Inlet Pilot Tidal Project—FERC Project No. 12690-005 (DOE/EA-1949)

Washington

Federal Energy Regulatory Commission
Office of Energy Projects
Division of Hydropower Licensing
888 First Street, NE
Washington, DC 20426

U.S. Department of Energy
Office of Energy Efficiency and Renewable Energy
1617 Cole Boulevard
Golden, Colorado 80401

August 2013

20130809-3010 FERC PDF (Unofficial) 08/09/2013

TABLE OF CONTENTS

LIST OF FIGURES iv

LIST OF TABLES v

EXECUTIVE SUMMARY x

1.0 INTRODUCTION 1
- 1.1 APPLICATION 1
- 1.2 PURPOSE OF ACTION AND NEED FOR POWER 1
  - 1.2.1 Purpose of Action 1
  - 1.2.2 Need for Power 3
- 1.3 COOPERATING AGENCY ROLES 4
- 1.4 STATUTORY AND REGULATORY REQUIREMENTS 4
  - 1.4.1 Federal Power Act 6
  - 1.4.2 Clean Water Act 7
  - 1.4.3 Endangered Species Act 7
  - 1.4.4 Marine Mammal Protection Act 8
  - 1.4.5 Magnuson-Stevens Fishery Conservation and Management Act 9
  - 1.4.6 Coastal Zone Management Act 10
  - 1.4.7 National Historic Preservation Act 10
- 1.5 PUBLIC REVIEW AND COMMENT 11
  - 1.5.1 Comments on the Draft License Application 11
  - 1.5.2 Interventions 12
  - 1.5.3 Comments on the License Application 13
  - 1.5.4 Comments on the Draft Environmental Assessment 14

2.0 PROPOSED ACTION AND ALTERNATIVES 15
- 2.1 NO-ACTION ALTERNATIVE 15
- 2.2 APPLICANT'S PROPOSAL 15
  - 2.2.1 Project Facilities 15
  - 2.2.2 Project Safety 15
  - 2.2.3 Project Installation and Removal 16
  - 2.2.4 Project Operation 19
  - 2.2.5 Project Maintenance 19
  - 2.2.6 Proposed Environmental Measures 21
- 2.3 STAFF ALTERNATIVE 23

3.0 ENVIRONMENTAL ANALYSIS 25
- 3.1 GENERAL DESCRIPTION OF THE PROJECT AREA 25
- 3.2 SCOPE OF CUMULATIVE EFFECTS ANALYSIS 26
  - 3.2.1 Geographic Scope 26
  - 3.2.2 Temporal Scope 27

3.3 PROPOSED ACTION AND ACTION ALTERNATIVES 27
3.3.1 Geologic and Soil Resources 28
3.3.1.1 Affected Environment 28
3.3.1.2 Environmental Effects 30
3.3.2 Marine Resources 35
3.3.2.1 Affected Environment 35
3.3.2.2 Environmental Effects 52
3.3.2.3 Cumulative Effects 84
3.3.3 Rare, Threatened, and Endangered Species 85
3.3.3.1 Affected Environment 85
3.3.3.2 Environmental Effects 105
3.3.3.3 Cumulative Effects 111
3.3.4 Terrestrial Resources 112
3.3.4.1 Affected Environment 112
3.3.4.2 Environmental Effects 113
3.3.5 Recreation 115
3.3.5.1 Affected Environment 115
3.3.5.2 Environmental Effects 119
3.3.6 Land and Ocean Use 122
3.3.6.1 Affected Environment 122
3.3.6.2 Environmental Effects 123
3.3.7 Navigation 132
3.3.7.1 Affected Environment 132
3.3.7.2 Environmental Effects 133
3.3.8 Aesthetic Resources 138
3.3.8.1 Affected Environment 138
3.3.8.2 Environmental Effects 139
3.3.9 Cultural Resources 142
3.3.9.1 Affected Environment 142
3.3.9.2 Environmental Effects 145
3.4 NO-ACTION ALTERNATIVE 147

4.0 DEVELOPMENTAL ANALYSIS 148
4.1 POWER AND ECONOMIC BENEFITS OF THE PROJECT 148
4.2 COMPARISON OF ALTERNATIVES 149
4.3 COST OF ENVIRONMENTAL MEASURES 151

5.0 CONCLUSIONS AND RECOMMENDATIONS 158
5.1 COMPARISON OF ALTERNATIVES 158
5.2 COMPREHENSIVE DEVELOPMENT AND RECOMMENDED ALTERNATIVE 163
5.3 UNAVOIDABLE ADVERSE IMPACTS 173
5.4 FISH AND WILDLIFE AGENCY RECOMMENDATIONS 174

20130809-3010 FERC PDF (Unofficial) 08/09/2013

5.5 CONSISTENCY WITH COMPREHENSIVE PLANS 177

6.0 FERC FINDING OF NO SIGNIFICANT IMPACT 179

7.0 LITERATURE CITED 180

8.0 LIST OF PREPARERS 202

APPENDIX A LICENSE ARTICLES RECOMMENDED BY STAFF A-1

APPENDIX B STAFF RESPONSES TO COMMENTS B-1

LIST OF FIGURES

Figure 1. Location of Admiralty Inlet Pilot Tidal Project (Source: application). 2

Figure 2. Illustration of the OpenHydro turbine (Source: application). 16

Figure 3. OpenHydro Installation Barge (Source: application). 18

Figure 4. ROV image of cobble pavement bottom in project area (Source: applicant). 29

Figure 5. Hjulstrom's Diagram showing the transport, deposition, and erosion of particles based on particle size and water velocity (Source: www.geographylwc.org.uk). 33

Figure 6. Percentile One-third octave levels (TOLs) for ambient noise (25 Hz – 1 kHz) (Source: application). 37

Figure 7. Median One-third octave levels (TOLs) for ambient noise (1 kHz – 25 khz) as a function of current velocity (Source: application). 38

Figure 8. Probability distribution of turbine source levels (left). Broadband (25 Hz – 25 kHz) one-third octave source levels (right) for select operating percentiles (Source: application). 74

Figure 9. Distance from project center (mid-point between turbines) to Level B harassment threshold for broadband (25 Hz – 25 kHz) sound pressure levels (Source: application). 77

Figure 10. Admiralty Head Marine Preserve and Keystone Conservation Area (Source: application). 117

Figure 11. Location of proposed turbine installations, shipping channels, and submerged cables in Admiralty Inlet (Source: NOAA, and applicant, as modified by staff). 134

20130809-3010 FERC PDF (Unofficial) 08/09/2013

LIST OF TABLES

Table 1. Major statutory and regulatory requirements for the Admiralty Inlet Pilot Tidal Project (source: staff). 5

Table 2. Shore bird, seabird, and other avian sightings within 0.4 km (0.25 miles) of Admiralty Inlet from Washington DFW vessel surveys (1992 to 2004). 50

Table 3. Federally listed threatened and endangered species with potential to occur in proposed project area (Source: application, as modified by staff). 85

Table 4. Population Size For Golden Paintbrush Populations On Whidbey Island (Source: FWS 2007). 105

Table 5. Population Trends For Golden Paintbrush Populations On Whidbey Island (Source: FWS 2007). 105

Table 6. Parameters for the economic analysis of the Admiralty Inlet Project (Source: Snohomish PUD and staff). 149

Table 7. Summary of the annual cost of alternative power and annual project cost for the alternatives for the Admiralty Inlet Pilot Tidal Project (Source: staff). 150

Table 8. Cost of environmental mitigation and enhancement measures considered in assessing the environmental effects of constructing and operating the Admiralty Inlet Project (Source: staff). 152

Table 9. Comparison of alternatives for the Admiralty Inlet Project. (Source: Staff).158

Table 10. Analysis of fish and wildlife agency recommendations for the Admiralty Inlet Project (Source: staff). 175

ACRONYMS AND ABBREVIATIONS

°C	degrees Celsius
°F	degrees Fahrenheit
ACRE	Alderney Commission for Renewable Energy
ADCP	Acoustic Doppler Current Profiler
aMW	average megawatt
AMP	adaptable monitoring package
APE	area of potential effects
APL	Applied Physics Laboratory
BA -	Biological Assessment
BGEPA	Bald and Golden Eagle Protection Act
BOD	Biochemical Oxygen Demand
cm	centimeter
cm^2	square centimeters
cm^3	cubic centimeters
Certification	Water Quality Certification
Coast Guard	U.S. Coast Guard
Commission	Federal Energy Regulatory Commission
Corps	U.S. Army Corps of Engineers
CPA	Coast Protection Act
CPDF	Cumulative Probability Density Function
CTD	Conductivity-Temperature-Depth
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
dB	decibels
DAHP	Department of Archaeology and Historic Preservation
DIDSON	Dual-Frequency Identification Sonar
DO	dissolved oxygen
DOE	U.S. Department of Energy
DPM	Detection Positive Minutes
DPS	Distinct Population Segment
EA	environmental assessment
EFH	essential fish habitat
EMEC -	European Marine Energy Center
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FERC	Federal Energy Regulatory Commission
FPA	Federal Power Act
Fugro	Fugro Seafloor Surveys, Inc.
FWS	U.S. Fish and Wildlife Service
GRP	Glass Reinforced Plastic
GWh	gigawatt-hour

HDD	horizontal directional drilling
HIRA	Hazard Identification and Risk Assessment
Hz	hertz
IHA	incidental harassment authorization
Interior	U.S. Department of the Interior
kHz	kilohertz
km	kilometer
km^2	square kilometers
km^3	cubic kilometers
kV	kilovolt
kW	kilowatt
kWh	kilowatt hours
LOU	letter of understanding
Magnuson-Stevens Act	Magnuson-Stevens Fishery Conservation and Management Act
MBTA	Migratory Bird Treaty Act
MLW	mean low water
MLLW	mean lower low water
M	meter
m^2 -	square meters
m^3	cubic meters
mL	milliliter
mg/L	milligrams per liter
MARC	Marine Aquatic Resource Committee
MLLW	mean lower low water
mm -	millimeter
m/s	meters per second
MMPA	Marine Mammal Protection Act
MW	megawatt
MWh	megawatt-hour
National Register	National Register of Historic Places
NEPA	National Environmental Policy Act
NERC	North American Electric Reliability Corporation
NHPA	National Historic Preservation Act of 1966
NMFS	National Marine Fisheries Service
NNMREC	Northwest National Marine Renewable Energy Center
NOAA	National Oceanic and Atmospheric Administration
OHWM	ordinary high water mark
O&M	operations and maintenance
PC-1	Pacific Crossing system—a trans-oceanic broadband fiber optic cable system
PC Landing	PC Landing Corporation
ppt	parts per thousand

20130809-3010 FERC PDF (Unofficial) 08/09/2013

PAH	polycyclic aromatic hydrocarbons
PBDE	polybrominated diphenyl ethers
PCB	polycholorinated biphenyl
PFMC	Pacific Fishery Management Council
PHS	priority habitats and species
POST	Pacific Ocean Shelf Tracking Project
PNNL	Pacific Northwest National Laboratory
project	Admiralty Inlet Pilot Tidal Project No. 12690
PSAMP	Puget Sound Assessment and Monitoring Program
PSAT	Puget Sound Action Team
rpm	revolutions per minute
RTE	rare, threatened, and endangered
SCADA	supervisory control and data acquisition
SEL	sound exposure level
SMP	Shoreline Master Program
SPL	sound pressure level
SRKW	Southern Resident killer whale
TISEC	Tidal In-Stream Energy Conversion
TGU	turbine generator unit
TSS	total suspended solids
U&A	Usual and Accustomed
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
Washington DOT	Washington State Department of Transportation
Washington DFW	Washington Department of Fish and Wildlife
Washington DNR	Washington Department of Natural Resources
Washington Ecology	Washington Department of Ecology
Washington PRC	Washington State Parks and Recreation Commission

20130809-3010 FERC PDF (Unofficial) 08/09/2013

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EXECUTIVE SUMMARY

Proposed Action

On March 1, 2012, the Public Utility District No. 1 of Snohomish County, Washington (Snohomish PUD) filed an application for a 10-year license to construct and operate its proposed Admiralty Inlet Pilot Tidal Project (Admiralty Inlet Project or project). The 600-kilowatt (kW) project would be located on the east side of Admiralty Inlet in Puget Sound, Washington, about 1 kilometer west of Whidbey Island, entirely within Island County, Washington. The project would not be located on federal lands.

Cooperating Agency Role

On September 16, 2010, Snohomish PUD was selected to receive financial assistance from the U.S. Department of Energy's (DOE) Office of Energy Efficiency and Renewable Energy to support the design, construction, deployment and monitoring phases of their project. To satisfy DOE's requirements under the National Environmental Policy Act (NEPA) for this project, DOE is participating as a cooperating agency in the preparation of the EA.

Project Description

The proposed Admiralty Inlet Pilot Tidal Project would consist of: (1) two 300-kW OpenHydro tidal turbines (Turbines 1 and 2), each approximately 19.2 feet high (6 meters) and mounted on a triangular subsea base; (2) two approximately 7,000-foot-long (2,200-meter), 4-kilovolt (kV) trunk cables, each consisting of: a) high power transmission core cables to transmit power from the turbines to shore; b) single mode fiber optic elements to convey turbine control and monitoring signals and environmental monitoring data between the turbines and the on-shore facilities; and c) low-power elements to provide power to the turbine control and monitoring system at the turbines; (3) an approximately 3.9-foot-long, 5.8-foot-wide, 2.9-foot-high on-shore cable termination vault; (4) 40-foot-long conduits to convey the power transmission core cables, the fiber optic elements, and the low-power elements from the cable termination vault to a cable control building; (5) a 24-foot-wide, 30-foot-long on-shore cable control building housing power and monitoring equipment; (6) a 7.2-kV step-up transformer located adjacent to the control building; (7) a 10-foot-long, buried 7.2-kV transmission line from the transformer to the Point of Metering and the Point of Common Ownership with Puget Sound Energy grid; and (8) appurtenant facilities. The estimated average annual generation of the project would be 244,000 kilowatt-hours (kWh).

Proposed Environmental Measures

Snohomish PUD proposes the following environmental measures:

- To avoid eelgrass beds and other sensitive near-shore habitats, implement a Horizontal Directional Drilling (HDD) Plan that would deploy trunk cables from on land to a minimum depth of 18 meters off-shore.

- To provide coordination, data reviews, and implementation of the above monitoring plans, implement an Adaptive Management Framework that includes conferring with a Marine Aquatic Resource Committee (MARC), composed of Snohomish PUD, agency, and tribal members.

- To avoid adverse effects on sensitive marine fish species, conduct marine installation during a Washington Department of Fish and Wildlife-approved work window of July 16 to October 14, or outside the work window if the MARC approves the timing of the specific installation activities.

- To avoid harming PC Landing's international fiber optic cable (PC-1 North), located near the site, conduct turbine installation and monitoring using "live-boat" techniques (i.e., without anchoring) and prepare and implement a Hazard Identification and Risk Assessment, developed in consultation with the U.S. Army Corps of Engineers (Corps), Coast Guard, and PC Landing, prior to marine operations that includes: (1) setting criteria for weather and wave conditions that must exist before marine operations occur; (2) using industry-approved equipment and redundancy in the use of equipment and vessels; (3) setting criteria for aborting operations; and (4) identifying an established "port of refuge," away from PC-1 North, in the event of unanticipated adverse weather or other events that would cause installation or operations to be aborted.

- To monitor environmental effects and identify corrective actions, implement the following monitoring plans: (1) an Acoustic Monitoring and Mitigation Plan; (2) a Benthic Habitat Monitoring and Mitigation Plan; (3) a Marine Mammal Monitoring and Mitigation Plan; (4) a Near-Turbine Monitoring and Mitigation Plan; (5) a Derelict Gear Monitoring Plan; and (6) a Water Quality Monitoring Plan.

- To minimize the introduction and spread of invasive plants on the land-based portion of the transmission line and around the control building, implement the following during site construction and project removal: (1) use gravel, rock, or other fill material from a weed free source; (2) revegetate disturbed areas with species native to Keystone Spit, with the source material (seeds or cuttings)

collected from Keystone Spit; (3) ensure that no imported soil, fertilizer, or tackifiers[1] are used in revegetating disturbed areas; and (4) inspect any fill and disturbed areas for invasive plants annually, between early and mid-June and again in August, and eradicate any detected invasive plants promptly.

- To educate the public about the project, the potential ocean energy resource in Puget Sound, and the natural and cultural environment of the project area, develop and implement an Interpretation and Education Plan that includes the installation of an interpretive display at Snohomish PUD's headquarters or at another appropriate location agreed upon with stakeholders.

- To ensure safe operation of the project, implement: (1) a Project and Public Safety Plan; (2) a Navigational Safety Plan; and (3) an Emergency Shutdown Plan.

- To restore the project site to a pre-project condition at the end of the license term if a new license is not sought or obtained, implement a Project Removal and Site Restoration Plan.

Alternatives Considered

This environmental assessment (EA) considers the following alternatives: (1) Snohomish PUD's proposal, as outlined above; (2) Snohomish PUD's proposal with staff modifications (staff alternative); and (3) no action, meaning the project would not be installed, DOE would not provide financial assistance to fund the project, and there would be no change to the existing environment (no-action alternative).

Under the staff alternative, the project would be constructed and operated as proposed by the applicant, but with the following additional measures:

- Include in the Project Removal and Site Restoration Plan provisions for filing for Commission approval: (1) a specific timeline for the removal and site restoration activities 6 months prior to license expiration; (2) documentation of consultation with appropriate parties regarding planned removal and site restoration activities 6 months prior to license expiration; and (3) documentation of completion of project removal and site restoration activities prior to license expiration.

---

[1] Tackifiers are used in erosion control on active construction sites. They bind mulch particles together to prevent displacement of the mulch particles by water or wind. Maintaining a consistent layer of mulch helps to protect the underlying soil from erosion.

- Include in the Emergency Shutdown Plan a provision for preventing further interaction with the turbines or interference with turbine shutdown equipment while the mechanical brake is being deployed.

- Include in the HDD Plan provisions to implement noise abatement measures in the event HDD processes extend into the nighttime hours.

- Include in the Benthic Habitat Monitoring and Mitigation Plan a provision to: (1) identify specific depth and width measurements of scour, as measured from the turbine footings, that would trigger the installation of protection measures on the sea bed; (2) develop the triggers in consultation with National Marine Fisheries Service, U.S. Fish and Wildlife Service, U.S. Coast Guard, Washington Department of Natural Resources, Washington Department of Fish and Wildlife, and Washington Department of Ecology; and (3) notify the Commission within 10 days of when such triggers are met and the licensee's plans for mitigating any such effects.

- Develop and implement an Interpretation and Education Plan for an interpretive display at Fort Casey State Park, subject to state approval, describing the project, the potential ocean energy resource in Puget Sound, and the natural and cultural environment of the project area.

- Halt work if previously unidentified archeological or historic properties are discovered and develop protective measures in consultation with the Washington State Historic Preservation Officer (Washington SHPO).

- Include a reservation of authority for the Corps of Engineers to request removal, relocation, or other alteration if the project becomes an unreasonable obstruction to free navigation of navigable waters.

- Coordinate project installation and maintenance activities with Washington State Ferries to avoid potential disruptions to scheduled ferry service.

The recommended staff modifications include or are based in part on recommendations made by the federal and state resource agencies and other stakeholders that have an interest in the resources that may be affected by construction and operation of the project.

Public Involvement and Areas of Concern

The intent of the Commission's pre-filing process is to initiate public involvement early in the project planning process and encourage citizens, governmental entities, tribes, and other interested parties to identify and resolve issues prior to an application being formally filed with the Commission. To this end, Snohomish PUD conducted

consultation, which included numerous meetings and conference calls with a range of stakeholders, including resource agencies, tribes, and non-governmental organizations. Commission staff held a technical conference on April 12, 2010, to scope issues and information needs. On July 7, 2011, we waived certain pre-filing requirements and approved the use of pilot licensing procedures. On October 6, 2011, we requested conditions and recommendations in response to the notice of ready for environmental analysis. Commission staff conducted a second technical conference on August 6, 2012, to discuss issues regarding the project's proximity to PC-1 North and effects on access to tribal fishing grounds, and a third technical conference on April 18, 2013 to discuss Snohomish PUD's revised emergency shutdown procedures.

The primary issues associated with licensing this project are potential effects on marine and anadromous fish; essential fish habitat; bull trout; marine mammals; marbled murrelets; navigation; an international fiber optic cable (PC-1 North); access to tribal fishing grounds; recreation; and aesthetics.

Staff Alternative

Snohomish PUD has designed the project in a manner that would minimize the potential for environmental effects during construction and operation. Key features include the small scale of the project; a mechanically controlled braking system for the turbines that would allow for the project to be shut down by a remotely operated vehicle (ROV) within four days;[2] and a turbine design that includes a shroud enclosing the blade tips, a 7.2-foot (2.2 meter) hole through the turbine allowing flow and objects to freely pass through the turbine, and relatively slow operating speeds (11 revolutions-per-minute [rpm] according to Snohomish PUD's calculations), minimizing the potential for turbine blade strikes on fish, diving birds, and marine mammals. In addition to these design features, the results of the studies Snohomish PUD conducted suggest that environmental effects from the project would be minor. In addition, Snohomish PUD's proposal includes monitoring measures that are designed to detect and address any unanticipated adverse effects.

[2] In its comments on the DEA, filed on February 14, 2013, Snohomish PUD revised its proposed braking system from an electrical break, with a maximum deployment time of six hours, to a mechanical brake deployed via a ROV with a deployment time of up to four days under most circumstances.

General

The proposed Project and Public Safety Plan includes measures for identifying and responding to emergencies at the project. The proposed Emergency Shutdown Plan includes procedures to shut down the project turbines within four days. These safeguard plans, in combination with the various environmental monitoring plans described below, would work interdependently to ensure that the project is operated and maintained in a safe manner that minimizes the potential for harm to the public and environmental resources in the project area.

The proposed Project Removal and Site Restoration Plan, which includes measures for removing the project and restoring the project site in the case that a new license is not obtained at the end of the license term, would ensure protection of the aesthetic and environmental resources in and around Admiralty Inlet. A staff recommended modification to the proposed plan that includes provisions for a specific timeline for the removal and site restoration activities, documentation of consultation with the appropriate agencies, six months prior to license expiration, and documentation of completion of project removal and site restoration activities prior to license expiration, would ensure that the project is removed and the site is sufficiently restored to near pre-project condition prior to license expiration.

Geologic Resources

Construction and operation of the project would likely have only minor effects on geologic resources, such as modifying localized sediment transport. The proposed Benthic Habitat Monitoring and Mitigation Plan, which includes the use of ROVs to conduct visual surveys of the seafloor in the project area would enable Snohomish PUD to identify adverse effects of scouring or sediment transport on benthic habitat, as well as threats to turbine stability or PC Landing's fiber optic cable created by excessive scour. Identifying specific criteria (depth and width measures of scour from the footings) that would trigger implementing scour protection measures would ensure timely implementation of the protection measures and further insure that project operations would not cause scour far from the project turbines.

Marine Resources

Construction and operation of the project would likely have only minor effects on marine resources, such as slightly modifying hydrodynamics and behavior of fish and marine mammals in the immediate project vicinity. Project operations may produce noise levels that may cause minor behavioral changes for marine mammals and fish very near the project, but would not rise to levels that would result in physical harm to these organisms. The proposed Near-Turbine Monitoring and Mitigation Plan, which would use a combination of stereo-optical and acoustical cameras mounted on the turbine foundation to observe interactions of marine fish, birds, and mammals near (9.8-23 feet

or 3-7 meters) the turbines, would identify unanticipated adverse effects of the project on fish and marine mammal behavior, determine if potential harm from blade strike is occurring, and identify the need for corrective action, including potentially shutting down the turbine. The proposed Acoustic Monitoring and Mitigation Plan, which includes the use of a combination of a drifting noise measurement system and hydrophones mounted on the turbine foundation, would measure noise radiated by the project and determine if it is occurring at levels that would require corrective action to minimize adverse effects on marine mammals. Although far-field behavioral changes in marine mammals are not expected, the proposed Marine Mammal Monitoring and Mitigation Plan, which would use a combination of acoustic hydrophones and on-shore observers to document marine mammal use in the vicinity of the turbines, would determine if the project is causing changes in marine mammal behavior in the vicinity of the project. The proposed Derelict Gear Monitoring Plan, which would use periodic ROV surveys to inspect project features, as well as the cameras mounted on the turbine foundation, would identify any derelict fishing gear accumulating on project features, minimizing entanglement hazards for marine fish, birds, and mammals.

Rare, Threatened, and Endangered Species

Operational noise near the project site may rise to levels that adversely affect the southern resident killer whale and Steller sea lion. The Acoustic Monitoring and Mitigation Plan and Marine Mammal Monitoring and Mitigation Plan would permit Snohomish PUD to determine if adverse effects are occurring and to take corrective actions. Project construction and operation would not be likely to adversely affect Pacific salmon and steelhead and their critical habitat, green sturgeon, eulachon, several rockfish species, and bull trout because of the small footprint of the project, the design characteristics of the turbines, and the abilities of the fish to detect and avoid the turbines. Project construction and operation would not affect marbled murrelet because the turbines would create little noise and the turbines would be located below their known maximum diving range. Project construction and operation would not affect the golden paintbrush because they are not likely present in the existing disturbed habitats. The U.S. Fish and Wildlife Service concurred that project construction and operation would not be likely to adversely affect bull trout and marbled murrelet.

Terrestrial Resources

Construction and operation of the project would result in the disturbance of about 0.3 acres (0.1 hectares) of native coastal shrubs and grasses and the temporary displacement of wildlife from the immediate construction area of the on-shore portion of the transmission line and the control building. Implementing Snohomish PUD's proposed measures would control the introduction and spread of invasive plants, revegetate disturbed areas with native species, and minimize potential adverse effects on

adjacent native vegetation on Keystone Spit, an area inhabited by rare coastal grasses and shrubs in Puget Sound.

Recreation

Project installation, maintenance, and removal may require boaters to maneuver around construction vessels; however, these effects would be minor and short-term given the majority of such activities would be located well off-shore and with adequate space to avoid construction activities. Snohomish PUD proposes to consult with stakeholders to develop and implement an Interpretation and Education Plan for the installation of an interpretive display at Snohomish PUD's headquarters, or at another appropriate location. Because of its proximity to Admiralty Inlet, development of an interpretive display at Fort Casey State Park, as opposed to Snohomish PUDs headquarters, would provide a more effective means of enhancing the public's understanding of the project and the potential value of Puget Sound as an ocean energy resource.

Navigation

Because the project is located outside the shipping channels and at sufficient depth to allow clearance for even the largest transport vessels, installation, maintenance, and removal activities would create only minor, short-term obstructions to navigation in a small part of Admiralty Inlet. The proposed Navigational Safety Plan would ensure mariners are alerted to installation activities and the presence of the project turbines, minimizing the potential to create obstructions to free navigation. The U.S. Coast Guard has determined that no restrictions to navigation are warranted at this time. Coordinating project installation and maintenance activities with Washington State Ferries as recommended by staff would help to avoid disruptions of scheduled ferry service.

Land and Ocean Use

The on-shore portions of the project are located on private property, and there would be no effects on existing public land uses. Implementing Snohomish PUD's proposed "live-boat" techniques and strict adherence to weather and tidal conditions and safety measures defined in the proposed Hazard Identification and Risk Assessment (HIRA) would minimize any potential harm to PC-1 North during project installation, monitoring, and removal. Because of the proposed project's small footprint and location, there would be sufficient room to repair the fiber optic cable in the unlikely event of a cable fault near the turbines. While installation, maintenance, and removal activities may create short-term minor obstructions to navigation, project operation would not prevent access to or use of tribal fishing areas because there would be no restrictions or obstructions to navigation at the project site, and the size of the project would be very small relative to the fishing area. There is no current use of the project site as a commercial salmon fishery.

Aesthetic Resources

Construction activities would result in minor, short-term effects on scenic vistas at Fort Casey State Park and the scenic byway near the site of the proposed control building and HDD operation. Strict adherence to the proposed construction schedules would minimize these effects. Noise from HDD processes is not expected to be highly disruptive, but may be noticeable at near-by residences if they extend into the evening hours. Implementing staff's recommendation to include noise abatement measures in the HDD plan to ensure that noise levels do not exceed 55 decibels at the site should evening drilling be required, would minimize these temporary effects on nearby residences. Because the project control building would be similar in appearance to existing residential buildings and associated structures, project construction and operation would not have a permanent or long-term effect on aesthetic resources.

Cultural Resources

The Washington SHPO has concluded that the project would have no adverse effect upon cultural resources in or eligible for conclusion in the National Register of Historic Places. However, if previously unidentified archeological or historic properties are discovered, staff's recommended provisions to notify the Commission and the Washington SHPO, and develop and implement needed measures to protect the properties, would ensure the protection of any newly discovered archeological or historic properties.

Conclusions

Based on our analysis, we recommend licensing the project as proposed by Snohomish PUD, with the staff-recommended modifications.

In section 4.0, *Developmental Analysis*, we compare the total project cost to the cost of obtaining power from a likely alternative source of power in the region, for each of the alternatives identified above. Our analysis shows that during the first year of operation, the project as proposed would produce power at a cost that is $1,840,307 (about $7,542.24/megawatt hour (MWh)) more than the cost of alternative power. Under the staff-recommended alternative, the project would have the same energy capacity and energy attributes and would produce power at the same cost.

Although the cost of power that would be produced at the project is high, building the project, in addition to generating electricity, would collect data to further the development of commercial-scale arrays. On the basis of our independent analysis, we conclude that issuing an original license for the project with the staff-recommended measures would not be a major federal action significantly affecting the quality of the human environment.

20130809-3010 FERC PDF (Unofficial) 08/09/2013

We chose the staff alternative as the preferred alternative because under it the project would: (1) provide a short-term dependable source of electrical energy from a renewable resource (244 megawatt hours annually) which would not contribute to atmospheric pollution; (2) include environmental measures to protect, mitigate, and enhance environmental resources affected by the project; and (3) provide, through proposed monitoring, an improved understanding of the environmental effects of tidal energy projects.

ENVIRONMENTAL ASSESSMENT

Federal Energy Regulatory Commission
Office of Energy Projects
Division of Hydropower Licensing
Washington, DC

Cooperating Agency
U.S. Department of Energy
Office of Energy Efficiency & Renewable Energy
Golden, CO

Admiralty Inlet Pilot Tidal Project
FERC Project No. 12690-005—Washington
DOE/EA-1949

1.0 INTRODUCTION

1.1 APPLICATION

On March 1, 2012, the Public Utility District No. 1 of Snohomish County, Washington (Snohomish PUD) filed an application with the Federal Energy Regulatory Commission (Commission or FERC) to construct and operate the proposed Admiralty Inlet Pilot Tidal Project (Admiralty Inlet Project or project). The 600-kilowatt (kW) project would be located on the east side of Admiralty Inlet in Puget Sound, Washington, about 1 kilometer west of Whidbey Island, entirely within Island County, Washington (figure 1). The project would not affect federal lands. The estimated average annual generation of the project is 244,000 kilowatt-hours (kWh).

1.2 PURPOSE OF ACTION AND NEED FOR POWER

1.2.1 Purpose of Action

The purpose of the proposed Admiralty Inlet Project is two-fold: (1) principally, to evaluate the technical, economic, and environmental viability of OpenHydro's design and the tidal energy generation at the proposed project site in Admiralty Inlet; and (2) secondarily, to provide a new source of hydroelectric power. Therefore, under the provisions of the Federal Power Act (FPA), the Commission must decide whether to issue a license to Snohomish PUD for the project and what conditions should be placed on any license issued. In deciding whether to issue a license for a hydroelectric project, the Commission must determine that the project will be best adapted to a comprehensive plan for improving or developing a waterway. In addition to the power and developmental purposes for which licenses are issued (such as flood control, irrigation, or

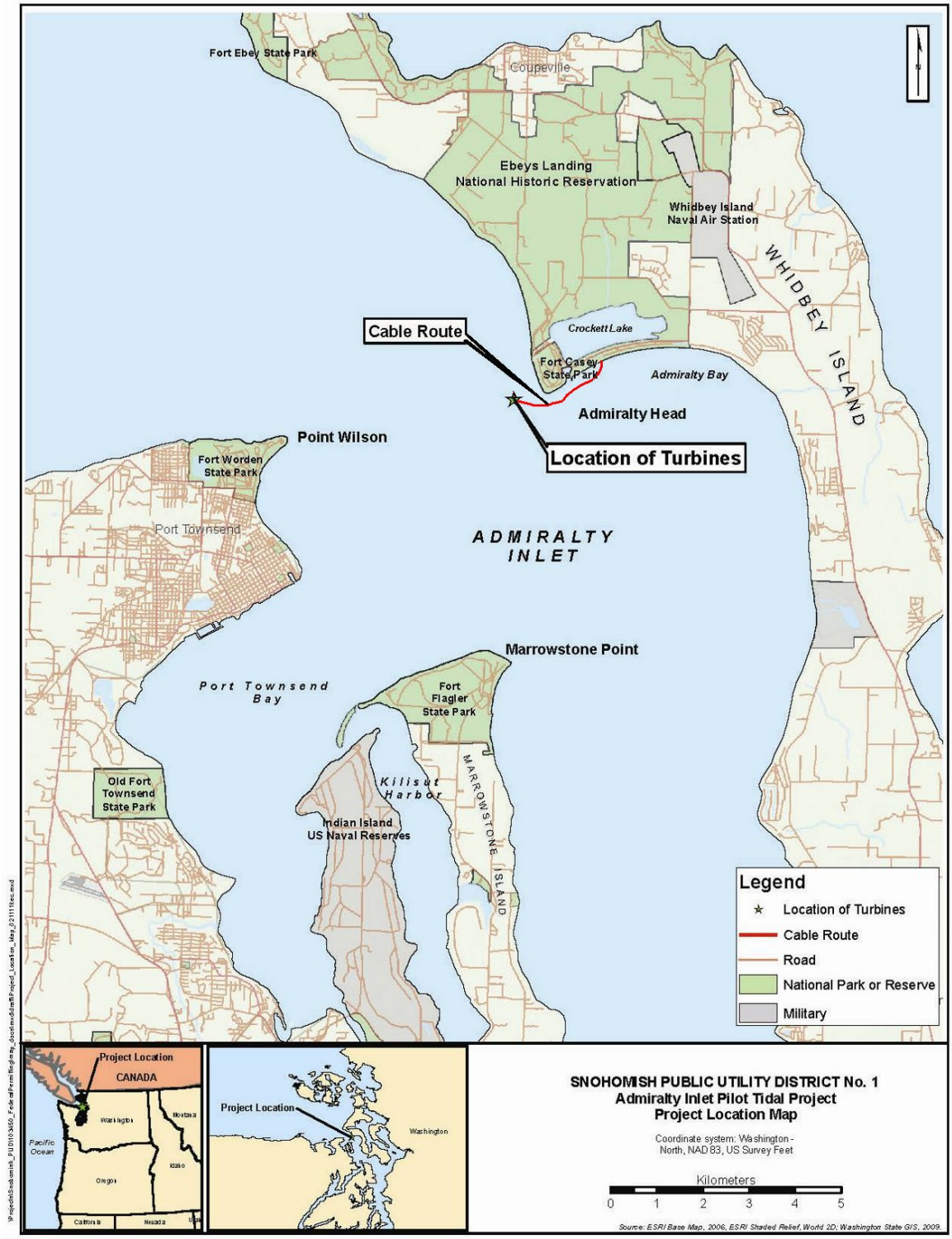

Figure 1. Location of Admiralty Inlet Pilot Tidal Project (Source: application).

water supply), the Commission must give equal consideration to the purposes of: (1) energy conservation; (2) the protection of, mitigation of damage to, and enhancement of, fish and wildlife resources; (3) the protection of recreational opportunities; and (4) the preservation of other aspects of environmental quality.

Issuing a license for the Admiralty Inlet Pilot Project would allow Snohomish PUD to generate electricity during its proposed 10-year license term, making electrical power from a renewable resource available to its customers. Snohomish PUD's proposed monitoring programs would also provide important information on any unanticipated environmental effects of tidal energy developments, which would assist with the evaluation of other similar projects.

The U.S. Department of Energy (DOE), Office of Energy Efficiency and Renewable Energy's overall mission is to invest in clean energy technologies to strengthen the economy, protect the environment, and reduce dependence on foreign oil. The mission of the DOE Water Power Program is to research, test, and develop innovative technologies capable of generating renewable, environmentally responsible, and cost-effective electricity from U.S. water resources. These include marine and hydrokinetic (MHK) technologies that harness the energy from waves and ocean/tidal/river currents. DOE investments in these technologies aim to advance the technical readiness of MHK systems and support the development of a robust and competitive MHK industry in the U.S. The purpose for funding Snohomish PUD's project is to further this mission and help advance the technological and operational readiness of marine and hydrokinetic water power technologies.

This environmental assessment (EA) evaluates the environmental and economic effects of constructing and operating the proposed project: (1) as proposed by the applicant, and (2) with staff's recommended measures. Staff also considers the effects of the no-action alternative. Important issues that are addressed include potential effects on marine and anadromous fish; essential fish habitat; bull trout; marine mammals; marbled murrelets; navigation; an international fiber optic cable (PC-1); access to tribal fishing grounds; recreation; and aesthetics.

1.2.2 Need for Power

The successful development of the Admiralty Inlet Pilot Tidal Project would demonstrate the potential of an emergent renewable energy industry segment with the goal of bringing clean, competitively priced electricity to commercial and residential consumers in Washington State and other coastal states. Based on EAI (2013) values, the projected 244,000 kWh of energy produced by the project per year would offset approximately 1,952,000 cubic feet of natural gas, preventing 273,280 pounds of carbon dioxide from entering the atmosphere each year. The future use of the project's power, its displacement of non-renewable fossil-fueled generation, and its contribution to a

diversified generation mix demonstrate that the project would help meet a need for power in the region.

1.3 COOPERATING AGENCY ROLES

DOE has provided financial assistance in support of the preliminary engineering and design phase of Snohomish PUD's project and is now considering authorizing the expenditure of additional federal funds in support of final project activities. Specifically, DOE funding would be used in support of the final design, construction, deployment, and monitoring phases of the project. Granting Snohomish PUD financial assistance for this project would constitute a major federal action as defined by the National Environmental Policy Act of 1969 (NEPA). DOE must consider the possible environmental impacts from the project before committing to provide funding. In accordance with the provisions of NEPA and DOE implementing regulations (10 C.F.R.1021), DOE has determined that an EA must be completed for the proposed project to evaluate the potential environmental impacts that could result from the award of the funding. To satisfy this requirement, on May 1, 2012, DOE filed a request to be a cooperating agency in the Commission's preparation of this EA. A letter of understanding (LOU), signed by both agencies, was issued on June 27, 2012, establishing DOE's cooperating agency status.

DOE's decision whether to provide financial assistance for the final design, construction, deployment and monitoring phases to Snohomish PUD for this project will be made after the completion of this EA and DOE's NEPA review process. Upon completion of this EA, DOE will assess all comments, FERC's conclusions, and all agency recommendations prior to issuing a final NEPA determination. This determination along with the final EA will be posted at DOE Golden, Colorado's Public Reading Room: http://www.eere.energy.gov/golden/NEPA_DEA.aspx.

1.4 STATUTORY AND REGULATORY REQUIREMENTS

A license for the project is subject to numerous requirements under the FPA and other applicable statutes. We summarize the major regulatory requirements in table 1 and describe them below.

Table 1. Major statutory and regulatory requirements for the Admiralty Inlet Pilot Tidal Project (source: staff).

Requirement	Agency	Status
Section 18 of the FPA (fishway prescriptions)	U.S. Department of the Interior (Interior) on behalf of the Fish and Wildlife Service (FWS)	Interior requested a reservation of authority to prescribe fishways under section 18 on May 23, 2012.
Section 10(j) of the FPA	National Marine Fisheries Service (NMFS), FWS, and Washington Department of Fish and Wildlife (Washington DFW)	NMFS, Interior, and Washington DFG filed 10(j) recommendations on May 23, 2012.
Clean Water Act – Water Quality Certification (Certification)	Washington Department of Ecology (Washington Ecology)	Application for certification was received by Washington Ecology on February 9, 2012. Snohomish PUD withdrew the application and reapplied on February 6, 2013.
Endangered Species Act Consultation	NMFS, FWS	Formal consultation with NMFS was requested on April 23, 2012 and January 22, 2013; a biological opinion was due on June 7, 2013. FWS concurred with staff's determination of not likely to adversely affect listed species on June 12, 2012.

Requirement	Agency	Status
Marine Mammals Protection Act	NMFS	Proposed construction and operation may adversely affect marine mammals. Snohomish PUD intends to request an Incidental Harassment Authorization pursuant to the Marine Mammal Protection Act after the license is issued but before any marine activities are conducted for the project.
Magnuson-Stevens Fishery Conservation and Management Act	NMFS	Project installation and operation is not expected to adversely affect Essential Fish Habitat (EFH). An EFH assessment was provided to NMFS on April 23, 2012.
Coastal Zone Management Act Consistency	Washington Ecology	Washington Ecology received a Coastal Zone Management Act consistency certification on March 26, 2012. Washington Ecology has not yet acted on the request, which was due September 24, 2012.
National Historic Preservation Act	Washington State Historic Preservation Office (Washington SHPO)	Washington SHPO concurred with a finding of no adverse effect on historic properties on February 28, 2012.

1.4.1 Federal Power Act

1.4.1.1 Section 18 Fishway Prescriptions

Section 18 of the FPA states that the Commission is to require construction, operation, and maintenance by a licensee of such fishways as may be prescribed by the Secretaries of Commerce or the Interior. Interior, by letter dated November 7, 2011,

requests that a reservation of authority to prescribe fishways under section 18 be included in any license issued for the project.

1.4.1.2 Section 10(j) Recommendations

Under section 10(j) of the FPA, each hydroelectric license issued by the Commission must include conditions based on recommendations provided by federal and state fish and wildlife agencies for the protection, mitigation, or enhancement of fish and wildlife resources affected by the project. The Commission is required to include these conditions unless it determines that they are inconsistent with the purposes and requirements of the FPA or other applicable law. Before rejecting or modifying an agency recommendation, the Commission is required to attempt to resolve any such inconsistency with the agency, giving due weight to the recommendations, expertise, and statutory responsibilities of such agency.

NMFS, FWS, and Washington DFG timely filed, on May 23, 2012, recommendations under section 10(j), as summarized in table 10, in section 5.4, *Fish and Wildlife Agency Recommendations.* In section 5.4, we also discuss how we address the agency recommendations and comply with section 10(j).

1.4.2 Clean Water Act

Under section 401 of the Clean Water Act (CWA), a license applicant must obtain certification from the appropriate state pollution control agency verifying compliance with the CWA. On February 7, 2012, Snohomish PUD applied to Washington Ecology for water quality certification (certification) for the Admiralty Inlet Project. Washington Ecology received this request on February 9, 2012.[3] On February 6, 2013, Snohomish PUD withdrew its application and reapplied for water quality certification; Washington Ecology has not yet acted on the request.

1.4.3 Endangered Species Act

Section 7 of the Endangered Species Act (ESA) requires federal agencies to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of the critical habitat of such species. Federally listed species known to occur, or that may occur, in the vicinity of the project include: Puget Sound Chinook salmon and its designated critical habitat, Hood Canal summer-run chum salmon and its designated critical habitat, Puget Sound steelhead, Coastal-Puget Sound bull trout, green sturgeon, bocaccio, canary

[3] Snohomish PUD requested the water quality certification through state's Joint Aquatic Resources Permit Application (JARPA).

rockfish, yelloweye rockfish, eulachon, southern resident killer whale and its designated critical habitat, North Pacific humpback whale, Steller sea lion, marbled murrelet, and golden paintbrush. Our analyses of project impacts on threatened and endangered species are presented in section 3.3.4, *Rare, Threatened, and Endangered Species*, and our recommendations in section 5.2, *Comprehensive Development and Recommended Alternative*.

Construction and operation of the project would not affect the golden paintbrush; is "not likely to adversely affect" the Puget Sound Chinook salmon and its designated critical habitat, Hood Canal summer-run chum salmon and its designated critical habitat, Puget Sound steelhead, Coastal-Puget Sound bull trout, green sturgeon, bocaccio, canary rockfish, yelloweye rockfish, eulachon, North Pacific humpback whale, designated critical habitat for the southern resident killer whale, and marbled murrelet; and "may adversely affect" southern resident killer whale and Steller sea lion. We requested FWS's concurrence with our determination on bull trout, marbled murrelet, and golden paintbrush on April 24, 2012; FWS concurred with staff's findings on June 12, 2012. We requested formal consultation with NMFS on the project's potential effects on the southern resident killer whale and Steller sea lion and their concurrence on not likely to adversely affect the remaining listed species on April 23, 2012. On May 23, 2012, NMFS stated that it could not begin formal consultation until the final monitoring and mitigation plans and the blade strike analysis for the southern killer whale were completed. The blade strike analysis was completed and filed with the license application on March 1, 2012. Final Benthic Habitat, Acoustic, Marine Mammal, and Near-Turbine Monitoring and Mitigation Plans, developed in consultation with NMFS and other agencies, were filed on November 19, 2012. We made a second request for formal consultation on January 22, 2013. The Biological Opinion was due on June 7, 2013.

1.4.4 Marine Mammal Protection Act

The 1972 Marine Mammal Protection Act (MMPA) prohibits, with certain exceptions, the "take" (defined under statute to include harassment)[4] of marine mammals

[4] Under the 1994 Amendments to the MMPA, "harassment" is statutorily defined as "any act of pursuit, torment, or annoyance that has the potential to: (a) injure a marine mammal or marine mammal stock in the wild (Level A Harassment); or (b) disturb a marine mammal or marine mammal stock in the wild by causing a disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering but which does not have the potential to injure a marine mammal or mammal stock in the wild (Level B Harassment)," [Marine Mammal Protection Act Amendments of 1994, Pub. L. No. 103-238, 108 Stat. 432 (1994); *see also* 50 CFR § 216.3 (2010) (regulation implementing the amendment)].

in U.S. waters and the high seas. In 1986, Congress amended both the MMPA, under the incidental take program, and the ESA, to authorize incidental takings of depleted, endangered, or threatened marine mammals, provided the "taking" (defined under the statute as actions which are or may be lethal, injurious, or harassing) was small in number and had a negligible impact on marine mammals. With this relationship between the MMPA and ESA, NMFS cannot complete section 7 consultation and issue an Incidental Take Permit for listed marine mammals until an Incidental Harassment Authorization (IHA)[5] has been issued.

The southern resident killer whale, humpback whale, and Steller sea lion are ESA-listed species, and may occur in the vicinity of the proposed project. Additional non-listed marine mammals (e.g., harbor porpoise) may occur in the project vicinity. Noise from the operation of the turbines will exceed received sound pressure levels (SPL) of 120 decibels (dB), the level that is considered Level B harassment by NMFS for non-impulsive sounds. Therefore, we conclude that the proposed project may adversely affect marine mammals due to noise related to the operation of the turbines. Snohomish PUD will need an IHA for marine mammals in Admiralty Inlet.

1.4.5 Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) requires federal agencies to consult with NMFS on all actions that may adversely affect EFH. The proposed project area contains EFH for Pacific groundfish, Pacific salmon, and several coastal pelagic species.

On April 23, 2012, an EFH assessment was filed with NMFS and requested that NMFS provide any EFH recommendations along with its biological opinion (BO). The effects of the project on EFH are summarized in section 3.3.2.2 *Environmental Effects*, *Marine Resources*. The only likely effects of the project are the immediate and temporary disturbance of the placement and presence of the devices and the trunk cables over a small fraction of the floor of the inlet. Therefore, we conclude that licensing the project would not likely adversely affect EFH for any of the species located in the project area.

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[5] In 1994, MMPA section 101(a)(5) was amended to establish an expedited process by which citizens of the U.S. can apply for an authorization, referred to as an Incidental Harassment Authorization or IHA, to incidentally take small numbers of marine mammals by harassment.

1.4.6 Coastal Zone Management Act

Under section 307(c)(3)(A) of the Coastal Zone Management Act (CZMA), 16 U.S.C. § 1456(3)(A), the Commission cannot issue a license for a project within or affecting a state's coastal zone unless the state CZMA agency concurs with the license applicant's certification of consistency with the state's CZMA program, or the agency's concurrence is conclusively presumed by its failure to act within 180 days of its receipt of the applicant's certification.

On March 26, 2012, Snohomish PUD submitted a request for CZMA consistency determination to Washington Ecology. Public notice of the application was issued on April 3, 2012. On September 26, 2012, Washington Ecology and Snohomish PUD jointly notified the Commission that the CZMA consistency determination cannot be granted until the State Environmental Policy Act (SEPA) determination, shoreline permit, and Section 401 water quality certification are issued and that there was insufficient time to obtain the SEPA determination, shoreline permit, and water quality certification before the September 24, 2012, deadline for issuing the CZMA consistency determination. Therefore, Washington Ecology and Snohomish PUD stated that they have agreed to extend the CZMA review period until Snohomish PUD can complete the enforceable policies under Washington's CZMA Program, and Ecology can issue CZMA consistency determination.

1.4.7 National Historic Preservation Act

Section 106 of the National Historic Preservation Act (NHPA) requires that every federal agency "take into account" how each of its undertakings could affect historic properties. Historic properties are districts, sites, buildings, structures, traditional cultural properties, and objects significant in American history, architecture, engineering, and culture that are eligible for inclusion in the National Register of Historic Places (National Register).

On November 7, 2008, the Commission designated Snohomish PUD as a non-federal representative for the purposes of conducting section 106 consultation under the NHPA. Pursuant to section 106, and as the Commission's designated non-federal representative, Snohomish PUD consulted with the Washington State Historic Preservation Office (SHPO) to locate, determine National Register eligibility, and assess potential adverse effects to historic properties associated with the project. In a letter dated February 28, 2012, the Washington SHPO concurred with Snohomish PUD's defined area of potential effects (APE) for the project and Snohomish PUD's finding that the proposed project will have no adverse effect on National Register eligible or listed historic or cultural resources. Therefore, the drafting of a programmatic agreement to resolve adverse effects to historic properties will not be necessary and no further action pursuant to Section 106 is required at this time.

1.5 PUBLIC REVIEW AND COMMENT

The Commission's regulations (18 C.F.R., §§ 5.1-5.16) require that applicants consult with appropriate resource agencies, tribes, and other entities before filing an application for a license. This consultation is the first step in complying with the Fish and Wildlife Coordination Act, the ESA, the NHPA, and other federal statutes. Pre-filing consultation must be complete and documented according to the Commission's regulations.[6]

1.5.1 Comments on the Draft License Application

On December 30, 2009, the Commission issued a notice that Snohomish PUD had filed a draft license application for the Admiralty Inlet Project. This notice set February 26, 2010, as the deadline for filing comments on the pre-filing materials. In response to the notice, the following entities commented:

Commenting Entities	Date Filed
Swinomish Indian Tribal Community	February 25, 2010
Sauk-Suiattle Indian Tribe	February 25, 2010
NMFS	February 26, 2010
U.S. National Park Service	February 26, 2010
FWS	February 26, 2010
Tulalip Tribes Of Washington (Tulalip Tribes)	March 1, 2010
Suquamish Tribe	March 3, 2010
American Waterways Operators	May 6, 2010, and June 1, 2010

Based on the received comments, Commission staff held a technical meeting on April 12, 2010, in Everett, Washington to further scope issues and to discuss information and monitoring needs for the license application. Discussions at the technical meeting focused on the information gaps that needed to be addressed to ensure that sufficient information existed for the Commission to make a determination on whether the

[6] The Commission waived sections 5.8 and 5.10 of its regulations, which specify the project scoping requirements for the Commission's Integrated Licensing Process, by letter issued July 7, 2011.

proposed project meets the criteria for a pilot project and for processing a license application for a pilot project once it is filed with the Commission.

Subsequently, Snohomish PUD began facilitating discussions with NMFS, FWS, and the Washington Department of Natural Resources (Washington DNR) to address outstanding concerns of the parties regarding the use of the pilot licensing procedures given potential project effects on southern resident killer whale, salmon and other fish.[7] Letters of support for using the pilot licensing procedures were filed by Washington DNR on July 2, 2010, NMFS on July 6, 2010, and FWS on July 8, 2010. On July 7, 2011, the Commission approved the use of the pilot project procedures.

1.5.2 Interventions

On April 23, 2012, the Commission issued a notice that Snohomish PUD had filed an application to license the project and set May 23, 2012, as the deadline for filing protests and motions to intervene. In response to the notice, the following entities filed notices or motions to intervene:

Intervenors	Date Filed
Washington Ecology	May 1, 2012
Washington DFW	May 4, 2012
Washington DNR	May 10, 2012
Tulalip Tribes	May 11, 2012
U.S. Department of Interior (Interior)	May 21, 2012
Whidbey Environmental Action Network	May 22, 2012
Sauk-Suiattle Indian Tribe of Washington	May 23, 2012
PC Landing Corporation	May 23, 2012*
NMFS	May 23, 2012
Swinomish Indians	May 23, 2012

* PC Landing Corporation (PC Landing) filed a motion to intervene in opposition to the project.

[7] While Washington Ecology and Washington DFW elected not to participate in the discussions, they were kept abreast of discussions through bi-monthly updates.

1.5.3 Comments on the License Application

The notice that the Commission issued on April 23, 2012, also requested comments, conditions and terms and recommendations. The following entities commented:

Commenting Agency and Other Entity	Date Filed
Interior	May 23, 2012
Washington DFW	May 23, 2012
NMFS	May 23, 2012
Public Safety and Homeland Security Bureau of the Federal Communications Commission (FCC)	May 24 and October 4, 2012
U.S. Army Corps of Engineers	June 11, 2012
GCI Communication Corporation	July 30, 2012
Point No Point Treaty Council	October 11, 2012
U.S Navy, Naval Facilities Engineering Command	June 22 and October 24, 2012

Snohomish PUD filed responses to comments, recommendations, and terms and conditions on June 22, 2012. Snohomish PUD filed a response to the Point No Point Treaty Council letter on October 22, 2012.

On August 6, 2012, Commission staff held a technical conference to discuss issues raised by PC Landing and the Federal Communications Commission (FCC) regarding the proximity of the proposed project to PC Landing's fiber optic communication cable, and the implications and information needs for possible alternative site locations for the hydrokinetic turbines. PC Landing filed comments following the conference on August 1 and 15, October 15, and November 6, 2012. Snohomish PUD filed responses to PC Landing's filings on August 27, September 10 and 26, October 25, and November 9, 2012. The FCC filed clarifying comments on October 4, 2012, indicating it did not oppose the Commission issuing a license for the project if certain conditions were included in the license to protect the fiber optical cable.

1.5.4 Comments on the Environmental Assessment

The EA for Admiralty Inlet was issued on January 15, 2013. Comments on the EA were due by February 14, 2013. Written comments on the EA were filed by the following entities:

Commenting entity	Date filed
Washington DFW	February 13, 2013
North American Submarine Cable Association	February 14, 2013
Snohomish PUD	February 14, 2013
Whidbey Environmental Action Network	February 14, 2013
PC Landing	February 14, 2013
Suquamish Tribe	February 14, 2013
Washington DNR	February 14, 2013
Point No Point Treaty Council	February 14, 2013
National Park Service	February 14, 2013
Tulalip Tribes	February 14, 2013
Washington State Ferries (Kojo Fordjour)	February 26, 2013
Orca Conservancy	February 26, 2013
Congressmen Ed Whitfield and Greg Walden	March 21, 2013
Pacific Whale Watch Association	August 2, 2013

Snohomish PUD responded to the comments filed on the EA on March 8, 2013. PC Landing filed a response to Snohomish PUD's response on April 1, 2013.

On April 18, 2013, staff held a technical conference to discuss Snohomish PUD's revised emergency shutdown procedures. Snohomish PUD filed supplemental information in response to staff's questions on the revised braking proposal on May 7, 2013. PC Landing filed comments related to the braking procedures on May 20, 2013 to which Snohomish PUD responded on May 31, 2013. PC Landing responded to Snohomish PUD on June 7, 2013. The Tulalip Tribes filed comments on braking procedures on June 11, 2013.

Appendix D summarizes the comments that were filed, includes our responses to those comments, and indicates where we modified the EA.

2.0 PROPOSED ACTION AND ALTERNATIVES

2.1 NO-ACTION ALTERNATIVE

The no-action alternative is license denial. Under the no-action alternative, the project would not be built, and the environmental resources in the project area would not be affected. In addition, under the no-action alternative, DOE would not authorize the expenditure of federal funds for the final design, construction, deployment, and monitoring of Snohomish PUD's proposed project.

2.2 APPLICANT'S PROPOSAL

2.2.1 Project Facilities

The Admiralty Inlet Project would consist of: (1) two 300-kilowatt (kW) OpenHydro tidal turbines (Turbine 1 and Turbine 2), each approximately 19.2 feet high (6 meters) and mounted on a triangular subsea base, fitted with an adaptable monitoring package for environmental monitoring equipment, instrumentation to monitor turbine vibration, and the potential for differential settlement; (2) two approximately 7,000-foot-long (2,200 meters), 4-kilovolt (kV) trunk cables, one extending from each turbine to the on-shore cable termination vault, each consisting of: a) high-power transmission core cables to transmit power from the turbine to shore; b) single mode fiber optic elements to convey turbine control and monitoring signals and environmental monitoring data between the turbines and the on-shore facilities; and c) low-power elements to provide power to the turbine control and monitoring system at the turbines;[8] (3) an approximately 3.9-foot-long, 5.8-foot-wide, 2.9-foot-high on-shore cable termination vault; (4) 40-foot-long conduits to convey the power transmission core cables, the fiber optic elements, and the low-power elements from the cable termination vault to a cable control building; (5) a 24-foot-wide, 30-foot-long on-shore cable control building housing power and monitoring equipment; (6) a 17.2-kV step-up transformer located adjacent to the cable control building; (7) a 10-foot-long, buried 7.2-kV transmission line from the transformer to the Point of Metering and the Point of Common Ownership with Puget Sound Energy grid; and (8) and appurtenant facilities. The turbine configuration is shown as figure 2.

2.2.2 Project Safety

As part of the licensing process, the Commission would review the adequacy of the proposed project facilities. Special articles regarding project safety and operation

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[8] The trunk cables would come on shore through a bore hole installed by horizontal directional drilling to the shore cable vault.

would be included in any license issued, as appropriate. Commission staff would inspect the licensed project both during and after construction. Inspection during construction would concentrate on adherence to Commission-approved plans and specifications, special license articles relating to construction, and accepted engineering practices and procedures. Operational inspections would focus on the continued safety of the structures, identification of unauthorized modifications, efficiency and safety of operations, compliance with the terms of the license, and proper maintenance.

For the purposes of addressing potential environmental impact and project safety concerns, Snohomish PUD is proposing the following Safeguard Plans:

- Project and Public Safety Plan
- Navigational Safety Plan
- Emergency Shutdown Plan
- Project Removal and Site Restoration Plan

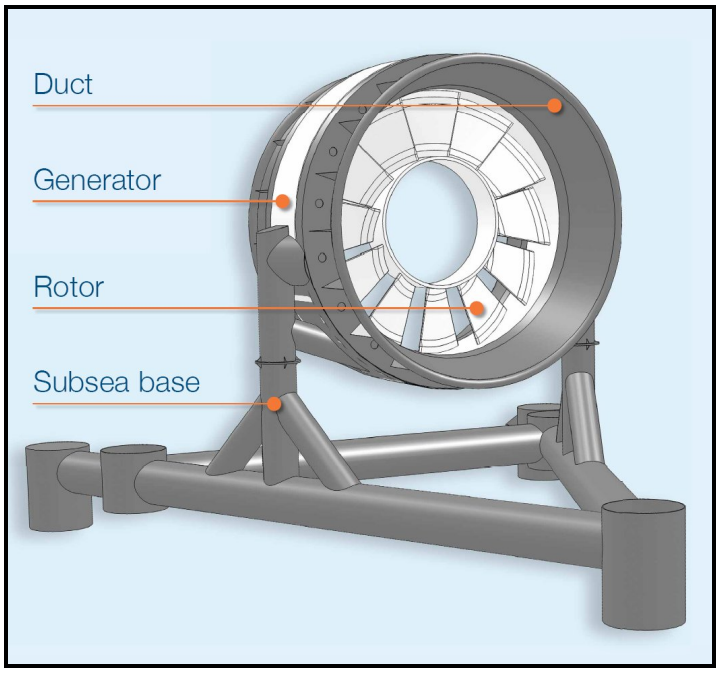

Figure 2. Illustration of the OpenHydro turbine (Source: application).

2.2.3 Project Installation and Removal

The installation process would begin with the construction of the on-shore cable control building, followed by horizontal directional drilling (HDD) operations to bring the trunk cables ashore. Snohomish PUD's proposed HDD Plan provides a detailed description of the procedures for conducting the process. In summary, a drill string would be forwarded from the land side to the marine side exit point. Bentonite and clay

drilling fluid would be used as a lubricant for the drill head. As the drill string approaches the exit point, this fluid would be replaced by water to achieve a mud-free exit. The void created by the drill string would be reamed as required to create a space suitable for a conduit installation. Once the desired space is achieved, conduit from a vessel positioned near the exit point would be lowered into the water and pulled through the void. The contractor would have the choice to either install one large conduit with a minimum of two sub-ducts or install two smaller conduits in separate drilling operations. The completion of the HDD would result in two conduits from shore to the pre-determined exit point, each capable of conveying the trunk cables beneath the shoreline environment

The cable laying process would begin during the flood tide. Two tugboats would be used to direct the cable laying barge from the turbine site toward shore over the cable route to the HDD sea floor exit point. A third tugboat would provide standby assistance in case of a problem with one of the other two tugboats. A remotely operated vehicle (ROV) would inspect the laying of the trunk cable along the sea floor. Once the trunk cable is close to the HDD sea floor exit point, the cable laying barge would be anchored. The cable laying barge would then pay out the remaining cable using floats to keep it on the surface. Assist boats would guide the trunk cable to the HDD sea floor exit point, where it would be attached to a pulling cable and pulled through the conduits to shore. Divers would monitor the trunk cable installation through the HDD conduit. After the trunk cables are pulled through the conduit, they would be terminated on shore at the cable termination vault.

The turbines would be installed when conditions are deemed optimal. Optimum conditions for installation include a tidal speed of less than 1.5 knots and wind speed less than 20 miles per hour, and any other criteria defined in a post-licensing Hazard Identification and Risk Assessment. The installation process would be the same for both turbines, but would occur approximately 30 days apart. The project's installation would require a turbine installation barge (see figure 3), two tugboats, an ROV with its own support vessel, and small support vessels. The turbine would be suspended in the center of the turbine installation barge. The turbine installation barge would be towed to the installation site by a tugboat during the ebb tide. The second tugboat would provide standby assistance to the first tugboat, if needed. Once the turbine installation barge is centered over the installation site, winches onboard would slowly lower the turbine to the sea floor. An ROV would monitor the final placement of the turbine on the sea floor. The installation process is expected to take less than one hour.

An umbilical cable stored on the turbine would be connected to the previously installed trunk cable within 24 to 48 hours of turbine deployment. Each cable would be retrieved and brought aboard a barge where their flanged termination housings would be connected and then redeployed. The cable connection would require a construction barge, three tugboats, and an ROV with its own support vessel. Two tugboats would

control the positioning of the barge during the cable connection operation. The third would provide standby assistance in case of a problem with one of the other tugboats. The flanged termination housings on the end of each cable would be connected and tested by personnel in the completed on-shore control building. The housing would be lowered to the seafloor by a tag line from the barge. The tugboats would direct the barge during redeployment to position and control the tension in the connected cables. The ROV would monitor the touchdown and record the final position of the housing and cables. The connection and redeployment operation is expected to take less than two hours.

Figure 3. OpenHydro Installation Barge (Source: application).

Snohomish PUD proposed a Project Removal and Site Restoration Plan that details how the turbines, subsea bases, and other equipment would be removed at the conclusion of the license. The turbines and subsea bases would be removed by reversing the installation process. Snohomish PUD would either leave in place or remove the trunk cables based on recommendations from the MARC. Snohomish PUD would remove all on shore equipment according to the terms of the agreement(s) between Snohomish PUD and the private land owners. Snohomish PUD would also remove the terrestrial transmission line and other transmission equipment in accordance with the terms of the agreement with Puget Sound Energy. It is expected that the control building would be converted to a garage for the adjoining residence.

2.2.4 Project Operation

The proposed project would operate using the natural tidal currents of Admiralty Inlet. The OpenHydro System is designed to generate electrical output during a range of water currents present in a full tidal cycle, operating in a stationary orientation in both ebb and flood tides. The turbine converts the kinetic energy of water flowing in currents from 0.7 meters per second (m/s) to 3.3 m/s into rotational motion and delivers that energy through the rotors into the generator. The turbines are expected to rotate approximately 70 percent of the time.

Manual controls located in the control building and remote web-based monitoring would be provided for turbine and grid connection functions. The system would be monitored continuously by Snohomish PUD personnel via an internet connection. The turbines would be monitored and controlled using a programmable logic controller and human machine interface. The monitoring of turbine operation would occur in real time and information on turbine operations would be transmitted to the control building through the fiber optic cables within the trunk cables. The electrical parameters of each turbine would be monitored, and automatic alarm thresholds would be set locally or remotely by project personnel. A three-axis orthogonal accelerometer or approved alternate instrument would be mounted on the turbine to measure real-time vibration in the x, y, and z axis, and would signal that the turbine should be shut down if excessive vibration was measured. An integrated tilt sensor or approved alternate instrument would be mounted on the turbine subsea base to monitor for any differential settling.

Snohomish PUD personnel would monitor for system alarms 24 hours-per-day, 7 days-per week. Depending on the severity of the alarm, Snohomish PUD personnel would evaluate whether provisions of the project safeguard plans should be implemented.

2.2.5 Project Maintenance

Although the OpenHydro turbines are designed to operate reliably with low maintenance demands, Snohomish PUD proposes to implement monitoring, inspection, and maintenance measures for the term of the license. Monitoring efforts would be conducted by the engineers to analyze data from the control and monitoring equipment on each turbine to highlight any anomalies in the equipment. This effort would be ongoing through the term of the installation.

Inspection would be done by the use of ROVs four times per year during the first year and two times per year each additional year of installation. Inspections would assess the overall structural integrity of each turbine and base, biological growth on the turbines and bases, condition of the turbine blades, condition of the anodes, position of the turbines on the sea floor, and the position and condition of the trunk cables. Inspections would be conducted on the following schedule: (1) immediately following installation of the tidal array; (2) following 1 month of operation; (3) following 3 months of operation;

(4) following 6 months of operation; (5) following 9 months of operation; (6) following 12 months of operation; (7) following 18 months of operation; and (8) following 24 months of operation.

Maintenance of the turbines is anticipated to occur five years after deployment. The turbines would be removed, and all mechanical and electrical parts would be inspected and repaired or replaced as needed. The adaptable monitoring package (AMP) attached to each turbine would be recovered and redeployed every three to six months as part of the standard maintenance cycle.[9]

Inspection and maintenance documentation would be integral to the early years of the project as standard maintenance intervals are developed for the Admiralty Inlet Project. Maintenance records would be kept and maintenance events monitored for system degradation. A dedicated computer and data collection program would maintain records of maintenance and would include a real-time operational display and historical charts. The data would be available at remote locations over the internet. A schedule would be developed for periodic database archival.

As proposed by Snohomish PUD in the Project and Public Safety Plan, unscheduled maintenance operations may be triggered by a failure of the environmental monitoring equipment, or an operational problem with the turbine. Snohomish PUD would likely use an ROV to inspect the turbine or equipment before making a decision on how to proceed. Snohomish PUD anticipates an ROV could be mobilized in a matter of days. In the event that a component of the environmental monitoring equipment would need to be replaced, an unscheduled maintenance event to recover the AMP and replace it with a spare would take approximately 30 minutes, and the window for the repair to occur (dictated by appropriate tidal and weather conditions and the availability of a vessel) would likely be completed in one week.[10] In the event that the turbine fails, or that the environmental monitoring equipment fails at a point between where the AMP

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[9] The AMP includes optical-acoustical cameras for observing marine animals in the near-field (< 5 m) of the turbine rotor and passive acoustic hydrophone arrays to detect, classify, and localize marine mammal vocalizations.

[10] The initial specifications for the removal and installation of the adaptable monitoring package is for operations to be completed within 30 minutes, with the currents fully set in one direction throughout the water column, a mean velocity less than 0.7 m/s, and a Sea State less than 3 on the Beaufort Scale (8 to 12 mph winds, wave height 2 to 3.5 feet high). Based on analysis of current data collected within the project area, there is a 75% chance of at least one maintenance window occurring within 7 days of a system fault notification and a 90% chance of at least one maintenance window occurring within 14 days of a fault notification.

connects to the power source and the shore, the turbine may be recovered to the surface as described in the Emergency Shutdown Plan and the Project Removal and Site Restoration Plan.

Snohomish PUD proposes in their Emergency Shutdown Plan to implement the following procedures when shutdown is required: (1) engage a mechanical brake via an ROV during the next viable slack tide, which would lock the turbine rotor in position and cease electrical generation; (2) electrically isolate the subsea systems from the grid; and (3) file a report with the Commission, agencies, and tribes detailing the measures undertaken during the shutdown. The time between the decision to cease turbine rotation and engaging the mechanical brake is likely to be less than a day and no more than four days. If the turbine must be removed, the process could take up to four weeks to complete. Turbine recovery would require the installer barge and associated equipment and crew to be mobilized and would have to be completed during acceptable tidal and weather conditions.[11] Any marine vessels that would be mobilized as part of a maintenance event would have to comply with the International Rules for Preventing Collisions at Sea and coordinated with the Coast Guard, as outlined in the Navigation Safety Plan.

2.2.6 Proposed Environmental Measures

Snohomish PUD proposes to construct and operate the project with the following environmental protection, mitigation, and enhancement measures:

- To monitor environmental effects and identify corrective actions, implement: (1) an Acoustic Monitoring and Mitigation Plan; (2) a Benthic Habitat Monitoring and Mitigation Plan; (3) a Marine Mammal Monitoring and Mitigation Plan; (4) a Near-Turbine Monitoring and Mitigation Plan; (5) a Derelict Gear Monitoring Plan; and (6) a Water Quality Monitoring Plan.

[11] Recovery of the turbine can occur when the Beaufort Sea State is 4 (13 to 17 mph winds and wave height 3.5 to 6 feet high) or lower, and tidal currents are set in one direction and have a velocity between 0.3 and 1.3 m/s for at least 90 minutes. Based on analysis of current data collected within the project site, there is a 70% chance of at least one suitable met-ocean window occurring within 14 days of the installer barge being mobilized.

- To provide coordination, data reviews, and implementation of the above monitoring plans, implement an Adaptive Management Framework that includes conferring with a Marine Aquatic Resource Committee (MARC).[12]

- To avoid eelgrass beds and other sensitive near-shore habitats, implement a Horizontal Directional Drilling Plan that would deploy trunk cables from on land to a minimum depth of 18 meters off-shore.

- To minimize the introduction and spread of invasive plants on the land-based portion of the transmission line and around the control building, implement the following measures during site construction and project removal: (1) use gravel, rock, or other fill material from a weed free source; (2) revegetate disturbed areas with species native to Keystone Spit, with the source material (seeds or cuttings) collected from Keystone Spit; (3) ensure that no imported soil, fertilizer, or tackifiers will be used in revegetating disturbed areas; and (4) inspect any fill and disturbed areas for invasive plants annually, between early and mid-June and again in August, and eradicate any detected invasive plants promptly.

- To avoid adverse effects on sensitive marine fish species, conduct marine installation during a Washington Department of Fish and Wildlife-approved work window of July 16 to October 14, or outside this work window only by agreement with the MARC.

- To educate the public about the project, the potential ocean energy resource in Puget Sound, and the natural and cultural environment of the project area, develop and implement an Interpretation and Education Plan that includes installation of an interpretive display at Snohomish PUD's headquarters or at another appropriate location agreed upon with stakeholders.

- To ensure safe operation of the project and protect the public, implement: 1) a Project and Public Safety Plan; 2) a Navigational Safety Plan; and 3) an Emergency Shutdown Plan.

- To avoid harming PC Landing's international fiber optic cable (PC-1 North), located near the site, conduct turbine installation and monitoring using "live-

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[12] The Committee would be composed of the following entities: Snohomish PUD, NMFS, FWS, Washington DFW, Washington Ecology, Washington DNR, the Tulalip Tribes, Suquamish Tribe, Swinomish Indian Tribal Community, and Sauk-Suiattle Tribe. Additional members could be added by unanimous agreement by the MARC.

boat" techniques (i.e., without anchoring) and prepare and implement a Hazard Identification and Risk Assessment, developed in consultation with the Corps, Coast Guard, and PC Landing, prior to marine operations that includes: (a) setting criteria for weather and wave conditions that must exist before marine operations occur; (b) using industry-approved equipment and redundancy in the use of equipment and vessels (e.g., tugboat with back-up engine; back-up tugboat for emergencies; towing gear, barge, winches, winch wire, and hydraulic lifting tools new or certified based on industry standards); (c) setting criteria for aborting operations; and (d) identifying an established "port of refuge," located away from PC-1, in the event of unanticipated adverse weather or other events that would cause installation or operations to be aborted

- To restore the project site to a pre-project condition at the end of the license term if a new license is not sought or obtained, implement a Project Removal and Site Restoration Plan.

2.3 STAFF ALTERNATIVE

The staff alternative includes all of the measures included in Snohomish PUD's proposal, with the following modifications and additional measures developed by Commission staff.

- Include in the Project Removal and Site Restoration Plan provisions for filing for Commission approval: (1) a specific timeline for the removal and site restoration activities 6 months prior to license expiration; (2) documentation of consultation with the MARC regarding planned removal and site restoration activities 6 months prior to license expiration; and (3) documentation of completion of project removal and site restoration activities prior to license expiration.

- Include in the Emergency Shutdown Plan a provision for preventing interaction with the turbines or turbine shutdown equipment while the mechanical brake is being deployed.

- Include in the HDD Plan provisions to implement noise abatement measures in the event HDD processes extend into the nighttime hours.

- Include in the Benthic Habitat Monitoring and Mitigation Plan a provision to : (1) identify specific depth and width measurements of scour, as measured from the turbine footings, that would trigger the installation of scour protection measures on the sea bed; (2) develop the triggers in consultation with NMFS, FWS, U.S. Coast Guard, Washington DNR, Washington DFW, and

Washington Ecology; and (3) notify the Commission within 10 days of when such triggers are met and the licensee's plans for mitigating any such effects.

- Develop and implement an Interpretation and Education Plan for the installation of an interpretive display at Fort Casey State Park, subject to state approval, describing the project, the potential ocean energy resource in Puget Sound, and the natural and cultural environment of the project area.

- Halt work if previously unidentified archeological or historic properties are discovered and develop protective measures in consultation with the Washington SHPO.

- Include a reservation of authority for the Corps of Engineers to require removal, relocation, or other alteration if the project becomes an unreasonable obstruction to free navigation of navigable waters.

- Coordinate project installation and maintenance activities with Washington State Ferries to avoid potential disruptions to scheduled ferry service.

3.0 ENVIRONMENTAL ANALYSIS

In this section, we present: (1) a general description of the project vicinity; (2) an explanation of the scope of our cumulative effects analysis; and (3) our analysis of the proposed action and other recommended environmental measures. Sections are organized by resource area. Under each resource area, historic and current conditions are first described. The existing condition is the baseline against which the environmental effects of the proposed action and alternatives are compared, including an assessment of the effects of proposed mitigation, protection, and enhancement measures, and any potential cumulative effects of the proposed action and alternatives. Staff conclusions and recommended measures are discussed in section 5.2, *Comprehensive Development and Recommended Alternative*.

3.1 GENERAL DESCRIPTION OF THE PROJECT AREA

The proposed project is located in Admiralty Inlet in the northwestern portion of Puget Sound, between the Olympic Peninsula and Whidbey Island (Island County). Puget Sound is the second largest estuary in the United States, where salt water from the Pacific Ocean is mixed with fresh water draining from the surrounding watersheds.

The average water depth in Puget Sound is 140 meters, with a maximum depth, just north of Seattle, of 285 m (935 feet) (Fugro, 2009). Puget Sound supports a wide range of habitats that are home to thousands of plant and invertebrate species, as well as more than 200 species of fish, 100 species of marine birds, and nine species of marine mammals (Gustafson et al., 2000; Palsson et al., 1997). Puget Sound is bordered to the west and east by the Olympic and Cascade mountain ranges, respectively. This topography generally channels winds in a north/south direction, although wind conditions across Puget Sound can vary depending on local effects.

Admiralty Inlet is the gateway to Puget Sound, sitting between the Olympic Peninsula on the mainland of the State of Washington and Whidbey Island. Admiralty Inlet is 3,240 m (10,630 feet) wide with an average depth of 64 m (210 feet) and a maximum depth of 81 m (266 feet) (Snohomish PUD 2012). It connects the northwestern end of Puget Sound to the Strait of Juan de Fuca. Tidal currents in Admiralty Inlet exceed 3 meters per second. The turbines would be located approximately 1 kilometer west-southwest of Admiralty Head, at a water depth of approximately 58 meters.

Fort Casey State Park occupies the nearest land on Admiralty Head, which is east of the turbine sites and to the west of the proposed cable control building. This part of the coastline is dominated by high, sandy bluffs. The beaches along Admiralty Head tend to be sand and cobbles. The Port Townsend-Coupeville ferry terminal and light residential development occur near the cable control building. Major land and water uses in the Project area include recreation, commercial fishing (except salmon), transportation,

and commerce. The main urban areas in the Project area are the town of Coupeville, several miles to the north on Whidbey Island, and Port Townsend, which is located on the opposite side of Admiralty Inlet from the Project. Much of Admiralty Inlet's western shoreline is characterized by forest, light residential development, and the city of Port Townsend, while a majority of the eastern half of the channel, particularly along the Whidbey Island shore, is characterized by forest and agriculture (City of Port Townsend 2007).

Admiralty Inlet serves as a main route for all shipping traffic for the ports of Everett, Seattle, Tacoma, and Olympia (McCurdy 2007). Admiralty Inlet is also traversed by a ferry route: the Port Townsend-Coupeville ferry runs between Port Townsend and Admiralty Head on Whidbey Island. Admiralty Inlet also supports substantial naval traffic, including that associated with the Naval Station Everett, Puget Sound Naval Shipyard, and the Bangor Submarine Base.

3.2 SCOPE OF CUMULATIVE EFFECTS ANALYSIS

According to the Council on Environmental Quality's regulations for implementing the National Environmental Policy Act (40 C.F.R. § 1508.7), a cumulative effect is the impact on the environment that results from the incremental impact of the action when added to other past, present and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such actions. Cumulative effects can result from individually minor but collectively significant actions taking place over time, including hydropower and other land and water development activities.

Based on information in the license application, agency comments, other filings related to the project, and our independent analysis, we have identified marine fish and mammals (including threatened, and endangered species), as resources/uses having the potential to be cumulatively affected by the proposed project in combination with other activities in the proposed project area, such as commercial fishing, and vessel traffic. While the installation of additional hydrokinetic devices may be possible in the future (e.g., as proposed by the U.S. Navy in Admiralty Inlet), their development is not well enough defined to be reasonably foreseeable and to be appropriately analyzed.

3.2.1 Geographic Scope

The geographic scope of the analysis for cumulatively affected resources is defined by the physical limits or boundaries of: (1) the proposed action's effects on the resources, and (2) contributing effects from other projects or activities. Based on the nature, size, and location of the proposed project, the geographic scope for cumulatively affected resources is Admiralty Inlet. We choose this geographic scope because the effects of project operations are primarily limited to Admiralty Inlet, where these

resources may directly and indirectly be affected by construction and operation of the project.

3.2.2 Temporal Scope

The temporal scope of analysis includes a discussion of the past, present, and future actions and their effects on marine resources. Based on the potential term of a license, the temporal scope looks 10 years into the future, concentrating on the effect of reasonably foreseeable future actions. The historical discussion is limited, by necessity, to the amount of available information for the resource.

3.3 PROPOSED ACTION AND ACTION ALTERNATIVES

In this section, we discuss the effect of the project alternatives on environmental resources. For each resource, we first describe the affected environment, which is the existing condition and baseline against which we measure effects. We then discuss and analyze the specific cumulative and site-specific environmental issues.

Admiralty Inlet is a constricted channel in Puget Sound, and therefore by its nature, experiences strong tidal currents and significant vertical mixing. Because the turbines that are being deployed and their potential to release pollutants or cause changes to the waters of Puget Sound are so small compared to the volume of water and tidal mixing forces of Puget Sound, anticipated water quality effects are expected to be localized and short-term. Therefore, the analysis of project effects on water quality focuses on the production of turbidity/sediment, changes in pH, spill of oil, and use of anti-bio-fouling paints. Nothing in the record suggests that project construction or operation would alter other water quality conditions in the larger Puget Sound (e.g., dissolved oxygen, temperature, etc.).

Similarly, Polagye et al. (2009) modeled the effects of energy removal of the project on Admiralty Inlet. Modeling results show that "The far-field effects of extraction from an array this size would have an immeasurably small effect on the tidal regime of Puget Sound… Any detectable effects should be confined to near-field flow variations in the immediate vicinity of the devices" (Polagye et al., 2009). Consequently, the analyses of project effects on hydrodynamics focus on the near-field environment.

We present our recommendations in section 5.2, *Comprehensive Development and Recommended Alternative.*

3.3.1 Geologic and Soil Resources

3.3.1.1 Affected Environment

The proposed tidal turbine project is located in Admiralty Inlet, a strait within Puget Sound that connects the Strait of Juan de Fuca to Puget Sound. Daily ebb and flood tides move water between the Pacific Ocean and Puget Sound via Admiralty Inlet. The project area is located in the Puget Sound Lowland physiographic province, a north-south trending structural basin located between the Olympic Mountains to the west and the Cascade Mountains to the east, with Puget Sound running through the center. This basin was formed by the subduction of the Juan de Fuca oceanic plate beneath the North American Plate.

At least six continental glaciations advanced into the Puget Sound Lowlands over the previous two million years. Each successive glaciation shaped the landscape by both partially eroding the existing ground surface, and depositing a fresh sequence of clay, silt, sand and gravel sediments. Advancing and retreating glaciers created deep and narrow channels in the region divided by islands and peninsulas, including Admiralty Inlet and Puget Sound. Sedimentary deposits that have been overridden by thick glacial ice are typically highly consolidated, and post glacial sediments are less consolidated, which influences the engineering behavior of the soils. The stratigraphy in the project area contains both glacially-consolidated and unconsolidated sediments.

In the proposed project turbine installation area, a series of generally east-west trending (active) seismic faults subdivide the Puget Sound basin. The region is characterized by moderate to high seismicity (U.S.G.S., 2012a). Johnson, et al., (1996) speculated that shallow crustal seismic faults in the area may generate earthquakes of magnitude 7 or higher. The Southern Whidbey Island Fault, cuts through the proposed project area (Polenz et al., 2005).

Movement of water through the relatively narrow Admiralty Inlet during the tidal cycle results in strong tidal currents, which is an important mechanism for sediment transport in the project area. The major source of sediment contributed to the project area is likely from erosion of the shoreline and bluffs along the west side of Whidbey Island. In areas where benthic slopes are steep, occasional slumps and slides occur that deliver sediments to the deeper seafloor. Earthquake activity may also trigger slumps and slides on the steep submarine slopes. Strong tidal currents in the project area scour small particles (sands and silts) and leave behind larger gravels and boulders.

In the project area, tidal currents can reach 3.4 m/s. The sea floor surface in the area of the turbine installation site is a cobbled pavement interspersed with gravel and

shell and small and large boulders (figure 4). The thickness of the layer of this cobbled pavement is estimated to be between three and six feet thick. The sediment beneath the cobble pavement layer is predicted to be clay/sand and/or sand/gravel/cobble/boulders.[13]

Figure 4. ROV image of cobble pavement bottom in project area (Source: applicant).

Snohomish PUD used a sub bottom profiler (SBP) system and a low frequency acoustic subsurface reflection (seismic reflection) system to measure the thickness of unconsolidated sediments in the project area. Less-consolidated sediments have different reflection patterns than more highly consolidated sediments, providing an indication of the overall density of sediments in the project area. While these techniques do not identify individual soil types, they do provide a measure of the relative consolidation of the sediment layers to each other, allowing some extrapolation of the predicted engineering properties at the site. While individual soil types measured by these techniques can be compared against soil core samples to verify the identity of the

[13] *See* Snohomish PUD 2012 (LA, Appendix L-11. Golder Associates, 2011. "Geophysical Investigation for Admiralty Inlet Turbine Project."

individual soils present, Snohomish PUD was unable to gather soil borings for comparison in the proposed project installation site because the samplers were unable to penetrate the cobble pavement to sample the soils beneath.

The on-shore facilities would be located on private land south of Crockett Lake. Soils include sand and cobbles, some larger particles, and a mix of sediment locally derived from shoreline bluffs. Specific soil types at the onshore facilities include:[14]

- Beaches: 50 percent
- Endoaquents, tidal, and similar soils: 30 percent
- Xerorthents and similar soils: 20 percent

3.3.1.2 Environmental Effects

Project installation, maintenance, operation, and removal will require land-disturbing activities associated with HDD processes, construction of the cable control building, and installation of the underground section of the trunk cable and the associated conduits between the cable termination vault and the cable control building, which can result in soil erosion and sedimentation and adverse effects on aquatic habitat and organisms. At-sea operations associated with the HDD processes would also result in the temporary disturbance of the seabed. During operation, PC Landing asserts that the design and the weight of the turbines could result in differential settling of the turbines and scouring of sediments.

Soil Disturbance and HDD Processes

Snohomish PUD proposes to implement a Horizontal Directional Drilling Plan to minimize soil disturbance at the sea floor where the trunk cables would burrow under the kelp bed to be brought ashore. Starting from the proposed cable termination vault, Snohomish PUD would use a mixture of bentonite clay and water as the drilling fluid, which would function as a lubricant for the drill head and pipe. The bentonite clay-water slurry and the dredging spoils removed during the drilling would be pumped to a holding tank. As the HDD conduit path approaches the exit on the sea floor (approximately 100 feet from the exit), the drilling fluid would be replaced with fresh water to remove mud from the conduit path and to ensure a clean exit. Pressure and volume would be monitored to ensure that fractures that could cause wet soil to escape to the surface or within the water column could be repaired.

[14] U.S.G.S., 2012b.

Snohomish PUD proposes the following measures for site restoration after the HDD and on-shore construction is complete: (1) restore the site to original grade; (2) replant and/or plant new grass, bushes and/or trees as needed; (3) repair any site structures such as roads, fences, curbs, retaining walls, etc. to equal or better condition if damaged during the installation; (4) remove any project generated garbage; and (5) remove any signs of the project such as ruts in the road, excessive dirt, etc.

Staff Analysis

Implementing Snohomish PUD's Horizontal Directional Drilling Plan would preserve geologic resources in the project area during construction by controlling the collection of any soils removed from the conduit without allowing wet soil to escape to the soil surface or within the water column. Proposed site restoration measures after the HDD and on-shore construction are complete would further minimize any potential for soil erosion or sedimentation from site construction activities. A detailed site-specific soil erosion control plan is typically required by the Commission as part of the final design and specifications. Such a plan would further minimize adverse effects of soil erosion and sedimentation on aquatic resources.

Differential Settling and Scour from the Turbines

The footprint of the turbine foundation would be three legs arranged in a triangular configuration with a cylindrical foot meeting the sea floor at each vertex. The pressure exerted down by the weight of the turbines would be distributed to the sea floor through the three cylindrical feet, each of which would be potentially designed to have a spiked extension on the bottom to allow penetration of the foot into the first 1.5 feet or so of the cobble pavement. The size of the footings can be enlarged to decrease the force experienced at each footing by the weight of the turbine and foundation. Each turbine foundation would cover a maximum area of approximately 10 square meters.

Snohomish PUD would monitor for differential settling of the turbines with an integrated tilt sensor, mounted on the turbine frame. Differential settling in excess of design thresholds would trigger the mechanical brake. Snohomish PUD also would monitor the installation area using ROVs to evaluate if excessive scour is occurring in the vicinity of the turbines. Inspections would be conducted on the following schedule: (1) immediately following installation of the tidal array; (2) following 1 month of operation; (3) following 3 months of operation; (4) following 6 months of operation; (5) following 9 months of operation; (6) following 12 months of operation; (7) following 18 months of operation; and (8) following 24 months of operation. Snohomish PUD also states that the turbine foundation would be designed to provide adequate support for the turbines, and that the turbine foundations would be designed to minimize scour.

Turbine 1 would be installed approximately 170 meters, or 558 feet (as measured from the centroid of the turbine base) from the buried PC-1 cable, and Turbine 2 is would

be installed approximately 237 meters, or 780 feet (as measured from the centroid of the turbine base) from the buried PC-1 cable.[15] PC Landing asserts that the turbine foundations may not be adequately designed because of the uncertainty in the composition of the sediment immediately beneath the cobble pavement at the project installation area. PC Landing is concerned that without an adequate foundation, differential settling of the turbine may cause the turbine to topple or list, requiring corrective action by Snohomish PUD and increasing the potential for damaging the PC-1 North cable. PC Landing is also concerned that the weight of the turbines could penetrate the cobble pavement to expose the softer sediments underneath, more readily mobilizing the softer sediments and resulting in scour several hundreds of meters away, exposing the buried PC-1 North cable and making it more vulnerable to damage. PC Landing councils that a greater separation (750 to 1,000 meters) between the turbines and the PC-1 North cable are necessary to reduce the risk to PC-1 North.

Staff Analysis

Scour is the suspension and subsequent movement of sediments and cobbles from the sea floor resulting from the movement of water. Little information is available on scour depth and width based on field monitoring of gravity structures in tidal currents. Experiments on monopile and tripod foundation structures show the propagation of scour radiating out from the device, but decreasing in depth as the distance from the device increases (Stahlmann and Schlurmann, 2010; den Boon, et. al., 2004). The distance of propagation depends upon the current speed, the depth of water, the depth of the scour, and the diameter of the base (DNV, 2010). The sediment type also influences the extent of scour. For example, the overall extent of scour in a sand bed is typically 4 to 5 times the diameter of the diameter of the foundation cylinder; however, greater extents have been observed (Whitehouse, et al., 2011). The scour process is not immediate, but is also a function of time (DNV, 2010).

The tidal currents in Admiralty Inlet are strong and have scoured the sea floor in the vicinity of the project, washing away clays and silts, shifting sands and gravels, and leaving surface areas of cobbles, rocks, and boulders that are too large to be mobilized on the sea bed. A generic example of this phenomena is shown below (figure 5): (1) the critical erosion velocity is the velocity required to mobilize a still particle from a stationary position (gray); (2) once mobilized, the velocity required to transport the particle is shown as the transportation velocity (peach); and (3) the velocity of the water below which the particle will drop out of suspension and settle to the sea floor is shown as the deposition velocity (pink). The exact curves for a waterway are dependent on the

[15] Snohomish PUD originally proposed a separation distance of 328 feet in the FLA. On August 27, 2012, Snohomish PUD proposed to move the installation sites to approximately 558 feet from the PC-1 cable.

features of the river or inlet, the depth of water, and the density of the particles. An obstruction in the flow of water, such as would be expected to occur when a turbine is installed on the sea floor, would force the water in the current to flow around the object more quickly, increasing the velocity at the site of the obstruction. The increased velocity could mobilize larger particles.

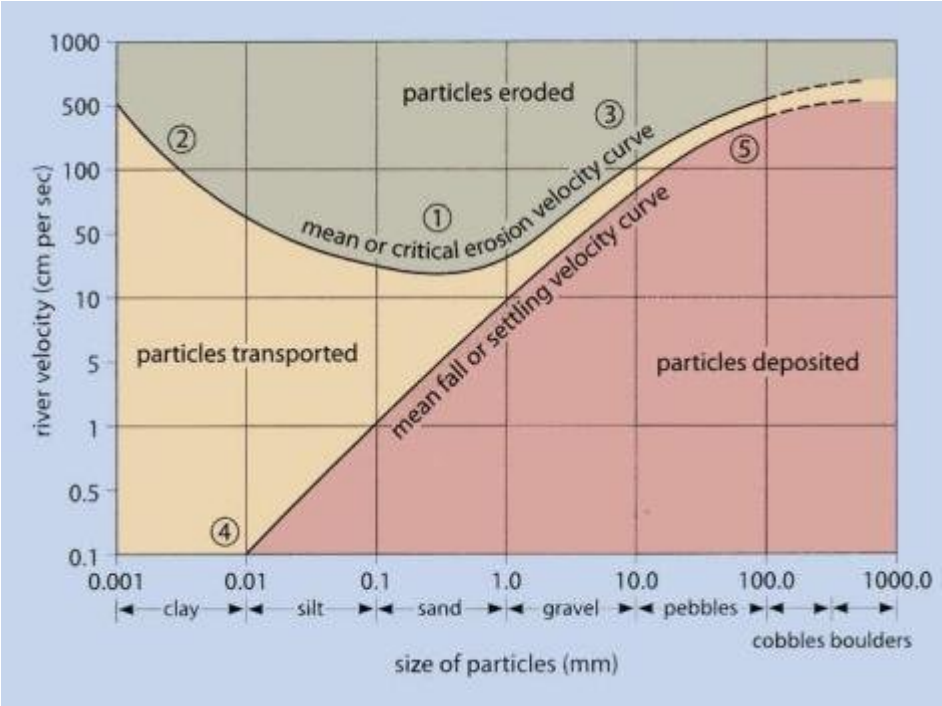

Figure 5. Hjulstrom's Diagram showing the transport, deposition, and erosion of particles based on particle size and water velocity (Source: www.geographylwc.org.uk).

Changes to the magnitude of tidal flows in the immediate vicinity of the proposed project could affect scour both at the project turbine and in the immediate vicinity. Snohomish PUD estimates that the velocity around the turbine foundation is expected to increase to around 2 m/s, which, according to the Hjulstrom Diagram shown above, would be high enough to locally mobilize and transport some cobbles but would not be anticipated to be high enough to mobilize and transport boulders. Under current conditions, the cobble pavement acts as scour protection for the softer sediments predicted to lie underneath. These smaller diameter particles may be exposed to the tidal currents and could experience scour if the turbine foundation structure penetrates the cobble pavement. While there is some uncertainty regarding if the turbine foundation would penetrate the cobble pavement, if the structure does, the lateral extent of the scour would likely be limited to the area where cobble-sized and smaller particles are exposed,

and would not be anticipated to laterally extend beyond where the cobble pavement would be intact.

Any scour that may occur at the project installation site would not be expected to occur all at once, but would be expected to increase over time until it reaches equilibrium within the system. ROV monitoring, as proposed in the Project Safeguard Plans, would occur three times in the near turbine areas within the first three months of the project installation. Any scour that occurs around the turbine foundation and propagates out can be measured and monitored over time. If scour is found to be a problem at the foundation site, either in causing differential settling to occur or in propagating toward the PC-1 North cable, scour protection (such as scour skirts or scour-resistant materials) could be installed at the turbine bases to minimize or correct the problem. Additional monitoring as detailed in the Project Safeguard Plans and the Benthic Habitat Monitoring and Mitigation Plan over the installation life of the project would provide an increased understanding on the effects of the two turbines on hydrodynamics and sediment transport processes.

The sea floor surface in the area of the turbine installation site is a cobbled pavement interspersed with gravel and shell and has small and large boulders. The thickness of the layer of this cobbled pavement is estimated to be between three and six feet thick. The sediment beneath the cobble pavement layer is predicted to be clay/sand and/or sand/gravel/cobble/boulders (Golder Associates, 2011). Available data and conservative design criteria suggest that the foundation feet will not penetrate the seabed to a depth greater than approximately 1.5 to 2 feet. During the final design phase of the project, Snohomish PUD would work with Commission engineers in the Division of Dam Safety and Inspections to ensure that the size of the footings and other design features would be adequate to support the turbine foundation given the anticipated geology at the installation site.

Given the shallow penetration of gravity base legs and the restricted spatial coverage of the devices, it is anticipated that there would be minimal effects on the rock faces where penetration occurs. Consequently, any scour would be localized around the foundation footings. Any differential settling would be detected, as noted above by Snohomish PUD's monitoring efforts, allowing Snohomish PUD time to take any corrective actions needed to stabilize the turbines. As PC Landing notes, specific criteria (i.e., depth and width measurements of scour) for when scour would be excessive and require mitigation measures have not been identified. Developing these criteria in consultation with NMFS, U.S. Coast Guard, Washington DNR, and Washington Ecology prior to installation would ensure timely implementation of protection measures and further insure that any scour effects remain close to the turbine, minimizing adverse effects on environmental resources.

While the proposed project has the potential to impact the sea floor in the immediate vicinity of the turbines, the effects on geologic resources in the vicinity of the

PC-1 cable in the project vicinity are expected to be minimal because of the small number of turbines (two), the distance between the turbine and the PC-1 cable (558 feet to the closest turbine), and the continued monitoring of the site after the installation has occurred.

3.3.2 Marine Resources

3.3.2.1 Affected Environment

Water Use

Admiralty Inlet serves as a main route for all shipping traffic for the ports of Everett, Seattle, Tacoma, and Olympia (McCurdy, 2007). Commercial and recreational fishing are important uses of Puget Sound and Admiralty Inlet, particularly to the tribes in the area. Recreation in other forms, such as boating and diving is important as well. Fishing, recreation, and navigation are discussed in detail elsewhere in this document.

Water Quality

The U.S. Environmental Protection Agency (EPA) designated Puget Sound as an Estuary of National Significance in 1988. There are indications that the increase in human disturbance in the Puget Sound area threatens the health of Puget Sound. These indicators include the loss or impairment of habitat, historic and current toxic contamination of sediment and organisms, and diminished populations of certain species.

Washington DFW has assigned the use designation, "Extraordinary," to Admiralty Inlet for the following uses: shellfish harvest, primary contact recreation, wildlife habitat, harvesting, commercial/navigation, boating, and aesthetics. Associated water quality criteria have been established. Under the National Pollutant Discharge Elimination System (NPDES) Washington Ecology has issued about a dozen discharge permits in the northern half of Admiralty Inlet, which it regulates.

Water Quantity and Tides

The volume of water between mean high water and mean low water in Puget Sound is equal to 8.1 km^3 (6.5 million acre-feet), about 4.8 percent of the total volume of 168.7 km^3 (137 million acre-feet) (Mofjeld and Larsen, 1984).

Tides in Puget Sound generally follow a semi-diurnal cycle over a 25-hour period, with two high and two low tides that tend to be different in range and timing. The average daily tidal variation is 2.4 m (7.8 feet) in northern areas of Puget Sound and 4.3 m (14.1 feet) in southern areas of Puget Sound. Geographic variation in the shape and depth of Puget Sound influences local tidal patterns. In Admiralty Inlet, the tidal range is recorded by the NOAA observational station 9444900 located at Port Townsend (48°6.7'N 122°45.4'W) and reaches 3.4 (11.2 feet) meters.

Currents within Puget Sound are primarily driven by tides and the inputs from surface water sources, although the speed and direction of winds can also be influential. Generally, current velocities in Puget Sound range from 0.3 to 1.0 meters per second (1 to 3 ft/s), although 1.5 meters per second (4.9 ft/s) is normal in some regions (Gilmore et al., 1996).

Strong currents occur within Admiralty Inlet because the relatively narrow and shallow channel reduces the cross-sectional area and regulates flow. Currents in the main portion of the inlet are effectively bi-directional, and velocities of 2.6 meters per second (Polagye et al., 2007) and 2.2 meters per second (NOAA, 2007*a*) have been recorded in the Project area. Outside of the deep channel, current velocities decrease because of shallower water depths and eddies. Numerous turbulent eddies form on ebb and flood tides (McGary and Lincoln, 1977). On flood tide, an eddy forms in the entirety of Admiralty Bay southeast of Admiralty Head, and on ebb tide, eddies form to the northeast of Admiralty Head (McGary and Lincoln, 1977).

Acoustic Environment

Several factors contribute to ambient noise in Admiralty Inlet, including anthropogenic sound, bedload transport associated with strong tidal currents, rain, and biological vocalizations. Anthropogenic sources of ocean noise include commercial shipping, military activities, geophysical surveys, oil drilling and production, dredging and construction, sonar systems, and oceanographic research. Sound pressure spectral densities can range from about 35 to 80 dB (re 1 $\mu Pa^2/Hz$) for usual marine traffic (10 to 1,000 Hz), and 20 to 80 dB (re 1 $\mu Pa^2/Hz$) for breaking waves and associated spray and bubbles (100 to 25,000 Hz) (Richardson et al. 1995).

At frequencies below 1 kHz, ambient noise levels are dominated by anthropogenic sound associated with commercial vessel traffic (Bassett et al., 2012). Consequently, the temporal patterns in ambient noise levels at those frequencies mirror those in commercial vessel traffic. Percentile ambient noise levels in the 25 Hz – 1000 Hz frequency range are shown in figure 6. These data are derived from measurements of ambient noise in Admiralty Inlet using autonomous recording hydrophones on seabed moorings (see Bassett 2010, Bassett et al. 2010, Bassett et al. 2012a, and Bassett et al. 2012*b*).

Figure 7 presents similar information for higher frequencies (1 kHz – 25 kHz), specifically, median one-third octave levels at different hub-height current velocities. The turbine source one-third octave levels derived from European Marine Energy Center (EMEC) measurements is shown in both figures as a red line. These measurements were conducted at a current velocity of 1.8 m/s. Bassett et al. (2012) demonstrates that low frequency ambient noise is dominated by shipping traffic. For higher frequencies, as the current velocity increases, bedload transport noise elevates ambient noise levels proportionally to the square of velocity (Bassett et al., in revision). While rainfall and

biological noise also elevate noise at these frequencies (e.g., 20 kHz), these do not affect ambient noise levels as significantly as bedload transport.

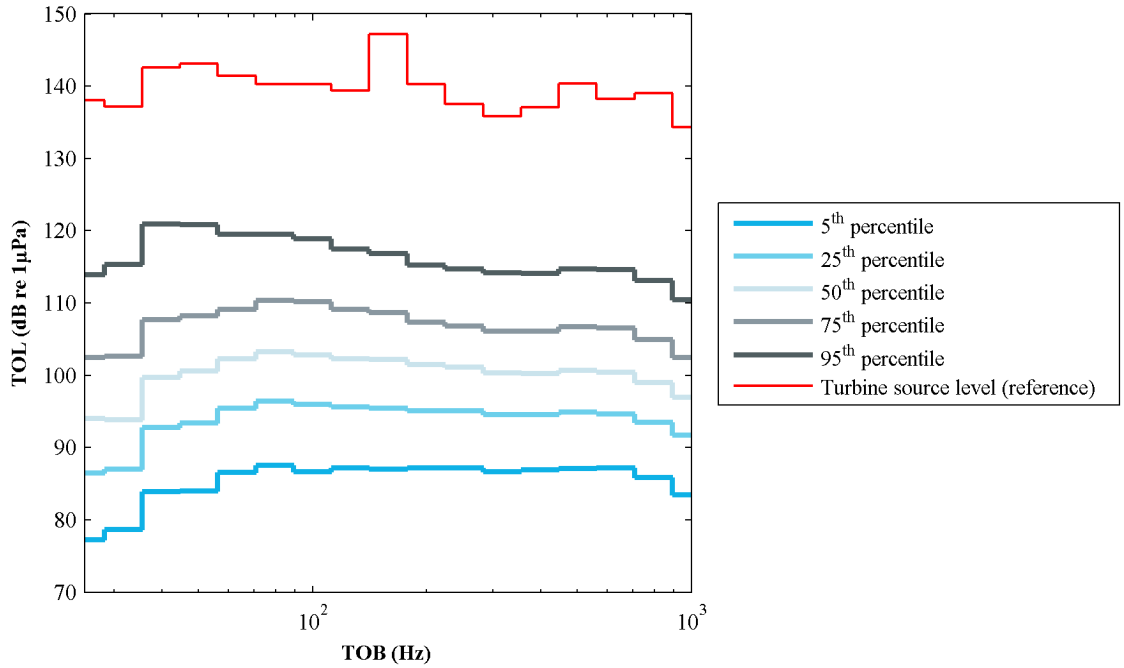

Figure 6. Percentile One-third octave levels (TOLs) for ambient noise (25 Hz – 1 kHz) (Source: Polagye et al., submitted).

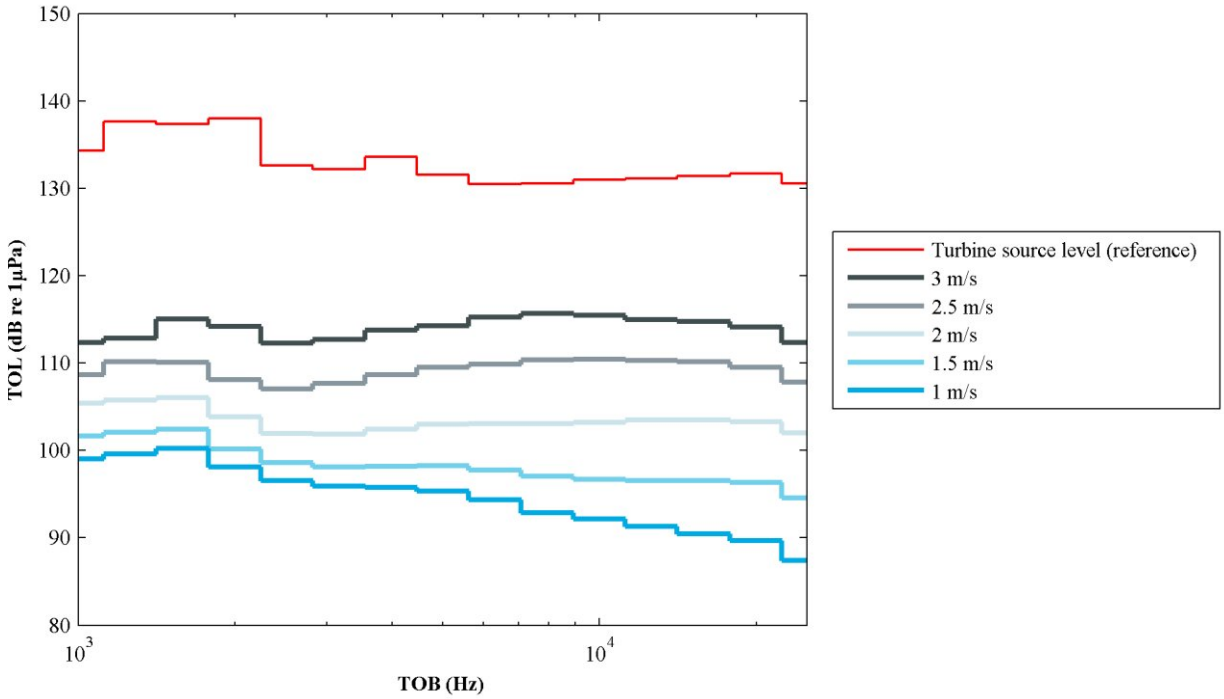

Figure 7. Median One-third octave levels (TOLs) for ambient noise (1 kHz – 25 kHz) as a function of current velocity (Source: Polagye et al., submitted).

Marine Invertebrates and Benthic Habitat

From 1987 to 2008 Washington DFW conducted 50 trawls in Admiralty Inlet in depth range of 31 to 60 m (102 to 198 feet), depths within which the turbines would be deployed. The primary crustaceans collected were dock shrimp, Alaskan pink shrimp, giant barnacle, Dungeness crab, and red rock crab (Snohomish PUD, 2012). The primary echinoderms collected were green sea urchin, sunflower star, red sea cucumber, and red sea urchin. The most abundant mollusks collected were pink scallop, California market squid, and northern horse mussel. Other invertebrates collected included gigantic anemone and warty sea squirt.

The primary invertebrate species harvested commercially in Admiralty Inlet are geoduck clams, Dungeness crabs, and green sea urchins. Total shellfish and fish harvest has decreased substantially in Admiralty Inlet over the last four decades, though the catch of commercially targeted crab and shrimp species has increased since the 1980s. Clam harvest has also increased in near-shore marine areas.

To characterize the site-specific benthic habitat and community, the District conducted ROV surveys in August, late September, and early October 2010 (Greene, 2011). The benthic community in the turbine site, especially the boulder and cobble

substrate, was dominated with encrusting organisms such as sponges, bryozoans, and tubeworms. The finer grain substrate, pebbles, and gravel are relatively easily moved by the tidal currents, and are therefore not encrusted with organisms. In addition a variety of attached organisms (anemones) were observed. The anemones varied in size from 4 to 12 cm (1.6 to 4.7 in) in diameter when closed and three basic types were distinguished by color and pattern. A total of 1,375 anemones were counted. Sessile organisms observed included chitons, limpids, tunicates, clams, and stemmed and basket sponges. Epifauna observed included shrimp, hermit crab, crab, sea stars, urchins, and turban snails. The most dominant epifauna species observed were urchin and common five-legged orange starfish, which composed 90 percent of the species observed (Greene, 2010).

An ROV video survey of the revised trunk cable route was conducted in July 2012, with a particular focus on surveying for eelgrass beds, kelp forests, and geoduck clams. Conditions were found to be similar to those observed in the October 2010 survey (Greene, 2012). No geoduck clams, eelgrass beds, or kelp forests were observed (McCallister, 2012).

Marine Fish

There are a total of eight salmonid species that reside within Puget Sound: Chinook salmon, chum salmon, coho salmon, pink salmon, sockeye salmon, steelhead, cutthroat trout, and bull trout. Bull trout, Puget Sound Chinook salmon, steelhead and chum salmon are ESA-listed species that are federally protected (DON, 2006). Species listed under the ESA are addressed in the section 3.3.3, *Threatened and Endangered Species*. Effects on fish in general are addressed in section 3.3.2.2 below.

For all species of anadromous salmonids originating from the Skagit River, Stillaguamish River, Snohomish River, Lake Washington Basin, Duwamish/Green River, Puyallup River, Nisqually River Deschutes River, Skokomish River, Hamma Hamma River, Dosewallops River, Duckabush River, and Quilcene River, both out-migrating juveniles and returning adults pass through Admiralty Inlet. These rivers collectively produce in excess of a million adult fish, of hatchery and wild origin, each year (Snohomish PUD, 2012).

Ground fish are important species for both commercial and recreational harvest in the Pacific Northwest, and are managed by the Pacific Fisheries Management Council (PFMC). It is estimated that 75 of the 82 ground fish species managed by PFMC occupy the Puget Sound area at least once during their life cycle (DON, 2006; Palsson et al., 1998).

The diverse species incorporated within the general grouping of ‘ground fish’ exhibit a wide range of life histories and habitat use. Rockfish are the most diverse group in terms of habitat use and can be found in nearshore areas as well as deeper shelf waters. Most adult rockfish are dependent of rocky substrate, but young rockfish use a range of

habitats (Washington DFW, 2011c). Open-water forage fish are an important base component of marine food chains and serve as prey for numerous predatory species. Pelagic fish are found throughout the water column and feed on small invertebrate species. Most pelagic fish are found in the warmer waters of California, but several important species are found within Puget Sound including northern anchovy, Pacific sardine, and Pacific mackerel. The abundance of each species can fluctuate greatly, varying considerably from year to year.

Comprising sharks, skates, and rays, or elasmobranchs, fish with a cartilaginous rather than bony skeleton. Puget Sound provides habitat for a number of such species including ten sharks, one ray, and five skates.

In terms of density of fish (number fish/hectare) sampled during Washington DFW surveys at the two locations nearest the project site, the most numerous fish sampled were spotted ratfish, ribbed sculpin, buffalo sculpin, grunt sculpin, kelp greenling, and lingcod. No salmon were captured in trawls at either of these locations (Snohomish PUD, 2012).

In the 50 trawls conducted in Admiralty Inlet by Washington DFW from 1987 to 2008 in a depth range within which the turbines would be deployed, the most numerous species collected was spotted ratfish (65 percent of the catch). The next most abundant species were Pacific sanddab (5 percent), English sole (4 percent), southern rock sole (4 percent), great sculpin (3 percent), buffalo sculpin, Pacific tomcod, spiny dogfish, and Puget Sound rockfish (all 2 percent). All species of rockfish caught (Puget Sound, copper, greenstripe, quillback, redstripe, and unidentified rockfish) composed 5 percent of the total catch (Snohomish PUD, 2012).

The State of Washington and the Corps have established work windows for 17 Tidal Reference Areas in the State of Washington's coastal waters to avoid or minimize impacts from marine construction.[16] The project is proposed in Tidal Area 10, Port Townsend, which includes waters of the San Juan Islands, Admiralty Inlet, the Strait of Juan de Fuca, and associated bays and inlets. The Tidal Reference Area 10 work windows are: salmon (start of work period begins July 16 and ends by March 1); bull trout (July 16 to February 15); Pacific hearing (May 1 to January 14); and Pacific sand lance (March 2 to October 14). When all of the species-associated work windows are combined, the start of the construction period begins July 16 and ends October 14.

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[16] See the Washington Administrative Code at Title 220, Chapters 110-230 through 110-330 (http://apps.leg.wa.gov/wac/default.aspx?cite=220-110-230) and Corps guidance (http://www.nws.usace.army.mil/Portals/27/docs/regulatory/ESA%20forms%20and%20templates/Marine%20Fish%20Work%20Windows%20(8-14-12).pdf).

Washington DFW's regulations on in-water construction for surf smelt are defined at a project-specific basis. Surf smelt, as mentioned elsewhere in this document, is an important forage species in Puget Sound. It is also a commercially and recreationally harvested species. Washington DNR has identified a surf smelt breeding area at Admiralty Head. Surf smelt in the Whidbey Island area may spawn through much of the year; therefore, there is no set in-water construction window similar to the species noted above. Their spawning habitat is limited to the intertidal zone (Washington DFW, undated).

Essential Fish Habitat

The Magnuson-Stevens Act, as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-297, 110 Stat. 3559), established procedures designed to identify, conserve, and enhance EFH for those species regulated under a federal fisheries management plan. Pursuant to the Magnuson-Stevens Act:

- Federal agencies must consult with NMFS on all actions, or proposed actions, authorized, funded, or undertaken by the agency, that may adversely affect EFH.

- NMFS must provide conservation recommendations for any federal or state action that would adversely affect EFH.

- Federal agencies must provide a detailed response in writing to NMFS within 30 days after receiving EFH conservation recommendations. The response must include a description of measures proposed by the agency for avoiding, mitigating, or offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with NMFS' EFH conservation recommendations, the federal agency must explain its reasons for not following the recommendations.

EFH means those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. For the purpose of interpreting this definition of EFH, waters include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; substrate includes sediment, hard bottom, structures underlying the waters, and associated biological communities; necessary means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers a species' full life cycle (50 CFR § 600.10 (2010)). Adverse effect means any impact that reduces the quality and/or quantity of EFH, and may include direct (e.g., contamination or physical disruption), indirect (e.g., loss of prey or reduction in species fecundity), site-specific, or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 C.F.R. § 600.810(a)).

EFH consultation with NMFS is required for any federal agency action that may adversely affect EFH, including actions that occur outside EFH, such as certain upstream and upslope activities. The objectives of EFH consultation are to determine whether the proposed action would adversely affect designated EFH and to recommend conservation measures to avoid, minimize, or otherwise offset any potential adverse effects to EFH.

Admiralty Inlet is EFH for Pacific groundfish, Pacific coast salmon, and coastal pelagics. There are 89 groundfish, 3 salmon and 5 coastal pelagic species specifically identified in the Fishery Management Plans (FMP) on the Pacific coast, though not all these species are found in the project area.

EFH Habitat Areas of Particular Concern (HAPCs) are discrete subsets of EFH. HAPCs, as provided in the EFH regulations, are types or areas of habitat within EFH that are identified based on one or more of the following considerations: the importance of the ecological function provided by the habitat; the extent to which the habitat is sensitive to human-induced environmental degradation; whether, and to what extent, development activities are or will be stressing the habitat type; or the rarity of the habitat type. A HAPC designation does not confer additional protection or restriction upon an area, but helps prioritize conservation efforts, and should be considered in an analysis of an area's sensitivity.

HAPCs include both geographic areas and habitat types. In some cases, HAPCs identified by means of specific habitat type may overlap with the designation of a specific area. HAPCs based on habitat type may vary in location and extent over time and include estuaries, canopy kelp, seagrass, rocky reefs, and areas of interest. Areas of interest are discrete areas that are of special interest due to their unique geological and ecological characteristics.

The project area is within HAPC for federally managed Pacific groundfish. The following is an overview of EFH for the three EFH groupings.

Pacific Groundfish

The Pacific Coast Groundfish Fishery Management Plan provides for management of more than 80 species that typically live on or near the bottom of the ocean (PFMC, 2008). Information on the life histories and habitats of these species varies in completeness, so while some species are well-studied, there is relatively little information on certain other species. Therefore, the Fishery Management Plan does not include descriptions identifying EFH for each life stage of the managed species, but rather, includes a description of the overall area identified as groundfish EFH. PFMC (2008) defines EFH for Pacific groundfish as:

- Depths less than or equal to 3,500 meters to mean higher high water (MHHW)[17] or the upriver extent of saltwater intrusion, defined as upstream and landward to where ocean-derived salts measure less than 0.5 parts per trillion (ppt) during the period of average annual low flow;

- Seamounts in depths greater than 3,500 meters as mapped in the EFH assessment GIS (PFMC, 2008); and

- Areas designated as HAPCs not identified by the above criteria.

This EFH identification is a precautionary approach because uncertainty still exists about the relative value of different habitats to individual groundfish species/life stages, and thus the actual extent of groundfish EFH (PFMC, 2008).

As mentioned above, the project area is within HAPC for Pacific groundfish. Specifically, estuaries, kelp beds, seagrasses, rocky reefs, and areas of interest are the HAPCs designated under the Magnuson-Stevens Act within the project boundary; these are defined below (Snohomish PUD, 2012).

- Estuaries - The inland extent of the estuary HAPC is defined as MHHW line, or the upriver extent of saltwater intrusion, defined as upstream and landward to where ocean-derived salts measure less than 0.5 ppt during the period of average annual low flow. The seaward extent is an imaginary line closing the mouth of a river, bay, or sound and extending to the seaward limit of wetland emergents, shrubs, or trees occurring beyond the lines closing rivers, bays, or sounds. This HAPC also includes those estuary-influenced offshore areas of continuously diluted seawater (Cowardin et al., 1979).

- Canopy Kelp - The canopy kelp HAPC includes waters, substrate, and other biogenic habitat associated with canopy-forming kelp species (e.g., Macrocystis spp. and Nereocystis spp.).

- Seagrass - The seagrass HAPC includes those waters, substrate, and other biogenic features associated with eelgrass species (Zostera spp.), widgeon grass (Ruppia maritima), or surfgrass (Phyllospadix spp.).

- Rocky Reefs - The rocky reefs HAPC includes those waters, substrates and other biogenic features associated with hard substrate (bedrock, boulders,

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[17] The mean higher high water line (MHHW) is at the average level of the higher of the two daily tides.

cobble, gravel, etc.) to MHHW. ROV sampling of the turbine installation site show extensive rocky reef habitat.

- Areas of Interest - All waters and sea bottom in Washington state waters from the three nautical mile boundary of the territorial sea shoreward to MHHW.

Of these five HAPCs, the placement and operation of the project would only affect Rocky Reefs and Areas of Interest.

Pacific Coast Salmon

The Pacific Coast Salmon FMP guides management of commercial and recreational salmon fisheries off the coasts of Washington, Oregon, and California. The Pacific salmon fishery includes Puget Sound Chinook, coho, and Puget Sound pink salmon.

The PFMC has designated both freshwater and marine EFH for these salmon species. In marine areas, designated EFH for Pacific salmon extends from nearshore and tidal submerged environments within state territorial waters out to the full extent of the economic exclusion zone (EEZ),[18] (370.4 km) (230.2 mi) offshore of Washington, Oregon, and California north of Point Conception (PFMC, 2000). The Pacific salmon EFH also includes marine areas off Alaska designated as EFH by the North Pacific Fishery Management Council. Puget Sound is designated EFH for Chinook, coho, and pink salmon.

Marine EFH supports three life stages of Pacific salmon including (1) estuarine rearing, (2) ocean rearing, and (3) juvenile and adult migration. Features of estuarine and marine habitats that are essential to these life stages include the following: (1) adequate water quality, (2) adequate temperature, (3) adequate prey species and forage base (food), and (4) adequate depth, cover, marine vegetation, and algae in estuarine and near-shore habitats (PFMC, 2000).

Coastal Pelagic Species

Coastal pelagic species are schooling fish that are associated with the open ocean and coastal areas and migrate in coastal waters. The Coastal Pelagics Species Fishery Management Plan consists of five species of which the following three had EFH

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[18] The economic exclusion zone, or EEZ, is a zone of the ocean in which, under international law, a coastal nation has, "sovereign rights for the purpose of exploring, exploiting, conserving, and managing living and nonliving resources," (U.S. Commission on Ocean Policy, 2004). The EEZ usually extends to 200 m (322km) from the coast.

identified in the Project area by NMFS (Snohomish PUD, 2012): Pacific sardine, northern anchovy, and Pacific mackerel (PFMC, 1998).

PFMC (1998) defines the east-west boundary of EFH for coastal pelagics as all marine waters out to the EEZ with water temperatures between 10ºC (50ºF) to 26ºC (79ºF). The southern boundary is the United States-Mexico maritime boundary. The northern boundary is defined as the position of the 10ºC (50ºF) isotherm, which varies seasonally and annually. Admiralty Inlet includes the five coastal pelagic species and is considered EFH when temperatures are between 10ºC and 26ºC (50 to 79ºF) (PFMC, 1998).

Marine Mammals

Marine mammals listed under the Endangered Species Act (ESA) are addressed in section 3.3.3, *Threatened and Endangered Species*. Non-ESA listed marine mammal species that are observed in central Puget Sound include harbor porpoise, Dall's porpoise, Minke whale, gray whale, California sea lion, harbor seal, and northern elephant seal.[19] Based on 12 years of surveys (1992 -2004) conducted by Washington DFW, harbor seals are the most commonly sighted (687 sightings) marine mammal within 0.4 km (0.25 miles) of Admiralty Inlet, followed by harbor porpoise (67 sightings), Dall's porpoise (16 sightings), river otter (12 sightings), killer whale (10 sightings), and California sea lion (8 sightings) (Washington DFW, 2006).

Harbor seal - Harbor seal is the most common, widely distributed pinniped found in Washington waters and represented 86 percent of the marine mammals observed by Washington DFW between 1992 and 2004. Harbor seals use hundreds of sites along the coast to rest or haulout including intertidal sand bars and mudflats in estuaries; intertidal rocks and reefs; sandy, cobble, and rocky beaches; islands; logbooms; docks; and floats in all marine areas of the state. Jeffries et al. (2000) identified 13 harbor seal haulout locations in the project area, the closest being located on Marrowstone Island, about 6 kilometers southwest of the project. In the Marrowstone Island vicinity, harbor seals have been sighted on haulouts on scattered intertidal rocks along the northeast and southeast side of the island. In the same vicinity, harbor seals have been noted along the beach and spit at the entrance into Kilisut Harbor. Northwest of the project area, harbor seals utilize haulouts on Protection Island. These include on the beach and spit areas around Kanem Point and Violet Point. Both of these areas are also considered nursery areas for harbor seals and have peak counts during the pupping season (mid-June through August) and annual molt (late July through September).

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[19] Northern fur seals typically occur offshore in Washington, though they occasionally visit the Juan de Fuca Strait, Puget Sound, and the Strait of Georgia, with one or two records per year (Calambokidis and Baird 1994).

Between October 2009 and April 2010, marine mammal pre-installation field studies were conducted to collect information to characterize the existing marine mammal use within the project vicinity. The field studies included land-based and boat-based observations of marine mammals in the study area (a five nautical mile radius around the proposed project deployment site). Overall, 2,145 sighting locations were recorded of seven species. Harbor seals were observed most often, occurring on 95 percent of days and 49 percent of all sightings, with a total of 1,041 sightings recorded on 110 separate days. Median group size of harbor seal observations was one and the maximum group size was four. Sightings of harbor seals sometimes included observations of surface feeding behavior events (Tollit et al., 2010).

Harbor seals are generally non-migratory, and often move based on factors such as tides, weather, season, food availability, and reproduction. According to aerial surveys conducted during 1999 and radio-tagging studies from 1991-1992, the Washington inland water stock of harbor seals is estimated to be at a population of 14,612 (Jeffries et al., 2003). The population of the Washington inland water stock of harbor seals was estimated to be growing at an annual rate of 10 percent with a maximum net productivity rate of 12 percent; the harbor seal population is within its optimum sustainable population level (Carretta et al., 2006).

California sea lion - The California sea lion is found in Washington waters and utilizes haulout sites along the outer coast, Strait of Juan de Fuca, and in Puget Sound. In Admiralty Inlet, only eight California sea lions were observed during Washington DFW marine mammal surveys conducted between 1992 and 2004 (Washington DFW, 2006). During the marine mammal pre-installation field studies conducted between October 2009 and April 2010, 19 California sea lions were observed on 15 separate days. Medium group size observed was one and maximum group size was four (Tollit et al., 2010).

Similar to harbor seals, haulout sites are located on jetties, offshore rocks and islands, logbooms, marina docks, and navigation buoys. Four California sea lion haulout locations have been identified in Admiralty Inlet—all navigation buoys in the southern half of Admiralty Inlet (Jeffries et al., 2000). California sea lions are frequently sighted resting in the water in groups within Puget Sound (Carretta et al., 2007). The California sea lion is a social species and can form groups of several hundred individuals onshore at haulout locations. They typically use shallow coastal and estuarine waters (NOAA, 2009*b*). The California sea lion population has been estimated at 238,000, which includes the range from southern Mexico to southwestern Canada (Carretta et al., 2007). Recent peak numbers of 3,000 to 5,000 California sea lions have been noted within northwest waters (Washington and British Columbia) during the fall until late spring when most return to breeding rookeries in California and Mexico. Peak counts of over 1,000 California sea lions have been recorded in Puget Sound in recent years (Jeffries et al., 2000).

Northern elephant seals - Northern elephant seals are the largest pinniped found in Washington waters. Breeding occurs at rookeries in California and Mexico. After the winter breeding season and annual molt cycles, they disperse to waters off Oregon and Washington and beyond. Males travel to the Gulf of Alaska to feed and females feed in deep offshore waters from southern California to northern Oregon (between 35° and 45° N) (Jeffries et al., 2000). Northern elephant seals spend much of the year in the ocean diving to depths of about 1,000 to 2,500 feet. However, while on land, northern elephant seals prefer haulouts on sandy beaches (NOAA, 2009*c*). Two northern elephant seal haulouts, Protection Island and Minor Islands, have been identified in the project area, where individuals have been seen hauled out at beaches. Pups have also been occasionally observed at these sites. Recent northern elephant seal counts have been recorded in excess of 100,000 animals in northwest waters (Jeffries et al., 2000).

Harbor porpoise - Harbor porpoise are found in coastal and inland waters extending from the Alaskan coast down to Point Conception, California. The species occurs year-round in the inland trans-boundary waters of Washington and British Columbia and along the Oregon and Washington coast. Harbor porpoises are relatively common and can be observed in the region year-round (Calambokidis and Baird, 1994). Densities of 1-1.5 animals/km^2 are reported in the region, with selection of habitat with high current speeds noted and abundances higher in the summer months (Hall, 2004). While seasonal changes in abundance along the west coast have been noted, movement patterns are not fully understood. From aerial surveys of inland waters of Washington conducted during August 2002 and 2003, the harbor porpoise population was estimated to be 10,682. In Admiralty Inlet, 67 harbor porpoise were observed during Washington DFW marine mammals surveys conducted between 1992 and 2004 (Washington DFW, 2006).

As part of Snohomish PUD's pre-installation studies, a multi-year study was conducted in the northeastern area of Admiralty Inlet to investigate the acoustic activity of porpoises logged by T-PODs - passive acoustic monitoring hydrophones used to collect high frequency cetacean echolocations. The study information was evaluated to characterize site use and investigate typical patterns of porpoises.

Between May 2009 and May 2010, four POD deployments were conducted using a T-POD. During the study, the PODs were attached vertically to a Sea Spider, which was then lowered to the sea floor. Data were logged over a period of 321 full days from a single T-POD moored at four locations in 51-62 meters water depth. The T-POD only detected porpoises; there were no detections on the 50 kHz scan channel set to detect dolphin echolocations (Tollit et al., 2010).

Porpoises were detected by the T-POD every day of the 321 day study period, with detections logging 16 individual hours of each day and averaging 130 detection positive minutes (DPM) per day, which represents on average nine percent of a day.

More than one third of all hours had no detectable porpoise click trains (e.g., DPM per hour = 0) and in 11.2 percent of hours recorded, DPM per hour exceeded 15. The median value was two minutes per hour; DPM per hour between night and day periods were found to be highly significant, with DPM median values during the night period five-fold than that of during the day period. Highs in DPM occurred around midnight, while lows occurred around midday. Further evaluation of the study indicates that echolocation use by porpoises in Admiralty Inlet is highest at night, especially during neap tides. Neap tides in Admiralty Inlet may also provide improved foraging conditions due to increased availability of prey aggregations or water clarity and/or potentially reduced energetic demands during foraging trips. The study also indicated monthly variation in click detections with clear lows (DPM) in April and August and a clear peak in June (Tollit et al., 2010).

Land-based studies that took place between October 2009 and April 2010, found that porpoises were present on average 63 percent of the 116 days, and 56 percent of every hour, monitored (n=231 hours) (Tollit et al., 2010). This appears to be consistent with data collected from the POD that had DPM in 51 percent of all daylight hours recorded.

The number of porpoise 'encounters' per day ranged from 30 to 48. Encounters (and DPM rates) may represent either multiple individuals or the same individual repeatedly. Typical group sizes in daylight periods were between two and six in land-based observer studies in the area (Tollit et al., 2010). This study also clearly documented that between October 2009 and April 2010, all porpoise sightings in the vicinity of the project site that were confidently confirmed to species were harbor porpoises (Tollit et al., 2010).

Since November, 2009, Sea Spider deployments have also included C-PODs.[20] These are the successor to the T-POD and, whereas a T-POD uses analog electronics, the C-POD records clicks digitally for post-processing to classify click trains (sonar, sediment motion, and echolocation). Because of their relatively recent development, C-PODs are not discussed to a great extent in the literature, but have provided further information about harbor porpoise trends at this site and the potential to use these tools for post-installation monitoring. Generalized Linear Model (GLM) analysis of long-term C-POD data identifies, among other factors, time of day, ambient noise level, tidal current velocity, and season as significant in explaining echolocation activity. However,

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[20] A C-POD is an instrument that detects and records certain high-frequency sounds in a marine environment. In combination with software and data analysis, a C-POD can be used to detect echolocation clicks of porpoises and other marine mammals, providing temporal data on animal presence.

the residual deviance in the model (detections unexplained by the model) is still quite high suggesting that activity is somewhat stochastic or driven by other factors not measured by Sea Spider instrumentation (e.g., prey density) (Cavagnaro et al., 2012; Collar et al, 2012).

Notably, both C-POD and T-POD data indicate harbor porpoise activity at this location is significantly higher than at other locations where tidal energy devices have been deployed, suggesting that harbor porpoise may serve as an effective marker species for understanding the effects that turbine operation may have on marine mammals. This conclusion is tempered by a study by Collar et al. (2012) that monitored harbor porpoise responsiveness to passenger ferries using C-PODs and concluded that no significant changes in harbor porpoise echolocation activity could be correlated with elevated noise levels from ferry passage, despite an expected pronounced avoidance response when broadband sound pressure levels exceed 140 dB re 1µPa (e.g., Southall et al., 2007). Turbine noise will only rarely reach the same intensity as ferry noise (further discussion later in this section). Results suggest that harbor porpoise in Admiralty Inlet may be habituated to relatively high levels of anthropogenic noise due to omnipresent shipping traffic (Bassett et al., 2012).

Dall's porpoise - Dall's porpoise are common in shelf, slope, and offshore waters along California, Oregon, and Washington. The species prefers temperate waters that are more than 600 feet deep with temperatures between 36˚F and 63˚F (NOAA, 2009*d*). North-south movement along the coast is based on changes in oceanographic conditions and seasonality. Dall's porpoise often travel in groups averaging between 2 and 20 individuals, but have also been seen in larger groups. The distribution of Dall's porpoise throughout the California, Oregon, and Washington region varies yearly due to oceanographic conditions. The most recent population estimate of Dall's porpoise for the west coast region is 48,376. An estimate of population for the inland waters of Washington State is not available (Carretta et al., 2008*a*). In Admiralty Inlet, 16 Dall's porpoise were observed during Washington DFW marine mammals surveys conducted between 1992 and 2004 (Washington DFW, 2006). During the marine mammal pre-installation studies conducted between October 2009 and April 2010, a probable Dall's porpoise was detected only once during the T-POD study (Tollit et al., 2010). C-POD auto-detection algorithms are, as yet, unable to discriminate between echolocation by Dall's porpoise and harbor porpoise.

Minke whale - The minke whale stock within the inland waters of Washington establishes home ranges and does not migrate like other stocks (Carretta et al., 2008*b*). Minke whales prefer temperate waters within coastal/inshore and oceanic/offshore areas and often feed in cooler waters (NOAA, 2009*e*). There is no estimated population size for minke whales and there are no data or trends related to minke whale abundance in inland Washington waters (Carretta et al., 2008*b*). No minke whales were observed in Admiralty Inlet during Washington DFW marine mammals surveys conducted between

1992 and 2004 (Washington DFW, 2006). However, two minke whale observations were documented in Admiralty Inlet from recreational land-based surveys conducted by the public during 2005 and 2006: one in March 2005 and one in September 2006 (OrcaNetwork, 2007). During the marine mammal pre-installation studies conducted between October 2009 and April 2010, four minke whales were sighted on two separate days. During each observation of minke whale, only one (lone whale) was observed (Tollit et al., 2010).

Gray whale - Gray whales make one of the longest migrations of any mammal between their winter breeding grounds off Baja California, Mexico and their feeding grounds in the Bering and Chukchi Seas and are found mainly in shallow coastal waters. Migration of gray whales along the Pacific Northwest coast occurs in December and January (southbound) and in the spring (northbound). Gray whales have also been identified outside of the migratory time periods along California, Oregon, Washington, and British Columbia and are referred to as "seasonal residents" or the Pacific Coast Feeding Aggregation whales by NMFS. Gray whales are frequently observed traveling alone or in small groups; however, in feeding and breeding grounds are often found in larger groups. Gray whales are occasionally observed in Puget Sound. In 1998, Calambokidis et al. (2002) sighted 35 individual gray whales in an area east of Cape Flattery, and extending to Admiralty Inlet; 15 of which were unique sightings. The research shows that gray whales using Puget Sound are the same few individuals returning to the same locations and usually in the springtime. Gray whales were also observed in Admiralty Inlet 11 times during the public recreational land-based surveys conducted during 2005 and 2006 (OrcaNetwork 2007):

Marine Birds

Shorebird and seabird observational data from Washington DFW vessel surveys are available from 1992 through 2004. Snohomish PUD processed these data in GIS to evaluate birds sighted within 0.4 kilometers (0.25 miles) of Admiralty Inlet (table 2). Sightings in Admiralty Inlet included 55,590 sightings, representing 57 species. Washington DFW also maintains records for seabird colonies in the vicinity of Admiralty Inlet and has identified 11 colonies of the either alcids, cormorants, and "other" species near the project.

Table 2. Shore bird, seabird, and other avian sightings within 0.4 km (0.25 miles) of Admiralty Inlet from Washington DFW vessel surveys (1992 to 2004).

Species	Number	Species	Number
American wigeon	2,698	Heermann's gull	3,853
Ancient murrelet	152	Herring gull	386
Bald eagle	83	Hooded merganser	183
Barrows goldeneye	67	Horned grebe	408
Belted kingfisher	38	Killdeer	2

Species	Number	Species	Number
Black brant	1,635	Mallard	889
Black oystercatcher	8	Marbled murrelet	250
Black scoter	258	Mew gull	432
Black turnstone	8	Northern pintail	444
Black-bellied plover	20	Northwestern crow	930
Bonapartes gull	1,879	Oldsquaw	398
Brandts cormorant	10	Osprey	3
Bufflehead	9,455	Pacific loon	502
California gull	99	Pelagic cormorant	98
Canada goose	35	Pigeon guillemot	1,897
Canvasback	25	Red-breasted merganser	815
Caspian tern	74	Red-necked grebe	318
Common goldeneye	662	Red-tailed hawk	4
Common loon	240	Red-throated loon	143
Common merganser	124	Rhinoceros auklet	5,177
Common murre	6,062	Rock dove	1
Double-crested cormorant	789	Ruddy duck	166
Dunlin	200	Sanderling	5
Gadwall	77	Surf scoter	2,748
Glaucous-winged gull	4,713	Tufted puffin	1
Great blue heron	419	Western grebe	3,129
Greater scaup	121	Whimbrel	1
Green-winged teal	141	White-winged scoter	1,198
Harlequin duck	1,117		
Species Total			57
Observational Total			55,590

Of note, rhinoceros auklets (*Cerorhinca monocerata*) nest at only two sites in the inland marine waters of Washington: about 34,000 birds nest on Protection Island (Wilson, 1977; Thompson et al., 1985), and about 2,600 birds nest on Smith Island (Speich and Wahl, 1989), located approximately 18 km and 22 km north of the Project area, respectively. The colony of rhinoceros auklets on Protection Island is considered the third largest colony in North America (Pers. comm., C. Collar, Snohomish PUD, with Sue Thomas, USFWS, August 27, 2009). From studies performed in the late 1970s it was found that Admiralty Inlet was a major foraging area for the auklets, with foraging occurring mostly in the western part of the Inlet near Port Townsend (Wahl and Speich, 1994).

3.3.2.2 Environmental Effects

Construction and operation of the project has the potential to affect water quality locally; alter localized marine benthic habitats due to changes in hydrodynamics in the immediate vicinity of the device; result in the injury or direct mortality of marine and anadromous fish, marine birds, and marine mammals due to contact with the turbines or marine debris entanglement; disrupt or impair essential behavior patterns or migrations in fish or marine mammals due to electromagnetic fields (EMF) and increased noise; and alter marine community composition (use patterns, attraction, aversion) due to the presence of project components and creation of "new" habitat features. As discussed below, such potential adverse effects of a pilot project are expected to be minor and short-term. Snohomish PUD proposes to implement a suite of mitigation and monitoring plans, developed in consultation with various stakeholders, to address the uncertainty associated with the installation and operation of this new technology and to mitigate for these effects. We discuss each of these effects below.

Water Quality Effects

Potential effects on water quality result from: turbidity/sediment generation during HDD operations and land-disturbing activities associated with project installation and removal; discharges of drilling mud (frac-out) during HDD operations; spills of oil during construction, operation, and maintenance; fluid leakage from project components; and leachate from antifouling paint.

To minimize and control these sources of water quality effects, Snohomish PUD proposes to implement a HDD plan and a Water Quality Monitoring Plan. The HDD Plan describes the procedures and methods for conducting HDD to minimize turbidity and occurrences of a frac-out. The Water Quality Monitoring Plan describes the measures Snohomish PUD would follow to control oil spills, minimize leachate from antifouling paint, and monitor turbidity/sediment, pH, and oil and sheen production during construction, maintenance, and project removal activities.

Specifically, during HDD operation, Snohomish PUD would cease HDD work if a frac-out or other release of grout material occurs and would not resume HDD work unless and until turbidity levels are less than or equal to 5 NTU over background turbidity when such levels are 50 NTU or less, or when there is more than a 10 percent increase over background turbidity when background turbidity is more than 50 NTU. If these benchmarks are exceeded, the Water Quality Monitoring Plan defines the steps that Snohomish PUD would take to further control turbidity including ensuring that all best management practices are in place and functioning properly, determining if additional measures are needed (such as off-site treatment, infiltration, filtration and chemical treatment within 24 hours if turbidity levels exceed 250 NTU), and conducting daily turbidity monitoring. Snohomish PUD would also monitor pH levels following a frac-

out. Snohomish PUD would also visually monitor for oil and sheen during vessel operations. No water quality monitoring is proposed during maintenance operations, except for visual monitoring for oil and sheen from marine vessels because sediment disturbance would not be great and localized. A monitoring report would be submitted to Washington Ecology.

To minimize fuel spills during the construction and maintenance of the project, all vessels would include secondary containment in the form of either a bounded area with a volume of 110 percent of the tank volume or the use of double-wall tanks. Snohomish PUD would include a secondary containment unit with a 1033-liter capacity on the OpenHydro deployment barge[21] and ensure that all marine construction and maintenance contractors maintain a spill response plan.

To minimize adverse effects of using anti-fouling paint, two coats of anti-fouling paint would be applied to the blades, outer venturis, inner venturis, coils, magnets, and mounting point for the AMP. The components requiring antifouling paint represent a small part of the turbine assembly. The gravity-based foundation, the turbine frame, and the steel portions of the duct would not require antifouling paint.

Washington DFW and FWS recommend that Snohomish PUD implement its proposed HDD and Water Quality Monitoring Plan.

Staff Analysis

Installation of the trunk cables would disturb the seabed, resulting in localized increases in turbidity due to the suspension of sediments and formation of sediment plumes.[22] However, such effects would be minor because the seabed at the deployment site of the two turbines consists primarily of granular sediments, cobbles, and boulders. Moreover, the adverse effect would be unavoidable, but short-term, as underwater currents and wave turbulence would quickly dissipate the sediment plumes.

While there is some potential for the release of soil or bentonite to the marine environment from horizontal directional drilling, the resulting turbidity would be minor

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[21] The OpenHydro deployment barge contains a 300-liter diesel tank and a 350-liter hydraulic oil tank.

[22]The seabed within the project area consists primarily of cobble. See section V.C.1 for more information on geological resources within the proposed project area.

and the materials raise little concern.[23] The District has a detailed plan for drilling in a manner that avoids substantial releases to the water. Monitoring of the drilling process, as proposed by Snohomish PUD, would aid in the detection of any seepage of the fluid and identification and implementation of any corrective measures (*e.g.*, rerouting the drill route or stopping drilling to allow the fracture to seal). Snohomish PUD's HDD plan and Water Quality Monitoring Plan include steps drill operators would take to avoid leaking drilling fluid into the surrounding bed stratum and water column. The small amount of material that would escape would be quickly diluted in the tidal flows of Puget Sound.

Because the project turbines do not contain oil or other synthetic coolants and lubricants eliminates any concern with that the devices might leak toxic chemicals. The potential would still exist for the construction and drilling equipment and associated vessels to leak or spill petroleum or other chemicals into the surrounding waters. Snohomish PUD's plans to require secondary containment, to visually monitor for oil sheen, and ensure contractor implementation of spill response plans would provide adequate spill protection. Such measures would be adequate to minimize adverse effects of an oil spill.

Antifouling paints can be applied to vessels, buoys, and piers or other in-water structures in the marine environment to prevent or reduce marine growth and associated adverse effects. Antifouling paints work by very slowly leaching toxic compounds into the water column, thereby creating a toxic layer around the working surface of a structure or vessel (MMS, 2007). Snohomish PUD would only paint those operational surfaces required to ensure efficient operation. A minimal amount of antifouling paint, approved for use in marine waters, would be used. No anti-fouling paint would be applied to turbine foundations. The paint will cover 95 m² of each turbine. Given the small amount of paint, any leacheate would quickly dissipate in the surrounding waters and represents a minor adverse effect.

Electromagnetic Field (EMF) Effects

Concern about the potential effects of anthropogenic electromagnetic fields (EMF) on marine organism is widespread but knowledge of such effects is very limited (Polagye, 2011; DOE, 2009). A variety of fish and other organisms have been found to be sensitive to EMF fields in general, and it is known that some fish use them for navigation or feeding. In some circumstances this sensitivity to EMF could affect fish movement and feeding.

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[23] Bentonite is a naturally-occurring, non-toxic, inert clay frequently used for the drilling of potable wells; therefore, if released, we do not expect long-term (persistent) adverse effects on water quality in the area.

Snohomish PUD does not propose to monitor EMF. In discussing its section 10(j) recommendations, NMFS states that EMF is not a concern in the context of this pilot-scale project proposal.

Staff Analysis

Electrical devices and cables generate EMF in the form of an electrical field (E field) and magnetic field (B field). The E field can, and usually is, shielded (U.S. DOE, 2009). The B field, in combination with moving water, can generate a third field called an induced field (iE field). The District reports that the OpenHydro turbine and generators have been designed to shield the E field and neutralize the B field, so that there is no magnetic field release from the turbine itself. With no B field, there would be no iE field. While OpenHydro, the turbine manufacture, has been able to neutralize the B field by using certain parts of the turbine generator to balance other parts, it is impossible to eliminate a B field from a transmission cable.

The proposed 5 cm-diameter, trunk cables would carry 4 kV of 3 phase, 22 amp alternating current (AC), which would produce the three types of fields. The transmission line would be shielded so that there would be no E field. However, the Snohomish PUD modeled the B field and estimated that while the intensity of the field at the surface of the cable would be 200 Amps per meter (A/m), it would drop to 40 A/m, equal to the intensity of the Earth's magnetic field at the latitude of the project, at a distance of 3.3 cm (1.3 inches) from the cable surface. Snohomish PUD describes the B field as very small in space and intensity. A small B field would result in a small iE field as well.

Sensitivity to EMF Effects

According to a literature review by the U.S. Department of Energy (2009) and the District's application, several species that could be present in the project area, or are related or similar to fish that could be present in Puget Sound, are known to be sensitive

to electric fields at low levels of intensity.[24] Several species are sensitive to low intensity B fields.[25] Sensitivity to EMF does not necessarily translate into vulnerability to harm from EMF. Some experiments have shown no effect of EMF at all.[26]

To experience a B field greater than the earth's magnetic field, a fish would have to be swimming within 8 cm of the cable which would be 5 cm in diameter and lying on the bottom of the inlet. Even in that case, it is not clear that there would be any effects.

Most of the migratory species, including salmon, typically swim higher in the water column than 8 to 18 cm (3.1 to 7.0 in) from the bottom. Even green sturgeon, which generally feed on the bottom, often travel higher in the water column. With the fish generally traveling much farther than 3.3 cm (1.3 in) above the transmission line it would not function to interfere with migration. For organisms using the area for food and general habitat, the trunk cable and associate B and iE fields would occupy a very small portion of the inlet, potentially excluding fish from an inconsequential amount of habitat. The land portion of the trunk cable would be deeply buried, keeping the zone of EMF out of easy contact with marine or terrestrial organisms.

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[24] Among the fish that might be affected by low intensity iE fields, sharks, skates, and rays have tissues used to sense electric fields to assist in finding prey. Two species of Asian sturgeon have been shown to react to electric fields. Atlantic salmon, eels, and cod have been shown to respond to iE fields. Skates showed physiological responses to electric fields, dogfish attacked electrodes, and sharks attacked iE fields. Dogfish avoided constant electric fields associated with 150 kV cables with 600 A current, but were attracted to an electric field of about $1/100^{th}$ of that intensity, which is similar to much of their prey. Sturgeon, including green sturgeon, are known to use electrical fields to find their prey and to respond to changes in electric fields. (Summarized from DOE, 2009.)

[25] Many marine species demonstrate sensitivity to B fields, including using magnetic fields for navigation. Some do so via sensitivity to iE fields and some via their own magnetic deposits. Four of the five species of Pacific salmon have magnetite crystals within them that are believed to serve this purpose. (Sea turtles and cetaceans use magnetic deposits as well.) Sharks and rays may use the iE field they induce while moving through the Earth's magnetic field to navigate. (Summarized from DOE, 2009.)

[26] Flounder and invertebrates exposed to potentially harmful magnetic fields for several weeks did not differ in survival from controls. Another set of invertebrates showed almost no difference in distribution between stronger and weaker areas of a magnetic field. Oxygen consumption of prawn subjected to different levels and types of magnetic fields did not vary. (Summarized from DOE, 2009.)

The scale of the project proposal is small and the timeframe relatively short at 10 years. The likelihood of negative effects on fish and invertebrates is small. The likelihood of negative effect is even smaller for marine mammals given relative the scale of the physical effect (centimeters) relative to the scale of the marine mammals (meters) and the scale of their routine movements (kilometers). Though there is not a specific EMF monitoring plan, other plans indirectly could detect some unexpected effects and any significant threat could be quickly addressed. No party had expressed significant and specific concerns regarding EMF and this proposal. Overall, EMF is not likely to have negative effects on fish or other organisms at the pilot-scale of this project proposal.

Benthic Habitat Effects

The turbine and foundation structure (turbine structure) would provide a hard surface, which would be colonized by benthic invertebrates as were several of the Snohomish PUD's baseline sampling devices.[27] The colonization of hard surfaces is the norm in marine environments. Each turbine structure could generate a reef effect, which could have broader effects on the community ecology near the turbines (Polagye et al., 2011).

Colonization also could affect machine performance and acoustic characteristics of the turbines. To preserve the operational functions of the device, the turbine blades, hub, and interior shroud would be painted with antifouling paint. The rest of the device would have no coating on the surfaces of steel and concrete. The unpainted portions would be colonized. Antifouling paint is discussed in the section on water quality effects.

Snohomish PUD has proposed a Benthic Habitat Monitoring and Mitigation Plan to describe the benthic habitat created by the installation and presence of the project. Snohomish PUD would monitor and characterize the colonization of the turbine structures, the area immediately around the contact points with the seabed, the trunk cable, and the drill exit point from horizontal directional drilling for the shore landing.

Using ROVs, Snohomish PUD would take video images of four specific portions of the turbine structures. The ROV filming would be carried out four times in year one and two times in each following year. A benthic ecologist would review the video,

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[27] See images at Benthic Habitat Monitoring and Mitigation Plan, page 9, figure 6, filed with the Commission on November 16, 2012, which show significant fouling by barnacles and red algae on a "sea spider" instrumentation package after deployment in the project area from May to August 2011. Tubeworms and chitin were also observed on similar devices upon deployment recovery (Benthic Habitat Monitoring and Mitigation Plan, page 8).

estimate the percentage represented by each taxa group and make qualitative estimates of rates of expansion or retreat of the colonized area, and records of any fish or marine mammals captured on video. The drilling exit point and two or three points along the trunk cable would be filmed. That video would be interpreted in a manner similar to the turbine structure footage and in comparison to adjacent areas. For three areas around the contact points of the turbine structure and the sea floor, video would be interpreted to attempt to quantify any scouring trends. Comparisons would also be made against ROV video of the turbine deployment area taken in August, September, and October of 2010 and along the cable route, including the drilling exit point, and the turbine deployment area, taken in July of 2012.

NMFS, FWS, and Washington DFW recommend that the District implement its proposed Benthic Habitat and Water Quality Monitoring Plan. Washington DFW noted the importance of eelgrass and kelp habitat to juvenile salmon and other organisms. Washington DFW also highlighted the economic importance of the geoduck clam harvest. Washington DNR wishes to discuss further baseline assessment of benthic conditions at the deployment site.

The Suquamish Tribe raises concern about effects of the project on the commercially and culturally important Dungeness crabs and shrimp. The Swinomish Tribe raises concerns that the project would reduce the productivity of shellfish rearing habitat or lead to direct mortality of shellfish. Both tribes reportedly harvest shellfish in the proposed project area.

Staff Analysis

Colonization

The turbine structures would be colonized quickly by benthic invertebrates, at least where they are not coated in antifouling paint. It was apparent in the growth on Snohomish PUD's water monitoring devices and has been observed and studied at several artificial reefs (Snohomish PUD, 2012; Bohnsack and Sutherland, 1985). At the outset, the cover and flow refuge provided by the turbine structure would probably attract fish, with or without the presence of benthic colonizers (Buckley and Hueckel, 1985). While the benthic colonizers would both influence and be influenced by the development of a larger community on the turbine structure, an abundance of benthic organisms as food sources would not necessarily be a prerequisite for a reef effect. A number of studies have demonstrated that fish who occupy reefs depend on the surrounding area for their food base (Bohnsack and Sutherland, 1985).

This colonization process should be detectable by comparison of ROV video imagery of the target areas over time. Baseline images of benthic habitat in the project area already exist. Similarly changes in the benthic community along the trunk cable and at the drilling exit should be detectable if present. Comparison with focal areas nearby,

but at least 20 m (66 feet) from the target sites would help to account for seasonal and inter-annual variation. ROV video of the area surrounding three connection points between the turbine structures and the seabed, would allow detection of scour.

If scouring is considered significant, the issue would be referred to consultation to determine if the focal points required adjustment (Adaptive Management trigger 2). If the drilling point exit is colonized by different fauna than was originally present, the issue would be referred to consultation as to whether to modify or increase monitoring or seek mitigation (Trigger 3). If erosion is observed around the turbine structure contact points, stability analysis of the entire structure would be carried out and the issue would be referred to consultation regarding the need for project modifications (Trigger 4).

The above consultation efforts would provide a means to monitor and control scour and changes to the benthic community. However, the Adaptive Management triggers would be improved by including specific criteria that defines scour significance (i.e., specific depth and width measurements). Defining the criteria prior to installation would foster more timely consultation and implementation of mitigation measures, and further ensure that adverse environmental effects associated with scour and erosion are confined to areas near the turbines as anticipated.

The issue of reef effects would be informed by the Near-Turbine Monitoring and Mitigation Plan and Marine Mammal Monitoring and Mitigation Plan as well as the Benthic Habitat Monitoring and Mitigation Plan.

Special or Commercial Benthic Resources

The seven invertebrates that were harvested from Admiralty Inlet in annual weights greater than 1,000 pounds were geoduck clams, manila clams, pacific pink scallops, Dungeness crab, sea cucumbers, and green and red sea urchins. In Washington DFW trawls at the depth of the turbines, Geoduck and manila clams were not found near the proposed turbine site. (Geoduck clams along the transmission corridor are discussed above.) Dungeness crabs, green sea urchins, and pink scallops were collected near the proposed turbine site and sea cucumbers and red sea urchins were collected at the depth of the turbine, but farther from the proposed turbine site.

Benthic invertebrates that support commercially and culturally valuable shellfish fisheries are present near and at the depth of the proposed turbine site. At the same time, these species appear to be widespread in Admiralty Inlet at low to moderate densities. As with fish, the project has the potential to affect small numbers of the benthic organisms, particularly the mobile ones. However, given the small footprint of the turbine structures and transmission corridor relative to Admiralty Inlet and the densities of these organisms, such effects would not convey to the fishery scale. There is no apparent mechanism through which productivity would be reduced. Using the measures in the Benthic Habitat Monitoring and Mitigation Plan and the Near Turbine Monitoring and Mitigation Plan,

the District would likely detect a surprising concentration of commercially valuable invertebrates near the turbine structures and the issue of monitoring adjustments of mitigation measures in response could be addressed through consultation and adaptive management.

Summary

Effects on the benthic community could have an indirect effect on other aspects of the project, such as reef effects and project operations and maintenance, but the benthic community is unlikely to be harmed. The Benthic Habitat Monitoring and Mitigation Plan would both help to detect and, if necessary, manage any negative effects on the benthic community. The plan, combined with other plans, would help in interpreting and managing for indirect effects of the project acting through the benthic factors.

Behavioral Changes and Injury from Interaction with the Turbines

Two potential categories of effects of tidal turbines on mobile marine organisms, including fish, marine mammals, and diving birds, are indirect effects occurring through behavior change and direct injury from the spinning blades. Behavior change could result from attraction to or avoidance of the turbines and lead to issues such as disruption of foraging, disruption of migration, or changes in predation (Polagye et al, 2011). Ultimately, behavior change could lead to stress effects including effects to reproduction, growth, or internal chemistry (Polagye et al, 2011). Direct impacts like blade strike could lead to injury or death. Such effects could be limited to individual organisms or could convey up to the population scale. Other potential effects, including acoustic energy effects and electromagnetic fields, have been discussed previously. Finally, potential direct or indirect effects could arise from performing installation activities at the project site or along the transmission corridor during biologically important times

Snohomish PUD proposes a Near-Turbine Monitoring and Mitigation Plan (near-turbine plan) to observe and minimize the effects of interactions of mobile marine organisms with the turbines. Near-turbine is defined as about 3 to 7 meters and is based on the characteristics of the available technology as well as the study goals. Snohomish PUD proposes to achieve three study objectives in the first year of project operations. The first year seasonal study sequence would consist of the following.

1) A presence or absence study to evaluate conditions, including current velocity and direction time of day, and season for which species presence or absence is likely. Another objective of this study would be to determine the effectiveness of the camera system to identify species under different environmental conditions.

2) An artificial lighting study to develop guidelines for strobe frequency, duration, and interval that would allow for observation of interactions with the turbine rotor

(aggregation, strike, passage) without altering marine animal behavior. This study would use an acoustic camera with a field of view similar to the optical camera.

3) A turbine interaction study to evaluate the frequency and type of near-turbine interactions between marine animals and the turbine rotor.

After the first year, assuming that the MARC concludes that direct interaction between marine animals is not sufficiently understood, two additional study objectives would be pursued in sequence:

4) An artificial reef effect study to characterize marine mammal use of the turbine structure.

5) A fish avoidance study to determine if fish are avoiding the turbines at a relatively close range.

Snohomish PUD proposes to use a stereo-optical camera, which would capture still images out to a distance from about 3 to 7 m. The stereo-optical camera would be assisted by a strobe light and would support 3-dimensional imagery. They would be complemented by an acoustic camera, which would take footage before and after the optical camera still shots. For maintenance purposes, and to allow reconfiguration of the camera systems, much of the monitoring system would be recoverable. Active sonar would likely be added for a later study phase as determined through the proposed adaptive management and consultation process. Snohomish PUD bases this design on an evaluation of previous efforts to monitor environmental effects of tidal energy elsewhere in the United State and the world.[28]

Snohomish PUD proposes to conduct each of the three first-year, near-turbine plan studies four times over the year, once in each season. In each season, Snohomish PUD would carry out each of the three studies in consecutive order as listed in their proposal. Snohomish PUD would establish design and timing of the remaining two studies of the near-turbine plan based on the findings of the first three studies and consultation with the MARC.

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[28] Examples reviewed include Verdant Power's Roosevelt Island Tidal Energy Project No. 12611 in the East River, New York; Ocean Renewable Energy Company's Cobscook Bay Tidal Energy Project No. 12711 in Eastport, Maine; Marine Current Turbine's Deployment in Strangford Lough, Northern Ireland, United Kingdom; and OpenHydro's deployments at the European Marine Energy Centre (EMEC) at the Orkney Islands, Scotland, United Kingdom and at the Fundy Ocean Research Centre for Energy (FORCE) at Minas Pass, Nova Scotia, Canada.

Snohomish PUD includes elements of adaptive management in the near-turbine plan proposal. Adaptive management triggers in the proposal include: (1) shutting the project down if harm to an ESA-listed species is suggested by monitoring; (2) consultation with the MARC if monitoring shows aquatic species passing through the turbine rotor; (3) consultation with the MARC if monitoring shows diving marine mammals in the field of view; (4) consultation with the MARC if monitoring shows diving sea birds in the field of view; (5) a contextually appropriate response to a monitoring system outage, including temporary shut-down if needed.

To avoid potential effects of installing the turbines and cables during biologically important times, Snohomish PUD (2012) has proposed to construct the project within the work windows identified by the State of Washington and the U.S. Army Corps of Engineers.

NMFS, FWS, and Washington DFW recommend Snohomish PUD implement the Near-turbine Monitoring and Mitigation Plan pursuant to section 10(j) of the FPA. They explain that the plan and its adaptive management elements address the agencies concerns about the effect of this project at its pilot scale. Washington DNR notes that surf smelt spawning habitat has been identified at Admiralty Head and seeks assurance that construction methods will avoid affecting surf smelt spawning.

The Tulalip, Sauk-Suittle, and Swinomish Tribes each raise concerns about the effects of the proposed project on fish and fish stocks. The Tulalip Tribe also raises the concerns about the accuracy of the near-turbine plan and the lack of a reference site. The Sauk-Suittle and Swinomish Tribes note that Admiralty Inlet is a migratory pathway for all five species of Pacific salmon and that the project may affect migration negatively and cause mortality of juvenile and adult salmon. The Sauk-Suittle and Swinomish Tribes also describe Admiralty Inlet as a rearing ground and identified direct mortality of young as a concern.

Staff Analysis

Likelihood of Exposure to Turbines

Washington DFW collected over 51 species of fish, representing a large range of life history patterns, in trawl surveys in the depth zone of 31 m (102 feet) to 60 m (198 feet). That depth zone includes the depth of the proposed turbines, which would be about 55 m (180 feet). Densities of fish trawled at that depth ranged from lows of less than 1.0 fish per hectare (2.5 fish per acre) for 27 species up to an outlier of 406 fish per hectare (1,015 fish per acre) for the spotted ratfish. The remaining 24 species collected ranged in density from 1.0 to 30 fish per hectare (2.5 to 45 fish per acre) (Snohomish PUD 2012). Given that these numbers are additive, the total density of fish in this depth zone is about 625 fish per hectare (1,563 fish per acre). At such densities, some fish would be likely to be in the vicinity of the turbines simply by chance. Adding to the background densities

the fact that many fish are attracted to structures, either artificial or natural, fish are likely to be in the vicinity of the turbines.

Diving birds could reach the depth of the turbines.[29] Though diving birds are capable swimmers, they are temporary visitors to the marine depths, particularly relative to the fish. There is a smaller likelihood of bird presence near the turbines than there is a likelihood of fish in the turbine area. If diving birds are attracted strongly to the devices, their presence should be detectable to surface observers as well as the near-turbine monitoring systems.

Likelihood of Direct Impact of Turbines on Fish

Though fish would be near the turbines, it is likely that most fish would avoid them once they detect them. Unlike the case in a conventional hydropower setting, any fish approaching the turbines would have the option of swimming around them. Fish living at the depth of the turbines, which is below the photic zone, are adapted to that environment. Even if they cannot see the turbines from a distance, they are likely to sense them. Snohomish PUD (2012) found in its hydraulic modeling that there would be a pressure wave from the turbines that would be detectable by fish as much as 10 m (32.8 feet) upstream. Detecting the pressure wave, fish could then avoid the device.

Such avoidance behavior was demonstrated by Alden Research Laboratories, Inc. through tests using rainbow trout of about 15 cm and 25 cm (5.9 and 9.8 in). They released the fish 7.5 m (25 feet) upstream of the device (EPRI, 2011). In four trials, about 90 percent of the 400 fish tested entirely avoided Lucent Energy Technology's horizontal axis, spherical turbine. Similarly, in tests at the U.S. Geological Survey's Conte Anadromous Fish Research Laboratory, Atlantic salmon smolts appeared to avoid a straight-bladed, cross-flow turbine (EPRI, 2011).

An OpenHydro turbine, similar to the ones proposed for Admiralty Inlet, was tested at the European Marine Energy Center facility off of the coast of Scotland. In 31 days of day photographing the device in the Springs of 2009 and 2010, pollock fed just downstream of the turbine when the current velocity was low and the blades were not turning. When velocities increased and the device was turning, the fish were not present.

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[29] Washington DFW (2012) provided references to diving birds reaching depths that could expose them to the turbines, including the common loon diving to 60 to 70 m (197 to 230 ft), the common murre diving to 180 m (591 ft), the pigeon guillemont diving to 50 m (164 ft), the rhinoceros auklet diving to 57 m (187 ft), and the tufted puffin diving to 100 to 110 m (328 to 361 ft). The theoretical maximum depth for the marbled murrelets is 47 m (154 ft).

In that case the fish vacated the area of the turbine when the tide generated higher velocity conditions and the turbine was spinning.

Finally, in addition to the having the option to swim around the turbine, in the case of the OpenHydro turbines, there is a 2.2 m (7.2 foot) hole through the center of the turbine through which fish might pass. Moderately low pressures in the hole, may actually encourage fish to go through the hole.

For those fish that do pass through the turbine's sweep, the hydrokinetic[30] characteristics of the OpenHydro turbine avoid much of the risk to fish associated with conventional hydropower turbines. These differences expose the fish to substantially milder pressure changes and shear forces, somewhat lower direct blade strike velocities under most conditions, and lower likelihood grinding when passing through the hydrokinetic OpenHydro turbine than when passing through a conventional hydropower turbine.

Rapid pressure changes in conventional hydropower operations can harm fish. The pressure change associated with the OpenHydro turbine is minimal compared to a conventional turbine. The maximum predicted pressure change associated with the OpenHydro turbine in a 2.5 m/s (8.2 ft/s) current is predicted to be 4.5 kiloPascals (kPa; 0.65 pounds per square inch, PSI) and would occur only in small areas on the blade margins (Snohomish PUD, 2012). A fish passing through a conventional hydropower plant and could experience an increase in pressure of 200 kPa (29 PSI) from the intake to the turbine followed by a reduction in pressure of about 300 kPa (44 PSI), all in two or three minutes (EPRI, 2011a). Minimum values for a threshold for pressure-induced harm to fish are on the order of 30 to 100 kPa (4.4 to 13.5 PSI) (Snohomish PUD, 2002; EPRI,

[30] Hydrokinetic turbines generate power from the kinetic energy in the velocity of flowing water without use of potential energy in the form of the head from a dam. The OpenHydro turbine is one of several examples of hydrokinetic turbines.

2011a). The estimated pressure around the proposed turbines is well below the threshold of concern for fish that pass through the turbine. [31]

Shear forces on a fish, resulting from rapid change in velocity between different areas of water affecting the surface of a fish at the same, can be put enough stress on a fish to be harmful. Shear force effects can be a problem in conventional hydropower plants. Forces below 500/s are believed to be below the threshold of harm for fish (EPRI, 2011a). The maximum shear force around the proposed turbines has been estimated at less than 80/s at the very edge of the blade (Snohomish PUD, 2002). The estimated shear forces around the proposed turbines are well below the threshold of concern for fish that pass through the turbine.

Another risk factor in conventional hydropower is damage or death from being struck by a blade. The risk of strike is reduced, relative to a conventional hydropower turbine, by the fact that the OpenHydro blades are expected to spin at 5 to 19 revolutions per minute (rpm) routinely, and up to 29 rpm at its limits, as compared to 30-150 RPM for a turbine in a conventional hydropower project (Snohomish PUD, 2012). Blade velocities below 4.5 m/s (15 feet/s) are considered to result in minimal injury to most fish, even to particularly long species like sturgeon and eels (EPRI, 2011a). The proposed turbines would have a maximum blade velocity of 7.0 m/s (23 feet/s), but would more typically operate at up to 4.9 m/s (16 feet/s) (Snohomish PUD, 2012 as converted by staff). The project turbines would operate most of the time at a level of minimal risk to fish that pass through the blades. The most significant risk for fish passing through the blades would occur if large fish pass through the blades when the blades are spinning at an unusually high speed.

Closely related to strike is the risk of harm to fish from grinding of fish between parts of a turbine, which is another concern in many conventional hydropower turbines (EPRI, 2011a). The OpenHydro device has a shroud enclosing the blade tips to prevent

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[31] For context, atmospheric pressure at sea level is about 101 kPa (13.5 PSI). Rockfish are quite sensitive to pressure compared to many other fish, including salmon and trout. (Rockfish are members of a group of fish whose swim bladders adjust pressure through gas diffusion rather than direct gas exchange.) Because of this vulnerability when anglers pull rockfish from depths of greater than 20 m (65 feet) to the surface (at atmospheric pressure) about 1/3 of the fish die from the rapid reduction in pressure (Washington DFW, 2011c). Pulling a rockfish from a 20 m (65 foot) depth exposes the fish to a pressure reduction of about 200 kPa (29 PSI). This pressure change is more equivalent to that of a fish passing through conventional hydropower plant than to a fish passing through the OpenHydro hydrokinetic turbine during which the fish would experience at most a pressure change of about 4.5 kPa (0.65 PSI).

fish from entering the device from the side at the fastest moving point (Snohomish PUD, 2012). The shroud should also minimize grinding by enclosing the space between the blade and the rim.

Indications of early testing are that hydrokinetic turbines have higher survival rates than those of conventional hydropower projects, even when fish are forced through the turbines. An *in situ* entrainment test of a small, ducted, hydrokinetic turbine in the Mississippi River at Hastings, Minnesota was carried out using balloon-tagged fish. Researchers found that 99 percent of the passed fish survived. In a laboratory setting, Alden Research Labs, Inc., in another element of the flume study mentioned previously, released rainbow trout and smallmouth bass at a point about 28 cm (11 in) in front one horizontal cross-flow (spherical) and one horizontal axis turbine (EPRI, 2011). Survival rates were between 98 and 100 percent and were not significantly different from those of the fish exposed to the control treatment (EPRI, 2011).

The near-turbine monitoring plan would be implemented from the beginning of the operation of the project and would observe interactions with the turbines. The combination of optical and acoustic imagery would capture strike events should they occur frequently. This information would allow the adjustment of operations through the mechanisms established in the adaptive management plan, or, if necessary, shutdown and removal.

Likelihood of Indirect Effects on Behavior

The turbines structures would displace a small amount of natural benthic habitat. However, relative to the area of natural habitat available, the turbine footprints are inconsequential. The transmission line and horizontal drilling exit point are expected to return to a natural condition.

The turbine structures, with their high relief, will attract fish. Fish and invertebrates are known to colonize artificial reefs quickly, though the community structure may take years to develop into a pattern similar to that of nearby, longstanding reefs (Bohnsack and Sutherland, 1985). In many reefs, larger fish will be the first colonizers and use the structure as cover, while obtaining most of their food in the surrounding environment (Buckley and Hueckel, 1985; Bohnsack and Sutherland, 1985; West et al., 1994; Washington DFW, 2011c). In spite of evidence that fish do most of their feeding around the reef, there has been positive correlation observed between the presence of predators and the abundance of prey on artificial reefs (Bohnsack and Sutherland, 1985).

It is difficult to predict the exact outcome of the aggregation of fish. At the scale of two turbines which would occupy a small portion of the Admiralty Inlet cross section, the probability of having a substantial harmful effect is minimal. There is no evidence that the turbine would prevent migration through the inlet, even if an organism were to

avoid them locally. Rockfish are oriented to the bottom and to structure in general (Washington DFW, 2011a). Effects on rockfish are discussed below with the Rare, Threatened, and Endangered Species. Aggregation would bring fish closer to the turbine blades. Direct effects of the turbine blades are discussed immediately above.

Snohomish PUD's monitoring plan is designed to attempt to identify species of fish near the turbine. Under the Benthic Community Monitoring and Mitigation Plan, Snohomish PUD would be identifying benthic colonizers. With this information, a reef effect should be detectable and the species composition could be analyzed for potential negative interactions. Interactions of concern could be addressed in the adaptive management and consultation process.

Installation Effects

Installation of the devices and transmission cables would be one of the most active periods of the project and, as a result, creates one of the greatest opportunities to affect fish. By identifying the more important and active times for key species life histories, the State of Washington and the Corps have established a system for minimizing or eliminating effects associated marine construction activities like installation of the turbines. In this case, by deploying the turbines within the work window of July 16 to October 14, Snohomish PUD would reduce or eliminate effects on salmonid; bull trout, Pacific herring , and Pacific sand lance.

Installation of the turbines likely would have no effect on surf smelt spawning in the intertidal zone for several reasons. First, horizontal drilling would occur away from the intertidal zone. The entry point would be on land and the exit would be at a minimum depth of 18 meters, which would be well below and offshore of the intertidal zone. Second, construction activities would occur well to the east of the observed spawning site at Admiralty Head. Third, project installation activities would have a very small footprint relative available spawning habitats within Puget Sound and Admiralty Inlet as a whole. These facts combined with the application of other protections for sensitive fish in the plans such as the Benthic Monitoring and Mitigation Plan, Emergency Shutdown Plan, etc. would protect the surf smelt from significant adverse effects from construction of the project.

Salmon and Fish Stocks

Regarding the tribes' concerns, the concern about harm to fish in general is addressed by the characteristics of the turbines; the experiences at other relevant projects; the small footprint and relatively short term nature of the project; and the monitoring, adaptive management, and mitigation schemes discussed above. Given these observations and protections, the likelihood of harm to fish is small, likely to be detected if it occurs, and certain to be addressed if it is detected. With these measures in place, an effect at the scale of a fish stock is extremely unlikely.

The Tribes specifically identify concerns about the project killing juvenile and adult salmon or interfering with their migration. Concerns about salmon in general are covered in more detail in section 3.3.3.2, *Threatened and Endangered Species*. The general discussion about the low risk of effects on fish from this project, included in this section, applies to salmon. Scheduling project installation in the State of Washington's work window will help to protect salmon and other fish stocks as well.

Adequacy of the Near-Turbine Monitoring Plan

Overall the monitoring plan builds on the latest studies around the world in the environmental effects of hydrokinetic turbines. The District's imaging design builds on previous efforts, proposing to combine optical and acoustic imaging and sonar in a way that should allow taxonomic distinction and behavioral observation beyond what has been done in the past. The Near-turbine Monitoring and Mitigation Plan was developed in extensive consultation with the experts at the NNMREC and elsewhere. The plan, as well as the monitoring results, is subject to adaptive management. Monitoring plan design issues, such as the influence of the strobe lighting on the monitoring results, are to be evaluated explicitly and adjusted as part of the plan.

The Tulalip Tribe raises concern about the accuracy of the results of the monitoring plans in general. The only specific concern they raise, however, is a lack of reference sites. There are no paired reference sites for the near-turbine study. For the issue of blade strike, the concept of a reference site is not applicable in an observational study. For the issues of behavior and reef effects, development of a reference site would be difficult, if not impossible, because the effect of the monitoring equipment itself on the fish behavior would be impossible to eliminate. The baseline information that has been collected by Snohomish PUD would serve to reference the monitoring results for the near-turbine study. For effects of the operating turbine, conditions under which the water velocities are too slow to turn the turbine blades would serve for comparison.

The two turbines are unlikely to cause either direct injury to the fish, such as blade strike, or to cause harm indirectly through behavior change. If one of these factors appears to cause acute harm to fish, the monitoring program would be likely to detect it, triggering consultation on adaptive management measures to mitigate the harm or remove the threat. Major purposes of the near-turbine plan would be to estimate the frequency of fish (or marine mammal) interaction with the turbine structures, conditions associated with the occurrence of interactions, and the outcome of interactions.

Noise Effects (Acoustic Monitoring and Mitigation Plan and Marine Mammal Monitoring and Mitigation Plan)

Noise effects can be divided into short-term, temporary effects associated with installation, maintenance and removal of the turbines, and long-term (up to 10 years for

the requested license), intermittent, but persistent effects from noise generated by the operation of the turbines.

Project installation, maintenance, and removal would result in the temporary production of underwater noise associated primarily from the HDD drilling process, installation activities, and service vessel engines running during these operations. To minimize environmental effects during project construction, Snohomish PUD would conduct marine installation work during Washington DFW-approved work windows.[32] In addition, Snohomish PUD would, during installation and removal, follow NMFS guidelines for vessel operations around marine mammals. Specifically, if a listed cetacean occurs within 500 meters, or listed pinniped occurs within 100 meters of an installation or removal vessel, installation or removal operations would be halted until the cetacean or pinniped leaves the vicinity of project operations.[33]

During operation, broadband noise would be generated by the rotation of the turbine. Noise generated during turbine operation is a function of tidal velocity and corresponding energy production. Noise generated by the flow of water around the support structure or in the turbine wake is not expected to significantly contribute to ambient noise levels because the source is weak (Polagye et al., 2011).

Marine life are sensitive to sound pressure levels (SPL) (expressed in dB re 1 μPa), particle velocity (expressed in m/s), and the frequency of sound (expressed in Hz). The potential effects of variable noise frequencies and pressure levels on marine life include changes in hearing sensitivity and behavioral patterns (NAS, 2003). Of particular concern, are effects of man-made noises on marine mammals because, at certain levels, they can cause stress, interfere with communication and predator/prey detection, and change behavior patterns. Interactions of marine mammals and tidal turbines are an area of high uncertainty (Polagye et al., 2011). As explained further below, sound from project operation is not expected to rise to a level that constitutes injury to marine mammals, but would periodically rise to a level that could cause behavioral changes over small scales.

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[32] The project is located in the Tidal Reference Area 10 (Port Townsend). The species work windows for this reference area include: salmon, bull trout, Pacific herring, and Pacific sand lance. The work windows are from July 16 to March 1 for salmon, July 16 to February 15 for bull trout, May 1 to January 14 for Pacific herring, and March 2 to October 14 for Pacific sand lance.

[33] This proposal is included in the Marine Mammal Monitoring and Mitigation Plan.

To determine whether levels of underwater noise are occurring at levels that may harm marine resources and whether such noise or other factors are resulting in behavioral changes in area marine mammals, Snohomish PUD proposes to implement an Acoustic Monitoring and Mitigation Plan and a Marine Mammal Monitoring and Mitigation Plan.

To determine the levels of underwater noise generated by the turbines during operation, Snohomish PUD proposes to implement a post-deployment Acoustic Monitoring and Mitigation Plan that would involve conducting *in-situ* measurements of the acoustic emissions of the operating turbines to test two hypotheses: (1) that the sound from tidal turbines vary with power generation state, and (2) that the sound from the tidal turbines change over time due to biofouling or component wear. To test the first hypothesis, acoustic data would be collected using five surface drifters—specifically the SWIFT (Surface Wave Instrument Float with Tracking), which is a buoyant spar buoy, equipped with a radio frequency transmitter, GPS logger, and hydrophone. The frequency response of the hydrophone and data acquisition system is linear (±3 dB) from 20 Hz to 80 kHz. The Automatic Identification System (AIS) receiver deployed on Admiralty Head in cooperation with Washington State Parks would be used to monitor vessel traffic and confirm that noise from commercial vessels is not masking turbine sound. Doppler profilers mounted to the turbine foundation would monitor tidal currents throughout the acoustic survey and the turbine Supervisory Control and Data Acquisition (SCADA) would monitor power output. Acoustic surveys would be conducted for nominal inflow velocity conditions of 1.5, 2.0 and 2.5 m/s. Data would be collected to sample noise from each turbine operating independently and together. The total data set would consist of five measurements, from five buoys, during six surveys (three velocity states measured on the rising and falling tide).

The data collected would be used to quantify the trend in source level with power generation state. Source levels would be estimated for root mean square (rms) sound pressure levels corresponding to four functional hearing groups for marine mammals to determine if noise generated by the project are occurring at levels that may harm marine mammals. The low frequency limit for each group would correspond to: low-frequency cetaceans (7 Hz), mid-frequency cetaceans (150 Hz), high-frequency cetaceans (200 Hz), and pinnipeds (75 Hz). The high-frequency limit would be determined, in consultation with the MARC, based the maximum frequency of sound produced by operating turbines, as determined from the monitoring study. Results of the study would be reported to the MARC, orally within 60 days of survey completion and in a final written report with 120 days.

To test whether noise generated by the project might change over time from wear or bio-fouling and approach levels that may be harmful to marine mammals, acoustic data would be collected by a hydrophone with a flow shield that is integrated into the adaptable monitoring package (AMP) on each turbine. Vessel traffic, tidal currents, and power generation would be monitored as described above. On a quarterly basis, a time

series analysis would be completed to determine noise levels and calculate sound pressure levels for the four functional hearing groups. If the mean, broadband sound pressure level increases by more than 5 dB relative to the mean broadband sound pressure level during the first quarter of operation and there are no obvious contributions from local anthropogenic sources, the increase in noise would be attributed to a change in the acoustic properties of the turbines and the MARC would be consulted to determine next steps.

The Marine Mammal Monitoring and Mitigation Plan is designed to test whether marine mammals, partitioned by the above functional groups, respond to the sound from project operation or prey aggregations through attraction, avoidance, or change in behavioral state. Monitoring would be conducted during installation, operation, removal of the project. The proposed monitoring uses a combination of shore-based visual observations and acoustic-based observations, depending on the functional group, and compliments existing efforts and expertise already in place, as represented by the Orca Network, Bean Reach marine Science and Sustainability School, NMFS, and the Whale Museum. Detailed methods are provided in the plan. In summary, for pinnipeds, 2 to 3 experienced observers positioned on Admiralty Head would, using scanning techniques, document pinnipeds entering into the study area (500 to 1000 meter radius, centered on the turbine).[34] Observations would be during winter (October 1 to March 31) and during summer (April 1 to September 30). These data, coupled with the vessel traffic data obtained from the AIS system, generation state from the SCADA, project generated noise from the Acoustic Monitoring and Mitigation Plan, and the presence of prey from the Near-turbine Monitoring and Mitigation Plan) would be analyzed to determine if pinniped presence/absence is correlated with turbine noise. Data would be collected for one calendar year of operation.

Harbor porpoise were selected to represent mid-frequency cetaceans because of their high level of use in the area and sensitive to acoustic disturbance (although in this area they may be habituated to sound from shipping traffic). Shore-based observers would use focal group techniques and high-definition video to follow harbor porpoise through the study area. Using these data point-of-closest-approach and directionality of movement would be tested to determine if turbine sound is altering movements. A pair of C-POD click detectors integrated into the AMP on each turbine would collect echolocation activity. These data would be compared to pre-installation studies to determine if there were any detectable changes. The study period would be for one calendar year as for pinnipeds.

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[34] The final study area would be determined in consultation with the MARC and based on observation trials to determine practical limits of the shore-based observers.

Because of their iconic and listed status, killer whales (both the listed southern resident and non-listed transients) would be followed for the entire license period through the use of shore-based observers, localizing hydrophones, and near-turbine monitoring system. The localizing hydrophones would consist of a passive acoustic array of four hydrophones located on each turbine. The hydrophones would be able to resolve frequencies up to 200 kHz in order to detect killer whale vocalizations. Shore-based observers would be dispatched upon auto-detection of killer whale calls on the hydrophones on the turbine, the hydrophone at the Port Townsend Marine Science Center, or sightings reported through the Orca Network. Direction of transit, surfacing interval, behavior state, surface active behavior, click rate and call rate would be recorded and analyzed to determine changes in behavior.

The plan includes a schedule for reporting monitoring results to the MARC and the Commission. It also includes eight triggers for modifying the plan based on monitoring results or identified adverse effects on marine mammals.

NMFS, FWS, and Washington DFW recommend implementing the Acoustic Monitoring and Mitigation Plan. The Tulalip Tribes object to issuing a license, in part, because they believe the project would interfere with marine mammal migration and movement and the proposed monitoring plans are insufficient to protect marine mammals.

Staff Analysis

Underwater noise would be generated from at sea actions including installation, maintenance, and removal of the project. At sea installation activities are expected to require approximately 20 days.

Removal of the turbines would require raising the turbines and support frames. This may also be required for unscheduled large-scale maintenance. For turbine recovery, a non-propulsion turbine installation barge, ROV, supporting tugboats, and personnel transfer/safety boats would be required. Removal is expected to be completed within one tidal cycle for each turbine.

Boats and ROVs would be required periodically for environmental monitoring and maintenance inspections. It is expected that these environmental monitoring and maintenance activities could occur during parts of several days each month during the early stages of operation and are expected to decrease in frequency over the five year deployment period.

The primary noise produced during project installation, maintenance, and removal operations would be from boat engines (Minerals Management Service [MMS] 2007) and construction equipment on the non-propulsion barges, but would also include divers and ROVs. All sound sources would be continuous and would range between 125 and 175

dB (re 1 µPa @ 1 m).[35] Noise from the tugboats and the construction barge would dominate other noise sources during these operations. Maximum source levels during HDD, cable laying, turbine installation and removal, routine maintenance, and environmental monitoring would range from 165 dB to 178 dB, with the frequency content expected to range from 20 Hz to 10 kHz (Richardson et al., 1995).

During project operations, broadband noise would be generated by the rotation of the turbine. The two turbines will be deployed for up to 10 years. During that time, the turbines are expected to create operational noise only when they are rotating, which, on the basis of pre-installation velocity surveys, is expected to occur 70 percent of the time (water velocity must exceed 0.7 m/s before the turbines will rotate). This noise would be a continuous, broadband source.

The spatial extent of this noise depends on the propagation of underwater noise and intensity of the noise source (which will vary with turbine rotation rate), and the temporal extent is dependent on the water velocity. There are limited data on noise generated by operating turbines. OpenHydro conducted an underwater noise assessment, using drifting hydrophone recordings, for a six-meter turbine at EMEC. OpenHydro obtained broadband source levels for the turbine by integrating over all frequencies of interest (i.e., from 10 Hz to 5 kHz). This resulted in an estimated broadband source level of 154 dB (re 1µPa at 1 m).

Polagye et al. (submitted) reanalyzed these data to estimate received levels associated with operation of the turbines in Admiralty Inlet for a range of inflow velocities in the context of ambient noise. Figure 8 shows the expected distribution of broadband source levels (dB re 1µPa at 1m) for a 6 m diameter turbine and the frequency distribution of the source for different operating percentiles. The "reference" measurements from EMEC fall around the 75th percentile level for Admiralty Inlet (i.e., turbine noise would be no louder than this 75% of the time and louder 25% of the time). The maximum broadband source level is estimated to be 172 dB re 1µPa at 1 m, corresponding to an inflow velocity of 3.6 m/s. This source level is predicted to occur infrequently during turbine operation (i.e., < 0.01% of the time based on Doppler velocity measurements). Source levels are not predicted to exceed 180 dB re 1µPa under any operating condition.

[35] Sound intensities reported in this EA are rms (root mean square) values.

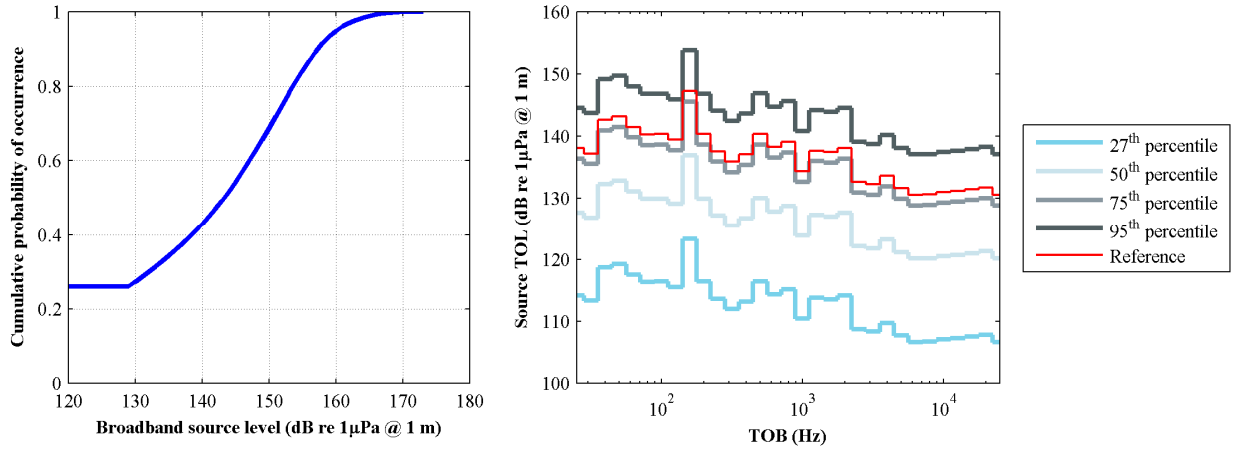

Figure 8. Probability distribution of turbine source levels (left). Broadband (25 Hz – 25 kHz) one-third octave source levels (right) for select operating percentiles (Source: Polagye et al., submitted).

Many marine fish and mammal species use sound in communication, navigation, predator/prey interactions, and hazard avoidance. Because these organisms have different biological receptors and sensitivities to sound, each would likely respond differently and at different sound intensity and frequency as explained further below for each group.

Marine Fish

Most species of fish can detect sounds between 75 and 150 dB (re 1µPa) and frequencies from below 50 Hz up to 500-1,500 Hz (Hastings, 2005; Popper and Hastings, 2009). Atlantic salmon, which share similar auditory systems with Pacific salmon, typically can detect sounds between 95 and 130 dB (re 1µPa), at frequencies between 30 and 400 Hz (Hastings and Popper, 2005). Consequently, noise from installation, maintenance, and removal activities, as well as operation of the turbines, are likely to be detectable by fish in the project area under some ambient noise conditions.

However, the studies reviewed by Hastings and Popper (2009) generally show that fish are not adversely affected by sound levels less than about 160 dB (re: 1 µPa), and at greater levels, fish exhibit avoidance responses, stress responses, temporary (TTS) and permanent (PTS) hearing loss, auditory and non-auditory tissue damage, egg damage, reduced growth rates, or mortality. An unpublished study (Jørgensen et al., 2005) reported that larval and juvenile (≤ 6 cm standard length) pollock, Atlantic cod, Atlantic herring, and spotted wolfish were exposed to between 4 and 100 pulses of 1 second duration of pure tones at 1.5, 4 and 6.5 kHz. Sound pressure levels at the location of the fish ranged from 150 to 189 dB (re 1 µPa), and "there were no effects on fish behavior during or after exposure to sound (other than some startle or panic movements for sounds

at 1.5 kHz) and there were no effects on behavior, growth (length and weight), or survival of fish kept as long as 34 days post-exposure."[36] Internal organs showed no damage resulting from the sound exposure (Jørgensen et al., 2005). Pacific Northwest National Laboratory conducted laboratory exposure studies of juvenile Chinook salmon in which the subjects were exposed to simulated turbine noise at 159 dB re 1µPa (broadband), continuously for 24 h (Halvorsen et al., 2011). Post-exposure necroscopies indicated that non-lethal, low levels of tissue damage may have occurred, but that noise exposure did not lead to PTS or TTS.

Based on estimated maximum sound levels of 178 dB (re 1 µPa @ 1 m) during installation, maintenance, and removal, fish may temporally avoid the immediate vicinity of at sea activities. Because the activities would be short-term (days or hours depending on the specific activity) and comparable to existing noise levels associated with the high vessel traffic of the shipping lanes, adverse effects are not expected to be significant. Adhering to Washington DFW work windows during installation would minimize potential disturbance of sensitive fish species when they are most vulnerable to disturbance.

As explained above, the maximum broadband source level for turbine operation is 172 dB (re: 1 µPa @ 1 m); thus fish are likely to detect turbine noise, and at such levels could, based on lab results, be subject to temporary hearing loss. However, these levels correspond to maximum generation, which occurs infrequently and for short periods (on the order of minutes, not hours); furthermore, noise generated from turbine operation will attenuate with distance (both horizontally and vertically). Modeling conducted by Polagye et al. (submitted) suggests that fish would detect the turbines and avoid the turbines before injury occurs.

Based on detection probabilities generated for Atlantic cod, a hearing generalist, Polagye et al. (submitted) predicted that for one-third octave bands with center frequencies exceeding 500 Hz, detection is unlikely under any combination of turbine noise and ambient noise due to increasing hearing thresholds. At lower frequencies, detection of turbine noise is only likely (i.e., probability exceeding 50%) within a few hundred meters of the project. This establishes an upper bound for the extent of potential behavioral disturbance (i.e., zone of responsiveness is equal to or, more likely, smaller than the zone of detection). The reasons for the relatively low detection probability is that, under most operating conditions, the turbine is relatively quiet and ambient noise at low frequencies (i.e., < 1 kHz) is dominated by shipping at this location (Bassett et al., 2012).

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[36] Exception was one test conducted on two groups of Atlantic herring at an SPL of 189 dB re 1 µPa, experienced post-exposure mortality of 20-30%.

For the above reasons, project operations are not expected to create noise at levels that will negatively affect fish, except perhaps in the immediate project area during peak tidal velocities, when avoidance may occur. Broadband source levels are estimated to exceed 160 dB less than 5% of the time and are estimated to decrease to less than 160 dB within 10 m of the turbine under all operating conditions. Therefore, these effects would be inconsequential given the scale of the project and available habitats surrounding the project. Additionally, exposure would be limited for those migratory species that may only be transiting through the project area (e.g., Pacific salmon). Marine Mammals

Sound induced effects on marine mammals are expected when the sound overlaps in frequency and level with the hearing capability of the species under consideration. There is considerable variation among marine mammals in both absolute hearing range and sensitivity. Marine mammals as a taxonomic group have functional hearing ranges of 10 Hz to 200 kHz; this includes ultrasonic, frequencies greater than 20 kHz, and infrasonic, frequencies less than 20 Hz. Odontocetes and pinnipeds are typically more sensitive to higher frequencies and mysticetes are more sensitive to lower frequencies (Richardson et al., 1995).

Noise exposure criteria for injury to marine mammals are given for two types of sounds, impulsive (transient) and non-impulsive (continuous). Impulsive sounds are generally characterized by rapid rise of sound pressure followed by a sound pressure fall. Examples of impulsive sound include explosions, gunshots, and pile driving strikes. No such activities would occur during project installation, operation, maintenance, or removal; therefore, project construction and operation will only generate non-impulsive sounds.

NMFS has established two levels of acoustic thresholds to evaluate potential effects to marine mammals, Level A and Level B Harassment. Level A Harassment has the potential to injure a marine mammal or marine mammal stock in the wild, while Level B Harassment has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering. For non-impulsive sounds, received sound pressure levels of 120 dB (re 1 μPa) is considered Level B harassment and has the potential for behavioral disturbance to cetaceans and pinnipeds.

NMFS uses a “do not exceed” exposure criterion of 180 dB (re 1 μPa) for mysticetes and (recently) all odontocetes exposed to sequences of impulsive sounds, and a 190 dB (re 1 μPa) criterion for pinnipeds exposed to such sounds (Southall et al., 2007). As described above, noise levels associated with project installation, maintenance, operation, and removal would be continuous and are not expected to exceed the 180 dB (re 1 μPa) threshold that could result in harm to marine mammals.

However, vessel use during project installation, maintenance, and removal activities may exceed the 120 dB (re 1 µPa) threshold. Because these effects would be temporary, and short-term and similar to existing sources of noise in the Admiralty Inlet, they are not expected to adversely affect marine mammal use, particularly considering the cross section of the two tidal turbines in comparison to the cross section of Admiralty Inlet at the deployment site is extremely small.

Turbine operation is also expected to exceed the 120 dB (re 1 µPa) threshold. Figure 9 shows the distance to the 120 dB re 1µPa isobel as a function of operating percentile for the turbines. Only beyond the 75th operating percentile does broadband noise from the turbines exceed the threshold for Level B harassment beyond 100 m.

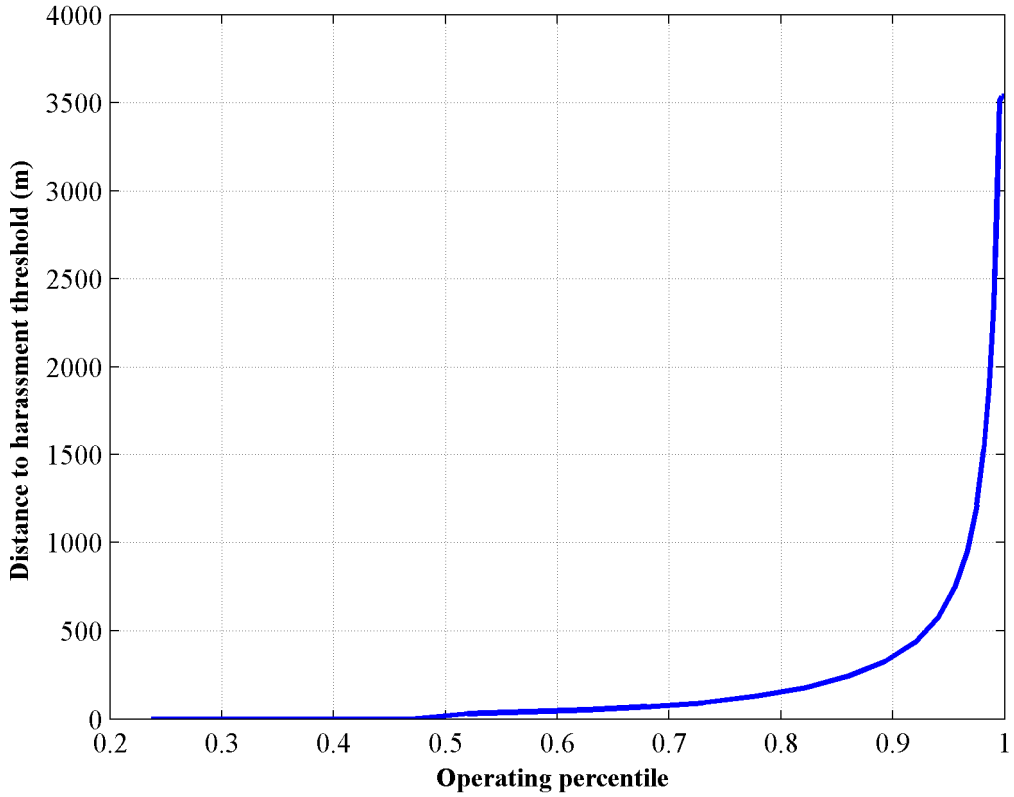

Figure 9. Distance from project center (mid-point between turbines) to Level B harassment threshold for broadband (25 Hz – 25 kHz) sound pressure levels (Source: application).

Polagye et al. (submitted) assessed the probability of detecting turbine noise relative to ambient noise (i.e., signal excess) for three classes of marine mammals: mid-frequency cetaceans (represented by killer whales), high-frequency cetaceans

(represented by harbor porpoises), and pinnipeds (represented by harbor seals). The probability of these classes of marine mammal detecting turbine noise was investigated for six one-third octave bands: 50 Hz, 160 Hz, 500 Hz, 2 kHz, 8 kHz, and 25 kHz. The first four bands correspond to "tonal clusters" in which turbine noise is at a relative maximum and, therefore, more likely to be detected against ambient noise. The final two bands are important for marine mammal communication.

In general, the probability of these marine mammals detecting turbine noise is less than 25 percent at ranges beyond a few hundred meters. This conclusion is based on a combination of sound attenuation (spreading and absorption), hearing thresholds, and the ambient noise baseline (turbine noise and shipping noise have similar spectral profiles). Mid-frequency cetaceans, high-frequency cetaceans, and pinnipeds are most likely to detect turbine noise at frequencies of a few hundred Hz. While detection of turbine noise at higher frequencies is possible, it is only likely very close to the project. Detection does not necessarily imply responsiveness, but does establish a likely upper bound for the possible zone of responsiveness. Snohomish PUD's Near-turbine Mitigation and Monitoring Plan (discussed earlier) and Marine Mammal Monitoring Plan (discussed later) would help determine marine mammal responses to the turbines.

Polagye et al. (2012*a*) did not evaluate noise detection by low-frequency cetaceans because no audiograms for this class of marine mammals exist (Southall et al., 2007). However, based on the results for fish hearing presented above, low-frequency cetaceans would be expected to detect turbine noise at greater range than other cetaceans or pinnipeds (e.g., high probability of detecting noise at distances out to 1 km from the project site).

Due to the device's passive mechanics and low rotational speeds, it is unlikely that radiated noise would induce physical harm, trauma, or dramatic behavioral response of marine fish and mammals. Nonetheless, direct and indirect interaction of hydrokinetic turbine technology and marine resources is not fully known. The Acoustic Monitoring and Mitigation Plan and Marine Mammal Monitoring and Mitigation Plan would effectively monitor noise levels emitted by project operation, provide a better understanding of any potential adverse effects to marine resources, and determine if noise levels that may harm marine resources have been exceeded. Furthermore, the Near-turbine Mitigation and Monitoring Plan and Marine Mammal Monitoring and Mitigation Plan would help determine marine mammal behavioral responses to the turbines. These plans contain adaptive management triggers and mitigation measures if adverse effects are detected. The methods and reporting proposed in the plan would allow for an adequate assessment of these potential effects and the need for any mitigation measures.

Marine Debris Entanglement

In dynamic tidal sites, any floating or benthic debris carried within the water column in the tidal flow could be become entangled on the turbine or gravity based

foundation. Such debris may include derelict fishing gear, which could pose an entanglement risk to marine mammals, fish, and potentially marine birds in the vicinity of the project.

Snohomish PUD proposes to monitor for derelict fishing gear as part of its Derelict Gear Monitoring Plan. There will also be an ability to monitor much of the turbine face from the video cameras installed as part of the Near-Turbine Monitoring and Mitigation Plan.

During the first year following project installation, Snohomish PUD would deploy an ROV at a minimum of once every three months to inspect project features for accumulation of derelict gear. Following the first year, Snohomish PUD would review the monitoring results with the MARC to determine the degree to which derelict gear gets caught on the project, if at all, and determine whether changing the frequency of subsequent underwater inspections is appropriate.

If the District observes derelict fishing gear snagged on the project works, Snohomish PUD would notify the MARC and would remove the gear as soon as possible in accordance with a removal plan developed in consultation with the Washington DFW and MARC. Because ROVs capable of detection and subsequent removal of derelict gear are available for deployment at the project site within 48 hours and, given the frequency of appropriate ocean conditions for ROV use, any derelict fishing gear snagged on project works would likely be removed shortly after it is detected (i.e., within one week). The derelict gear removal would generally involve a support vessel maintaining position using "live boat" techniques, ROV approach and assessment of the derelict gear and any aquatic species trapped, ROV securing of the derelict gear using a manipulator arm and/or cutting tool, and winching up of the ROV and derelict gear by the support vessel. Upon removal, the derelict gear will be examined by a marine biologist. Species, size, and number of trapped or entangled marine life observed by video and from observations of gear brought to surface will be recorded and reported to the MARC. Disposal would typically consist of removal of lead from nets for recycling, and landfill disposal for all remaining material.

FWS and Washington DFW recommend that Snohomish PUD implement the Derelict Gear Monitoring Plan filed with the license application.

Staff Analysis

Commercial and recreational fishing activities have contributed to numerous instances of derelict fishing gear in the Puget Sound region. The Northwest Straits Commission independently estimated that as many as 4,000 derelict fishing nets and gear items are present on the seafloor in Puget Sound and the Northwest Straits south of the U.S.-Canada border (NWSF, 2007). Good et al. (2009) reported that for the 902 derelict fishing nets recovered since 2002 from the United States portions of the Juan de Fuca

Strait and Puget Sound, 876 were gillnets, 23 were purse seines, two were trawl nets, and one was an aquaculture net. Most gillnets were recovered from depths less than 22 meters, with a maximum depth of 42.7 meters (Good et al., 2009).[37]

However, recovery efforts by the Northwest Straits Marine Conservation Initiative have significantly reduced derelict gear in Puget Sound, including Admiralty Inlet. Utilizing divers and side scan sonar, approximately 2,500 high priority derelict nets have been removed from Puget Sound, moving towards fulfillment of the goal to clear 90 percent of the existing derelict fishing nets from high priority areas of Puget Sound by 2012 (Northwest Straits, 2012). High priority areas in Puget Sound include the San Juan Islands, Central Puget Sound, and Admiralty Inlet (Northwest Straits 2009). Because of these efforts, it is expected that the risk of derelict fishing gear snagging on project works has decreased substantially, and will decrease even more in the future.

The probability of derelict gear becoming snagged on the project turbines is further reduced by the lack of any mooring or anchoring lines that could snag floating debris, and by the hydrodynamic movement of water around the turbine and through the open center, and by the reversal of the tide direction every 6 hours, which would likely prevent debris from attaching or remaining attached to project works. Additionally, no gillnet fishing occurs in Admiralty Inlet (gillnets represented 97 percent of the derelict gear retrieved as reported by Good et al. [2009]). The closest commercial gillnet fishing occurs in Hood Canal to the south and the San Juan Islands area to the north (Washington DFW, 2010b).

In the unlikely event that marine debris becomes entangled on the project turbines, performance of turbines is expected to drop and would be detected by Snohomish PUD's operations control system. As an additional safeguard, Snohomish PUD's Derelict Gear Monitoring and Mitigation Plan would provide a means for detecting and removing derelict gear snagged on project works. Furthermore, the video cameras installed as part of the Near-Turbine Monitoring and Mitigation Plan would provide a means to monitor much of the turbine face. Consultation with the MARC would provide a mechanism to evaluate the effectiveness of monitoring methods and determine whether adjustments to monitoring methods are necessary.

Essential Fish Habitat

Snohomish PUD developed an EFH assessment that it included in Appendix G of the Admiralty Inlet Pilot Tidal Project license application (the Biological Assessment).

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[37] The report does not specify whether the derelict gear is more common in depths less than 22 meters or if gear in shallower water was targeted for recovery.

As noted in the EFH assessment, Admiralty Inlet has been designated as EFH for Pacific Groundfish, Pacific Coast Salmon, and Coastal Pelagics. The assessment characterized potential effects of the project on EFH, including habitat alteration, biofouling and species attraction, blade strike and entrainment, noise, and the introduction of EMF. A summary of that assessment is provided in the analysis above.

Snohomish PUD does not expect any significant effects on EFH, given the following proposed environmental measures:

- Use HDD to deploy transmission cable from a minimum depth of 18 meters to shore to avoid adverse impacts to nearshore and shoreline habitats;
- Lay the transmission cables on the seabed to avoid the need for dredging or open trenching, thereby eliminating potential sediment suspension or transport;
- Conduct installation work only during Washington DFW-approved work windows;
- Conduct near-turbine monitoring and identification of aquatic species (Near-Turbine Monitoring and Mitigation Plan);
- Monitor for derelict gear and remove it as necessary (Derelict Gear Monitoring and Mitigation Plan);
- Conduct benthic habitat monitoring (Benthic Habitat Monitoring and Mitigation Plan);
- Conduct environmental monitoring during Project construction and removal (Water Quality Monitoring Plan);
- Finalize an Emergency Shutdown Plan (part of Project Safeguard Plans); and
- Implement adaptive management to modify Project and Project operations, as necessary, based on monitoring results and consultation (Adaptive Management Plan).

Staff Analysis

As with the discussion of risk to species or taxa groups, the risk to their habitats is small with this project proposal. The first reason is that the proposed project is small relative to the habitat available in Admiralty Inlet. A second reason is that analysis shows that the risks from direct impact through blade strike and indirect effects through behavior change (including that caused by reef effects, avoidance, acoustic factors, or EMF) are small. Finally, detailed monitoring plans, developed with area stakeholders and other experts, would detect such effects. Included with the monitoring measures are measures to consult with stakeholders who helped develop the plans and adapt the plans or the project if concerns about harm to organisms or their habitats dictate. In a worst case scenario, the project would be shut down and removed. The only likely effects of the project are the immediate and temporary disturbance of the placement and presence of the devices and the transmission line over a small fraction of the floor of the inlet. In

the context of the project surroundings, the proposed monitoring and mitigation plans, and the minor and localized nature of any potential effects, we conclude that the project would not adversely affect EFH.

Adaptive Management Framework and Emergency Shutdown Plan

Snohomish PUD proposes to use an adaptive management framework within its environmental monitoring plans to allow for future modifications to the plans based on preliminary results. This adaptive management strategy would entail implementing and reviewing the various monitoring and mitigation plans with a Marine Aquatic Resource Committee (MARC) consisting of representatives from state and federal agencies and Tribes. The adaptive management framework includes specific triggers for addressing identified adverse effects on marine resources. The framework also defines meeting protocols and dispute resolution procedures.

Washington DFW recommends the Commission include as a license term, a steering committee called the MARC which would assist and review creation and implementation of monitoring and management plans, including the use of adaptive management.

Snohomish PUD notes that its adaptive management framework already provides for consultation with the MARC and that a specific article requiring its establishment is not necessary. Further, to the extent that Washington DFW is requesting that the MARC be obligated to implement certain license obligations, it suggests the FERC must reject the recommendation because it would obligate parties other than the licensee.

In its comments on the EA, Snohomish PUD revised its proposed shutdown plan to include the use of a mechanical brake rather than a remotely triggered electrical brake to shut down the turbines. As explained during a technical meeting on April 18, 2013 and in follow-up filings, due to advances in the OpenHydro turbine technology, an electrical brake is no longer possible because it would not hold against the forces transferred through the blades.[38] The result would be that the turbine would continue to turn rather than brake when, or soon after, the brake was engaged, and in the process, overheat and be damaged. Therefore, Snohomish PUD now proposes to stop the turbine

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[38] An electric brake is only effective, if when engaged, the hydrodynamic torque generated by turbine rotor is insufficient to overcome the electrical torque applied by the electrical generator ("the electrical brake"). If the rotor dynamic torque is able to overcome the braking torque, the electrical brake will be unable to stop the turbine from rotating, or hold the rotor in a locked position. Snohomish PUD estimates that the electrical brake will be overcome and the turbine will begin to spin freely in currents of 1.5 m/s.

through the mechanical process of inserting a pin through the outer ring of the turbine and into the blade housing. As with the electronic brake, the mechanical break would have to be applied at slack tide, which could fall as much as five or six hours after the decision to shut down. A ROV would be used to install the pin. Depending on sea conditions, it could take up to four days to deploy the ROV and complete the shutdown, but more likely, it could be achieved in less than a day.[39]

Snohomish PUD considered but dismissed the use of automated mechanical brake because of risk of damage from an unintended application of the brake. Snohomish PUD experienced multiple events of unintended triggering of mechanical controls on sampling devices.

Staff Analysis

The purpose of the Commission's hydrokinetic pilot project license is to allow for the deployment of new technology marine and hydrokinetic projects in which the environmental effects are not yet well understood, while managing the uncertainty through required post-license monitoring and safeguard plans that ensure the protection of the public and environment. Because of the learning curve of monitoring these types of projects in their often volatile environments (*i.e.*, strong currents, extreme tidal fluctuations), the ability to utilize an adaptive management strategy to receive feedback from stakeholders and modify plans as necessary is imperative.

The consultation framework provided in the various monitoring plans provides for managing uncertainty with feedback from stakeholders, including Washington DFW. Further, as noted by Snohomish PUD, the Commission's jurisdiction is limited to its licensee's.

Integral to the Commission's procedures for licensing a pilot hydrokinetic project and Snohomish's proposed adaptive management framework is the ability to shut down the project if an unexpected source of harm to people, infrastructure, endangered species, other organisms, or the Admiralty Inlet environment occurs. To date, remotely activated, electrical brakes have been used in tidal and in-river pilot projects authorized by the Commission to immediately shut down the project under such circumstances. The use of a mechanical break and a possible delay of four days to shut down the project would reduce the effectiveness of one of the project's safeguards.

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[39] Based on tidal current measures and sea state conditions between August 2011 and May 2012, Snohomish PUD estimates that the probability that the mechanical brake for both turbines would be engaged within 24, 48, 72, and 96 hours of the decision to engage the brake is 90, 97, 99, and 99.7 percent.

However, in this case, much information about the site and possible adverse effects on environmental and other resources has been developed and analyzed throughout this EA, substantially lowering risks and the need for near immediate shutdown. Here, the most likely reasons that turbine rotation would need to cease occurs under four circumstances, which are considered in Snohomish PUD's adaptive management procedures: (1) if a killer whale in the Salish Sea is found to have lacerations or discolorations within a week of a known transit through Admiralty Inlet and a veterinarian and the MARC determine that the injuries may have been caused by the project; (2) if acoustic monitoring indicates received noise levels have the potential to injure marine mammals; (3) if monitoring suggests injuries or mortality beyond incidental take limits (which have yet to be defined); and (4) if vibration or differential settlement in excess of design thresholds are detected. For reasons discussed in various sections of this EA, the probability of these conditions is very low.

3.3.2.3 Cumulative Effects

Although it is unclear to what extent the proposed project would affect marine resources until the results of the proposed monitoring plans have been analyzed, marine resources have the potential to be cumulatively affected by the proposed project in conjunction with other past, present, and reasonably foreseeable actions in Admiralty Inlet. The environmental effects of new technology hydrokinetic projects would be evaluated through the effective monitoring of pilot projects such as is being proposed by Snohomish PUD.

Nonetheless, given the small scale of the project, short term of operation, a mechanically controlled braking system for the turbines that would allow for the project to be shut down in the case of an emergency; the design of the turbines, with the blade tips shrouded within the duct, that minimizes the potential strikes on fish, diving birds, and marine mammals; and site restoration following operation, any cumulative adverse effects from project construction and operation are not expected or would be insignificant.

3.3.3 Rare, Threatened, and Endangered Species

3.3.3.1 Affected Environment

Fourteen ESA-listed species (nine fish, three mammals, one bird, and one plant) are considered to have the potential to occur in the project area (table 3).

Table 3. Federally listed threatened and endangered species with potential to occur in proposed project area (Source: application, as modified by staff).

Common Name (Stock)	Scientific Name	Federal Status	Relevant Recovery Plans and Status Reports
Fish			
Chinook Salmon (Puget Sound)	*Oncorhynchus tshawytscha*	CH T	Good et al. 2005; SSPS 2007
Chum Salmon (Hood Canal Summer-run)	*Oncorhynchus keta*	CH T	Good et al. 2005; Brewer et al. 2005; SSPS 2007
Steelhead (Puget Sound)	*Oncorhynchus mykiss*	T	Good et al. 2005; NOAA 2005*b*
Bull Trout (Coastal/Puget Sound)	*Salvelinus confluentus*	CH T	USFWS 2004; SSPS 2007
Green Sturgeon (Southern DPS)	*Acipenser medirostris*	CH T	NMFS 2005*c*
Bocaccio (Puget Sound/Georgia Basin)	*Sebastes paucispinis*	E	Drake et al. 2010*a*
Canary Rockfish (Puget Sound/Georgia Basin)	*Sebastes pinniger*	T	Drake et al. 2010*a*
Yelloweye Rockfish (Puget Sound/Georgia Basin)	*Sebastes ruberrimus*	T	Drake et al. 2010*a*
Eulachon (Southern Pacific)	*Thaleichthys pacificus*	T	Drake et al. 2010*a*
Marine Mammals			
Southern Resident Killer Whale	*Orcinus orca*	CH E	NMFS 2008*c*; Krahn et al. 2004
Humpback Whale (North Pacific)	*Megaptera novaeangliae*	E	NMFS 2005*e*, 1991

Common Name (Stock)	Scientific Name	Federal Status	Relevant Recovery Plans and Status Reports
Steller Sea Lion (Eastern)	*Eumetopias jubatus*	CH T	NMFS 2008*e*; Angliss and Outlaw 2006
Birds			
Marbled Murrelet	*Brachyramphus marmoratus*	CH T	USFWS 2003, 1997
Plants			
Golden Paintbrush	*Castilleja levisecta*	T	USFWS 2007, 2000

E = Endangered
T = Threatened
CH=Critical Habitat

Each species is discussed below relative to known or expected distributions, habitat requirements, recovery plans, and designated critical habitat. The discussion is a summary of the detailed information contained in the biological assessment filed with NMFS and FWS on April 23 and April 24, 2012, respectively.

Chinook Salmon (Puget Sound)

NMFS listed the Puget Sound evolutionarily significant unit (ESU) of Chinook salmon as a threatened species on March 24, 1999[40] and reaffirmed the listing on June 28, 2005.[41] Factors threatening naturally spawned Chinook salmon throughout its range are numerous and varied. The present depressed condition is the result of several long-standing, human-induced factors including habitat degradation, water diversions, harvest, and artificial propagation (64 FR 14316). Recovery efforts for the Puget Sound population of Chinook salmon are addressed in the Puget Sound Salmon Recovery Plan (Shared Strategy for Puget Sound [SSPS], 2007). NMFS designated critical habitat for Puget Sound Chinook salmon on September 26, 2005, with the designations effective January 2, 2006.[42] Within designated areas, EFH extends from the line of extreme high tide out to a depth of 30 meters. Admiralty Inlet and the project action area are included in the critical habitat designation.

Chinook salmon exhibit two life histories: ocean-type and stream-type. Ocean-type Chinook salmon generally migrate from freshwater to the marine environment as sub-yearlings; however, if environmental conditions are not conducive to outmigration,

[40] 64 FR 14308-14328.
[41] 70 FR 37160-37204.
[42] 70 FR 52630-52858.

they may remain in freshwater for their entire first year (Meyers et al., 1998). Populations of Puget Sound Chinook salmon exhibit a great deal of variation in the timing of outmigration by juveniles (SSPS, 2007). Stream-type Chinook salmon generally remain in freshwater for two years, sometimes three years before entering saltwater. Ocean-type Chinook utilize estuaries and coastal waters, whereas stream-type Chinook utilize freshwater systems and a variety of habitats within these systems (Meyers et al., 1998).

Upon entering saltwater, Chinook salmon remain at sea for one to six years, but more commonly two to four years, before returning to their natal streams to spawn. While at sea, Chinook salmon exhibit coastally oriented ocean migration patterns. Chinook salmon originating from Puget Sound tributaries predominantly mature as three or four-year olds (SSPS, 2007).

Admiralty Inlet is an important environment for both juvenile and adult Chinook salmon. Juvenile Chinook use the shoreline and nearshore habitats in Puget Sound, including Whidbey Island, for foraging and rearing, prior to moving off-shore to deeper waters.

Hood Canal Summer-run Chum Salmon

NMFS listed the Hood Canal Summer-run evolutionarily significant unit (ESU) of chum salmon as a threatened species on March 24, 1999[43] and reaffirmed the listing on June 28, 2005.[44] Factors threatening naturally spawned chum salmon throughout its range are numerous and varied. The present depressed condition is the result of several long-standing human-induced factors including habitat degradation, water diversions, harvest, and artificial propagation.

Residence in the estuary appears to be the most critical life phase for chum salmon. Chum salmon are considered second to Chinook salmon in their dependence upon estuarine waters (Groot and Margolis, 1991).

Admiralty Inlet contains critical habitat that is an extension of that from Hood Canal. The Inlet constitutes an important marine habitat that is frequently used by both juveniles and adults (Good et al., 2005). Because spawning occurs within Hood Canal, Admiralty Inlet provides a migratory pathway into Puget Sound (Good et al. 2005).

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[43] 64 FR 14308-14328.

[44] 70 FR 37160-37204.

Steelhead (Puget Sound)

Puget Sound Distinct Population Segment (DPS) steelhead was listed as a threatened species on May 11, 2007.[45] The primary listing factors for steelhead are the present or threatened destruction, modification, or curtailment of its habitat or range; barriers to fish passage and adverse effects on water quality and quantity resulting from dams, the loss of wetland and riparian habitats, and agricultural and urban development.

Steelhead, the sea-run form of freshwater rainbow trout, displays a wide range of life history diversity that enables the species to persist in highly variable environments. The diversity of life history characteristics include the potential presence of resident and anadromous forms, varying periods of freshwater and ocean residency, summer and winter adult return timing to freshwater, and plasticity of life history between generations (Washington DFW, 2008).

There are two life-history types of anadromous steelhead: summer-run and winter-run. The difference in the steelhead runs is the timing of adult freshwater entry for spawning (Moyle, 1976). Steelhead are iteroparous, which means that they are capable of repeating spawning. In contrast, Pacific salmon are semelparous, which means that they spawn once in lifetime. Steelhead females do not guard their redds (nests), but return to the ocean following spawning (Burgner et al., 1992). In some cases, anadromous steelhead yield offspring of the freshwater rainbow trout variation (72 FR 26722). Reproductive interactions may occur between steelhead and resident rainbow trout (Washington DFW, 2008).

Puget Sound steelhead feed in the ocean for one to three years before returning to their natal stream to spawn. Adult steelheads on the central coast of British Columbia spend considerable time at the surface, based on telemetry. The geometric mean depth was 1.6 meters, and on average the fish spent 72 percent of the time in the top one meter of the water column. The maximum depth observed was 30 meters (Ruggerone et al., 1990).

Bull Trout (Coastal/Puget Sound)

The FWS listed the Coastal-Puget Sound DPS of bull trout as a threatened species on November 1, 1999.[46] Primary listing factors include present or threatened destruction, modification, or curtailment of its habitat or range, specifically barriers, timber harvesting, agricultural practices, and urban development. On October 18, 2010 the FWS

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[45] 72 FR 26732.

[46] 64 FR 58910-58933.

revised the critical habitat for bull trout, with the designations effective November 17, 2010.[47] The proposed critical habitat for nearshore marine areas is based on the photic zone. Critical habitat for nearshore marine areas extends from the mean higher high water line offshore to the depth of 10 meters (33 feet) relative to the mean lower low water line.[48] This distance equates to the average depth of the photic zone and is considered the habitat most consistently used by bull trout in marine waters. Critical habitat is not designated within Admiralty Inlet and therefore is not located within the Project area.

Bull trout are members of the char group within the family Salmonidae. Bull trout closely resemble Dolly Varden, a related species. Genetic analyses indicate, however, that bull trout are more closely related to an Asian char than to Dolly Varden (Pleyte et al., 1992).

Bull trout exhibit four distinct life history types: resident, fluvial, adfluvial, and anadromous. The fluvial, adfluvial and resident forms exist throughout the range of the bull trout (Rieman and McIntyre, 1993). These forms spend their entire in freshwater. The anadromous life history form is currently known only to occur in the Coastal-Puget Sound region within the coterminous United States (Volk, 2000). Technically, the Coastal-Puget Sound population segment is amphidromous, meaning individuals often return seasonally to freshwater as subadults, sometimes for several years, before returning to their natal tributary to spawn. These subadult bull trout move into marine waters and return to freshwater to take advantage of seasonal forage opportunities to feed on salmonid eggs, smolts, or juveniles (SSPS, 2007). Multiple life history types may be expressed in the same population, and this diversity of life history types is considered important to the stability and viability of bull trout populations (Rieman and McIntyre, 1993). While juvenile bull trout are limited to freshwater, subadult and adult bull trout occur in Puget Sound. In a study to assess spatial and temporal distribution of bull trout in estuarine and nearshore marine waters of Puget Sound, tagged adult and subadult bull trout were found in depths ranging from 1 to 20 meters, over all substrate types (Goetz et al., 2003).

The majority of growth and maturation for anadromous bull trout occurs in estuarine and marine waters. In marine waters of Washington, bull trout feed on Pacific herring, Pacific sand lance, and surf smelt (Goetz et al., 2004; Washington DFW et al., 1997). Bull trout normally reach sexual maturity in four to seven years and may live

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[47] 75 FR 63973.

[48] The mean lower low water line (MHHW) is at the average level of the lower of the two daily tides.

longer than 12 years (FWS, 2004). Unlike Chinook and chum salmon, bull trout have the ability to spawn more than once in a lifetime. Bull trout spawn annually or bi-annually in headwater areas, and return to larger rivers, lakes or estuaries to forage. Repeat spawners are extremely important to the long-term persistence of bull trout populations; they typically have greater fecundity, and these survivors have multiple opportunities to contribute to the gene pool (SSPS, 2007).

Admiralty Inlet provides important foraging, migrating, and overwintering habitat for bull trout. Marine important foraging, migrating, and overwintering habitat for Coastal-Puget Sound bull trout includes portions of Puget Sound and associated nearshore and estuarine areas. These habitats provide an abundance of preferred prey species, including juvenile trout, salmon, and forage fish species such as sandlance, surf smelt, and herring. Bull trout are dependent upon productive forage fish spawning beaches and intertidal habitats such as eelgrass beds and large woody debris present in nearshore areas. Both subadult and adult bull trout have been observed using tidally influenced areas (USFWS, 2004). Bull trout in the Coastal-Puget Sound population segment also move through marine areas to gain access to independent streams to forage or take refuge from high flows (SSPS, 2007).

Green Sturgeon (Southern DPS)

Based on a preliminary genetic analysis and suspected fidelity to natal rivers, the North American green sturgeon was split into a northern and southern DPS under the ESA on January 29, 2003.[49] The Northern DPS consists of green sturgeon populations originating from coastal watersheds northward of, and including, the Eel River in northern California. NMFS determined that the Northern DPS did not warrant listing as an endangered or threatened species.

The Southern DPS consists of green sturgeon populations originating from watersheds south of the Eel River in California. NMFS determined that green sturgeon from the Sacramento River and Delta system has declined substantially and that the Southern DPS would likely become endangered in the near future if ongoing threats were not addressed. On April 7, 2006[50] NMFS issued a final rule listing the green sturgeon Southern DPS as a threatened species based on the following listing factors: reduction of access to spawning areas, concentration of adults into one spawning area, destruction, modification or curtailment of habitat, and inadequacy of existing regulatory mechanisms. Critical habitat for the green sturgeon Southern DPS was finalized on

[49] 68 FR 4433.
[50] 71 FR 17757.

October 9, 2009.[51] Admiralty Inlet and Puget Sound are not included in the final critical habitat designation.

The green sturgeon is a long-lived anadromous fish species with a wide distribution. Green sturgeon are thought to reach a maximum age of 60 to 70 years (NMFS, 2007b). This species reaches maturity at 15 to 19 years of age (Van Eenennaam et al. 2006), spawning every two to five years (Adams et al., 2002; Erickson and Webb, 2007). Green sturgeon are large, with mature fish ranging from 139 to 223 centimeters (54.7 to 87.8 in.) in length and weighing up to 350 pounds (159 kilograms)(NMFS, 2007c and Skinner, 1982).

Based on information from some genetic analyses, limited tagging studies, and commercial fishing reports, green sturgeon are believed to make extensive movements from natal rivers, generally in a northerly direction (NMFS, 2005b; Adams et al., 2002; Erickson and Hightower, 2007; Israel and May, 2007, Lindley et al., 2008). Data collected from seven out-migrating green sturgeon tagged with pop-off archival tags in the Rogue River indicates that green sturgeon are more active at night, generally inhabiting depths of 40 to 70 m, and occasionally making rapid ascents to the surface.

The primary threat is attributed to the decrease in spawning habitat to a single population in the upper Sacramento River. Migration barriers and water diversion projects have reduced or eliminated what was thought to have been historical spawning habitat in the nearby Feather and San Joaquin River systems. Water quality degradation due to thermal and potential contaminants within the Sacramento River system is also considered a factor in the population decline and a continued threat to the Southern DPS. While there is no focused fishery for green sturgeon, incidental catches and mortality from commercial and recreational fishing industry, in part targeting white sturgeon, was also listed as a threat (Erickson and Webb, 2007). Invasive species, such as the striped bass, also pose a potential risk, as they are known to prey on juvenile green sturgeon.

Bocaccio (Puget Sound/Georgia Basin)

NMFS determined that the bocaccio populations in the Georgia Basin (Puget Sound and the Strait of Georgia) are a DPS and are "at high risk" of extinction throughout all its range. NMFS listed bocaccio as endangered on April 28, 2010,[52] but has not designated any critical habitat yet. The primary factors responsible for the decline of bocaccio are overutilization for commercial and recreational purposes; degradation of water quality, including low dissolved oxygen and elevated contaminant

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[51] 74 FR 52300.

[52] 75 FR 22276.

levels; and loss of rocky habitat, loss of eelgrass and kelp, and introduction of non-native species that modify habitat.

Bocaccio is a deepwater rockfish species often associated with steep slopes consisting of sand or rocky substrates and occurring in Central Puget Sound, Tacoma Narrows, and Ports Gardner and Susan, and along the Strait of Juan de Fuca (Miller and Borton, 1980). They range from Baja California to the Gulf of Alaska, but are most common from Baja California to Oregon (Love et al., 2002). They are most frequently located between 50 and 250 meters deep, but are found as deep as 475 meters (Orr et al., 2000). Deep-benthic habitats for rockfish primarily include boulder, bedrock, and hardpan outcroppings, in the South Sound; deep rocky habitats are not as common, but do occur, in Admiralty Inlet (NMFS letter dated July 23, 2009). Bocaccio are believed to live as long as 54 years (Drake et al., 2008).

Approximately 50 percent of adults mature in four to six years (MBC, 1987). Bocaccio spawn in the fall, generally between August and November (74 FR 18516). Fecundity ranges from 20,000 to over 2 million eggs, which is significantly more than many other rockfish species (Love et al., 2002). Bocaccio larvae feed on larval krill, diatoms, and dinoflagellates (74 FR 18531). Pelagic juveniles feed on fish larvae, copepods, and krill. Larvae and juvenile pelagics tend to frequent surface waters and tend to remain there for three to six months until moving to deeper waters of 18 to 30 meters (Carr, 1983; Feder et al., 1974; Johnson, 2006; Love and Yoklavich, 2008). Adults are generally associated with hard substrate but will venture into mud flats. The main predators of bocaccio are marine mammals (Committee on the Status of Endangered Wildlife in Canada, 2002).

There is no single reliable historic or current population estimate for bocaccio within the Puget Sound/Georgia Basin DPS; however, a dramatic decline in abundance is apparent (Drake et al., 2010b).

Canary Rockfish (Puget Sound/Georgia Basin)

NMFS determined that the canary rockfish (Sebastes pinniger) populations in the Georgia Basin are discrete from coastal populations and are a DPS. NMFS concluded that the Georgia Basin DPS is at "moderate risk" of extinction throughout its range based on a steep decline in abundance in Puget Sound. NMFS listed canary rockfish as threatened on April 28, 2010,[53] but has not designated any critical habitat.

The primary factors responsible for the decline of canary rockfish are overutilization for commercial and recreational purposes; degradation of water quality,

[53] 75 FR 22276.

including low dissolved oxygen and elevated contaminant levels; and loss of rocky habitat, loss of eelgrass and kelp, and introduction of non-native species that modify habitat.

The canary rockfish is a large rockfish that reaches up to 2.5 feet in length and 10 pounds in weight. As with most rockfish, canary rockfish live long lives, and mature and reproduce slowly, making them vulnerable to overfishing. Canary rockfish can live up to 69 years off the west coast of the United States (Palsson et al., 2009).

The canary rockfish occupies rocky and coarse habitats that occur throughout Puget Sound (Miller and Borton, 1980), and their range extends from the western Gulf of Alaska to northern Baja California (Boehlert, 1980; Mecklenburg et al., 2002). Larval and pelagic juveniles are typically found in surface waters (Love et al. 2002), but canary rockfish tend to move into deeper water as they age. Adults inhabit waters 160 to 820 feet (50 to 250 meters) deep (Orr et al., 2000), but have been found up to 1,400 feet (425 meters) deep (Boehlert, 1980).

Canary rockfish reach sexual maturity around ages 7 to 9 for males and 7 to 12 for females (Echeverria, 1987; Lea et al., 1999). Canary rockfish spawn annually with females producing between 260,000 and 1,900,000 eggs per year. Off Oregon and Washington coasts, parturition peaks in December and January (Barss, 1989; Echeverria, 1987).

Canary rockfish larvae feed on primarily crustacean larvae, invertebrate eggs, and copepods (Moser and Boehlert, 1991; Love et al., 2002). Juveniles consume prey such as crustaceans, barnacle cyprids, and euphasiid eggs and larvae (Gaines and Roughgarden, 1987; Love et al., 1991). Predators of juveniles include other fishes (e.g., lingcod, cabezon, salmon, and other rockfish), birds, and porpoise (Ainley et al., 1981; Love et al. 1991; Miller and Geibel, 1973; Morejohn et al. 1978; Roberts 1979). Adults feed on crustaceans and small fishes (Cailliet et al., 2000; Love et al., 2002). Predators of adults include yelloweye rockfish, lingcod, salmon, sharks, dolphins, and seals (Antonelis, Jr. and Fiscus, 1980; Merkel, 1957; Morejohn et al., 1978; Rosenthal et al., 1982).

There is no single reliable historic or current population estimate for canary rockfish within the Puget Sound/Georgia Basin DPS; however, a dramatic decline in abundance is apparent (Drake et al., 2010b). Palsson et al. (2009) note a precipitous decline in several species of rockfish in Puget Sound, including bocaccio, yelloweye rockfish and canary rockfish, and concluded that fishery removals (including bycatch from other fisheries) are highly likely to limit recovery of depleted canary rockfish populations in Puget Sound. In addition, they establish habitat disruption, derelict fishing gear, low dissolved oxygen, chemical toxicants and predation as moderate threats to Puget Sound rockfish populations.

The total rockfish population in the Puget Sound region is estimated to have declined around 3 percent per year for the past several decades, which corresponds to an approximate 70 percent decline in the time period ranging from 1965 to 2007 (Drake et al., 2010b)

Canary rockfish were infrequently observed in Puget Sound from 1996-2001 recreation data; they were reported at a frequency of 0.73 percent (sample size 550) in south Puget Sound, and 0.56 percent (sample size 1,718) in northern Puget Sound (Drake et al., 2008). These percentages are lower than historical percentages of catch from 1969 to 1989. Since 2002, fishing for canary rockfish has been prohibited.

Yelloweye Rockfish (Puget Sound/Georgia Basin)

Based upon stock assessments in adjacent coastal waters, NMFS determined that the yelloweye rockfish (Sebastes ruberrimus) populations in the Georgia Basin are a DPS and have a depleted status, and are therefore likely to become endangered in the foreseeable future throughout all its range. As a result, NMFS listed yelloweye rockfish as threatened on April 28, 2010,[54] but has not designated critical habitat. The primary factors responsible for the decline of yelloweye rockfish are overutilization for commercial and recreational purposes; degradation of water quality, including low dissolved oxygen and elevated contaminant levels; and loss of rocky habitat, loss of eelgrass and kelp, and introduction of non-native species that modify habitat (FR 22276).

Yelloweye rockfish range from Mexico to the Aleutian Islands, Alaska, but are most common from central California to the Gulf of Alaska (Clemens and Wilby, 1961, Eschmeyer et al. 1983, Hart 1973, Love 1996). Yelloweye occur in waters 25 to 475 meters deep (Orr et al. 2000) but are most commonly located between 91 to 180 meters (Love et al. 2002), and inhabit rocky pinnacles (Washington 1977, Love et al. 2002) and boulder fields (Wang 2005). Yelloweye are one of the largest species of rockfish, weighing up to 25 pounds (Love at al. 2002). Yelloweye are also one of the longest-lived rockfish, reaching ages of at least 118 years (Love, 1996; Love et al., 2002; O'Connell, 1987).

Yelloweye rockfish are a slow maturing species, with an average age maturity ranging from 19 to 22 years (Palsson et al., 2009). Females internally fertilize and are capable of storing sperm for several months before fertilization occurs, generally between September and April (Echeverria, 1987). Fecundity ranges from 1.2 to 2.7 million eggs, significantly more than other rockfish species (Love et al., 2002). In Puget Sound juvenile yelloweye occupy primarily shallow waters with high relief zones (Love et al., 1991; Richards et al., 1985). Juveniles prey on fish larvae, copepods, and krill. Adults

[54] 75 FR 22276.

move into deeper waters and continue to associate with rocky, high relief areas (Carlson and Straty, 1981; Love et al., 1991; Richards et al., 1985), and generally have a small home range (Coombs, 1979; DeMott, 1983; Love et al., 2002). Adult yelloweye are opportunistic feeders and are able to eat much larger prey than other rockfish. Adults feed on smaller yelloweye, and typically feed on sand lance, gadids, flatfish, shrimp, crab, and gastropods (Love et al., 2002; Yamanaka et al., 2006). Predators of yelloweye include salmon and killer whales (Ford et al., 1998; Love et al. 2002).

Eulachon

NMFS determined that the population of eulachon found within the states of Washington, Oregon, and California and extending from the Skeena River in British Columbia south to the Mad River in Northern California is a DPS (NMFS, 2009a). In March, 2010 (effective May 17, 2010), NMFS listed eulachon as threatened,[55] but has not designated critical habitat. The primary factors responsible for the decline of the Southern DPS of eulachon are the destruction, modification, or curtailment of habitat; dams and water diversions in rivers inhabited by eulachon; sediment dredging in areas inhabited by eulachon; overutilization for commercial, recreational, scientific, or educational purposes; and the inadequacy of existing regulatory mechanisms.

Eulachon is an anadromous smelt, which spawns in the lower portions of certain rivers draining into the northeastern Pacific Ocean ranging from Northern California to the southeastern Bering Sea in Bristol Bay, Alaska (Hubbs, 1925; Schultz and DeLacy, 1935; McAllister, 1963; Scott and Crossman, 1973; Wilson et al., 2006). In the continental United States, most eulachon originate in the Columbia River Basin. Eulachon spend 95 to 98 percent of their lives at sea (Hay and McCarter, 2000). In the ocean, juvenile eulachon move from shallow nearshore areas to deeper waters on the continental shelf. Larvae and young juveniles distribute widely in coastal waters, where, along with adults, they inhabit the ocean bottom in waters 20-150 meters deep (Hay and McCarter, 2000) and sometimes as deep as 182 meters (Barraclough, 1964).

Historical information dating back to 1858 indicates that eulachon were present in Puget Sound (Drake et al., 2010a). A 2007 Washington DFW technical report entitled "Marine Forage Fishes in Puget Sound" (Pentilla, 2007) presents detailed data on the biology, status, and trends of surf smelt and longfin smelt in Puget Sound, but states that "there is virtually no life history information within the Puget Sound Basin" available for eulachon. Similarly, detailed notes provided by Washington DFW and Oregon DFW as part of the ESA status review provide no evidence of spawning stocks of eulachon in Puget Sound rivers (Washington DFW and Oregon DFW, 2008).

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[55] 75 FR 13012.

Eulachon typically spend three to five years in saltwater before returning to freshwater to spawn from late winter through mid-spring. Eggs are fertilized in the water column, and after fertilization the eggs sink and adhere to the river bottom, typically in areas of gravel and coarse sand. They are an important link in the food chain between zooplankton and larger organisms, including small salmon, lingcod, and other fish (NWPCC, 2004).

Eulachon are a small fish, rich in calories and important to marine and freshwater food webs, with historical importance to commercial and recreational fishermen as well as indigenous people from northern California to Alaska.

Southern Resident Killer Whale

NMFS listed the southern resident killer whale DPS as endangered on November 18, 2005.[56] NMFS determined the southern resident killer whale stock as a depleted species under the Marine Mammal Protection Act in May, 2003.[57] NMFS (2008c) issued a recovery plan for the southern resident killer whale in January 2008. NMFS designated critical habitat for the southern resident killer whales on November 29, 2006[58] Critical habitat includes three distinct marine areas identified as the Summer Core Area, Puget Sound Area, and the Strait of Juan de Fuca Area, and includes "waters relative to a contiguous shoreline delimited by the line at a depth of 6.1 meters (20 feet) relative to extreme high water." These three areas constitute the majority of Washington's northwestern coastline, excluding a few small areas. Admiralty Inlet lies within the Puget Sound Area. The following primary constituent elements were identified in the critical habitat ruling: water quality to support growth and development; prey species of sufficient quantity, quality, and availability to support individual growth, reproduction and development, as well as overall population growth; and passage conditions to allow for migration, resting, and foraging.

Listing factors that continue to pose a threat or risk to killer whales within Puget Sound include: depleted prey abundance (salmon), low genetic diversity due to inbreeding, underwater noise pollution (e.g., from commercial, recreational, and research vessels), disease, and environmental contaminants.

Killer whales follow one of three life history forms or ecotypes. These forms include resident (which is a colloquial term referring not necessarily to site fidelity but

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[56] 70 FR 69903-69912.

[57] 68 FR 31980-31983.

[58] 71 FR 69054-69070.

rather to centralized movement patterns), transient, and offshore. The specific diet of pods varies both by location and by resident or transient behavior. Resident pods generally eat fish with few attacks on marine mammals, while transient pods are more prone to aggressive attacks on larger prey.

The southern resident killer whale DPS consists of three pods (one or more matriline groups traveling together), designated J, K, and L, that reside for part of the year in the inland waterways of Washington State and British Columbia (Strait of Georgia, Strait of Juan de Fuca, and Puget Sound), principally during the late spring, summer, and fall (Bigg, 1982; Ford et al., 2000; Krahn et al., 2002). Pods can be found in the Puget Sound year-round, but during fall, winter and spring, southern resident killer whales are more prone to excursions and can be seen as far south as California. The majority of sightings of southern resident killer whales occur at locations off San Juan Island, where there have been 750-1,550 sightings from 1993-2005.

Winter and early spring movements and distribution are largely unknown for the population (NMFS, 2008*c*); ranges are best known from late spring to early autumn, when survey and observational effort is greatest. During this period, all three southern resident killer whale pods are regularly present in the Georgia Basin (including Georgia Strait, San Juan Islands, and Strait of Juan de Fuca) (NMFS, 2008*c*; Whale Museum, 2009*a*). The K and L pods typically arrive in May or June and spend most of their time in Georgia Basin until departing in October or November. While in inland waters during warmer months, all of the pods concentrate their activity from the south side of San Juan Islands through Haro Strait northward to North and South Pender Islands and Boundary Passage. Less time is generally spent elsewhere, including Admiralty Inlet west of Whidbey Island and Puget Sound (Hauser, 2006; NMFS, 2008*c*).

Since the 1970s, the Whale Museum in Friday Harbor, Washington has maintained a database of whale sightings—the Orca Master. From January, 1990, through December, 2008, the Orca Master database recorded 2,532 sightings of southern resident killer whale in Puget Sound "proper" (south of Deception Pass and Admiralty Inlet), and of those, 196 occurred within five nautical miles of the proposed project (Whale Museum, 2009b). These data suggest that southern resident killer whale transit through Admiralty Inlet as opposed to Deception Pass. All three pods use Puget Sound, with J pod the most common, and followed by K pod. Given reported pod associations during forays into Puget Sound it was estimated that a total of 1,442 southern resident killer whale animals transit through Admiralty Inlet in a year. During these transits, southern resident killer whales are more likely to use the western side of Admiralty Inlet, although the eastern portion is used as well. During these transits southern resident killer whales are often traveling, but also exhibiting social and foraging behavior (Whale Museum 2009b).

Southern resident killer whales spend 95 percent of their time underwater, nearly all of which is between the surface and a depth of 30 meters (Baird, 2000; Baird et al.,

2003, 2005). Baird et al. (2003, 2005) reported southern resident killer whale in inshore water of southern British Columbia and Washington averaged about 0.7 to two dives per hour made below 30 meters, with such dives occurring more often during the daytime. These represented 5 percent of all dives and occupied less than 2.5 percent of an animal's total dive time. During the day, dives greater than 150 meters deep were made on average about once every five hours (Baird et al., 2003, 2005). Because dives below 30 meters represented only 2.5 percent of an animal's dive time, it is assumed that dives to 150 meters represent an extremely small portion of a whale's dive time.

Ford et al. (2000) report four behavioral states in killer whales, including foraging, traveling, resting, and socializing. Resident killer whales spend approximately 50 to 67 percent of time foraging, either actively feeding or searching for food (Ford, 1989). While traveling, killer whales swim in a tight formation, consistently swimming in a specific direction, often surfacing and diving simultaneously (Ford et al., 2000). This behavior is commonly observed among killer whales moving between locations such as feeding areas (Wiles, 2004). Resting, often occurring after foraging, composes approximately 10 to 21 percent of resident killer whale behavior (Ford, 1989; Heimlich-Boran, 1988). During resting behavior, killer whales swim slowly, usually abreast, and in a tight formation, and surface and dive in unison (Ford et al., 2000). Socializing includes physical interactions, displays (e.g. breaching, tail slapping, spyhopping), and vocalizations (Ford et al., 2000). During the summer, residents spend approximately 12 to 15 percent of their time socializing (Ford, 1989; Heimlich-Boran, 1988).

Since 1974, when annual censuses were initiated by the Department of Fisheries and Oceans Canada and later assumed by the Center for Whale Research in 1976, the population of southern resident killer whales ranged between 67 and 96 individuals. The L pod is the largest of the three pods, while J and K pods have similar numbers. As of November 2009, the estimated population totals 87 individuals: 41 in L pod, 27 in J pod, and 19 in K pod (Center for Whale Research, 2009). Survival of killer whales is age-specific, with higher mortality rates among young calves and low mortality rates among reproductive females. Generally, males have a lower life expectancy and higher mortality rates compared to females (Northwest Fisheries Science Center, 2008). Over the past three decades, on average, 3.3 calves were born each year, with an approximate 81 percent survival rate. Since 1978, there has been an average of 3.25 deaths per year (Northwest Fisheries Science Center, 2008).

Snohomish PUD also monitored marine mammal use of the project area by boat and from a vantage point on Admiralty Head between October, 2009 and April, 2010. The visual observation data collected during this study were used to complement results from passive acoustic monitoring (PAM) efforts from two hydrophones already mounted on the seafloor in the project area, as well as a cabled hydrophone located near Port Townsend. Southern resident killer whales were seen in the study area by land based observers on three observer days (October 10, 20, and 21, 2009 and one fast response day

[December 6, 2009]). During the study period, an estimated 22 southern resident killer whale transits[59] were observed. Of the 22 times that southern resident killer whale transited the study area, the southern resident killer whale were detected acoustically via the automated algorithm of the Port Townsend Marine Science Center (PTMSC) hydrophone (14 times, 64 percent) and/or by human listeners (10 times, 45 percent) (Tollit et al., 2010b).

This study used opportunistic sighting information and PAM to successfully collect new data on seven (of the estimated 22) southern resident killer whale transits observed through Admiralty Inlet. Opportunistic dive depth information was collected in the vicinity of the proposed installation site using a vertical hydrophone array. The vertical array was deployed and used to collect recordings during seven of the southern resident killer whale transits. Of the 189 total minutes recorded, localized calls or clicks were recorded during a total of 104 minutes (55 percent). A total of 655 calls and clicks were localized at depths from the surface down to 142 meters; however, 80 percent of the vocalizations were produced at depths of 30 meters or less, with little difference in average depth by behavior category. During the closest approach to the proposed project site (October 21, 2009), while the focal group was categorized as foraging, depths from 23 to 58 meters were recorded from eight calls and clicks. This study indicated that there is great variability in the amount southern resident killer whales vocalize when transiting through the study area (0 to 92 percent of recording time). Periods of little or no vocal activity were witnessed, most notably on October 10, 2009, when the pods were described as undertaking slow (thought to be restful) travel (Tollit et al. 2010b).

Seven boat-based follows were conducted as southern resident killer whale transited the study area between October, 2009 and April, 2010. Location data of the focal group of whales showed a wide use of the study area by the whales traveling through the shipping lanes and generally west and southwest of the project site; land-based observations provided similar data. All three southern resident killer whale pod matrilines were observed transiting the study area. J pod was observed on six occasions, K pod on four occasions, and L pod on three occasions (all in October, 2009). On October 21, 2009, all three pods spent more than four hours in the study area, moving through the inlet to the north and then circling back for a double transit pass in one day; also on this day, the whales were observed (by boat and land) foraging close (~275 meters) to the project site. The same southern resident killer whale approach was detected by the C-POD during the PAM study (Tollit et al., 2010b) and by the Port Townsend hydrophone. In summary, during transits, a total of 11.5 hours of focal sampling were conducted. During this time, southern resident killer whale spent most of

[59] A transit of Admiralty Inlet is defined as any crossing (entry or exit) of the line connecting Admiralty Head and Point Wilson.

their time in the study area traveling (74 percent), while the remainder of the time was spent foraging (21 percent) and socializing (5 percent) (Tollit et al., 2010b).

Humpback Whale (North Pacific)

The humpback whale was listed as endangered on December 2, 1970.[60] There has been a prohibition on taking humpback whales since 1966. A recovery plan was issued for the humpback whale in 1991 (NMFS, 1991). Critical habitat has not been designated for the humpback whale.

The humpback whale occurs in all oceans, with the possible exception of the Arctic (NMFS, 1991). Humpback whales in the North Pacific feed in coastal waters from California to Russia and in the Bering Sea. Following restrictions on the whaling industry and prohibition of taking of humpback whales since 1966, populations of humpback whale have been increasing. The North Pacific humpback population is estimated to be 6,000 whales (Calambokidis et al., 1997).

Movement along the western United States coastline primarily occurs during summer and fall; however, historical whale observations have been made in every month except February, March, and April (NMFS, 1991). Within the summer feeding areas, humpback whales' distribution is likely driven by locations of dense patches of prey which vary inter-annually, seasonally, diurnally, and daily (NMFS, 1991). Generally, humpback sightings in northwest coastal waters are relatively uncommon. Barlow and Forney (2007) estimated 1,096 humpbacks in California, Oregon, and Washington waters based on summer/fall ship line-transect surveys in 2001. Forney (2007) estimated 1,769 humpbacks in the same region based on a 2005 summer/fall ship line-transect survey, which included additional fine-scale coastal strata not included in the 2001 survey.

Humpback whales feed on small crustaceans (krill), and various species of small fish (anchovies, herring, pollock, mackerel, sand lance). Each whale may consume nearly a ton of food per day while feeding and filter huge volumes of seawater. Feeding behavior is diverse and can vary from use of columns, clouds or nets of expelled bubbles to concentrate prey; herding, and possibly disabling prey by maneuvering, flicking or pounding with flukes and flippers; using the water surface as a barrier to prevent the escape of prey; feeding in formation ("echelon feeding"); acoustic cues to synchronize feeding lunges; and short and long-term cooperation between individuals (NMFS, 1991; Weinrich et al. 1992).

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[60] 35 FR 18319.

Steller Sea Lion (Eastern)

NMFS listed the Steller sea lion as threatened on April 5, 1990.[61] In May 1997, NMFS reclassified the species as two DPS, the western and eastern stock (NOAA, 2007b). The western stock occurs from the western Gulf of Alaska west to Japan, while the eastern stock is found from Alaska south along the West Coast states of California, Oregon and Washington (NOAA 2007b). The western stock was reclassified as an endangered species under the ESA, while the eastern stock remained classified as a threatened species.[62] In March 2008, NMFS issued the final recovery plan for the species (NMFS, 2008e). On August 27, 1993, NMFS designated critical habitat for both the western and eastern DPS of Steller sea lions; however the designated habitat area does not include waters of Washington.[63]

Primary listing factors included decline in prey abundance and quality. While the eastern DPS is improving, threats still exist. In order of relative importance, these include environmental variability, competition with fisheries, predation from killer whales, toxins, inadvertent commercial take, Alaskan native harvest, disease, and adverse interactions associated with tourism and research (NMFS, 2008e).

Sea lion habitat includes both marine waters and terrestrial rookeries (i.e., breeding grounds and haulouts), with the primary factor influencing habitat selection being prey availability. Males are the primary occupants of haulout sites. Although Steller sea lions may be found on gravel or cobble beaches, their preferred terrestrial habitat typically consists of exposed rocky shorelines associated with shallow well mixed waters, average tidal speeds, and gradual bottom slopes. Rookeries are nearly exclusively located on offshore islands and reefs (NMFS, 2008e).

Breeding primarily occurs from late May to early July (NMFS 2008e). Females remain with pups for one week after birth and then leave for varying lengths of time to feed. During June and July, Steller sea lions show high fidelity to their natal rookeries. Outside of June and July, however, Steller sea lions can travel great distances to feed. Foraging Steller sea lions have been observed traveling up to 1,770 kilometers from their natal grounds at travel rates exceeding 160 kilometers/day (NMFS, 2008e).

There are no rookeries within Washington State; however, adolescent and adult Steller sea lions can be found along the coast throughout the year (NMFS, 2008e; Pitcher

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[61] 55 FR 12645.

[62] 62 FR 24345-24355.

[63] 58 FR 45269-45285.

et al., 2007). There are four haulouts, including two major sites (sites with greater than 50 animals) in Washington, which are regularly used during the breeding season. Steller sea lions at these sites are assumed to be immature animals and non-breeding animals associated with rookeries from other areas.

Steller sea lions are observed in Puget Sound in the fall, winter, and spring. From 1983 to 1986, Steiger and Calambokidis (1986) observed Steller sea lions overwintering in South Puget Sound, south of Tacoma Narrows. The first sightings occurred in late fall and early winter, with numbers peaking in April or May, with the last sightings in May (Steiger and Calambokidis, 1986).

Steller sea lion use of Puget Sound, and the project area, appears to be increasing in recent years. In 2000, Jeffries et al. (2000) surveyed the area in and around Marrowstone Island, located in Admiralty Inlet, about 8.4 kilometers south of the project, and did not find any signs of habitat usage or haulout. Since 2000, a steady use of a site on the northeast side of the island has occurred. Three to 15 sea lions have been observed at this site over the last five years (personal communication, T. Loughlin, NRC, Inc. and P. Browne, HDR with S. Jeffries, Washington DFW). Three other sites at which Steller sea lions have been observed are located 37 to 58 kilometers north of the project, and 5 to 50 Steller sea lions have been observed at these sites (personal communication, P. Browne, HDR with S. Jeffries, Washington DFW, July 2009; Jeffries et al., 2000).

Snohomish PUD's marine mammal field studies, conducted between October 2009 and April 2010, recorded 362 sightings of Steller sea lions in the project study area over 77 separate days. Steller sea lions were sighted mainly within about 1 kilometer of the observation point (bluffs at Fort Casey, near Admiralty Head) and were more frequently observed in the inshore zone (71 percent of observations). Typically, lone Steller sea lions were observed; however, interquartile range was 1 to 2, with a maximum group size of 14 observed. Sightings of Steller sea lions sometimes included observations of surface feeding behavioral events (Tollit et al., 2010a).

Marbled Murrelet

The USFWS listed the marbled murrelet as threatened under the ESA on September 28, 1992.[64] In 1997, the USFWS finalized a recovery plan for this species (FWS, 1997).

Once thought to be abundant in the Pacific Northwest, marbled murrelets are now only considered common during certain times of the year (FWS, 1997). Listing factors for marbled murrelet include loss and modification of nesting habitat primarily due to

[64] 57 FR 45328-45337.

commercial timber harvesting, threats from mortality associated with gill net fishing operations, and effects of oil spills.

The marbled murrelet is a long-lived small seabird of the Alcidae family that inhabits the eastern Pacific coastline from Alaska to southern California. Spending much of its life at sea, but using old-growth forests for nesting, the marbled murrelet is generally found in association with calm, shallow coastal waters and bays typically less than 1-1.6 kilometers from shore (Seattle Audubon Society, 2007).

Marbled murrelets forage for prey by diving and swimming underwater, propelling themselves with their wings. They generally forage in nearshore waters shallower than 30 meters but are capable of diving to depths of up to 47 meters (Mathews and Burger 1998). During summer, fish form a significant part of their diet, with typical prey including Pacific sand lance, Pacific herring, northern anchovy, smelts, and sea perch (FWS 1997). During winter and spring, fish are less important and invertebrates such as euphausiids, mysids, and gammarid amphipods may represent a considerable fraction of their total diet (FWS, 1997). As such, marbled murrelets are considered opportunistic feeders, requiring primarily that their prey fall within certain size classes (FWS 1997).

Marbled murrelets nest from late March to late September, in coniferous old-growth forests or stands that may be as many as 70 to 80 kilometers inland (Seattle Audubon Society 2007; USFWS 1997, 2006). Due to its sheltered waters, mixed rock and sandy shorelines, and its proximity to old-growth forests, Puget Sound is used heavily during the breeding season (Strong 1995; USFWS 1997). Puget Sound is also believed to be a vital wintering area for populations of marbled murrelets moving south from British Columbia to take advantage of the basin's protected bays and channels (Speich and Wahl 1995; USFWS 1997). Areas of winter concentration include Sequim, Discovery and Chuckanut Bays; the waters around the San Juan and Whatcom County islands; and the inland waters east of and including Admiralty Inlet (Seattle Audubon Society 2007; Speich and Wahl 1995).

Snohomish PUD's field studies documented five marbled murrelets on one occasion (December 10, 2009) in the project area (Tollit et al. 2010a). Marbled murrelet population sizes and trends are regularly monitored in Puget Sound between May 15 and July 31 (Raphael et al. 2007). The proposed project is located within Conservation Zone 1 (Puget Sound) and includes marine habitat. Conservation Zone 1 is subdivided into three strata and each stratum is divided into "Primary Sampling Units" (PSUs) that are about 20 kilometers long.

Conservation Zone 1 contains one of the larger murrelet populations in the species' listed range, and supports an estimated 41 percent of the murrelets in the coterminous United States (Huff et al. 2003). Since 2000, the estimated population size for Conservation Zone 1 has ranged from a low of 5,500 murrelets in 2004 to a high of

9,700 in 2002. The most recent (2007) estimated population size for Conservation Zone 1 is 6,985 murrelets. Since 2000, the estimated murrelet density in Conservation Zone 1 has ranged from 1.56 to 2.78 murrelets per km^2. Admiralty Inlet occurs within stratum 2 in Conservation Zone 1. At-sea population surveys estimated marbled murrelet densities for stratum 2 varied from 1.12 to 2.43 murrelets per square kilometer between 2000 and 2007 (Huff et al. 2003; Falxa et al. 2008).

Population numbers in Conservation Zone 1 are likely declining; however, the precise rate of decline is unknown. The juvenile ratio derived from at-sea survey efforts is 0.09 in Conservation Zone 1. Although the juvenile ratio appears low, exact numbers are still unknown as juvenile ratios in Washington may be skewed by murrelets coming and going to British Columbia (FWS 2008).

Golden Paintbrush

The FWS listed the golden paintbrush as a threatened species on June 11, 1997.[65] Primary listing factors were loss of habitat and encroachment of native and nonnative woody species. A final recovery plan for the species was issued in August 2000 (USFWS 2000).

Golden paintbrush is a short-lived perennial herb. Plants emerge in early March. By mid-April, the plant is in bud, flowering generally begins the last week in April and continues until early June. Fruits mature from June to mid-July; by mid-July, the plants are in senescence. Capsules persist on the plants well into August.

Golden paintbrush is endemic to the Pacific Northwest. The historic range of the species extends from the Puget Trough physiographic province in Washington and British Columbia to as far south as the Willamette Valley of Oregon (WSDNR 1997, USFWS 2000). However, assessments of the species' status in its range found the plant extirpated from many of the recorded sites. In Washington, golden paintbrush occurs at elevations from sea level to approximately 91 meters (300 feet) above sea level. The species generally occurs on flat, open grasslands that are characterized by mounded topography, and on steep coastal bluffs that are grass dominated.

FWS (2000) identifies 11 extant populations of golden paintbrush, nine in Washington, and two in British Columbia. In Washington, the populations occur in Thurston County (1), San Juan County (3), and Island County (5 populations on Whidbey Island). The five populations on Whidbey Island occur on the following sites: Admiralty Inlet Natural Area Preserve (formerly Bocker Environmental Reserve), Fort Casey State Park, West Beach, Forbes Point, and Ebey's Landing. Three sites are less than one acre

[65] 62 FR 31740-31748.

and two are approximately 1 acre in size (USFWS 2000). Fort Casey State Park is the closest site to the Project area.

FWS (2007) reports only two of the 11 extant populations (one in Thurston County, Washington and one in British Columbia) are stable (i.e., population of at least 1,000 individuals for at least five years), while the remaining nine populations are considered to be declining. Overall, the abundance of the species remains constant, with some populations increasing and others declining (FWS 2007). The population size and trend for the five populations on Whidbey Island between 1999 and 2006 are shown in tables 4 and 5, respectively).

Table 4. Population Size for Golden Paintbrush Populations on Whidbey Island (Source: FWS 2007).

Site	1999	2000	2001	2002	2003	2004	2005	2006	Average
Admiralty Inlet (Naas)	277	97	97	98	122	59	120	94	121
Fort Casey State Park	175	151	166	185	307	235	260	760	280
West Beach	797	463	167	53	54	82	130	189	197
Forbes Point	1,572	1,882	1,834	711	765	532	123	260	960
Ebey's Landing	1,079	7,627	-	-	-	-	669	214	2,397

Table 5. Population Trends for Golden Paintbrush Populations of Whidbey Island (Source: FWS 2007).

Site	10-year recovery trend	5-year recovery trend
Admiralty Inlet (Naas)	Increasing in the short term	Increasing in the short term
Fort Casey State Park	Increasing in the short term	Increasing in the short term
West Beach	Stable	Stable
Forbes Point	Declining	---
Ebey's Landing	Stable	Declining

3.3.3.2 Environmental Effects

Effects of project installation, maintenance, operation, and removal on federally listed species are summarized below. Greater detail is provided in the biological assessment filed with NMFS and FWS on April 23 and April 24, 2012, respectively.

Because of the similarity of stressors on groups of species, potential environmental effects to these federally listed species are discussed below in the following groups: salmon and trout, green sturgeon, rockfish, eulachon, marine mammals, marbled murrelet, and golden paintbrush. The analysis considers and describes the stressor, the expected exposure to the stressor, the likelihood of exposure to the stressor, and the risk to individuals and populations of listed species. With regard to project effects on listed marine fish, many of the factors that potentially would affect the ESA-listed fish species

would have similar potential to affect fish in general and have been discussed earlier. These sources include blade strike, behavior change, and acoustic effects. Blade strike and behavioral change are covered in the section on Behavioral and Direct Effects on Fish, Marine Mammals, and Birds Near the Turbines. Acoustic effects are covered in section on the Noise Effects. Our analysis of potential effects on fish in those sections applies unless modified, by more specific information described below.

Chinook Salmon, Chum Salmon, Steelhead, and Bull Trout

The Puget Sound Chinook salmon, Hood Canal summer-run chum salmon, Puget Sound steelhead, and bull trout are related species and have broad similarities in their life histories and habitat use. Data from 158 sampling net tows in Puget Sound revealed that all juvenile salmon, including chum and Chinook salmon, were collected above a depth of 45 m (148 feet). The top of the turbines would be at a depth of about 47.5m (156 feet). Adult salmon can be found at a range of depths, but are more commonly found in the top 30 m (98 feet), reducing their chances of interacting with the turbines. Steelhead trout juveniles are found in the top 6 m (20 feet) of water about 95 percent of the time. Adults at sea occur at any depth down to 200 m (656 feet), but have been found above 30 m (98 feet) of depth in Puget Sound. Bull trout adults are found at depths of 1 to 20 m (3.3 to 65.6 feet). Juveniles are not found in Admiralty Inlet.

Also, adult salmon are pelagic feeders. It is unlikely that their prey of schools of small fish and invertebrates would concentrate near the turbines. Steelhead trout feed on fish and invertebrates. Bull trout feed on fish (herring, sand lance, and surf smelt).

The probability of salmon or trout having direct interaction with the turbines would be largely by chance, which would be small given the relatively small portion of the Admiralty Inlet cross section occupied by the turbines and the small amount of time these fish spend at the depth of the turbines. The benthic organisms that are likely to collect on the turbine structures would not attract salmon and trout. Finally, probability would be further reduced by any avoidance behavior by these extremely strong swimmers.

Therefore, project construction, operation, maintenance, and removal are not likely to adversely affect these species.

Green Sturgeon

Green sturgeon feed on a benthic diet, and may be found near the turbines. Admiralty Inlet is one of many places the members of the southern DPS may feed in a lifetime. Admiralty Inlet is not an access corridor to their spawning grounds, which are in, or closer to, the Sacramento, River in California. While the turbines are more closely associated with green sturgeon habitat, the numbers of southern DPS green sturgeon near the turbines is likely to be small and again, given the small footprint of the turbines

relative to the size of the benthic habitat in the inlet, the probability of frequent interaction is small.

There is some possibility that the turbine structures would attract benthic organisms of interest to green sturgeon, but only in the immediate area of the turbine structures, if at all. The probability of attraction and turbine interaction is low considering that green sturgeon do not prefer the deeper habitats that the turbines would occupy (Kelly et al., 2007) and because they are believed to be in the area at only very low densities. Finally, the rare chance that a green sturgeon would be near the turbine is the type of condition intended to be detected and addressed in the Benthic Habitat Monitoring and Mitigation Plan and the Near-Turbine Monitoring and Mitigation Plan. Green sturgeon, because of their distinctive shape, would be among the most likely fish to be identifiable by the optical and acoustic camera images. Thus, their attraction to the turbine structures would be likely to be detected. Finally, with their adaptations for maneuvering and feeding on the bottom in dark places, the green sturgeon may be quite sensitive to the presence of the turbine and avoid it.

Therefore, the project is not likely to adversely affect this species.

Rockfish (Boccaccio, Canary, and Yelloweye)

The three ESA-listed rockfish species are grouped as a deepwater rockfish species assemblage in Washington DFW's Final Puget Sound Rockfish Conservation Plan (2011b). They have been observed infrequently (canary and yelloweye rockfish) to never (bocaccio) in Washington DFW's tows described earlier. Though rare, the canary and yelloweye rockfish have been observed at multiple life stages near the project area. Rockfish are attracted to high-relief structures and are likely to be attracted to the 13 meter (43 ft) tall turbine structures. In general, adult rockfish quickly colonize artificial reefs (Washington DFW, 2011c). The turbine structures are likely to gather rather than displace adult rockfish. Even with the possibility of attraction to the project, the rockfish densities should remain low, because of the small population size in Puget Sound and the modest amount of appropriately rocky habitat nearby.

A concern with high relief, fish attracting structures is negative reef effects. One such effect would be if the turbine structures became high mortality hot spot for endangered juvenile rockfish within the zone around the turbines. In a case where an artificial reef was created at a 30 m depth in Puget Sound by Washington DFW, rockfish segregated by size of hiding spaces, with juveniles occupying only places where they could enter a small hole when startled (West et al., 1994). If the juveniles of the deepwater rockfish assemblage behave the same way as those at the shallower depth, they will only occupy the turbine structure to the extent that there is adequate hiding space for them. Such behavior would reduce the risk of the turbine habitat becoming a sink for juvenile rockfish.

The risk to the rockfish is limited by the very small scale of the project structures relative to the extensive habitat. The benthic, near-turbine, and marine mammal monitoring plans limit the risk further.

Vulnerability to turbine strike for rockfish is subject to the same factors as fish in general as discussed in the section on Behavioral and Direct Effects on Fish, Marine Mammals, and Birds Near the Turbines. The adult rockfish that approach the turbine structures, and particularly the large rockfish, should be detectable and observable with the cameras used in the Near-Turbine Monitoring and Mitigation Plan.

With the expected low level of interaction and the monitoring and adaptive management measures in place, risk to the threatened and endangered rockfish species would be manageable for the small, short term, project. Therefore, the project is not likely to adversely affect these species.

Eulachon

Though eulachon occur at the project depth, they only infrequently occur in Admiralty Inlet. They feed on zooplankton, which are drifting organisms that would not concentrate around the turbines. Therefore, eulachon would be unlikely to concentrate near the turbines.

As with the other ESA-listed species of fish, the same factors that reduce risk to other fish apply to the euchalon. These include the small footprint of the project, the characteristics of the turbines, the lack of concern about EMF, and the possibility of local avoidance of the turbines. Finally, the same monitoring and adaptive management safeguard plans apply.

Therefore, the project is not likely to adversely affect this species.

Marine Mammals (southern resident killer whale, humpback whale, and Steller sea lion)

Southern resident killer whale, humpback whale, and Steller sea lion are known to pass through the project area. Based on consultation with stakeholders, potential direct effects of project deployment and operation include: blade strike, underwater noise, and marine debris entanglement. No indirect effects have been identified.

The potential for injury or mortality to any of these species from blade strike is small. Humpback whales are infrequent and sightings in northwest coastal waters are uncommon, occurring one to two times per year in Admiralty Inlet (Osborne et al. 1988).

In Admiralty Inlet, southern resident killer whale and humpback whales are both migratory and are therefore expected to be transiting through the Admiralty Inlet area and would be exposed to the turbines infrequently. While southern resident killer whale do dive to depths at which the turbines would be located (Tollit et al. 2010a), most southern resident killer whale dives occur to depths less than 30 meters (Baird 2000, Baird et al. 2003, 2005). In contrast, Steller sea lions are known to dive depths of the turbines and spend longer periods of time in Puget Sound and therefore could be exposed to the stressor more frequently. Nonetheless, the small project footprint relative to Admiralty Inlet,[66] design of the turbine (close shroud and open center), low rotational speeds (typical rotational speeds will range from 5 to 19 RPM, with a maximum rotational speed of 29 RPM), and frequency of operation (because the turbine does not start rotating until tidal velocity is 0.7 m/sec, the turbines will rotate only 60 to 70 percent of the time) minimizes potential risk of marine mammals coming in contact with a moving blade. In the unlikely event of that a southern resident killer whale does interact with the turbines, the consequences would be, at worst, minor bruising (Carlson et al., 2012).

As explained earlier in section 3.3.2.2, each of the species would be exposed to low-level noise during installation, maintenance, operation and removal of the turbines. During installation, maintenance, and removal activities, noise levels would be temporary and short-term and are primarily from vessel engines, which are similar to existing noises. Consequently, these species may be habituated to construction noises. In addition, Snohomish PUD would cease installation activities if a listed cetacean occurs within 500 meters, or listed pinniped occurs within 100 meters of an installation or removal vessel until the cetacean or pinniped leaves the vicinity of project operations.

Turbine operation is expected to exceed NMFS's level B harassment threshold of 120 dB close to the project. During the highest tidal velocities, the three species would be exposed to NMFS Level B Harassment threshold as follows: humpback whale - within 650 meters; southern resident killer whale - within 260 meters; Steller sea lion - within 390 meters.[67] Ambient noise is expected to further limit the area of which received levels are both detectable and exceed 120 dB. The predominance of vessel traffic noise associated with passenger ferries and cargo vessels (Bassett et al., 2012) and, at high currents, bedload transport (Bassett et al., in revision), would generally limit

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[66] The turbine rotor diameter is 4.7 meters (the venturi duct diameter is 6 meters) with a 2.2 meter diameter open center, and therefore turbine sweep area would be 13.5 square meters for both turbines.

[67] Because turbine noise is dependent on current velocity, turbine noise will only ensonify an area greater than 100 m to Level B harassment (120 dB re 1μPa) 25 percent of the time.

marine mammal detection of turbine noise to within a few hundred meters of the project (Polagye et al., submitted).

Although all three species could be exposed to derelict gear entangled on the turbine, the likelihood of such exposure is very small because: there is no gillnet fishing occurring in Admiralty Inlet; much of the derelict gear has been removed (NWSF 2011); limited potential for these species to encounter the project turbines relative to the Admiralty Inlet (these species can pass through 99.95 percent of cross-section of Admiralty Inlet at the Project location without encountering the proposed turbines); and the risk of derelict gear entangling with the turbine is reduced due to the hydrodynamic movement of water around the turbine and through the open center, and because of the reversal of the tide direction every 6 hours.

For the stated reasons, project installation, maintenance, operation and removal is not likely to adversely affect humpback whale, but due to noise levels, may adversely affect southern resident killer whales and Steller sea lions.

Primary constituent elements for southern resident killer whales critical habitat are: water quality to support growth and development; prey species of sufficient quantity, quality, and availability to support individual growth, reproduction and development, as well as overall population growth; and passage conditions to allow for migration, resting, and foraging. As described in section 3.2.2.2, project installation, maintenance, operation, and removal would not affect water quality, southern resident killer whale prey, or passage conditions; therefore, the proposed project would not be likely to adversely affect southern resident killer whale critical habitat.

The following proposed measures would allow Snohomish PUD to monitor for adverse effects and take appropriate steps, including shutting down the turbines; if adverse effects are found: the Near-turbine Monitoring and Mitigation Plan would allow Snohomish PUD to monitor close encounters with turbines; the Acoustic Monitoring and Mitigation Plan would permit Snohomish PUD to determine if operational noise levels are exceeding anticipated thresholds; the Marine Mammal Monitoring and Mitigation Plan would allow Snohomish PUD to monitor for changes in behavioral patterns of marine mammals and to stop installation activities if a listed marine mammal comes near the project vessels; and the Derelict Gear Monitoring Plan would allow Snohomish PUD to detect and remove any gear entangled on the turbine.

Marbled Murrelet

Based on consultation with stakeholders, potential direct effects of project deployment and operation include: blade strike, underwater noise, and marine debris entanglement. No indirect effects have been identified.

Marbled murrelets generally forage in nearshore waters shallower than 30 meters but are capable of diving to depths of up to 47 meters. The top of the turbine structure would be at a depth of 47.5 meters. Therefore, the project would be located at or below the calculated theoretical maximum diving depth (47 meters) of the marbled murrelet (Mathews and Burger 1998). At that depth, it is extremely unlikely that a marbled murrelet would directly interact with the turbine rotors.

The maximum expected broadband source level for a turbine is estimated at 172 dB rms (re: 1 ~Pa) @ 1m. The presence of a second turbine is not expected to increase this estimate significantly. Turbine sound is also expected to attenuate through spreading and absorption, such that at maximum source levels, broadband received levels are expected decrease to 150 dB within 13 meters of the turbine. FWS considers behavioral response of murrelets to occur, with reasonable likelihood, when they are exposed to sound levels of 150 dB or greater. Based on the limited distance from the turbine this sound pressure level is predicted to occur and the depth at which this sound pressure level originates, it is extremely unlikely murrelets will be exposed to, and therefore adversely affected by, turbine noise.

The Acoustic Monitoring and Mitigation Plan is designed to measure actual sound generated by the tidal turbines under the full tidal range and rotational speeds. This information would be used to determine if estimated noise levels or FWS guidelines have been exceeded, and corrective actions identified. The plan provides triggers and mitigation measures for when the project is adversely affecting species, including potentially shutting the turbines down.

For the above reasons, project installation, maintenance, operation, and removal are not likely to adversely affect marbled murrelets. FWS concurred with this determination on June 12, 2012.

Golden Paintbrush

Although populations of golden paintbrush are known to occur on Whidbey Island, existing populations are not located near where land-disturbing activities associated with project installation would occur. Further, the project site consists of disturbed habitats associated with local residences, such that habitat conditions are not likely to support golden paintbrush. Therefore, project installation, maintenance, operation, and removal would not affect the golden paintbrush.

3.3.3.3 Cumulative Effects

Though commercial fishing has declined significantly in the last 20 years, commercial fishing and crabbing will continue in Admiralty Inlet, as will recreational fishing. Maritime travel on Puget Sound is heavy and will continue, with all maritime traffic bound for, or departing from, the ports of Seattle, Everett, Tacoma, and Olympia

transiting through Admiralty Inlet via a major shipping lane in the middle of the inlet. The Port Townsend-Coupeville ferry will continue to run about 1.5 kilometers from the turbine deployment site, with about 10 round trips occurring daily across Admiralty Inlet during summer. Use of the area by small commercial and recreational craft will also continue. No other reasonably foreseeable actions have been identified in project area.

When considered cumulatively, the effects described above may have a small negative effect on federally listed fish and marine mammals and designated critical habitat. Snohomish PUD's proposed monitoring, adaptive management and consultation with resource agencies would ensure these effects are timely addressed.

3.3.4 Terrestrial Resources

3.3.4.1 Affected Environment

The on-shore portion of the proposed project would be located on private land east of Admiralty Head. Admiralty Head and the surrounding areas of Whidbey Island contain two vegetative zones: Puget Sound Douglas-fir and Woodland/Prairie Mosaic (Washington Gap Analysis Project 1996). Both of these zones have been heavily converted to both agriculture and development.

The on-shore portion of the project site is located in a light residential development. In the EA, staff characterized the onsite vegetation as disturbed and dominated by grasses and herbs based on aerial photos and the presence of residents. In comments filed on February 14, 2013, the Whidbey Environmental Action Network (Network) stated that the EA inaccurately characterized the site as maintained lawns. The Network states that there is no "maintained" vegetation or landscaping and that aerial photos show that the particular property is similar to the other private inholdings on Keystone Spit. The Network characterized the onsite vegetation as dominated by coastal and prairie grasses and shrubs including plant species typically associated with prairies and balds, a suite of uncommon plant associations that have been reduced in extent by over 90 percent from pre-European settlement conditions. According to the Network, Keystone Spit, including the specific project site, primarily has a cobble substrate and contains unusual plant communities for this substrate. The Network asserts that the project site supports, what it believes to be the largest populations in Puget Sound of nodding onion and sea blush, as well as other native species including bare stem parsley, field Chickweed, and coastal red fescue.

The grasslands abut a rocky intertidal beach front. No wetland habitats are found onsite. However, the marshy grasslands associated with Crockett Lake immediately north of the project site attract over 90 species of migratory waterfowl and shorebirds (NPS 2003). Given the developed character of the project site, wildlife that may use the project site include species that are likely habituated to human disturbance, such as chipmunks, deer, foxes, squirrels, and ravens. Although Whidbey Island contains a

variety of habitats that support state-listed species of concern, the disturbed character of onsite habitats would not support or attract these species.

3.3.4.2 Environmental Effects

Potential effects on terrestrial resources are limited primarily to vegetation and wildlife disturbance associated with construction activities, and to a lesser degree, project removal activities.

In its comments filed on February 14, 2013, the Network recommended the following measures to reduce the introduction and spread of invasive plants: (1) use gravel, rock, or other fill material from a weed free source; (2) revegetate disturbed areas with species native to Keystone Spit, with the source material (seeds or cuttings) collected from Keystone Spit; (3) ensure that no imported soil, fertilizer, or tackifiers will be used in revegetating disturbed areas; and (4) inspect any fill and disturbed areas for invasive plant annually, between early and mid-June and again in August, and eradicate any detected invasive plants promptly. In its response filed on March 8, 2013, Snohomish PUD agreed to implement the above measures, though it stated that "slight variations may be required given the specific work to be conducted at the Project." Snohomish PUD did not specify the slight variations.

Potential effects on terrestrial resources would be limited primarily to vegetation and wildlife disturbance associated with construction activities, and to a lesser degree, project removal activities. Resource agencies and stakeholders have not raised specific concerns related to project effects on terrestrial resources, and no one has recommended specific measures to minimize effects on terrestrial resources.

Snohomish PUD has sited the terrestrial components of the project such that the power cables come onshore to connect to the grid at a location that is close to shore, that has been previously developed, and that requires no new roads. To minimize effects to the littoral and nearshore environment, Snohomish PUD proposes to use HDD to bring the subsea trunk cables ashore from a minimum depth of 18 meters to a vault located about 55 meters shoreward from the ordinary high water mark. An approximately 9-meter back haul cable would run underground from the vault to a constructed control building, and an approximately 70-meter back haul cable would run from the control building to the grid intertie.

The bentonite slurry/dredging spoils from the HDD would be recovered into an excavated temporary sump pit, expected to be less than 1.8 meters (6 feet) deep, no more than 6 meters (20 feet), and with a width of approximately 2.4 meters (8 feet). The final engineering design of the site will dictate the actual dimensions. The fluid that is picked up by the sump pump would be transferred to the solids control unit where the solids contained in the drilling fluid are mechanically separated allowing the mud to re-

circulated down the HDD hole and used again. The solids are discarded into dumpsters (hoppers) and transported to a local prearranged dump site.

On land construction activities would require about five months to complete. Terrestrial vegetation would be left intact as much as possible during site preparation activities, and following construction, the HDD laydown area and any other disturbed areas would be returned to its pre-installation condition. Fuel and lubricant leakages may inadvertently be discharged from vehicles during construction and facility maintenance activities. Snohomish PUD would implement best management practices to reduce the potential for a discharge and minimize impacts.

For project decommissioning and removal, Snohomish PUD states that it would remove all shore-based equipment according to the terms of the agreement(s) between itself and the owner of the private property on which the equipment would be constructed. Similarly, Snohomish PUD would remove the project transmission line and other equipment in accordance with agreement with Puget Sound Energy. Snohomish PUD further states that because several removal and restoration activities would be determined based on the condition of the site and equipment at the time of removal (e.g., subsea cables), a detailed scope of work cannot be completed at this time. Snohomish PUD proposes to work with the MARC when developing the scope of work. For our analysis purposes, we assume that with the exception of the control building, which would likely be left to serve as a garage, all project equipment, including the power cables, would be removed from the site. This removal would require the cable vault and power cables to be removed and trenches back-filled with the excavated materials and the area returned to existing grade. The cables would be disposed of in an appropriate manner, including recycling where possible.

Staff Analysis

Land disturbing activities, including grading, trenching, backfilling and HDD processes, would disturb an area of about 0.3 acres (0.1 hectares). Because of the small footprint and disturbed character of the vegetation, adverse effects on vegetation and wildlife would be minor and temporary. Restoring the HDD laydown area and back haul trench surface areas to pre-installation conditions would further minimize adverse effects to wildlife. Mobile wildlife species are expected to avoid the project area during construction and would utilize similar habitats, which are abundant nearby, to conduct their life cycle activities following placement of the project components.

Soil-disturbing activities associated with project deployment could potentially cause erosion during project construction. Although Snohomish PUD proposes to use best management practices to minimize soil erosion and areas of disturbance, Snohomish PUD has not filed an erosion control plan. A detailed soil erosion control plan would ensure that best management practices are followed to limit the effects of erosion during

project construction and deployment. The Commission typically requires the development of such plans.

Soil-disturbing activities can create site conditions conducive to the introduction and spread of exotic invasive plant species, which could adversely affect adjacent properties and native plant communities. The measures proposed by the Network and agreed to by Snohomish PUD to control weeds would minimize the introduction and spread of weeds, result in the reestablishment of native grasses and shrubs, and minimize adverse effects on native vegetation and wildlife.

Following construction, only the cable termination vault and control building would be above ground and maintenance activities would not likely adversely affect wildlife and vegetation. If the project components were to be removed following construction, some soil disturbing activities could again temporarily disrupt wildlife and vegetation and could result in soil erosion. A detailed site removal plan, as proposed by Snohomish PUD, describing best management practices that would be followed during these activities would minimize adverse effects on terrestrial resources.

3.3.5 Recreation

3.3.5.1 Affected Environment

Admiralty Inlet and surrounding coastal areas host a wide array of recreation resources and activities, including fishing, boating, windsurfing, kite-boarding, diving, beach combing, hiking, sightseeing, picnicking, and camping. Admiralty Inlet is a popular location for whale watching and birding. The beach nearest the proposed turbines, known as Admiralty Head, is a popular shore-fishing site for salmon and steelhead.

Several state parks, two marine protected areas, and miles of public beaches are located along the shoreline to the north and east of the project area. The closest state park is Fort Casey, located on Admiralty Head. Fort Casey State Park is a 467-acre park located on Admiralty Head, with more than two miles of shoreline along Puget Sound, including Keystone Spit, the strip of land separating Crocket Lake from Admiralty Inlet, on which the land-based portions of the project would be located. The state park is an historical military fort that offers hiking, beachcombing, bird watching, boating, fishing, picnicking, and camping. The beach and bluff, a lighthouse, and the old gun batteries offer sweeping views across Admiralty Inlet and are popular attractions. The park is fully developed with parking, restrooms, campsites, trails, boat launch, and picnic areas. The proposed project turbines would be sited approximately a half kilometer offshore of the park.

Fort Casey State Park is also located within the nation's first national historical reserve, which is administered as a unit of the national park system. Ebey's Landing

National Historical Reserve (Reserve) includes over 400 historical structures and nearly 17,600 acres of farms, prairies, dense forests, lakes, lagoons, and coastal and marine areas. The Reserve was created in 1978 to protect the rural working landscape, native and pioneer land use traditions, and ecological resources on central Whidbey Island.[68] The Reserve offers opportunities to beachcomb, hike, boat, camp, and watch wildlife. The proposed project's land-based components, including underground cables and the control building, would be sited on private land within the Reserve close to its southern boundary.

Two marine reserves designated by the Washington DFW to preserve species and/or habitat are located near the project: Admiralty Head Marine Preserve and the Keystone Conservation Area. The Admiralty Head Marine Preserve (figure 10) is located along the western shore of Admiralty Head and is managed as a partially-protected marine reserve for non-tribal citizens. Recreational and commercial fishing and harvesting activities, except for dive fishing for sea urchins and sea cucumbers, are prohibited.[69] The project turbines would be sited approximately a half kilometer south of the Admiralty Head Marine Preserve. The Keystone Conservation Area is a fully protected marine reserve for non-tribal citizens. The Keystone Conservation Area includes the eastern side of the jetty enclosing the Keystone Ferry harbor and extends eastward to a row of pilings. The project control building and land-based construction activities would be located about 350 meters to the northeast of the Keystone Conservation Area. Recreational and commercial fishing and harvesting are prohibited, although the Keystone Conservation Area is a popular location for recreational divers and student researchers. The project's subsea trunk cables would pass near the east corner of the Keystone Conservation Area.

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[68] National Park Service (NPS), 2006. Ebey's Landing National Historical Reserve General Management Plan. The reserve includes about 13,600 acres of land and nearly 4,000 acres of water (mostly at Penn Cove). General information about the reserve is available at: www.nps.gov/ebla/.

[69] WDFW. Marine Protected Areas within Puget Sound: Admiralty Head Marine Preserve. See http://wdfw.wa.gov/fishing/mpa/admiralty_head.html (accessed December 3, 2012).

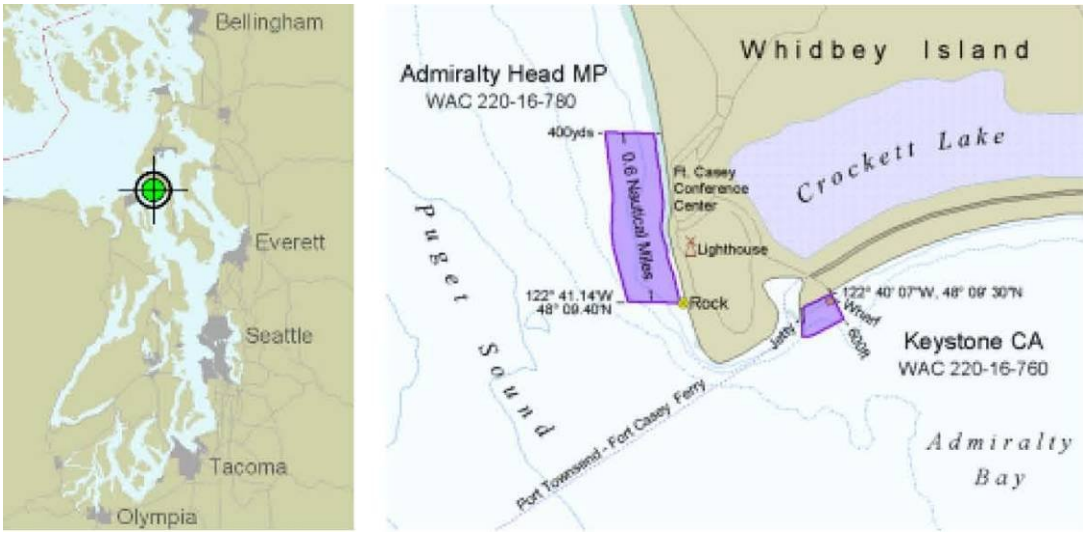

Figure 10. Admiralty Head Marine Preserve and Keystone Conservation Area (Source: application).

Also in the vicinity of the project are campsites and put-in/take-out points for the Cascadia Marine Trail, a regional water trail for paddlers. The Cascadia Marine Trail (CMT) extends nearly 140 miles north from Olympia, Washington, through Admiralty Inlet, to the Canadian border. It is a designated National Recreation Trail and one of 16 National Millennium Trails. The non-motorized water trail does not follow a particular alignment and instead utilizes a broad area of marine waters to provide unique opportunities for experiencing the natural and aesthetic resources of the region. The CMT connects with more than 50 campsites.[70] Campsites that are nearest the proposed project include those at Fort Flagler State Park and Fort Worden State Park on the opposite shore of Admiralty Inlet. Both of these parks are located over three kilometers from the proposed turbines. To the north, a campsite at Fort Ebey State Park, also within the Ebey's Landing National Historical Reserve, is linked to the CMT, but it is located over nine kilometers from the proposed turbines.

In addition to paddling on the water trail, a variety of motorized and non-motorized recreational boating occurs in Admiralty Inlet. Commercial charters and cruise ships utilize Admiralty Inlet on a regular basis, while other boaters travel to and from a large number of public and private docks, ramps, harbors, and beaches throughout

[70] Washington Water Trails Association, www.wwta.org/trails/cmt/index.asp (accessed December 3, 2012).

the region.[71] Due to strong currents and substantial shipping traffic, recreational boating in and around the project area consists of mostly thru-traffic, with some limited trolling and stationary sport fishing. Admiralty Inlet forms the principal entrance to all of Puget Sound and is utilized primarily as a traffic waterway rather than as a destination.

Many recreational boaters fish the marine waters of Admiralty Inlet for salmon, steelhead, many types of groundfish, and other species. Small parties in light, open boats, runabouts, and cabin-cruisers are not uncommon during more favorable weather. Some salmon charters operate virtually year round. Recreational anglers also use hook and line from beaches, piers, and docks. Others utilize pots, ring nets, and bare hands to capture Dungeness and red rock crab. Some clam-digging occurs on area beaches, and divers will forage for fish and shellfish as well.

Sportfishing, including trolling for salmon, is popular throughout Puget Sound. In Admiralty Inlet, the average sport catch of salmon from 2000 to 2006 was approximately 26,500 fish, with the vast majority being coho and pink.[72] Sportfishing with downriggers for Chinook salmon and bottom fishing for halibut and other species is known to occur at depths comparable to the proposed turbines. However, favored fishing areas are dispersed over a wide area of Admiralty Inlet, and the immediate site of the proposed turbines is not known to be a specific fishing destination.

Recreational diving in Admiralty Inlet typically takes place in waters close to shore and away from stronger currents. Popular diving locations near the proposed project include Admiralty Head Marine Preserve, adjacent to Fort Casey State Park, and the Keystone Conservation Area, a well-known and regionally significant diving destination. The Keystone dive area is managed as an underwater park and is located on the opposite side of the ferry harbor from Fort Casey State Park. A rock jetty comprised of large boulders forms an extensive underwater habitat supporting anemones, urchins, sea stars, rockfish, wolf eels, giant Pacific octopus, and many other watchable wildlife species. The upland area includes parking, restrooms, changing area, and showers.

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[71] The applicant reported that there were 244 marinas and 331 launch sites for small boats in the Puget Sound region, based on data contained in a 2003 report from the Puget Sound Action Team.

[72] The applicant-prepared EA reported the average catch over this period to be 35,500, based on personal communications with WDFW staff. The average catch of 26,500 stated above is based on data contained in the Washington State Sport Catch Report 2007, published by WDFW in September 2011.

Whale-watching outfitters offer spring, summer, and fall tours and have reported seeing whales throughout Admiralty Inlet, although most tours are focused on other locations (e.g., San Juan Islands). Species of interest include killer whales, minke whales, gray whales, harbor seals, harbor porpoises, Dall's porpoises, and California sea lions.

3.3.5.2 Environmental Effects

Project effects on recreation are primarily associated with minor, short-term disruptions and degradation of marine recreational uses during project installation, maintenance, and removal activities. These activities may prevent some boats from transiting the project area; however, these disruptions would generally last only a few hours or days. The degradation of recreational experience is mostly associated with temporary changes in the aesthetic character of the inlet during installation activities, which is addressed further below in section 3.3.8.2.

Effects on recreational activities during operation are also considered minor and are associated with potential interactions with fishing and diving near the turbines. Because the land-based components would not be located on land that is currently utilized or available to the public for recreation, project operation would not be expected to adversely affect recreational opportunities. Consequently, Snohomish PUD does not propose any recreational monitoring plans.

Snohomish PUD proposes to implement a Navigation Safety Plan to minimize potential hazards to fishing vessels in the vicinity of the project. These measures, discussed in greater detail in section 3.3.7, *Navigation*, below, include coordinating with the Coast Guard and NOAA to mark the installed turbines and the cable route on electronic and other navigational charts. Safety procedures would be reviewed annually with the Coast Guard and new precautions proposed for Commission review, if necessary. Snohomish PUD's Project and Public Safety Plan would provide for the distribution of informational materials on the project to commercial fishermen in coordination with Washington Sea Grant and to local recreational users in coordination with the Port Townsend and Central Whidbey Chambers of Commerce and the Washington State Parks and Recreation Commission (Washington PRC).

In its May 22, 2012, motion to intervene, the Whidbey Environmental Action Network expressed concern that the proposed project would degrade the natural environment, including fisheries and flora, which would negatively affect the area's recreational opportunities. Potential impacts to these resources are addressed in other sections of this EA; however, no adverse effects on these resources have been identified that would impact recreation in the area.

In its May 23, 2012 and February 14, 2013 comment letters, Interior recommends that Snohomish PUD work with the National Park Service, Ebey's Landing Historical

Reserve Trust Board, Island County Marine Resources Committee, and other stakeholders to develop and implement an interpretation and education plan in conjunction with the proposed project. In their June 22, 2012 response to Interior's recommendation, Snohomish PUD proposed to collaborate with National Park Service and other stakeholders to develop and implement a plan for establishing an interpretive and educational display at Snohomish PUD headquarters or at another appropriate location as agreed by the stakeholder group consulted, as long as the display does not require a significant commitment of resources and does not result in the expansion of the project boundary. The Washington DFW, in its comment letter of February 13, 2013, also supported the interpretive display.

No other agencies or interested parties voiced any additional concerns related to effects on recreational boating, fishing, or other recreational use (fishing concerns raised by the tribes are discussed in section 3.3.6.2).

Staff Analysis

All marine-based project components would be located underwater. Temporary effects to coastal recreation, such as visual impacts, could occur when equipment, such as tugboats, barges, cranes, and support vessels, install or perform maintenance of the submerged components of the project. In addition, during construction, coastal recreation may be affected by large infrastructure such as construction vehicles, transport vessels, and cranes that would be necessary to perform work activities. Though the presence of workboats and other vessels during project construction and operation may briefly impede the ability of recreational boaters to transit the project area or for fishermen to fish where facilities are being deployed, these effects would be temporary and involve only a very small area of Admiralty Inlet. Boaters should be able to easily navigate around these activities. These impacts would be temporary and minimized by a timely project construction schedule.

During operation, effects on recreational boating, fishing, and diving would be minor. Few recreational boaters would likely attempt to anchor in the vicinity of the turbines, due to the strong currents, nearby shipping and ferry traffic, and deep water. Implementation of Snohomish PUD's proposed Navigation Safety Plan would further minimize potential adverse interactions by alerting these users to the turbine's presence.

The risk to divers would also be very minor. The proposed turbine locations are not known to be in a recreational diving destination, and[73] only the more technically

[73] Advanced divers have visited the wreck of the *SS Governor* located several miles to the northwest at a depth of 240 feet.

experienced divers would be expected to possess the skills necessary to safely descend to the depth of the turbines (47 meters minimum). To access the turbines, a diver would need to approach the area under difficult conditions that include strong currents, poor visibility, exposed weather, and other boating traffic in the area. Snohomish PUD's Near-turbine monitoring program would alert Snohomish PUD in the unlikely event that divers are diving near the project and allow for the development of appropriate mitigation actions to ensure public safety.

Construction and operation may indirectly affect whale watching if these activities cause marine mammals to alter their behavior. While such effects are not expected, Snohomish PUD's marine mammal monitoring program would provide a means to monitor changes in marine mammal behavior and to take appropriate actions to minimize adverse effects, which would also benefit whale-watchers.

The proposed interpretive display would benefit visitors to the area by educating them about this new energy resource. However, the display would be more effective if it could be located within view of the project's turbine location in Admiralty Inlet. While the actual turbines would not be visible, the tidal currents that the project would rely on often are visible immediately offshore of Admiralty Head and Fort Casey State Park. This is consistent with the primary purpose of the project, which is to demonstrate the potential for tidal energy in Washington State and other coastal states, and would enhance the visitor experience and provide a new educational opportunity. While the display could serve as a key component of the recommended interpretation and education plan, few details have been provided by Snohomish PUD and others on the structure and goals of such a plan beyond the interpretative display. Consultation on the design and location of the display would help ensure that it is designed and sited consistent with the existing local recreation management programs of Washington PRC and the National Park Service.

3.3.6 Land and Ocean Use

3.3.6.1 Affected Environment

Land Use

The proposed project would be located in and adjacent to Admiralty Inlet, a major marine waterway between Whidbey Island and the Olympic Peninsula that forms the entrance to Puget Sound. The most urbanized areas of Puget Sound are south of Whidbey Island. Coastal areas around Admiralty Inlet, with the exception of Port Townsend, are generally more rural or undeveloped. The portion of Whidbey Island that is nearest the project is developed with a state park, the Port Townsend-Coupeville ferry terminal, an historic lighthouse, and a conference retreat center utilizing numerous historic buildings (Camp Casey). Farther north along the shoreline are large areas of public and private open space and park land.

Areas east of the ferry terminal include a public boat launch and beach access area, undeveloped state park lands, several residences, and additional open space. Recreation is the predominant land use in the immediate project area.

Ocean Use

A diversity of commercial and non-commercial uses occur in Admiralty Inlet, including marine shipping (e.g., container ships, tankers, barges); tugboat services; car and passenger ferry service; military vessel activities; subsea cables and communication services; maintenance and operation of docks, harbors, terminals, and navigation channels; commercial, tribal, and recreational fishing; cruise ships and charter services; general boating (recreational and otherwise); commercial and recreational diving; marine research; conservation; and beach and tideland activities. Ocean energy development does not yet exist in Admiralty Inlet, but has been considered at several locations, including the site of the current proposal.

Larger commercial vessels generally travel within or near established shipping lanes located roughly through the center of the waterway. Scheduled ferry service crosses the shipping lanes from east to west several times daily. Although marine traffic is substantial,[74] the proposed turbines would be located well outside these corridors. Other boating is more widespread, as are commercial, tribal, and sport fishing activities.

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[74] The applicant reports that container traffic through ports in Seattle and Tacoma totaled more than $70 billion in 2005 (citing the Trade Development Alliance of Greater Seattle, 2005). Much of the volume would have passed through these shipping lanes.

Although boating among smaller vessels is not routinely tracked or recorded, it is likely these vessels regularly occur in the general area of proposed turbine locations. The nearest developed harbor facilities are at the ferry terminal in Keystone Harbor. The harbor is dredged every few years to keep a channel clear for the ferry.

In addition, there are a number of subsea cables that traverse Admiralty Inlet in the proposed project area. Subsea cable GIS layers available from NOAA show at least 5 separate cables that run north to south through Admiralty Inlet.[75] The cable closest to the proposed project, the PC-1 Landing cable, is a trans-oceanic communications cable that runs in a loop between the U.S. to Japan, with two landing stations in Japan, and two landing stations in the U.S. Within Washington State, the PC-1 system includes two cables, a north cable (PC-1 North) that links with Japan and an east cable (PC-1 East) that links with a landing site in Grover Beach, California. Both cables traverse Admiralty Inlet and land at Harbour Pointe, in the town of Mukilteo, approximately 20 miles southeast of the proposed turbine installation site. The entire PC-1 cable system contains approximately 12,900 miles of subsea cable. PC-1 North is closest to the proposed project site.

Admiralty Inlet was closed to commercial salmon fishing in the early 1990s. Although sport fishing for salmon and limited tribal and non-tribal commercial fishing for other species occurs outside the shipping lanes, commercial fishing in the Inlet has declined by two-thirds since the 1970s. Commercially harvested species include herring (97 percent of the commercial catch), as well as spiny dogfish, sole rock, and starry flounder. Sport fishing and tribal fishing also target halibut and other groundfish. Scuba divers harvest geoduck clams, sea urchins, and sea cucumbers, while others use pots to capture Dungeness crab. The proposed site of the turbines is not known to be a specific fishing destination.

3.3.6.2 Environmental Effects

No conflicts with existing land uses have been identified or raised by stakeholders. Land uses would be unaffected by the construction and operation of proposed marine-based facilities, including the turbines and subsea power cable. Snohomish PUD indicates that adequate harbor facilities are available in the region to support the transit of equipment, materials, and personnel necessary to develop and operate the project. Construction of the control building would introduce a new use to the area; however, all equipment would be contained inside a modest building having the appearance of a typical residential garage, with no apparent effect.

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[75] See http://ocsgis.ncd.noaa.gov/ENC_Direct/encdirect_download.html.

However, with regard to ocean uses, the Tulalip Tribes, the Suquamish Tribe, and the Swinomish Indian Tribal Community are concerned that installation of the project would prevent the tribes from accessing their fishing grounds and adversely affect salmon and shellfish resources. Additionally, PC Landing is concerned that project construction and operation would increase the risk of harm to the operation of PC-1 North. No other conflicts or concerns have been raised in the record. Therefore, the analysis below focuses on tribal fishing access and interactions with PC-1.

Access to Tribal Fishing Grounds and Resources

The Tulalip and Suquamish Tribes assert that the project would impact fishing in areas used by the tribes and would interfere with the tribes' access to usual and accustomed fishing areas.[76] The Tulalip Tribes view the installation of the pilot project in Admiralty Inlet, within the Tulalip Tribes Usual and Accustomed fishing grounds and stations, as impairing, limiting, or eliminating tribal fishing access. The Tulalip Tribes state that the project threatens to impair passage of fish and degrade fish habitat necessary for the production of anadromous and resident fish stocks, to interfere with marine mammal migration and movement, and to interfere with the movement of currents, sediments, nutrients and forage fish; therefore, the Tulalip Tribes assert that the project is likely to cause unknown adverse impacts to treaty-protected fisheries resources. The Tulalip Tribes also state that the project and its associated on- and off-shore infrastructure may also interfere with tribal fleet movements and operations. They state that the presence of the turbines is a threat to long-line fishing gear, and that the mechanical brake would take too long to deploy to protect entangled long lines that could be used to fish for halibut near the turbines. The Tulalip Tribes request that the license be denied.

The Suquamish Tribe states that the project will negatively affect tribal fishing activity. Within Admiralty Inlet, the Suquamish Tribe conducts commercial, ceremonial, and subsistence fisheries that target multiple species including, but not limited to, demersal fish species, Dungeness crab, shrimp, and numerous bivalve clams. The Suquamish Tribe asserts that some harvest gear and methods "would be excluded by the presence of the turbines and cables."

The Point No Point Treaty Council also expresses concern regarding interference with the use of usual and accustomed fishing grounds for the Jamestown S'Klallam and

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[76] The Tulalip Tribes describe the usual and accustomed fishing areas relevant to the Admiralty Inlet project to include "Admiralty Inlet", including its Whidbey Island Bays, Sartatoga Passage, Penn Cove, and Holmes Harbor; and Possession Sound and Puget Sound south of Whidbey Island to the present West Pint Lighthouse, including Tulalip Bay and Port Gardner. See letters filed with the Commission by the Suquamish Tribe, dated 2/26/2010 and 10/9/2012, and by the Tulalip Tribe, dated 8/17/2012.

Port Gamble S'Klallam Tribes. They point out that though commercial fishing is currently prohibited in Admiralty Inlet, it cannot be assumed that it will remain so through the term of the license.

The Swinomish Indian Tribal Community also expressed concern that the project may alter migration or cause direct mortality on migrating salmon and steelhead vital to the Tribe and may reduce the productivity of rearing habitat or cause direct mortality of forage fish and shellfish rearing within the project area

Snohomish PUD asserts that the project would not impair the tribes' ability to exercise their treaty fishing rights because the project is sited in a specific location where there are currently no treaty fisheries occurring; there would be no navigational restrictions around the project through the Coast Guard; and there would be no permanent effects due to the short-duration of project (10 years) and site restoration measures following project removal. Regardless, Snohomish PUD would collaborate with the tribes in the event that the tribes decided to pursue a specific fishery within the geographic location of the project during the term of the license.

Staff Analysis

Potential effects on fish, shellfish, marine mammals and their habitats are discussed in section 3.3.3.2, *Marine Resources*. Snohomish PUD's proposed monitoring plans for these animals and their habitats are discussed there as well. Available data suggests that effects on these resources are likely to be minor to inconsequential, but the various monitoring plans proposed by Snohomish PUD would help determine if adverse effects are occurring and to identify and take appropriate mitigation. Therefore, there should be no effect on availability of resources important to the culture and use of the various Tribes.

Although the Tribes and commercial fishermen fish in Admiralty Inlet, the record suggests that commercial fishing (tribal and non-tribal) is not known to occur on a regular basis near the turbine sites or over the route of the cables. Regardless, during installation of the turbines, tribal (and other commercial) fishing vessels attempting to fish near the project or to traverse through the project area to get to desired fishing grounds would have to steer around the various barges and vessels. However, such effects would be short-term (20 days) and minor considering the vast expanse of the Admiralty Inlet. The project, and installation of various components, would occupy less than 0.05 percent of the horizontal cross section of Admiralty Inlet. Snohomish PUD's proposed Navigation Safety Plan would alert all mariners, including tribal fisherman, to the temporary installation activities so they could plan their fishing accordingly.

Once the turbines are installed and operating, no travel restrictions over the turbines would be required; therefore project operation would not affect tribal fleet movement, operations, or access to fishing grounds. The Coast Guard has determined

that a Regulated Navigation Area (RNA), which would have restricted towing, anchoring, bottom fishing, dredging, or other deep-water activities in the RNA is not needed at this time. However, if issues arise during operation, these restrictions might be reconsidered, and the tribes would be afforded the opportunity to express their concerns before such implementation.

Tribal and other fishermen would not likely want to anchor or use nets, dredging, or long-line fishing gear in the immediate area of the turbines and power cables to avoid losing the valuable gear. Any fishing gear that becomes entangled with the turbines likely would be lost, regardless of the braking system. As noted earlier, the probability of this occurring is small considering that the turbines will be marked on navigation charts and there would be navigational restrictions to maneuver to avoid the turbines. Any such effects would be minor considering the limited use of the area due to the proximity of the shipping lanes, the temporary nature of the project, the presence of the strong tidal currents, the small size of the project relative to the vast area of the inlet, and the presence of known fishing areas in the inlet that are located several kilometers or more from the proposed turbine sites.

Interactions with PC-1 North

PC Landing asserts that by installing the two turbines within 170 and 249 meters of PC-1 North that Snohomish PUD is unduly increasing the risk of damaging the cable during installation and maintenance activities. Damage would likely come from either dropping the turbines or an anchor from the installation or monitoring vessels on the cable. PC Landing states that during a maritime emergency, a ship's captain may elect to drop an anchor, even in a no-anchor zone, to protect life or property; consequently working close to PC-1 North would subject the fiber optic cable to unnecessary risk of damage. PC Landing stated that unplanned maintenance and repair activities may occur in inclement weather or adverse tidal conditions, which could push vessels maintaining or installing the turbines off-course, increasing the risk that project vessels may anchor in the area of PC-1 North. PC Landing also states that locating the project so close to PC-1 North reduces its ability to maintain and repair the cable in case of a cable fault, whether damage to the cable is related or unrelated to the project. PC Landing recommends that Snohomish PUD relocate the turbines to a site that is 750 to 1,000 meters from PC-1 North in accordance with International Cable Protection Committee[77] (ICPC)

[77] ICPC is a non-profit organization that helps to protect submarine cables from man-made and natural hazards. ICPC publishes recommendations, responds to information requests, facilitates exchange of information, and provides other services to submarine cable owners, maintenance authorities, and manufacturers; cable ship operators; submarine cable route survey companies; governments; and other seabed users. ICPC is a non-governmental organization and has no regulatory authority.

recommendations, but suggested that an area between at least 500 to 950 meters may be suitable for development.[78] In the alternative, PC Landing requests that the Commission deny the license application.

In response to concerns raised by PC Landing and the FCC, Snohomish PUD reexamined site energy characteristics and determined it could increase the turbine separation from PC-1 North from 104 and 150 meters to 170 and 249 meters (as measured from the centroid of the turbines); however, any further modification was not possible because it would likely prevent achieving the project's objectives of gathering information to determine if the energy potential for a commercial scale project is feasible and possible environmental effects of the turbine technology, both at the pilot and commercial scale. In support of the conclusion, Snohomish PUD explains that its chosen site includes high resource intensity; water depth reflective of commercial-scale conditions; seabed and slope stability adequate for gravity foundation deployment; a location outside of high vessel traffic and close enough to shore to enable marine mammal monitoring by shoreline observers; ease of grid connection; and lack of impact to infrastructure (i.e., crossing of PC-1 North). Snohomish PUD states that it considered but abandoned sites with potentially higher kinetic power densities in Admiralty Inlet as too shallow for installation of the turbines, too close to major shipping channels, too steep a seabed slope, and substantially longer power cable runs.

Snohomish PUD also asserts that installation, maintenance, monitoring and removal would not pose a risk to PC-1 North because such operations do not require the use of anchoring (i.e., "live-boat" techniques), except during the installation of the trunk cables at the HDD sea floor exit, which would be located over 1,666 meters (5,300 feet) from the PC-1 North cable. To provide greater stability and back-up in case of vessel problems during installation, Snohomish PUD would use at least two tugboats to stabilize the installation vessel and two tugboats to stabilize the cable lay vessel. In addition, Snohomish PUD proposes to develop a Hazard Identification and Risk Assessment (HIRA) in consultation with the Coast Guard, the Corps, and PC Landing prior to marine operations that includes: (a) criteria for what weather and wave conditions must exist before marine operations can occur (e.g., wind speed less than 20 miles per hour, waves less than 2 meters, with a tidal velocity window of less than 1.5 knots, and during a

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[78] In response to Commission staff inquiries as to possible alternative locations, PC Landing identified an area for further study that is located west of the proposed turbines and about 500 to 950 meters from PC-1 North. The proposed study area would be limited by the navigational channel and geologic hazard zones, and exhibits a wide region of gradually varying slopes, mostly between 0 and 2 degrees. Snohomish PUD stated slopes less than 5 degrees, depths between 40 and 100 meters are needed for successful project installation.

running tide, with certainty of conditions remaining prevalent for duration of deployment or recovery); (b) use of industry-approved equipment and redundancy in the use of equipment and vessels (e.g., back-up tugboat for emergencies; towing gear, barge, winches, winch wire, and hydraulic lifting tools that are new or certified based on industry standards); (c) criteria for aborting operations; and (d) an established "port of refuge," located kilometers away from PC-1 North, in the event of unanticipated adverse weather or other event. The HIRA would be developed after the issuance of any license for the project. Snohomish PUD has also committed to coordinate with PC Landing on any repairs needed in the vicinity of the project to ensure no damage occurs to either party.

Because of PC-1 North's importance to the American public, business, and financial institutions, the Public Safety and Homeland Security Bureau of the Federal Communications Commission (FCC), which licensed PC Landing's fiber optic cable on November 19, 1998,[79] initially recommended on May 23, 2012, that the Commission consider requiring a 500-meter separation between the turbines and PC-1 North. The FCC's recommendation was based on concerns that at a separation distance of about 100 meters, Snohomish PUD may need more room to safely affix the turbines to the seabed and that maintenance of the fiber optic cable could be impaired by the presence of the turbines. Using ICPC recommendations,[80] the FCC recommended a separation distance of 500 meters.[81] On August 28, 2012, Snohomish PUD responded to the FCC's concerns, moving the turbines to 170 to and 249 meters from PC-1 North and defining strict conditions under which installation and removal would occur (described above). On October 4, 2012, the FCC stated that Snohomish PUD's August 28, 2012, filing presented relevant information indicating that installation and removal would not impair

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[79] *See* In the Matter of PC Landing Corp., *Cable Landing License*, 13 FCC RED 23384.

[80] *See* "ICPC Recommendation No. 13, Proximity of Wind Farm Developments and Submarine Cables," ICPC, 2007.

[81] The ICPC recommendations are based on the distances required for a cable ship to carry out a cable repair relative to wind farms. With respect to wind farms, the recommendation is that the position of turbine structures in relation to existing submarine cables should allow access for a ship to repair an existing submarine cable. The distance is dependent on the depth of water where the cable is buried, and takes into account the length of a typical cable repair ship, the distance required to retrieve a cable using a grapnel, and a buffer of safety around the wind farm installation. Using the same principles for wind energy farms, the FCC recommended a distance of 500 meters, allowing 450 meters for "run-on (the distance between the submarine cable and the point at which the grapnel hits the ocean floor).

the ability to repair PC-1 North. Therefore, the FCC does not oppose licensing the project at the new distances from PC-1 North as long as the Commission determines that the project does not present a material risk to PC-1, and the Commission is able to ensure through its own licensing process (via imposition of conditions if appropriate), that Snohomish PUD and its agents, contractors and successors adhere to the safety and separation distance representations it has made in its August 28, 2012 filings. The Naval Seafloor Cable Protection Office similarly concluded that the changes and conditions noted also alleviate the concerns of its office (pers. communication via email, Catherine Creese, Assistant Director, Naval Seafloor Cable Protection Office, with David Turner, FERC, October 24, 2012).

Staff Analysis

Potential effects upon PC-1 North would either be from direct damage caused by physical interaction with the cable, or indirect effects from reduced access to existing cables for maintenance or repair work. OpenHydro has successfully deployed turbines using the "live-boat" techniques under the sea-state conditions described above on three occasions—two of which involved larger turbines and heavier subsea bases than those that would be installed at Admiralty Inlet, in areas of much stronger currents—with an accuracy of between 2 and 3.4 meters.[82] Installing the turbines using the "live-boat" process and only under the most favorable weather and tidal conditions (wind speed less than 20 miles per hour, waves less than 2 meters, with a tidal velocity window of less than 1.5 knots, and during a running tide[83]) would further ensure historical accuracy in installing the turbines and minimizing any potential for inadvertently dropping the turbines on the cable. Given the short period required to install each turbine (less than two hours), favorable weather and tidal conditions are likely to be available and remain throughout deployment. Snohomish PUD's proposed use of industry-approved equipment and equipment redundancy, development of criteria for halting installation and establishment of "port of refuge" located away from PC-1 North would minimize the potential of unexpected emergencies and adequately define procedures that would be

[82] In 2008, OpenHydro deployed a 6-meter, 220-ton turbine and gravity foundation off the coast of Orkney Scotland in less than 1 hour and within 2 meters of the target deployment coordinates. In 2009, OpenHydro deployed a 10-meter, 280-ton turbine a gravity foundation in the Bay of Fundy, Nova Scotia in under 1 hour and within 2.8 meters of the target location. In 2011, OpenHydro installed a 16-meter, 1,000-ton turbine and gravity foundation off northern Brittany's coast in France in under 1 hour and within 3.4 meters of the target location.

[83] This ensures that ensures the tugboat and barge and turbine have the correct orientation to tidal direction. This tidal orientation is parallel to, or away from, PC-1 North, further decreasing the risk to the cable.

implemented if those emergency conditions arose. Involving Coast Guard, the Corps, and PC Landing in the development of the HIRA would further ensure that their experience and operational needs are considered.

Physical interactions between the turbines once installed and the buried cable do not appear to be likely. The supporting design report predicts that the turbines will resist overturning with a factor of safety greater than three (i.e., the structure can withstand more than three times the expected load on the structure from the tidal currents without overturning) at all three vertices of the subsea turbine base. An encounter with tow cables or chains from tugboats is not anticipated to overturn the approximately 250-ton turbines. Therefore, physical interactions after installation are anticipated to be insignificant.

Given the small number and footprint of the turbines, the presence of the turbines would not prevent PC Landing's ability to repair PC-1 North in the very unlikely event of a cable fault at the turbine location not related to project installation or maintenance,[84] which for the reasons explained above are expected to be minimal. Even then, a repair could be successfully implemented, but would require procedures and additional cable that are not unlike procedures that would be applied if other obstructions were to be encountered during such a repair.

Subsea cable breaks or other malfunctions are typically repaired by a cable repair ship working as close as feasible to the break. Typically, an ROV or grapnel[85] is used to find the cable fault or break in a fiber optic cable, cut the cable near the cable fault, and retrieve the two ends for splicing with a new cable on the repair ship. Once aboard, the

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[84] The primary cause of cable disturbance is external damage from human activities, as opposed to damage occurring from natural events, such as earthquakes. The number of length-normalized faults in submarine cables installed in shallow (less than 3,280 feet deep) water is less than 0.35 faults per year per 3.28 million feet of cable installed (Kordahi et al. 2007). Using the failure rate of 0.35 faults per 3.28 million feet of installed submarine cable per year, the expected fault rate of the cable in the vicinity of the turbines is 0.1%, or 0.001 faults per year. The probability that a fault would occur from an event not associated with the installation, operation, maintenance, or removal of the turbines that would require repair during the proposed term of any license is considered insignificant.

[85] A long cable with a specialized hook on the end that is dragged either along the seabed or through the subsea floor (if the cable is buried) at a right angle to the cable until the hook "grabs" one of the cut cable ends.

two cut ends are repaired and spliced back together, and the repaired cable is installed on the seabed or reburied.

If a cable fault occurred at the turbine location, the ship would have to make a cut in the cable north of the turbine and a second cut in the cable south of the turbine. This would leave a north end, a center section, and a south end. The cable north end would be hauled to the surface and spliced to a new cable section on board the ship sufficient to span the distance between the north cut and the south cut. The cable south end would then be brought to the surface and spliced to the other end of the new cable section. The repaired cable, with the new section installed, would then be relaid on the sea floor or buried, as required. The center section may be removed from the sea bed for disposal or left in place, depending on the circumstances of the project. The time required for a repair ship to make the additional cuts, the additional time to repair two spliced ends instead of one, the additional time to relay the longer length of cable on the sea floor (which may include burying the cable), and the cost of the new cable required to span the length of sea floor between the north and south cuts with enough slack to be lowered from the repair ship, would all contribute to an increased cost to repair the cable. The additional cuts and repairs would also lengthen the time of cable outage, resulting in lost data transmission for PC Landing's customers. Customers of PC Landing may purchase protection to have their data rerouted via other networks in the event of a cable disruption. Per PC Landing's August 1, 2012 filing, customers representing 16 percent of the sold capacity on the system have purchased protection that would automatically reroute their data to other PC-1 segments. Other customer traffic would be rerouted if available capacity existed within the system, but additional time delays may be incurred if the rerouting was done manually.

Snohomish PUD estimated an additional 4-8 hours; however, PC Landing says it would be "significantly greater", but did not say how much greater, only stating this non-standard operation would add significant cost, delay, and complexity to the repair operation.

Moving the turbines further away from PC-1 North could eliminate them as obstacles to such a repair, but would expose the turbines to higher vessel traffic and a greater potential for adverse interaction with tugboats towing large barges. Moreover, as noted by Snohomish PUD, the further away from the shore the turbines are located the more difficult it becomes to implement the Marine Mammal Mitigation and Monitoring Plan, increases the cost of power cable installation, and would require crossing PC-1 North with the power cable.

3.3.7 Navigation

3.3.7.1 Affected Environment

Admiralty Inlet is located between the Olympic Peninsula and Whidbey Island where the northwestern end of Puget Sound meets the Strait of Juan de Fuca. Essentially all maritime traffic transiting to and from the ports of Seattle, Tacoma, Olympia, and Everett must pass through Admiralty Inlet. In 2011, the Port of Seattle was the sixth largest U.S. port based on shipping volume.[86] Admiralty Inlet also supports naval traffic associated with Naval Station Everett, Puget Sound Naval Shipyard, and Bangor Submarine Base. Additional maritime traffic is generated by the Port Townsend-Keystone ferry, which runs between Port Townsend and the Keystone community near Coupeville on Whidbey Island. Recreational uses of Admiralty Inlet, including boating, diving, recreational fishing, and camping also contribute to the volume of maritime traffic.

Activities in and adjacent to Admiralty Inlet are regulated by federal, state, and local authorities, including the Corps and the Coast Guard. The proposed location of the tidal energy project is in a Regulated Navigation Area subject to Coast Guard Vessel Traffic Service (VTS) control. VTS monitors, tracks, and communicates with all commercial vessel traffic in Puget Sound to facilitate the flow of maritime commerce and prevent accidents between multiple vessels using the inlet. The project is located approximately 3,000 feet east of the northbound lane of a regulated and International Maritime Organization-established Traffic Separation Scheme (TSS) (figure 11).

Maritime traffic transits the Inlet via northbound lanes when exiting Puget Sound into the Strait of Juan de Fuca, or southbound lanes when entering Puget Sound from the Strait of Juan de Fuca. A separation zone acts as a buffer between the northbound and southbound traffic to prevent vessel collisions.

The turbines would also be located 2,800 feet to 3,000 feet from the Coupeville – Port Townsend ferry route. The ferry operates year round, but provides more crossings of Admiralty Inlet during peak summer season. The number of daily crossings varies depending on weather conditions, the number of ferries available, and maintenance issues.

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[86] http://www.portseattle.org/About/Publications/Statistics/Seaport/Pages/default.asp.

20130809-3010 FERC PDF (Unofficial) 08/09/2013

3.3.7.2 Environmental Effects

Turbine and cable installation, maintenance, and removal will require barge, tugboat, and personnel vessels to operate in the project area for periods of up to 20 days. On-shore operations for the horizontal directional drilling are anticipated to take 45 days, with divers and ROVs used during specific operations. Unplanned maintenance activities could result in additional boat traffic in the area of the turbine installation. Such activities could represent temporary obstacles to navigation. Following installation, the project turbines could represent a navigational hazard for tugboats and the vessels in tow if their tow lines were to be slack enough to encounter the turbines.

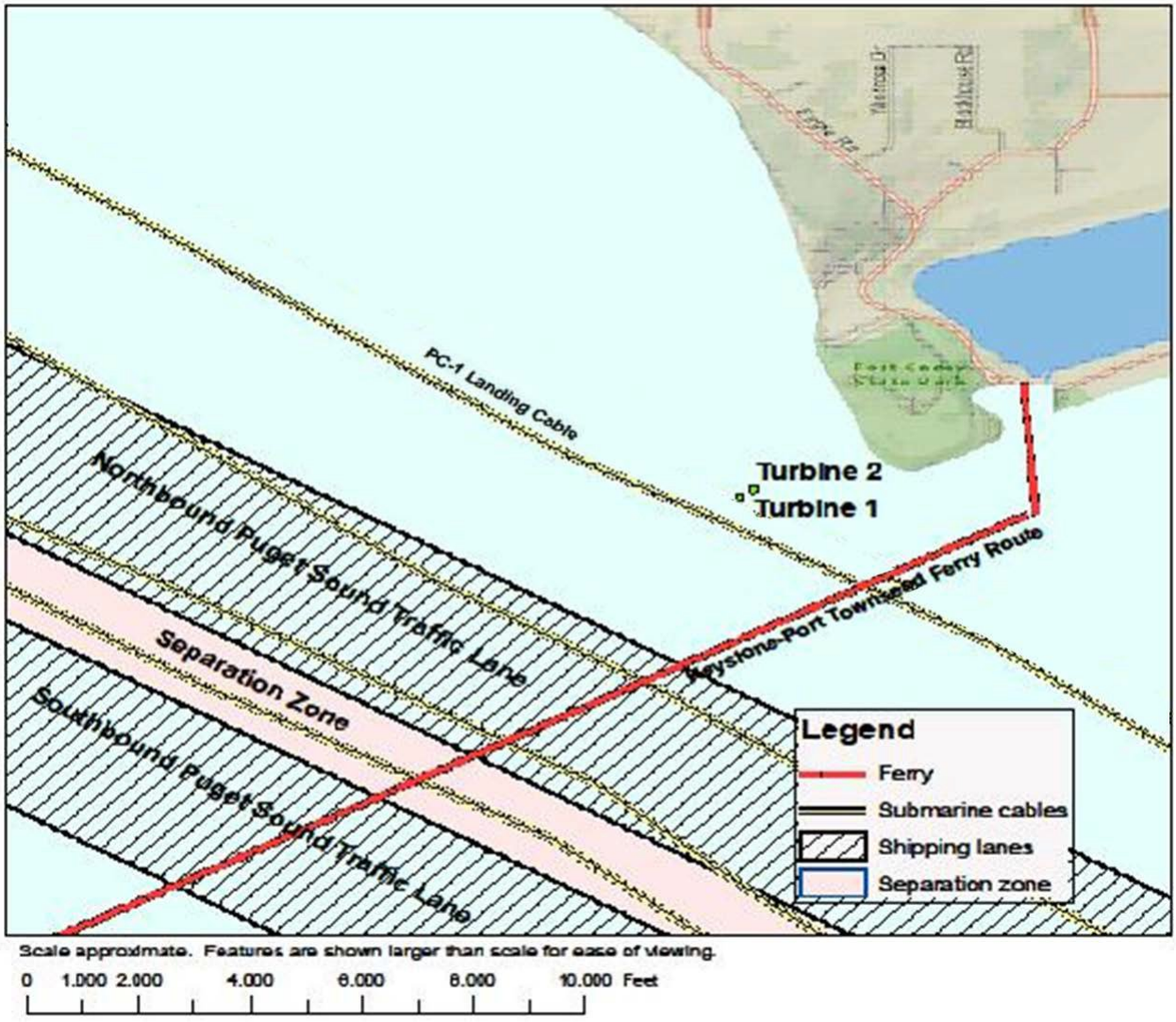

Figure 11. Location of proposed turbine installations, shipping channels, and submerged cables in Admiralty Inlet (Source: NOAA,[87] and applicant, as modified by staff).

Strong and turbulent currents complicate navigation and reduce tugboat maneuverability in the vicinity of the project. When tugboats are in motion, their towlines do not have a great deal of slack hanging in the water. However, if the tugboat and its tow both significantly slow to avoid other maritime traffic (such as two ships

[87] NOAA EIC Direct to GIS, accessed May 11, 2012 at http://ocs-spatial.ncd.noaa.gov/encdirect/viewer.htm.

meeting head-on) or for other reasons, the tugboat and its tow may move closer together and the towline between the ships will start to develop slack that hangs in the water between them in a catenary fashion. Depending on the length of the towline, this slack can be significant. The American Waterways Operators (AWO) asserts that tugboats and their vessels transiting the area can have towlines or chains that are up to 1,500 feet long and can dip 80 to 120 feet below the surface of the water. AWO also asserts that occasionally larger, faster-moving ships in the shipping lane can crowd the smaller, slower-moving tugboats out of the shipping lanes. If both a southbound and a northbound tugboat with a tow are diverted east of the shipping lanes, one or both ships may reduce speed and/or maneuver further east to avoid meeting head-on. The increased length of the towline resulting from the slowing of the tugboat and the movement of the tugboats east of the shipping lane could increase the likelihood that the slack towline could catch on the submerged turbines. If towlines were to catch on the turbines, it could cause damage to the vessels, their cargo, and potentially present a safety hazard to the crew. AWO and the Coast Guard recommend that Snohomish PUD not include buoys as they could create an additional navigational risk for vessels that would have to move around them.

To minimize potential navigation hazards posed by the project, Snohomish PUD developed a Navigation and Safety Plan[88] that includes provisions for (1) ensuring that all project vessels will comply with the International Rules for Preventing Collisions at Sea (COLREGS) in markings and operation, (2) ensuring that all such project vessel operations would be coordinated with the Puget Sound VTS, (3) conducting, at minimum, annual discussions with the Coast Guard to review project safety; and (4) reviewing the Navigational Safety Plan with the Coast Guard following any navigation safety issue that may arise during installation, operation, or decommissioning of the project.[89] Snohomish PUD would also distribute informational materials on the project to local commercial fishermen in coordination with Washington Sea Grant, and to local recreational users in coordination with the Port Townsend and Central Whidbey Chambers of Commerce and the Washington PRC.

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[88] One of the plans within the Project Safeguard Plan filed as Appendix E of the license application. A revised Navigational Safety Plan was filed with the Commission on November 16, 2012.

[89] Snohomish PUD originally proposed a Regulated Navigation Area (RNA) around the project to further reduce potential accidental encounters with other vessels; however, after consultation with the Coast Guard, Snohomish PUD removed a RNA from their proposal. The Coast Guard reserves the right to require a RNA or other project safety provisions, if needed, in the future.

In addition to the measures proposed by Snohomish PUD in the Navigation and Safety Plan, the location of any submerged hydrokinetic device installed in Admiralty Inlet would be forwarded by the Coast Guard to NOAA for inclusion in the U.S. Coast Pilot[90] and on electronic and printed navigation maps.[91] The location would also be publicized to local mariners by the Coast Guard.

Washington State Ferries also stated that the summer months are the busiest months for passenger ferry traffic, and that any interruption of ferry traffic would directly affect ferry operations and the local economy.

Staff Analysis

A number of factors reduce the project's potential effect on navigation. The turbines will be deployed outside the regulated TSS and ferry routes by approximately 2,800 feet to 3,000 feet, limiting the potential conflicts with the majority of vessels transiting through Admiralty Inlet. The short period for installation, maintenance, and removal activities and small footprint required for such activities would not represent a major navigational risk. Snohomish PUD's proposal to have all marine vessels associated with the project comply with the COLREGS, and to coordinate all vessel operations with the Coast Guard would reduce the likelihood of adverse interactions between the surface vessels and other marine traffic in the area. ROV monitoring equipment and maintenance personnel would have a reduced likelihood of adverse interactions with other marine traffic by the Coast Guard alerting or diverting other vessels in the area through the VTS.

Following turbine deployment, the turbines would represent only a minor risk to navigation because of the application of existing safeguards provided by the Coast Guard's VTS tracking and warning system and the depth of water. For those vessels that do leave the vessel traffic lanes and traverse over the proposed installation site, the depth of turbines (the top of the turbine will be approximately 140 feet below the water surface) would limit potential interactions to only those very few vessels with a tow line, chains,

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[90] The U.S. Coast Pilot is a series of nautical books that contain supplemental information that is difficult to portray on a nautical chart. Topics covered in the Coast Pilot include channel descriptions, anchorages, bridge and cable clearances, currents, tide and water levels, prominent features, pilotage, towage, weather, ice conditions, wharf descriptions, dangers, routes, traffic separation schemes, small-craft facilities, and Federal regulations applicable to navigation.

[91] *See* "Telephone Memo" filed November 28, 2012, between Coast Guard and Commission staff.

or other equipment that would fall at least that far below the surface of the water. The project would not be expected to affect any communications, radar, or positioning systems that would prevent a vessel from identifying or being notified of the turbines by the VTS system in case of an emergency. Existing restrictions on commercial salmon fishing in the vicinity of the project reduces the potential risk of fishing gear becoming entangled in the turbines.

The potential for a tugboat's towline to snag a turbine is small. The installation site is over 2,800 feet from the navigation channel, which limits the number of marine vessels that traverse over the site. For calendar year 2010, 113 vessels passed within 650 feet of the proposed installation site based on information provided by the Automatic Identification System.[92] Snohomish PUD's risk assessment determined that the likelihood of two vessels meeting head-on in a 2-mile-long by 0.75-mile wide area over the proposed installation site would be less than one occurrence per month.[93] Therefore, approximately once per month there is a potential for one or more vessels transiting near the turbines at the same time to be required to change course to avoid a close passage. The Coast Guard's VTS tracking system would warn approaching vessels in the vicinity of the turbines, providing the tugboats sufficient notice to either avoid the turbines or winch in their tow cables to reduce the length of slack line that might encounter the turbines. The turbine installation site represents less than 0.05 percent of the horizontal cross-section of Admiralty Inlet. The sparse traffic outside of the navigation lanes should provide adequate room for vessels to alter their course to avoid transiting over the small area occupied by the turbines when cable tow lines are likely to be slack. The location of the turbines would also be publicized on navigational charts and through other sources so that mariners could avoid inadvertent interaction with the turbines.

The state ferry route does not approach the turbine locations, although it does cross over the proposed alignment of the power cables. It is highly unlikely the ferry would deploy an anchor or otherwise interact with the cables. Ferry service is highest during the summer season of June 16 through September 24, which falls within the

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[92] The Automatic Identification System (AIS) is an automated tracking system used on ships and by VTS for identifying and locating vessels. The AIS is fitted aboard ships that make international voyages with gross tonnage (GT) of 300 or more tons, and all passenger ships regardless of size. The AIS is designed to assist traffic monitoring personnel at VTS or other maritime authorities and watchstanders aboard ship by facilitating the tracking and monitoring of vessel movements.

[93] "Head-on" for the purposes of this assessment was defined as two vessels both being present in the 0.75-mile-wide, 2-mile-long area over the proposed installation within 15 minutes of each other.

proposed installation work window of July 16 to October 14. During the proposed 19-day installation period for the trunk cables, the Horizontal Directional Drilling Plan states that a diving support crew would be deployed during mobilization to verify a profile of the ocean floor and would be deployed when the drill exits the sea floor. These two installation days would introduce diving vessels in the vicinity of the ferry boat traffic. Two additional dives of approximately two hours each would be needed to connect the trunk cables to the turbine cables; however, this connection point is located well outside of the ferry route as shown on NOAA navigation charts. If the installation of the trunk cables is coordinated with the Washington State Ferries, and diving vessels avoid the scheduled ferry service route, then minimal impacts on ferry traffic would be expected.

The small footprint of the project reduces the probability of encountering the turbines and allows for continued navigation around the proposed project, as necessary. Operation of all vessels associated with the project using COLREGS standards and in coordination with the Coast Guard would help minimize adverse interactions with other vessels in the project area during construction and installation, maintenance, and removal of the project. Continued consultation with the Coast Guard throughout the term of any license issued for the Admiralty Inlet Project would ensure that appropriate safety measures remain in place and any scheduled or unscheduled events that could affect navigation are appropriately addressed and necessary steps are taken to maintain public safety. Commission notification within 10 days of any adverse navigation event would allow Commission staff to coordinate the implementation of any unanticipated safety measures with Snohomish PUD and the Coast Guard.

While the proposed project has the potential to affect navigation in Admiralty Inlet, most of these impacts would be minimal because the project is located outside of the normal marine vessel transit routes, the Coast Guard directs traffic in the area of the turbines through the existing VTS, and the turbines would be installed below navigational traffic depth. While the trunk cable route crosses the normal ferry vessel route, the potential number of interactions during the cable installation would be small and of short duration each, which would not be anticipated to cause adverse impacts to ferry operations. The small footprint of the project and Snohomish PUD's proposal to implement the Navigational Safety Plan would mitigate any of the minor effects of the project on navigation in Admiralty Inlet.

3.3.8 Aesthetic Resources

3.3.8.1 Affected Environment

Admiralty Inlet offers many scenic vistas and outdoor recreation opportunities that appeal to residents and visitors year round. Several state and local parks and a national historical reserve exist in the vicinity of the proposed project and provide viewpoints from which to observe the waters of Admiralty Inlet and surrounding landscapes. The shoreline nearest the proposed turbine locations, Admiralty Head, is predominantly a

mixed sand and gravel, bluff-backed beach with a large upland area occupied by Fort Casey State Park. The park affords sweeping views of the Inlet, the Olympic Peninsula, and Port Townsend. A popular viewing area is the broad, grassy bluff and historic gun batteries that overlook the Inlet and the proposed site of the underwater turbines. An undeveloped area of the park exists along the shoreline of Keystone Spit near the site of the proposed control building.

Ebey's Landing National Historical Reserve surrounds and includes the state park and other lands and offers extensive views of picturesque farmland, wild bluffs and beaches, Admiralty Inlet, and the Cascade and Olympic Mountains. The proposed control building and portions of the power cables and transmission line would be located on a private parcel within the reserve. This parcel and several neighboring properties are developed with homes and accessory buildings. These homes include historic properties, including the Schulke/Steadman House immediately west of the control building site.

The Whidbey Scenic Isle Way is a 54-mile state-designated scenic byway that runs the length of Whidbey Island and passes through the project area. This unique island byway provides convenient access to area towns, beaches, parks, wildlife areas, and historic sites, and includes a branch (State Route 20) connecting to the Port Townsend-Coupeville ferry terminal adjacent to Fort Casey State Park. The ferry crossing passes within 1.5 kilometers of the proposed turbine sites. The proposed control building would be located adjacent to the byway in a relatively quiet and lightly developed area a half kilometer east of the ferry terminal.

3.3.8.2 Environmental Effects

The project includes marine and land-based components that could potentially affect aesthetic resources. Because the marine components (two 6-meter turbines and subsea cables) would be located on the sea floor approximately a half kilometer west of Admiralty Head, they would not be visible or audible from land or water, and therefore, would have no lasting effects on aesthetic resources. However, short-term effects are likely during project construction, monitoring, maintenance, and removal activities, when marine vessels, equipment, and the turbines would be visible in Admiralty Inlet and Admiralty Bay. Upon arrival, the 6-meter diameter turbines would likely be conspicuous from Fort Casey State Park and other nearby viewing areas, but would remain above water only briefly. Snohomish PUD indicates they could be deployed in a single 6-hour tidal cycle, which would substantially diminish any potential visual impact. Deploying the turbines, laying the subsea cables, and other associated marine activity would be of a short duration, with all marine installation activities expected to be completed within 20 days. Most activity would be located a half kilometer or more from likely viewing areas at Fort Casey State Park and the ferry terminal, resulting in only minor, temporary effects. Some marine activities may be audible onshore, but are not expected to generate any significant noise concerns. No mitigating measures are proposed or recommended for this activity.

Snohomish PUD projects that the primary visual disturbance would occur during the land-based HDD bore drilling process. Up to six large trucks would deliver equipment and materials to the site. A drill rig would be set up on the property to drill an HDD bore beneath the beach and nearshore area, exiting underwater at a point at least 18 meters below the surface. Sections of the 10-inch diameter conduit liner would be partly assembled on the beach then towed seaward a short distance before being hauled through the bore. The power cables transmitting power from the turbines to the control building would be hauled by cable through the lined bore to a connection point at a subsurface vault adjacent to the control building. This drilling, assembling, and hauling activity would extend over a 45-day period and would likely be visible and audible to area residents, travelers on the ferry and scenic byway, nearby boaters, and those recreating along the beach. The activity would be substantial, resulting in temporary noise and visual effects on neighboring properties and those who may be traveling or recreating in the area. No lasting effects would be expected because Snohomish PUD would revegetate all disturbed areas following installation.

The control building would be the only substantial aboveground component that would be visible over the life of the project. Measuring 24 by 30 feet, and approximately 16 feet in height, the size of the control building would be comparable to other structures in the area. Due to the sensitivity of the site's location along the scenic byway and within the Ebey's Landing National Historical Reserve, the appearance of the structure could potentially conflict with the historic character and visual quality of the reserve and byway.[94] To minimize these effects, Snohomish PUD proposes to design the control building to be generally compatible with existing buildings in the surrounding area.

As with project construction and installation, project removal could also affect views from nearby areas. Removal of the marine-based components would require the presence of several marine vessels, a barge, one or more tugboats, and a personnel transfer/safety boat. Visual effects would likely be minor and of short duration. Snohomish PUD would remove the land-based components according to the terms of the agreements with the private property owner and Puget Sound Energy. It is expected that if the project is terminated, equipment would be quickly removed and the control building would be utilized by the homeowner as a garage. Any newly disturbed areas would be revegetated, as needed.

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[94] A previous configuration of the project proposed locating the control building at Camp Casey to the north of Fort Casey State Park, which raised a concern about aesthetic impacts in a comment letter from the National Park Service. Snohomish PUD agreed to design the structure consistent with Camp Casey historical guidelines, which alleviated the concern. No comments were received regarding the relocation of the control building to Keystone Spit, which is also within the national historical reserve.

In their May 22, 2012, motion to intervene, the Whidbey Environmental Action Network expressed concern that the aesthetic character of the natural environment may be degraded by the proposed project.

The HDD bore drilling process, as described in Snohomish PUD's HDD Plan, would be likely to generate substantial noise that may affect residents, travelers, and recreationists in the vicinity of the project, including visitors to Fort Casey State Park, those utilizing the ferry and scenic byway, and boaters who may pass through the area while drilling is underway. The drill rig, associated pumps, vehicles, and other equipment could be moderately or highly disturbing to the quiet ambience that people in the area may be more accustomed to. The impacts would be temporary and are expected to last approximately 45 days. Snohomish PUD intends to conduct the HDD drilling up to 12 hours per day over a seven day period, but does not propose other measures to reduce noise, such as temporary sound barriers.

Equipment housed in the control building, including transformers, power inverters, and conditioners, cabling, and heating, ventilating, and air conditioning systems, may also create low-level noise that would be audible outside the control building over the life of the project. The impact would likely be minor and may only affect the nearest residences. No measures are proposed to minimize this potential noise impact.

Staff Analysis

Although the presence of marine vessels during project installation or removal (e.g., turbine deployment barge, cable-laying barge, tugboats, and small support vessels) could potentially affect the viewshed from Fort Casey State Park and other nearby areas, these vessels are expected to be no more conspicuous than vessels associated with frequent shipping traffic through Admiralty Inlet. Moreover, such effects would be temporary and short-term (lasting up to 45 days).

It is expected that noise from HDD drilling activity could be considerable and may be disruptive to neighboring residences. However, the impact would likely be comparable to other general construction activity involving heavy equipment, such as utility or road construction. Although the work is expected to be completed in seven days operating 12 hours per day, it is not uncommon with HDD drilling for unexpected problems to arise where it may become necessary to continue operating equipment for more than 12 hours at a time. If this were to occur here without a contingency plan in place, noise impacts to nearby residents could become more significant. Typically, when a noise sensitive area (NSA) is located within a half-mile of the noise source, additional measures may be necessary to maintain day-night sound levels below 55 dB within the

NSA.[95] The NSA in this instance would be the adjacent residences near the drill rig. Having a contingency in place that includes the placement of temporary sound barriers (e.g., plywood sound barrier surrounding the drilling operation) or other measures to reduce noise impacts on the NSA would provide an important safeguard in the event that HDD drilling does not proceed as smoothly as expected.

The control building would not significantly obstruct views from the scenic byway, nor be conspicuous to boaters in Admiralty Inlet. Designing the building to be compatible with existing structures would adequately minimize visual effects on the reserve and prevent any long-term degradation of the aesthetic environment of the reserve.

3.3.9 Cultural Resources

3.3.9.1 Affected Environment

Section 106 of the NHPA, as amended (section 106), requires the Commission to evaluate potential effects on properties listed or eligible for listing in the National Register prior to an undertaking. An undertaking means a project, activity, or program funded in whole or in part under the direct or indirect jurisdiction of a federal agency, including, among other things, processes requiring a federal permit, license, or approval. In this case, the undertaking is the proposed issuance of an original license for the project. Potential effects associated with this undertaking include project-related effects associated construction or with the day-to-day operation and maintenance of the project.

Historic properties are cultural resources listed or eligible for listing on the National Register. Historic properties represent things, structures, places, or archeological sites that can be either Native American or Euro-American in origin. In most cases, cultural resources less than 50 years old are not considered eligible for the National Register. Cultural resources also have to have enough internal contextual

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[95] The EPA reports that an outdoor day-night sound level of 55 decibels (dB) provides satisfactory outdoor sentence intelligibility for normal voices at a distance of approximately 11 feet (3.5 meters) and that the average expected community reaction to a noise level below 55 dB is minimal. This level would protect the vast majority of the population under most conditions against annoyance. Further, the noise level inside a typical home would be reduced by about 15 dB, resulting in additional protection from noise impacts. Therefore, 55 dB is a reasonable maximum level for construction noise at the property boundary outside of normal construction hours (e.g., 7:00 p.m. to 7:00 a.m.). See *Protective Noise Levels: Condensed Version of EPA Levels Document*. EPA, November 1978.

integrity to be considered historic properties. For example, dilapidated structures, heavily disturbed archeological sites, and isolated artifacts, may not have enough contextual integrity to be considered eligible.

Section 106 also requires that the Commission seek concurrence with the Washington State SHPO on any finding involving effects or no effects on historic properties, and allow the Advisory Council on Historic Preservation an opportunity to comment on any finding of adverse effects on historic properties.

The area of potential effects (APE) for the project is determined to include all submerged lands and terrestrial lands within the project boundary. The Washington SHPO concurred with the APE on August 3, 2011.

Culture Context

Pre-Contact and Ethnography of Native Americans

Native American groups have inhabited the region around Admiralty Inlet and Puget Sound since the end of the Pleistocene. The early inhabitants of the area were adapted to a coastal environment exploiting both marine and terrestrial resources, living in base camps and smaller seasonal habitation sites. The preservable material culture associated with these groups consists of chipped stone tools, including lanceolate-shaped projectile points, bifaces, flakes and scrapers, used for fishing, hunting, gathering of plants, and shelter construction.

Native Americans living in the region were probably ancestral to Southern Coast Salish culture group who were indigenous to this part of the Northwest Pacific coastal region when Europeans arrived at the turn of the 18th century. The groups living in the area around Admiralty Inlet were Northern Lushootseed speakers, which were further divided into Lower and Upper Skagit communities, including the present-day Sauk-Suiattle Tribe, Suquamish Tribe, Swinomish Indian Tribal Community, and Tulalip Tribes.

At the time of European contact, the groups had evolved into highly developed fishing societies adept in woodworking skills, manufacturing large ocean-going canoes, plank houses, and other endeavors involving beautiful totemic and anthromorphic religious artwork. These people were also skilled craftsmen in various textiles and basketry used for clothing and storage.

Following the arrival of European fur traders, Native American populations declined dramatically with the depletion of fur-bearing animals and introduction of European diseases. When the Americans established permanence in the Pacific Northwest, Governor Isaac Stevens of the newly established Washington Territory made various treaties with the Southern Coast Salish between 1854 and 1855. Many Native

Americans became quickly dissatisfied with the treaties, resulting in the Indian Wars of 1855-1856. Hostilities between encroaching Anglo-American settlers and various Indian tribes continued in the region for the rest of decade.

Euro-American Occupation

Puget Sound was explored in 1792 by a British expedition under the leadership of George Vancouver. During the first decades of the 19th century, explorers and trappers of the Hudson Bay Company continued to make incursions in and around Puget Sound, adjacent waterways and rivers in pursuit of fur-bearing animals for international trade.

The lands north of Admiralty Inlet were surveyed as early as 1841 by the United States Exploring Expedition under the direction of Charles Wilkes. In 1851, a settlement at Elliot Bay was established by American settlers in an area that is now the center of Seattle at Pioneer Square. A peninsula of land on the north side of Admiralty Inlet, known as Admiralty Head, was settled a short time afterwards in 1853. From the 1860s through the 1890s, the area in and around Admiralty Head was fortified with a lighthouse and several forts to guard the entrance of Puget Sound and the burgeoning city of Seattle to the south. By the end of the 19th century, one of the forts at Admiralty Head became Fort Casey which was garrisoned up until the beginning of the First World War, when it was converted into a training post for the National Guard. From the beginning of the American settlements at Admiralty Head, the civilian population centered on the town of Ebey's Landing has continued to develop.

Known Cultural Resources

AMEC Environment & Infrastructure, Inc. (AMEC) surveyed the terrestrial portions of the APE in January 2012. AMEC found two sites eligible for listing on the National Register. The first is a built resource consisting of a gabled roof house and associated garage, known as the Schulke/Steadman House[96] which continues to be occupied.[97] The house and garage were documented in 1983 by National Park Service personnel and is considered a contributing element to the Central Whidbey Island Historic District, established by the National Park Service in 1972, and is part of the

[96] The Schulke/Steadman House was built in 1910 and was initially occupied by an enlisted man (Amos Schulke) and his family who was stationed at Fort Casey between 1915 and 1920.

[97] Another house, the Reynolds House (built in 1928) was located just outside of the APE, not far from the Schulke/Steadman House. This house is not eligible for the National Register, nor would it be affected by the proposed project.

larger Ebey's Landing National Historical Reserve established in 1978.[98] During field work investigations, AMEC personnel documented a light surface scatter of historic materials (archeological site 45IS303) associated with the Schulke/Steadman House occupation. Both the house and associated archeological site are considered eligible for inclusion in the National Register.

The second eligible site (archeological site 45IS304) was located along the shoreline within the APE. This archeological site represents a Native American occupation consisting of a light concentration of chipped stone material dating prior to European contract. The extent of the site is approximately 10 by 5 meters.

Snohomish PUD contracted Golder Associates, Inc. to conduct geophysical investigations for the submerged portions of the APE (Sylwester and Findley 2011). The contractor used a sub-bottom profiler with a seismic reflection system to map the benthic topography of the sea floor and its underlying structure. No shipwrecks or other cultural resource-related anomalies were detected. No historic properties were located within the submerged portion of the APE.

No traditional cultural properties were located within or near the APE.

3.3.9.2 Environmental Effects

Land-disturbing activities associated with the construction of the cable control building, installation of the transmission cable, and project removal could potentially affect cultural resources. However, based on site investigations, Snohomish PUD determined that the proposed project would not have any adverse effects on historic properties, including Schulke/Steadman House and its associated historic artifact scatter, and the pre-contact Native American site. The Washington SHPO concurred with Snohomish PUD's finding of no adverse effect on February 28, 2012. Snohomish PUD did not propose any additional measures to protect cultural resources.

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[98] Both the reserve and historic district represent an unbroken historic sequence of the Puget Sound area from the exploration and Anglo-American settlement periods. It is represented by a town, 17 farms, and more than 400 historical structures and homes, many of which are occupied to the present day

In a letter filed with the Commission on May 23, 2012, the Tulalip Tribes stated that in the area immediately south of the proposed powerhouse[99] there is a known tribal archeological site, the northern extent of the site has not been established, and there is a high likelihood of finding additional artifacts and or burial remains during project construction.

Staff Analysis

Field investigations consisting of a 10 meter interval pedestrian survey accompanied by shovel test probes were conducted throughout surficial lands within and adjacent to the APE. Shovel tests were confined to 60 centimeters due to sloughing side walls caused by the lose structure of the marine gravels. AMEC concluded that each shovel test was dug to a sufficient depth to detect any pre-contact archaeological material. A metal detector was also used to identify cultural material. Thus all terrestrial portions of the proposed project that would be subject to disturbance were surveyed using accepted protocols.

The only Native American archeological site found during the survey was site 45IS304, located along the shore. HDD to install the transmission would go under this particular archeological site and would not adversely affect it.

Commission staff agrees with the findings and determinations made by AMEC and Snohomish PUD and concurs that the proposed project would not have any adverse effects on historic properties.

As with any project, however, there is a chance that construction activities could lead to unanticipated discoveries of historic resources. To ensure protection of these resources in the event they are uncovered, it would be beneficial for any license order issued by the Commission to include a license article describing the procedures to be followed regarding cultural resources. Among other things, the article could state that: (1) following construction of the project, but prior to any new land-clearing or ground-disturbing activity that may be necessary over the license term, the licensee would consult with the Washington SHPO in compliance with section 106; and (2) in the event that cultural materials or human remains are inadvertently discovered during the course of constructing or developing project works or other facilities at the project, or over the license term, the licensee would stop all land-clearing and land-disturbing activities in the

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[99] The Tulalip Tribe states that the archeological site is south of the proposed powerhouse; however, the turbine deployment site, which generates electric power, is offshore. We conclude that the Tulalip Tribes is referring to the proposed control building, which would lie just to the north of archeological site 45IS304.

vicinity of the discoveries and consult with the Washington SHPO. If historic properties are identified, a Historic Properties Management Plan could be crafted by the licensee in consultation with the Washington SHPO, depending on the nature of the historic properties identified.

3.4 NO-ACTION ALTERNATIVE

Under the no-action alternative, the Admiralty Inlet Project would not be installed and DOE would not provide financial assistance to fund the project. There would be no changes to the physical, biological, or cultural resources of the area and electrical generation from the project would not occur. There would be no potential for harming PC Landings fiber optic cable and there would be no changes in the navigation risks of Puget Sound. The power that would have been developed from this project would not be available to the grid. The energetic, biological and environmental information that would be developed from installing and monitoring the operation of the tidal turbines would not be gathered.

4.0 DEVELOPMENTAL ANALYSIS

In this section, we look at the Admiralty Inlet Project's use of the natural tidal currents of Admiralty Inlet for hydropower purposes to see what effect various environmental measures would have on the project's costs and power generation. Under the Commission's approach to evaluating the economics of hydropower projects, as articulated in *Mead Corp*.,[100] the Commission compares the current project cost to an estimate of the cost of obtaining the same amount of energy and capacity using a likely alternative source of power for the region (cost of alternative power). In keeping with Commission policy as described in *Mead Corp*, our economic analysis is based on current electric power cost conditions and does not consider future escalation of fuel prices in valuing the hydropower project's power benefits.

For each of the licensing alternatives, our analysis includes an estimate of: (1) the cost of individual measures considered in the EA for the protection, mitigation and enhancement of environmental resources affected by the project; (2) the cost of alternative power; (3) the total project cost (i.e., for construction, operation, maintenance, and environmental measures); and (4) the difference between the cost of alternative power and total project cost. If the difference between the cost of alternative power and total project cost is positive, the project produces power for less than the cost of alternative power. If the difference between the cost of alternative power and total project cost is negative, the project produces power for more than the cost of alternative power. This estimate helps to support an informed decision concerning what is in the public interest with respect to a proposed license. However, project economics is only one of many public interest factors the Commission considers in determining whether, and under what conditions, to issue a license.

4.1 POWER AND ECONOMIC BENEFITS OF THE PROJECT

Table 6 summarizes the assumptions and economic information we use in our analysis. This information, unless otherwise identified, was provided by the applicant in its license application and subsequent filings. We find that the values provided by the applicant are reasonable for the purposes of our analysis. Cost items common to all alternatives include taxes and insurance costs; estimated future capital investment required to construct, maintain, and extend the life of equipment and facilities; licensing costs; and normal operation and maintenance cost.

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[100] See *Mead Corporation, Publishing Paper Division*, 72 FERC ¶ 61,027 (July 13, 1995). In most cases, electricity from hydropower would displace some form of fossil-fueled generation, in which fuel cost is the largest component of the cost of electricity production.

Table 6. Parameters for the economic analysis of the Admiralty Inlet Project (Source: Snohomish PUD and staff).

Parameter	Value
Period of analysis (years)[a]	30
Federal income tax rate (%)[b]	35
Insurance cost $/year	$20,000
Initial construction cost ($)[c]	$16,000,000
Future operation and maintenance ($/year)[d]	$198,000
Licensing cost ($)[d]	$2,500,000
Energy value ($/MWh) [e]	$30
Interest rate (%)[b]	6

[a] Regardless of the potential license term (e.g., 5-year pilot, 30, 40 or 50 years), we perform a 30-year economic analysis.

[b] Estimated by staff.

[c] Initial construction cost was provided by the applicant in the license application.

[d] The total cost of project operation and maintenance over the five-year period of operations is $4,430,000. The cost shown in the table is levelized over the 30-year period used for the FERC Mead analysis.

[e] In the FERC Mead analysis the value of energy is estimated from the *Energy Information Administration, Supplement to the Annual Energy Outlook 2012*

4.2 COMPARISON OF ALTERNATIVES

Table 7 compares the installed capacity, annual generation, cost of alternative power, estimated total project cost, and difference between the cost of alternative power and total project cost for each of the alternatives considered in this EA: no action, Snohomish PUD's proposal, and the staff alternative.

The Admiralty Inlet Project is a proposed pilot project. Pilot projects are small, short-term, removable, and carefully-monitored projects intended to test technologies, sites, or both. From our comparison, both Snohomish PUD's proposal and the staff alternative would have an initial annual cost that far exceeds the current power value. The costs associated with the project are not indicative of future and larger-scale projects.

Table 7. Summary of the annual cost of alternative power and annual project cost for the alternatives for the Admiralty Inlet Pilot Tidal Project (Source: staff).

	Applicant's Proposal	**Staff Alternative**
Installed capacity (kW)	600	600
Typical operating capacity (kW)	30.95	30.95
Annual generation (MWh)	244	244
Annual cost of alternative power	$7,320	$7,320
(2012 $/MWh)[a]	30.00	30.00
Annual project cost	1,847,627	$1,848,294
($/MWh)	7,572.24	7574.98
Difference between the cost of alternative power and project cost [b]	(1,840,307)	($1,840,974)
($/MWh)	(7,542.24)	(7,544.98)

[a] Alternative fuel prices come from the Energy Information Administration's *Annual Energy Outlook 2012*, available at http://www.eia.gov/forecasts/aeo/index.cfm.

[b] A number in parentheses denotes that the difference between the cost of alternative power and project cost is negative, thus the total project cost is more than the cost of alternative power by that amount.

4.2.1 No-action Alternative

Under the no-action alternative, the project would not be constructed as proposed, and would not produce any electricity, and DOE would not provide financial assistance to fund the project.

4.2.2 Snohomish PUD's Proposal

Snohomish PUD proposes to install two OpenHydro turbines and associated facilities in Admiralty Inlet. Upon completion of the installation of the turbines, the trunk cables, the cable control building, and the interconnection to an existing transmission line, the project's installed capacity would be 600 kW, and would generate an average of 244 MWh of electricity annually. The average annual cost of alternative power would be $7,320, or $30.00/MWh. The average annual project cost would be $1,847,627, or about $7,572.24/MWh. Overall, the project would produce power at a cost that is $1,840,307 or $7,542.24/MWh, more than the cost of alternative power.

4.2.3 Staff Alternative

The staff alternative includes the same project facilities and operations as proposed by Snohomish PUD and, therefore, would have the same capacity and energy attributes. In addition to Snohomish PUD's proposed environmental protection and enhancement measures, staff recommends implementing noise abatement measures if HDD processes are required outside of expected construction schedules. Such costs would only be incurred in such circumstances. Consequently, project generation and costs would be the same as proposed by Snohomish PUD

4.3 COST OF ENVIRONMENTAL MEASURES

Table 8 gives the cost of each of the environmental enhancement measures considered in our analysis. All costs are converted to equal annual (levelized) values over a 30-year period of analysis to give a uniform basis for comparing the benefits of a measure to its cost

Table 8. Cost of environmental mitigation and enhancement measures considered in assessing the environmental effects of constructing and operating the Admiralty Inlet Project (Source: staff).

Enhancement/Mitigation Measures	**Entities**	**Capital Cost (2012$)**	**Annual Cost (2012$)**	**Levelized Annual Cost (2012$)[a]**
Safeguard Plans				
1. Project Removal and Site Restoration Plan	Applicant, Staff, Interior, WDFW	$0[b]	$0	$0
2. Project and Public Safety Plan	Applicant, Staff, Interior, WDFW	$0[c]	$0	$0
3. Navigational Safety Plan	Applicant, Staff, Interior, WDFW	$0[d]	$0	$0
4. Hazard Identification and Risk Assessment and use of "liveboat" techniques	Applicant, Staff, Interior, WDFW	$30,000	$0	$2,000
5. Emergency Shutdown Plan	Applicant, Staff, Interior, WDFW	$0[c]	$0	$0

Enhancement/Mitigation Measures	Entities	Capital Cost (2012$)	Annual Cost (2012$)	Levelized Annual Cost (2012$)[a]
6. Provision in the Emergency Shutdown Plan to prevent interactions with the turbines or turbine shutdown activities from the time of declaration of emergency until shutdown is achieved.	Staff	$10,000	$0	$670
Aquatic Resources				
7. Water Quality Monitoring Plan	Applicant, Staff, Interior, WDFW	$50,000	$0	$3,340
8. Implement HDD Plan	Applicant, Staff, Interior, WDFW	$0[b]	$0	$0
9. Environmental Monitoring Infrastructure	Applicant, Staff, Interior, WDFW	$1,100,000	$0	$73,370
10. Derelict Gear Monitoring Plan	Applicant, Staff, Interior, WDFW	$0	$58,360[e]	$58,360
11. Acoustic Monitoring and Mitigation Plan	Applicant, Staff, Interior, NMFS, WDFW	$16,000	$35,350[f]	$36,420

Enhancement/Mitigation Measures	Entities	Capital Cost (2012$)	Annual Cost (2012$)	Levelized Annual Cost (2012$)[a]
12. Near-Turbine Monitoring and Mitigation Plan	Applicant, Staff, Interior, NMFS, WDFW	$425,000	$103,390[g]	$131,740
13. Marine Mammal Monitoring and Mitigation Plan	Applicant, Staff, Interior, NMFS, WDFW	$106,000	$111,730[h]	$118,800
14. Benthic Habitat Monitoring and Mitigation Plan	Applicant, Staff, Interior, NMFS, WDFW	$0	$58,030[i]	$58,030
15. Implement Adaptive Management Framework, including conferring with a Marine Aquatic Resource Committee	Applicant, Washington DFW	$0	$0[j]	$0
Terrestrial Resources				
16. Implement measures to minimize and control the spread of invasive plant.	Whidbey Environmental Network, Applicant, Staff	$0	$0[b]	$0

Enhancement/Mitigation Measures	Entities	Capital Cost (2012$)	Annual Cost (2012$)	Levelized Annual Cost (2012$)[a]
Recreation				
17. Interpretation and Education Plan for an interpretive display	Applicant, Staff, Interior	$5,000	$0	$330
Aesthetics				
18. Implement noise abatement contingency measures if drilling occurs during the evening hours.	Staff	$0	$0	$0[k]
Other Measures				
19. Relocate project turbines 500 to 950 meters or more away from PC-1 North	P.C. Landing	$335,000 to $600,000	$0	$22,350 to $40,020[l]
20. Modify the Project Removal and Site Restoration Plan to include specific timelines for removal	Staff	$0	$0	$0

Enhancement/Mitigation Measures	Entities	Capital Cost (2012$)	Annual Cost (2012$)	Levelized Annual Cost (2012$)[a]
Cultural Resources				
21. Stop work if archaeological or historical resources are discovered and develop protection measures.	Staff	$0	$0	$0[m]

[a] The applicant provided estimated O&M costs, including monitoring costs, over the five-year timeframe of the license procedures. As it is Commission policy to annualize all costs over a 30-year time frame, we have, where appropriate, converted the provided five-year annual costs to a present value, and then annualized that value over a 30-year term.

[b] No cost estimated – included in the total operation and maintenance costs ($4.43 million).

[c] The implementation of the Project and Public Safety Plan and the Emergency Shutdown and Removal Plans are anticipated to be $0, unless there is an emergency. In the event of an emergency removal, costs could range from $500,000 to $1,000,000.

[d] The implementation of the Navigational Safety Plan would be coordinated in consultation with the Coast Guard. The Coast Guard would notify NOAA, local mariners, and the VTS to the location of the turbines; therefore, no cost is anticipated for Snohomish PUD for this measure.

[e] Snohomish PUD would conduct five years of derelict gear monitoring at a cost of $175,000 per year. The cost is levelized over the 30-year period of the Mead analysis.

[f] Snohomish PUD would conduct five years of acoustical monitoring at a cost of $106,000 per year. The cost is levelized over the 30-year period of the Mead analysis.

[g] Snohomish PUD would conduct five years of near-turbine monitoring at a cost of $310,000 per year. The cost is levelized over the 30-year period of the Mead analysis.

[h] Snohomish PUD would conduct five years of marine mammal monitoring at a cost of $335,000 per year. The cost is levelized over the 30-year period of the Mead analysis.

[i] Snohomish PUD would conduct five years of benthic habitat monitoring at a cost of $174,000 per year. The cost is levelized over the 30-year period of the Mead analysis.

[j] Adaptive management provisions, including conferring with the Marine Aquatic Resource Committee, are already included in many of the proposed plans; therefore, creating a formal group to coordinate the consultation that is otherwise required to fulfill the license conditions of any license granted is not anticipated to generate an incremental cost to Snohomish PUD. The incremental cost of this measure is anticipated to be minimal.

[k] Implementation of staff's recommended noise abatement measures are anticipated to $0, unless HDD drilling processes extend into the nighttime hours. In that event, costs would likely be less than $5,000.

[l] Using an estimated cost of $250,000/km for additional cable, costs ranged from a low of $167,500 per cable (for 670 meters of additional cable) to a high of $300,000 per cable (for 1,170 meters of additional cable).

[m] Cost would only be incurred if archaeological or historical resources are discovered during land-disturbing activities.

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5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 COMPARISON OF ALTERNATIVES

In this section, we compare the developmental and non-developmental effects of Snohomish PUD's proposal, the staff alternative, and the no-action alternative.

We estimate the annual generation of the project under the two action alternatives identified above. Our analysis shows that the annual generation would be 244 MWh for the proposed action and the staff alternative.

We summarize the environmental effects of the project under the applicant's proposal and the staff alternative below (table 9). Under the no-action alternative, the project would not be constructed, DOE would not provide financial assistance to fund the project, and environmental conditions would not be altered by the project.

Table 9. Comparison of alternatives for the Admiralty Inlet Project. (Source: Staff).

Snohomish PUD's Proposal	Staff Alternative
General	
• Implementing the Project and Public Safety Plan and Emergency Shutdown Plan would help to ensure environmental and public safety. • Implementing the Project Removal and Site Restoration Plan would help to ensure protection of the aesthetic and environmental resources in and around Admiralty Inlet.	• Same as applicant's proposal, plus: • Provision in the Emergency Shutdown Plan to prevent further interactions with the turbines or interference with turbine shutdown activities from the time of declaration of emergency until shutdown is achieved would help to achieve shutdown as quickly and safely as possible to minimize risks to marine life and people, • Provisions in the Project Removal and Site Restoration Plan for providing a specific timeline for the removal and site restoration activities, as well as documentation of consultation with the appropriate agencies, 6 months prior to license expiration, and documentation of completion of project removal and site restoration activities prior to

Snohomish PUD's Proposal	Staff Alternative
	license expiration, would ensure that the project is removed and the site is sufficiently restored to near pre-project condition by the end of the license term.
Geologic and Soils	
• Implementing the HDD Plan would avoid sensitive shoreline habitats, but would result in minor, short-term, localized soil-disturbance on-shore and at-sea. • Implementing the Near-Turbine Monitoring and Mitigation Plan and Benthic Habitat Monitoring and Mitigation Plan would identify any unanticipated adverse effects of the project on scouring or sediment transport processes. • Implementing the Water Quality Monitoring Plan would identify the release of high turbidity levels and oil during installation, and implement any needed corrective actions, preventing adverse effects on aquatic resources.	• Same as applicant's proposal, except identification of specific criteria for implementing scour protection measures would ensure timely implementation of any needed mitigation measures and ensure scour is limited to the near-turbine area.
Marine Resources	
• Conducting in-water installation only during a Washington DFW work-window of July 16 to October 14 would avoid adverse effects on sensitive fish resources. • Implementing the Acoustic Monitoring Plan would characterize noise radiated by the project, monitor changes in noise radiated by the project over time from wear, and determine if corrective actions are needed if exceeding noise thresholds	• Same as applicant's proposal.

20130809-3010 FERC PDF (Unofficial) 08/09/2013

Snohomish PUD's Proposal	Staff Alternative
for marine mammals. • Implementation of the Benthic Habitat Monitoring and Mitigation Plan would help to ensure effective project operation and health of the benthic community in the project area. • Implementing the Near-turbine Monitoring and Mitigation Plan would help identify adverse behavioral changes and potential injury of marine fish, mammals, and birds interacting with the turbines and define any needed corrective actions. • Implementing the Marine Mammal Monitoring and Mitigation Plan would avoid adverse interactions between work vessels and marine mammals during installation, identify behavioral changes from turbine noise or prey aggregations during operation, and define any needed corrective actions. • Implementing the Derelict Gear Monitoring Plan would help ensure that any derelict gear caught on the turbines would be detected and promptly removed.	
Rare, Threatened, and Endangered Species	
• The project is not likely to adversely affect the Puget Sound Chinook Salmon and its designated critical habitat, Hood Canal summer-run chum salmon and its designated critical habitat, Puget Sound steelhead, Coastal-Puget Sound bull trout, green sturgeon, bocaccio, canary rockfish, yelloweye rockfish, eulachon, southern resident killer whale designated critical habitat, North Pacific humpback	• Same as applicant's proposal.

20130809-3010 FERC PDF (Unofficial) 08/09/2013

Snohomish PUD's Proposal	Staff Alternative
whale, and marbled murrelet; and would not affect golden paintbrush. Noise from turbine operations may exceed harassment thresholds for the southern resident killer whale and Steller sea lion; therefore, they may be adversely affected. Implementing the Acoustic Monitoring Plan and Marine Mammal Monitoring Plan would ensure such effects are minimal and appropriate corrective actions are implemented.	
Terrestrial Resources	
• Implementing the HDD Plan would minimize habitat disturbance and revegetate disturbed areas (about 0.3 acres of grass habitat). • Implementing measures to control the introduction and spread of invasive plants would minimize adverse effects on native plant communities and wildlife.	• Same as applicant's proposal.
Recreation	
• Developing and implementing an Interpretation and Education Plan including an interpretive display at Snohomish PUD's headquarters or at another appropriate location would educate the public about the project and the potential ocean energy resource of Puget Sound	• Same as applicant's proposal, except for developing a plan to install the interpretative display within view of the turbine installation site, in a location in Fort Casey State Park, subject to state approval, which would more directly benefit those recreating in the project area.
Navigation	
• Implementing the Navigation and Safety Plan would ensure that project installation and operation are coordinated with vessel traffic, avoiding potential navigation hazards.	• Same as applicant's proposal, plus: • Adding a reservation of authority of the U.S. Army Corps of Engineers to require removal, relocation, or other alteration of the project if it becomes

Snohomish PUD's Proposal	Staff Alternative
	an unreasonable obstruction to navigation would ensure that navigation hazards are minimized. • Coordinating project installation and maintenance activities with Washington State Ferries would avoid potential disruptions to scheduled ferry service.
Land and Ocean Use	
• Conducting turbine installation and monitoring using "live-boat" techniques and developing and implementing a Hazard Identification and Risk Assessment would ensure that project installation, operation, maintenance, and removal actions are conducted in a manner that would minimize any risk of damaging PC Landing's fiber optic cable.	• Same as applicant's proposal.
Aesthetic Resources	
• Implementing the HDD process would result in noise levels that could disturb nearby residences.	• Same as applicant's proposal, plus: • Implementing noise abatement measures if HDD processes extend into the night would minimize adverse effects on near-by residences.
Cultural Resources	
• None	• Same as applicant's proposal, plus: • Implementing further protection for inadvertent discoveries of archaeological or historical resources would ensure protection of cultural resources in the project area.

5.2 COMPREHENSIVE DEVELOPMENT AND RECOMMENDED ALTERNATIVE

Sections 4(e) and 10(a)(1) of the FPA require the Commission to give equal consideration to the power development purposes and to the purposes of energy conservation; the protection, mitigation of damage to, and enhancement of fish and wildlife; the protection of recreational opportunities; and the preservation of other aspects of environmental quality. Any license issued shall be such as in the Commission's judgment will be best adapted to a comprehensive plan for improving or developing a waterway or waterways for all beneficial public uses. This section contains the basis for, and a summary of, our recommendations for licensing the Admiralty Inlet Pilot Tidal Project. We weigh the costs and benefits of our recommended alternative against other proposed measures.

Based on our independent review of agency and public comments filed on this project and our review of the environmental and economic effects of the proposed project and its alternatives, we selected the staff alternative as the preferred option. We recommend this option because: (1) issuing a license to Snohomish PUD would allow them to test the generating equipment's dependability as a source of electrical energy for the region and evaluate the tidal energy potential of Admiralty Inlet; (2) the 244-MWh of electric energy generated annually during the 10-year license would come from a renewable resource, which would not contribute to atmospheric pollution; (3) the applicant has demonstrated that the project poses very little risk to fish and wildlife resources; (4) the recommended environmental measures would adequately protect, mitigate, and enhance fish and wildlife, recreation, aesthetic resources affected by the project; (5) the recommended safeguard and maritime operational measures would ensure navigation and international communications are not interrupted; and (6) the monitoring proposed for the project would provide an improved understanding of the environmental effects of tidal energy projects, which would be instrumental in assessing the potential effects of future projects of this type and identifying measures to minimize adverse environmental effects.

In the following section, we make recommendations as to which environmental measures proposed by Snohomish PUD or recommended by agencies and other entities should be included in any license issued for the project. In addition to Snohomish PUD's proposed environmental measures, we recommend the inclusion of some additional measures in any license issued for the project.

Measures Proposed by Snohomish PUD

Based on our environmental analysis of Snohomish PUD's proposal as discussed in section 3.0 and the costs discussed in section 4.0, we recommend including the

following environmental measures proposed by Snohomish PUD in any license issued for the project.

- Implement the Project and Public Safety Plan.
- Implement the Emergency Shutdown Plan.
- Implement the Project Removal and Site Restoration Plan.
- Conduct in-water installation activities within the Washington DFW-approved work window of July 16 to October 14.
- Implement the following measures to control the introduction and spread of invasive plants during site construction and project removal: (1) use gravel, rock, or other fill material from a weed free source; (2) revegetate disturbed areas with species native to Keystone Spit, with the source material (seeds or cuttings) collected from Keystone Spit; (3) ensure that no imported soil, fertilizer, or tackifiers will be used in revegetating disturbed areas; and (4) inspect any fill and disturbed areas for invasive plants annually, between early and mid-June and again in August, and eradicate any detected invasive plants promptly.
- Implement the HDD Plan
- Implement the Water Quality Monitoring Plan.
- Implement the Acoustic Monitoring and Mitigation Plan.
- Implement the Benthic Habitat Monitoring and Mitigation Plan.
- Implement the Marine Mammal Monitoring and Mitigation Plan.
- Implement the Near-Turbine Monitoring and Mitigation Plan.
- Implement the Derelict Gear Monitoring Plan
- Develop and implement the Interpretation and Education Plan.

- Implement the Navigational Safety Plan.

- Develop a Hazard Identification and Risk Assessment and conduct turbine installation, monitoring, and removal activities using "liveboat" techniques.

Additional Measures Recommended by Staff

In addition to Snohomish PUD's proposed measures, we recommend including the following measures in license issued:

- Include in the Project Removal and Site Restoration Plan provisions for filing for Commission approval: (1) a specific timeline for the removal and site restoration activities 6 months prior to license expiration; (2) documentation of consultation with the MARC regarding planned removal and site restoration activities 6 months prior to license expiration; and (3) documentation of completion of project removal and site restoration activities prior to license expiration.

- Include in the Emergency Shutdown Plan a provision to prevent interactions with the turbines or turbine shutdown activities from the time of declaration of emergency until shutdown is achieved.

- Include in the HDD Plan provisions to implement noise abatement measures in the event HDD processes extend into the nighttime hours.

- Include in the Benthic Habitat Monitoring and Mitigation Plan a provision to: (1) identify specific depth and width measurements of scour, as measured from the turbine footings, that would trigger the installation of scour protection measures; (2) develop the triggers in consultation with NMFS, FWS, U.S. Coast Guard, Washington DNR, Washington DFW, and Washington Ecology; and (3) notify the Commission within 10 days of when such triggers may have been met and the licensee's plans for mitigating any such effects.

- Limit the Interpretation and Education Plan to the design and location of an interpretive display at Fort Casey State Park, subject to state approval, describing the project, the potential ocean energy resource in Puget Sound, and the natural and cultural environment of the project area.

- Halt work if previously unidentified archeological or historic properties are discovered during land-disturbing activities and develop protective measures in consultation with the Washington SHPO.

- Include a reservation of authority for the Corps of Engineers to request removal, relocation, or other alteration if the project becomes an unreasonable obstruction to free navigation of navigable waters.

- Coordinate project installation and maintenance activities with Washington State Ferries to avoid potential disruptions to scheduled ferry service.

The following discussion provides the basis for our additional recommendations for licensing the Admiralty Inlet Pilot Tidal Project.

Project Removal and Site Restoration Plan

Integral to the Commission staff's guidance for licensing hydrokinetic pilot projects is the requirement that pilot projects be removed, and their sites restored at the end of the license term unless a new license is obtained. Snohomish PUD proposes a Project Removal and Site Restoration Plan that provides general information on the facilities that would be removed, the monitoring that would take place during removal, and the length of time that removal would take. Provisions in the Project Removal and Site Restoration Plan for providing a specific timeline for the removal and site restoration activities, as well as documentation of consultation with the appropriate agencies, 6 months prior to license expiration, and documentation of completion of project removal and site restoration activities prior to license expiration, would ensure that the project is removed and the site is sufficiently restored to near pre-project condition by the end of the license term. We estimate that the costs of these provisions would be minimal and therefore conclude that the benefits outweigh any costs.

Noise Abatement Measures

HDD processes would occur in a lightly developed residential section of Whidbey Island. Noise from HDD drilling activity may become disruptive to neighboring residences if they continue into the evening hours. Although Snohomish PUD proposes to conduct HDD processes over 7 days on a 12-hour daytime schedule (e.g., 7 am to 7 pm), it is not uncommon with HDD drilling for unexpected problems to arise that may cause drilling to have to continue for more than 12 hours. To minimize potential noise effects during the evening hours, we recommend that Snohomish PUD's HDD Plan be modified to require installation of temporary sound barrier(s) (e.g., a plywood sound barrier surrounding the drilling operation) to maintain day-night sound levels below 55 dB at the project boundary, if HDD processes extend into the evening hours. There would be no cost to implement these measures, unless such circumstances arise. Should the sound barrier(s) be needed, we estimate the cost to construct a temporary sound barrier to be $5,000 (annualized to $330 over 30 years) and find this cost to be worth the benefit.

Interpretation and Education Plan

Snohomish PUD proposes to develop and implement an Interpretation and Education Plan, in consultation with the National Park Service and other stakeholders, which provides for installing an interpretive display at Snohomish PUD's headquarters in Everett Washington or at another appropriate location so long as the display does not require a significant commitment of resources or expand the project boundary. Because Fort Casey State Park is a popular recreation and tourism destination and provides views of the portion of Admiralty Inlet where the turbines would be installed, installing the display at Fort Casey State Park would more directly benefit area visitors by educating them about this new energy resource and its relation to the environment. Because of the project's small size and short term, a plan for interpretation and education that goes beyond the design and location of the sign would appear to provide limited additional public benefit. . Therefore, we recommend that Snohomish PUD consult with the Washington State Parks and Recreation Commission (Washington PRC), National Park Service, Ebey's Landing Historical Reserve Trust Board, and Island County Marine Resources Committee on the design and location for the display at the park, subject to Washington PRC approval. If a suitable site cannot be found at Fort Casey State Park, an alternative site should be proposed. Regarding, Snohomish PUD's concern about expanding the project boundary, the Commission does not typically enclose appurtenant features of such a small scale as an interpretive sign within a project boundary when the feature is not contiguous with the rest of the project.

Cultural Resources

There are no known historical or archaeological properties within the project area listed or eligible for listing in the National Register. However, archaeological or historic sites could be discovered during any project construction or modification that requires land-disturbing activities. Therefore, we recommend that Snohomish PUD halt work and notify the Commission and Washington SHPO if previously unidentified archeological or historic properties are discovered during the course of constructing, maintaining, or removing project works or other facilities at the project. Additionally, Snohomish PUD should implement any measures developed in consultation with the Washington SHPO to protect the archeological or other cultural resources from further potential adverse effects. There would be a nominal cost for this measure and we recommend including this requirement in any new license issued for the project.

Navigation

The project turbines would be located outside the shipping lanes in Admiralty Inlet, but occasionally tugboats and their tows could venture over the turbines. As part of the Navigation Safety Plan, Snohomish PUD would work with the Coast Guard, Corps, and NOAA to update navigation charts and disseminate information to local mariners. These measures should be sufficient to ensure that the project does not

represent a navigation obstruction. Nonetheless, the Corps, through its jurisdictional authorities under the Rivers and Harbors Act and its implementation through section 4(e) of the FPA, requests that the Commission reserve the Corps' ability to require removal, relocation, or other alterations if the project becomes an obstruction to navigation. Removal, relocation, or alteration if the project proves to be an obstruction is consistent with the intent of the pilot project. Therefore, we recommend including any such reservation of authority in any license issued.

The trunk cable route crosses the normal ferry vessel route. Cable installation work windows, defined to protect sensitive aquatic resources, would also require some limited activities near or within the ferry vessel route during the time of year when its use is highest. The potential number of ferry interactions during the cable installation would be small and of short duration each, which would not be anticipated to cause significant impacts to ferry operations. Regardless, to minimize potential disruptions to scheduled ferry service in the project area, staff recommends that Snohomish PUD coordinate project installation and maintenance activities with Washington State Ferries.

Project and Public Safety Plan and Emergency Shutdown Plan

The purpose of the Commission's guidance on licensing hydrokinetic pilot projects is to provide for the deployment of new technology marine and hydrokinetic projects in which the environmental effects are not yet well understood, while managing the uncertainty through required post-license monitoring and safeguard plans that ensure the protection of the public and environment. The staff guidance emphasizes post-licensing monitoring with the possibility of modifying, shutting down, or removing the project if it presents a risk to public safety or environmental resources.

Snohomish PUD proposes to implement a Project and Public Safety Plan in coordination with an Emergency Shutdown Plan that includes shut down procedures if ordered by the Commission or if unusual or unsafe conditions arise that cause or could cause unauthorized injury or death to species protected under ESA or MMPA, or present a hazard to public safety. Since the application was filed, Snohomish PUD revised the shutdown procedures from the use of a remotely operated electrical brake to a mechanical brake because advances in the turbine technology prevent using an electrical brake to stop and prevent the turbine blades from rotating. The mechanical brake would be a pin inserted between the moving and stationary parts of the outer edge of turbine. The pin would be inserted by an ROV. The electrical braking system would have been nearly instantaneous once the decision to stop the turbines was made and a slack tide was available. Unlike the original electric brake, the time to complete the mechanical braking procedure would be between a few hours and four days in foreseeable circumstances, with one or two days being most likely. Snohomish PUD estimates that there is about a 90% chance that both turbines could be shut down within 24 hours.

PC Landing and the Tulalip Tribe state that this is too long given the sensitive nature of the resources in Admiralty Inlet (e.g., listed killer whales, salmon, usual and accustomed tribal fishing access, and an international fiber optic cable) and that the project should not be authorized. To date, only remotely activated, electrical brakes have been approved in tidal and in-river pilot projects authorized by the Commission as a safe guard to immediately shut down the project.

In this case, much information about the site and possible adverse effects on environmental and other resources has been developed and analyzed throughout this EA, indicating low risk to resources. Here, the most likely reasons that turbine rotation would need to cease occurs under four circumstances, which are considered in Snohomish PUD's adaptive management procedures: (1) if a killer whale in the Salish Sea is found to have lacerations or discolorations within a week of a known transit through Admiralty Inlet and a veterinarian and the MARC determine that the injuries may have been caused by the project; (2) if acoustic monitoring indicates received levels has the potential to injury marine mammals; (3) if monitoring suggests injuries or mortality beyond incidental take limits (which have yet to be defined); and (4) if vibration or differential settlement in excess of design thresholds is detected. For reasons discussed in various sections of this EA, the probability of these conditions arising is very low. In addition, the extensive monitoring plans would likely catch potential issues sufficiently early to address them or begin taking the steps necessary to apply the brake and make appropriate notifications as quickly as possible once the decision to deploy it is made.

Similarly the potential for interaction between people and the devices is low. The proposed location for the turbines is over 2,800 feet from the navigation channel and over 140 m below the water surface. The turbines would be far below the depths accessible to typical SCUBA divers. The most likely reasons for human interaction with the turbines would be through the snagging of a very slack tow cable or fishing gear. As the area is currently used, such incidents are unlikely. Further, tug boat operators and fishermen would be made aware of the presence of the turbines through Coast Guard notification procedures and could navigate to avoid the turbines accordingly.

Nonetheless, if an interaction with the turbines was to occur and public safety was at risk, project shutdown could be needed. While such a shutdown would not be instantaneous, Snohomish PUD could take measures (such as notification of Coast Guard, deployment of buoys or warning devices, etc.) to keep that area near the turbines clear of unnecessary traffic and prevent further interaction with the turbine until the shutdown is completed. Therefore, staff recommends that Snohomish PUD develop such a contingency plan as part of its Emergency Shutdown Plan. The contingency plan should be developed in consultation with the U.S. Coast Guard. Development of this

contingency plan would have an estimated cost of $10,000. We find the benefits of this measure worth the cost.

In sum, the need for nearly immediate shutdown in this case is tempered by available information indicating a low likelihood of harm to environmental resources, the proposed monitoring efforts and adaptive management protocols to identify and take timely corrective actions, site characteristics resulting in low risk of interaction with the devices by the public, and the staff-recommended addition to the Emergency Shutdown Plan described above.

Measures Not Recommended

The following discusses the basis for staff's conclusion not to recommend some of the measures recommended by agencies and other interested parties.

Relocating the Project Turbines

Snohomish PUD proposes to install two turbines within 170 and 249 meters of PC Landing's international telecommunications fiber optic cable, PC-1 North. PC Landing asserts that installing the turbines so close to the fiber optic cable would unduly risk damaging the cable during installation, maintenance, and removal activities. Damage could come from either dropping the turbines or an anchor from the installation or monitoring vessels on the cable or from seabed scour created by the turbines uncovering the buried cable. PC Landing also states that locating the project so close to PC-1 North reduces its ability to maintain and repair the cable if needed, whether damage to the cable is related or un-related to the project. Consequently, PC Landing recommends that Snohomish PUD locate the turbines at a site 750 to 1,000 meters from PC-1 North in accordance with International Cable Protection Committee recommendations, but suggested that an area between at least 500 to 950 meters west of the PC-1 North may be suitable. In the alternative, PC Landing requests that the Commission deny the license application.

Snohomish PUD asserts that installation, maintenance, monitoring and removal would not pose a risk to PC-1 North because such operations do not require the use of anchoring, except during the installation of the trunk cables at the HDD sea floor exit, which would be located over 1,666 meters (5,300 feet) from the PC-1 North cable; and OpenHydro, the manufacture of the turbines, has the experience and equipment to install the turbines within five meters (16.4 feet) of the targeted location. In addition, Snohomish PUD proposes to develop a Hazard Identification and Risk Assessment (HIRA) in consultation with the Coast Guard, the Corps, and PC Landing prior to marine operations that includes: (a) criteria for weather and wave conditions that must exist before marine operations can occur (e.g., wind speed less than 20 miles per hour, waves less than 2 meters (6.56 feet), with a tidal velocity window of less than 1.5 knots, and during a running tide, with certainty of conditions remaining prevalent for duration

of deployment or recovery); (b) use of industry-approved equipment and redundancy in the use of equipment and vessels (e.g., back-up tugboat for emergencies; towing gear, barge, winches, winch wire, and hydraulic lifting tools that are new or certified based on industry standards); (c) criteria for aborting operations; and (d) an established "port of refuge," located at least two kilometers (6,562 feet)[101] away from PC-1 North, in the event of unanticipated adverse weather or other event.

Because of PC-1 North's importance to the American public, business, and financial institutions, the FCC initially recommended that the Commission consider requiring a 500-meter separation between the turbines and PC-1 North. It later stated that it does not oppose licensing the project at the currently proposed distances from PC-1 North if the Commission determines that the project does not present a material risk to PC-1 North, and the Commission is able to ensure through its own licensing process (via imposition of conditions if appropriate), that Snohomish PUD and its agents, contractors and successors adhere to the safety and separation distance representations Snohomish PUD made in its August 28, 2012, filings. The Naval Seafloor Cable Protection Office similarly concluded that the changes noted by the FCC also alleviate its concerns.

As explained in section 3.3.6.2, *Land and Ocean Use*, locating the turbines 500 meters or greater from PC-1 North would provide an increased margin of safety during installation, maintenance, and removal activities, and would provide PC Landing more room to repair the cable in the unlikely event that the section of the PC-1 North cable near the turbines needs to be repaired. With regard to making repairs to PC-1 North, the depth of the turbines would be well below the anticipated draft depth of cable repair boats. Further, while there could be some interference with grappling and subsequent reinstallation of the PC-1 North cable if a repair was needed, such repairs could be made with the turbines in place.

Moving the turbines west of PC-1 North would increase the estimated cost for the additional length of the two power cables extending from shore to a site 500 meters (1,640 feet) from PC-1 North by at least $335,000 ($22,350 annualized over 30 years); would put the turbines closer to heavy shipping lanes, with an increased chance of the

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[101] Snohomish PUD, in their filing of August 28, 2012, stated that they would create "an established "port of refuge," located kilometers away from PC-1, in the event of unanticipated adverse weather or other event." As their proposal is not specific as to how many kilometers from the PC-1 North the port would be established, Commission staff is using two kilometers for analysis.

turbines becoming an obstruction to navigation; and would adversely affect monitoring.[102]

Regardless, relocating the turbines to avoid risking damaging PC-1 North is not necessary because installing the turbines using the "live-boat" process (i.e., without the use of anchors) and under strict weather and tidal criteria (likely to include a wind speed less than 20 miles per hour, waves less than 2 meters, with a tidal velocity window of less than 1.5 knots, and during a running tide) would ensure OpenHydro's ability to install the turbines within its historical accuracy and adequately minimize potential for inadvertently dropping the turbines on the cable. Implementing the additional safety measures as defined in the HIRA above would further minimize any risk to the cable.

Existing tidal currents are not likely to result in scour except immediately around the turbine foundation. Measures could be implemented to control scour if monitoring shows that scour is occurring significantly beyond turbine footing. Identifying specific triggers (i.e., width and depth thresholds) that would cause Snohomish PUD to implement scour mitigation measures now would ensure timely implementation of those measures and insure that scour is confined to the area near the turbine and does not reach PC-1 North. Therefore, staff recommends that the Benthic Monitoring and Mitigation Plan and Near-Turbine Monitoring Plan be modified to include a provision to identify specific width and depth scour thresholds that would trigger mitigation measures, that the triggers be developed in consultation with state and federal agencies, and that Snohomish PUD notify the Commission when such triggers are reached. These modifications would not increase the cost of the plan because consultation procedures are already built into the plan. In summary, with this measure we expect that Snohomish PUD would be able to identify and mitigate any excessive erosion or scour before scour would reach an extent that would affect PC Landing's PC-1 North cable.

For the above reasons, we do not recommend changing the installation location of the turbines and find that the benefits of doing so are not worth the cost, including the cost of jeopardizing achievement of the project's objectives of determining if the energy potential for a commercial scale project is feasible and possible environmental effects of the turbine technology, both at the pilot and commercial scale. We recommend that any license issued for the project require the development of the HIRA in consultation with the Coast Guard, the Corps, and PC Landing to further ensure risks to PC-1 North are minimized.

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[102] Because Snohomish PUD would use land-based observations for some monitoring efforts, increasing the distance of the turbines from shore would make implementation of the Marine Mammal Monitoring and Mitigation Plan more difficult.

Marine Aquatic Resource Committee (MARC) and Seeking Consensus from Agencies during Consultation

Washington DFW recommends that the Commission include as a license condition the establishment of a steering committee called the MARC, which would assist in the creation and review of monitoring and management plans, including adaptive management provisions. In its justification for the measure, Washington DFW states that Snohomish PUD should consult with the appropriate agencies and tribes when writing or implementing the monitoring and management plans and that the MARC creates a venue for such consultation to occur. Washington DFW goes on to state that "The MARC should be required to coordinate, as appropriate, the design and implementation of research and monitoring programs, the sharing of data and information, and the conduct of other activities under license terms…." Washington DFW also recommends that in all cases involving consultation, that the Commission require Snohomish PUD to obtain the views of, and attempt to reach consensus with, parties with authority under section 10(j) of the FPA.

Each of Snohomish PUD's monitoring and mitigation plans already provides for consultation with the MARC, which include agencies with 10(j) authority. The plans also include adaptive management provisions, which would be implemented in consultation with the MARC. We recommend implementing the plans, including the consultation and adaptive management requirements. A separate license condition requiring the establishment of the MARC would be redundant. Further, to the extent that Washington DFW is requesting that the Commission includes a license requirement that would obligate the MARC to implement certain conditions of the license; we do not recommend such a requirement because it would not be enforceable by the Commission, as it would purport to place responsibility of the license on a non-licensee.

5.3 UNAVOIDABLE ADVERSE IMPACTS

There would be localized, short-term disturbances to the seabed during the HDD process and installation of the turbines. On-shore construction activities would disturb about 0.3 acres of previously disturbed residential habitats and may temporarily displace some wildlife during these activities. On-shore construction activities would create noise and visual effects, and require the use of heavy construction equipment, which could disturb residences, but these effects would be minor and short-term. Fishermen and recreational boaters may need to work around project barges and vessels during project installation, on-site maintenance, and removal, but these activities will be short-term and minor considering the expanse of the Admiralty Inlet.

It is not yet clear if there are unavoidable adverse impacts that would occur as a result of the operation of the proposed project. The purpose of the proposed environmental monitoring plans would be to better understand such potential impacts. Because there would be no restrictions to fishing at the site of the turbines or its cables,

there would be no restrictions to navigation or access to tribal fish grounds; however, fishermen may lose valuable gear if they get caught on the turbines or cables.

5.4 FISH AND WILDLIFE AGENCY RECOMMENDATIONS

Under the provisions of section 10(j) of the FPA, each hydroelectric license issued by the Commission shall include conditions based on recommendations provided by federal and state fish and wildlife agencies for the protection, mitigation, and enhancement of fish and wildlife resources affected by the project.

Section 10(j) of the FPA states that whenever the Commission finds that any fish and wildlife agency recommendation is inconsistent with the purposes and the requirements of the FPA or other applicable law, the Commission and the agency shall attempt to resolve such inconsistency, giving due weight to the recommendations, expertise, and statutory responsibilities of the agency. In response to the ready for environmental analysis notice, the NMFS, FWS, and Washington DFW[103] submitted recommendations for the project on May 23, 2012. Table 10 lists the section 10(j) recommendations, and whether the measures are recommended by staff. Recommendations that we consider outside the scope of section 10(j) have been considered under section 10(a) of the FPA and are addressed in the specific resource sections of this document and the previous section.

[103] On May 23, 2012, Washington DFW requested protection of eelgrass, kelp, and geoduck clams, a survey of the transmission corridor and horizontal drilling exit point to check for these resources, and inclusion of the transmission corridor and horizontal drilling exit point in the Benthic Monitoring Plan. In June of 2012 an ROV survey of the transmission corridor and horizontal drilling exit point was completed and also revealed no eelgrass, kelp, or geoducks (Greene, 2012; McCallister, 2012). On December 10, 2012, Washington DFW affirmed that the final Plan, filed on November 16, 2012, adequately addresses monitoring requirements for benthic monitoring and can be approved (see phone memo between Stephen Bowler, FERC, and Brock Applegate (Washington, DFW), December 13, 2012).

Table 10. Analysis of fish and wildlife agency recommendations for the Admiralty Inlet Project (Source: staff).

Recommendation	Agency	Within the scope of section 10(j)	Annualized Cost	Adopted? and Basis for Preliminary Determination of Inconsistency
1. Implement the Acoustic Monitoring and Mitigation Plan proposed by Snohomish PUD.	NMFS, FWS, Washington DFW	Yes	$36,420	Yes
2. Implement the Marine Mammal Monitoring and Mitigation Plan proposed by Snohomish PUD.	NMFS, FWS, Washington DFW	Yes	$118,800	Yes
3. Implement the Near-turbine Monitoring and Mitigation Plan proposed by Snohomish PUD.	NMFS, FWS,[a] Washington DFW	Yes	$131,740	Yes
4. Implement the Benthic Habitat Monitoring and Mitigation Plan proposed by Snohomish PUD.	NMFS, FWS	Yes	$58,030	Yes.
5. Implement the Derelict Gear Monitoring Plan proposed by Snohomish PUD.	FWS and Washington DFW	Yes	$58,360	Yes
6. Implement the Water Quality Monitoring Plan proposed by Snohomish PUD.	FWS and Washington DFW	Yes	$3,340	Yes
7. Implement the Project Safeguard Plans proposed by Snohomish PUD (the Safeguard Plans consist of: the Project and Public Safety Plan, Navigation Safety Plan, Emergency Shutdown Plan, and Project Removal and Site Restoration Plan).	FWS and Washington DFW	Yes, for the Emergency Shutdown and Project Removal Plan; No for the remaining plans because	$0[b]	Yes.

Recommendation	Agency	Within the scope of section 10(j)	Annualized Cost	Adopted? and Basis for Preliminary Determination of Inconsistency
		they are not specific measures to protect, mitigate, or enhance fish and wildlife resources.		
8. Implement the Horizontal Directional Drilling Plan.	FWS and Washington DFW	No, not a specific measure to protect, mitigate for, or enhance fish and wildlife resources.	$0[b]	Yes
9. Establish a Marine Aquatic Resource Committee (MARC) to review the development and implementation of the monitoring and management plans, including use of adaptive management, and during consultation, attempt to reach consensus with the specified parties, specifically including those parties with authority under section 10(j).	Washington DFW	No, not a specific measure to protect, mitigate for, or enhance fish and wildlife resources.	$0[c]	No, because the measure is redundant with Snohomish PUD's adaptive management framework and consultation requirements specified in the separate monitoring plans.

[a] The FWS initially recommended that Snohomish PUD modify the Near-turbine Monitoring and Mitigation Plan to include provisions to monitor turbine interaction with marine birds. On November 27, 2012, FWS affirmed that the final Plan filed

20130809-3010 FERC PDF (Unofficial) 08/09/2013

on November 16, 2012, adequately addresses monitoring requirements for marine birds and the plan can be approved (see phone memo between David Turner, FERC, and Tim Romanski (FWS), November 28, 2012).

[b] This measure would only be implemented in the event of an unanticipated emergency; therefore, there is no cost for this measure.

[c] The cost of the establishment of this group and the specification of consultation activities are not anticipated to generate an incremental cost to Snohomish PUD.

5.5 CONSISTENCY WITH COMPREHENSIVE PLANS

Section 10(a)(2)(A) of the FPA, 16 U.S.C. § 803(a)(2)(A), requires the Commission to consider the extent to which a project is consistent with the federal or state comprehensive plans for improving, developing, or conserving a waterway or waterways affected by the project. Under section 10(a)(2)(A) of the FPA, federal and state agencies filed comprehensive plans that address various resources in Washington. We determined that six comprehensive plans (listed below) are relevant to the project. We found no inconsistencies.

Interagency Committee for Outdoor Recreation. 2002. Washington State Comprehensive Outdoor Recreation Planning Document (SCORP): 2002-2007. Olympia, Washington. October 2002.

National Marine Fisheries Service, Seattle, Washington. Pacific Fishery Management Council, Portland, Oregon. 1978. Fishery management plan for commercial and recreational salmon fisheries off the coasts of Washington, Oregon, and California commencing in 1978. Department of Commerce. March 1978. 157 pp.

Northwest Power and Conservation Council. 2010. The Sixth Northwest conservation and electric power plan. Portland, Oregon. Council Document 2010-09. February 2010.

U.S. Fish and Wildlife Service. Undated. Fisheries USA: the recreational fisheries policy of the U.S. Fish and Wildlife Service. Washington, D.C.

Washington Department of Fisheries, Point No Point Treaty Council, and U.S. Fish and Wildlife Service. Settlement agreement pursuant to the July 2, 1986, Order of the U.S. District Court for the Western District of Washington in Case No. 9213.

Washington Department of Fisheries. 1987. Hydroelectric project assessment guidelines. Olympia, Washington. 91 pp. Washington Department of Wildlife. Point No Point Treaty Council. 1987. 1987-88 winter and

20130809-3010 FERC PDF (Unofficial) 08/09/2013

summer Steelhead forecasts and management recommendations. Olympia, Washington. December 1987. 19 pp.

20130809-3010 FERC PDF (Unofficial) 08/09/2013

6.0 FERC FINDING OF NO SIGNIFICANT IMPACT

On the basis of our independent analysis, FERC concludes that approval of the proposed action, with our recommended measures, would not constitute a major federal action significantly affecting the quality of the human environment.[104] Preparation of an environmental impact statement is not required.

[104] DOE's decision document will be posted separately.

20130809-3010 FERC PDF (Unofficial) 08/09/2013

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20130809-3010 FERC PDF (Unofficial) 08/09/2013

7.0 LITERATURE CITED

Adams, P.B., C.B. Grimes, S.T. Lindley, and M.L. Moser. 2002. Status Review for North American Green Sturgeon, Acipenser medirostris. NOAA, National Marine Fisheries Service, Southwest Fisheries Science Center, Santa Cruz, California. 49 p. Available online at URL: http://www.nmfs.noaa.gov/pr/species/statusreviews.htm.

Ainley, D.G., D.W. Anderson, and P.R. Kelly. 1981. Feeding ecology of marine cormorants in southwestern North America. Condor 83: 120-131. Cited in 74 FR 18516.

Antonelis, Jr., G.A. and C.H. Fiscus. 1980. The pinnipeds of the California Current. CalCOFI Rep. 21: 68-78. Cited in 74 FR 18516.

Baird, R.W. 2000. The killer whale: foraging specializations and group hunting. Pages 127-153 in J. Mann, R.C. Connor, P.L. Tyack, and H. Whitehead (editors). Cetacean societies: field studies of dolphins and whales. University of Chicago Press, Chicago, Illinois. Cited in NMFS 2008c.

Baird, R.W., M.B. Hanson, and L.M. Dill. 2005. Factors influencing the diving behavior of fish-eating killer whales: sex differences and diel and inter-annual variation in diving rates. Canadian Journal of Zoology 83:257-267. Cited in NMFS 2008c.

Baird, R.W., M.B. Hanson, E.A. Ashe, M.R. Heithaus, and G.J. Marshall. 2003. Studies of foraging in "southern resident" killer whales during July 2002: dive depths, bursts in speed, and the use of a "Crittercam" system for examining subsurface behavior. National Marine Fisheries Service, National Marine Mammal Laboratory, Seattle, WA . Cited in NMFS 2008c.

Barraclough,W.E. 1964. Contribution to the marine life history of the eulachon Thaleichthys pacificus. Journal of the Fisheries Research Board of Canada. 21:1333-1337. Cited in NMFS 2010b.

Barss, W.H. 1989. Maturity and reproductive cycle for 35 species from the family Scorpaenidae found off Oregon. Report No. 89-7, Oregon Department of Fish and Game, Portland, Oregon. Cited in 74 FR 18516.

Bassett, C. 2010. Underwater Ambient Noise at a Proposed Tidal Energy Site in Puget Sound. University of Washington.

Bassett, C.S., J. Thomson, and B. Polagye. 2010. Characteristics of underwater ambient noise at a proposed tidal energy site in Puget Sound, MTS/IEEE Oceans 2010, Seattle, WA, September 20-23, 2010.

Bassett, C.S., J.M Thomson, and B. Polagye. In revision, 2013. Sediment generated noise and bed stress in a tidal channel. J. Geo. Res, in revision.

Bassett, C.S., Polagye, B., Holt, M., and Thomson, J.M. 2012. A vessel noise budget for Admiralty Inlet, Puget Sound, WA (USA), To be submitted to the J. Acoust. Soc. Am.

Bigg, M. 1982. An assessment of killer whale (Orcinus orca) stocks off Vancouver Island, British Columbia. Report of the International Whaling Commission 32:655-666. Cited in NMFS 2008c.

Boehlert, G.W. 1980. Size composition, age composition, and growth of canary rockfish, Sebastes pinniger, and splitnose rockfish, S. diploproa, from the 1977 rockfish survey. Marine Fisheries Review 42: 57-63. Cited in 74 FR 18516.

Bohnsack, J.A. and D.L. Sutherland. 1985. Artificial reef research: a review with recommendations for future priorities. Bulletin of Marine Science, 37(11): 11-39.

Buckley R.M. and G.J. Hueckel. 1985. Biological processes and ecological development on an artificial reef in Puget Sound, Washington. Bulletin of Marine Science, 37(1): 50-69.

Burgner, R.L., J.T. Light, L. Margolis, T. Okazaki, A. Tautz, and S. Ito. 1992. Distribution and origins of steelhead trout (Oncorhynchus mykiss) in offshore waters of the North Pacific. International North Pacific Fisheries Commission Bulletin Number 51, 92 p. Cited in NMFS 2005b.

Cailliet, G.M., E.J., Burton, J.M. Cope, and L.A. Kerr (editors). 2000. Biological characteristics of nearshore fishes of California: A review of existing knowledge. Vol. Final Report and Excel Data Matrix, Pacific States Marine Fisheries Commission. California Department of Fish and Game. Cited in 74 FR 18516.

Calambokidis, J. and R. Baird. 1994. Status of marine mammals in the Strait of Georgia, Puget Sound and the Juan de Fuca Strait and Potential human impacts. Symposium on the Marine Environment. January 13 and 14, 1994.

Calambokidis, J., G.H. Steiger, J.M. Straley, T.J. Quinn, II, L.M. Herman, S. Cerchio, D.R. Salden, M. Yamaguchi, F. Sato, J. Urbán, R.J. Jacobsen, O. von Ziegesar, K.C. Balcomb, C.M. Gabriele, M.E. Dahlheim, N. Higashi, S. Uchida, K.B.

Ford, Y. Miyamura, P. Ladrón de Guevara, S.A. Mizroch, L. Schlender and K. Rasmussen. 1997. Abundance and population structure of humpback whales in the North Pacific Basin. Final Contract Report 50ABNF500113 to Southwest Fisheries Science Center, P.O. Box 271, La Jolla, CA 92038. 72p. Cited in NMFS 2008d.

Calambokidis, J., J. Darling, V. Deecke, P. Gearin, M. Gosho, W. Megill, C.M. Tomback, D. Goley, C. Torpova, and B. Gisborne. 2002. Abundance, range and movements of a feeding aggregation of gray whales (Eschrichtius robustus) from California to southeastern Alaska in 1998. J. Cetacean Res. Manage. 4(3):267-276, 2002.Carlson, H.R., and R.R. Straty. 1981. Habitat and nursery grounds of Pacific rockfish, Sebastes spp., in rocky coastal areas of southeastern Alaska. Marine Fisheries Review 43(7): 13-19. Cited in 74 FR 18516.

Carlson, T.J., J.L. Elster, M.E. Jones, B.E. Watson, A.E. Copping, M. Watkins, R. Jepsen, and K.Metzinger. 2012. Assessment of strike of adult killer whales by an OpenHydro tidal turbineblade. Pacific Northwest National Laboratory technical report, PNNL-21177.

Carr, M.H. 1983. Spatial and temporal patterns of recruitment of young-of-the-year rockfishes (Genus Sebastes) into a central California kelp forest. Master of Arts, San Francisco State University/Moss Landing Marine Laboratories. Cited in 74 FR 18516.

Carretta, J.V., K.A. Forney, M.S. Lowry, J. Barlow, J. Baker, D. Johnston, B. Hanson, M.M. Muto, D. Lynch, and L. Carswell. 2008b. NOAA Technical Memorandum NMFS, U.S. Pacific Marine Mammal Stock Assessments: 2008. Minke Whale (Balaenoptera acutorostrata): California/Oregon/Washington Stock. Revised: December 15, 2008.

Carretta, J.V., K.A. Forney, M.S.Lowry, J. Barlow, J. Baker, D. Johnston, B. Hanson, M.M. Muto, D. Lynch, and L. Carswell. 2007. NOAA Technical Memorandum NMFS, U.S. Pacific Marine Mammal Stock Assessments: 2008. California Sea Lion (Zalophus californianus californianus): U.S. Stock. Revised October 30, 2007.

Carretta, J.V., K.A. Forney, M.S. Lowry, J. Barlow, J. Baker, D. Johnston, B. Hanson, M.M. Muto, D. Lynch, and L. Carswell. 2006. NOAA Technical Memorandum NMFS, U.S. Pacific Marine Mammal Stock Assessments: 2008. Harbor Porpoise (Phocoena phocoena): Washington Inland Waters Stock. Revised: December 15, 2006.

Cavagnaro, R., B. Polagye, J. Wood, and D. Tollit (in preparation) Harbor porpoise echolocation activity in Admiralty Inlet, Puget Sound, WA.

20130809-3010 FERC PDF (Unofficial) 08/09/2013

Center for Whale Research. 2009. Southern Resident Killer Whale Research. [Online] URL: http://www.whaleresearch.com/research.html. Accessed December 21, 2009.

City of Port Townsend. 2007. Shoreline master program. City of Port Townsend, Port Townsend WA.

Clemens, W.A. and G.V. Wilby. 1961. Fishes of the Pacific coast of Canada. Bulletin of the Fisheries Research Board of Canada 68: 443. Cited in 74 FR 18516.

Committee on the Status of Endangered Wildlife in Canada. 2002. COSEWIC assessment and status report on the Bocaccio Sebastes paucispinis in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 43 p. Cited in 74 FR 18516.Collar, C., J. Spahr, B. Polagye, J. Thomson, C. Bassett, J. Graber, R. Cavagnaro, J. Talbert, A. deKlerk, Capt. A. Reay-Ellers, D. Tollit, J. Wood, A. Copping, T. Carlson, and M. Halvorsen (2012). Study of the acoustic effects of hydrokinetic tidal turbines in Admiralty Inlet, Puget Sound, Final report to US DOE under DE-EE0002654.

Coombs, C.I. 1979. Reef fishes near Depoe Bay, Oregon: movement and the recreational fishery. Master of Science, Fisheries and Wildlife, Oregon State University. Cited in 74 FR 18516.

Cowardin, L.M., V. Carter, F. Golet, and E. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Fish and Wildlife Service.

DeMott, G.E. 1983. Movement of tagged lingcod and rockfishes off Depoe Bay, Oregon. Master of Science, Oregon State University. Cited in 74 FR 18516.

Drake, J., E. Berntson, J. Cope, R. Gustafson, E. Holmes, P. Levin, N. Tolimieri, R. Waples, S. Sogard. 2008. Preliminary Scientific Conclusions of the Review of the Status of 5 Species of Rockfish: Bocaccio (Sebastes paucispinis), Canary Rockfish (Sebastes pinniger), Yelloweye Rockfish (Sebastes ruberrimus), Greenstriped Rockfish (Sebastes elongatus) and Redstripe Rockfish (Sebastes proriger) in Puget Sound, WA . National Marine Fisheries Service, Northwest Fisheries Science Center. Seattle, WA . 209p.

Drake, J., R. Emmett, K. Fresh, R. Gustafson, M. Rowse, D. Teel, M. Wilson, P. Adams, E. Spangler, R. Spangler. 2010a. Status Review Update for Eulachon in Washington, Oregon, and California. Prepared by the Eulachon Biological Review Team. National Marine Fisheries Service, Northwest Fisheries Science Center.

Echeverria, W.T. 1987. Thirty four species of California rockfishes: maturity and seasonality of reproduction. Fish. Bull. 85: 229-250. Cited in 74 FR 18516.

Electric Power Research Institute (EPRI). 2011. Evaluation of fish injury and mortality associated with hydrokinetic turbines. EPRI Technical Report 1024569, Palo Alto, CA.

Electric Power Research Institute (EPRI). 2011a. Fish passage through turbines: application of conventional hydropower data to hydrokinetic studies. EPRI Technical Report 1024638, Palo Alto, CA.

Erickson, D.L. and J.E. Hightower. 2007. Oceanic distribution and behavior of green sturgeon. American fisheries Society Symposium 56:197-211.

Erickson, D.L. and M. Webb. 2007. Spawning periodicity, spawning migration, and size at maturity of green sturgeon, Acipenser medirostris, in the Rogue River, Oregon. Environmental Biology of Fishes 79:255-268.

Eschmeyer, W.N., E.S. Herald, and H. Hammon. 1983. A field guide to Pacific Coast fishes of North America. Houghton Mifflin, Boston, Massachusetts, 336 p. Cited in 74 FR 18516.

Falxa, G., M. Huff, J. Baldwin, S. Miller, R. Young, C.J. Ralph, M.G. Raphael, T. Bloxton, C. Strong, Pearson, Scott; M. Lance, D. Lynch, B. Galleher, K. Nelson. 2008. Marbled Murrelet Effectiveness Monitoring Northwest Forest Plan - 2004-2007 Summary Report.

Feder, H.M., C.H. Turner, and C. Limbaugh. 1974. Observations on fishes associated with kelp beds in southern California. Fish Bulletin 160: 144. Cited in 74 FR 18516.

Ford, J.K.B. 1989. Acoustic behavior of resident killer whales (Orcinus orca) off Vancouver Island, British Columbia. Canadian Journal of Zoology 67:727-745. Cited in Wiles 2004.

Ford, J.K.B., G.M. Ellis, and K.C. Balcomb. 2000. Killer whales: the natural history and genealogy of Orcinus orca in British Columbia and Washington State. Second edition UBC Press, Vancouver, British Columbia. Cited in Wiles 2004.

Ford, J.K.B., G.M. Ellis, L.G. Barrett-Lennard, A.B.Morton, R.S. Palm, and K.C. Balcomb. 1998. Dietary specialization in two sympatric populations of killer whales (Orcinus orca) in coastal British Columbia and adjacent waters. Canadian Journal of Zoology 76(1456-1471). Cited in Drake et al. 2008.

Forney, K.A. 2007. Preliminary estimates of cetacean abundance along the U.S. West Coast and within four National Marine Sanctuaries during 2005. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-406. 27p.

Fugro. 2009. Bathymetric and geophysical survey site characterization Admiralty Inlet Pilot Tidal Project. Prepared for Snohomish County PUD No. 1 (SnoPUD). Survey period: June 25 to 30, 2009. Report Number: 0902J001. Vol. 1 of 1: draft final.

Gaines, S.D., and J. Roughgarden. 1987. Fish in offshore kelp forests affect recruitment to intertidal barnacle populations. Science 235: 479-481. Cited in 74 FR 18516.

Garish, T. and J. Cooper. 2012. Cultural Resources Assessment of the Pilot Tidal Energy Project (FERC #62110) Island County, WA . Prepared by AMEC for Snohomish County PUD. February 22, 2012.

Gilmore, R.R. Englebretson, R. Handlers, and S. Brand. 1996. Puget Sound area heavy weather port guide. Naval Research Laboratory, Monterey, CA.

Goetz, F., E. Jeanes, and E. Beamer. 2004. Bull trout in the nearshore. Preliminary draft. U.S. Army Corps of Engineers, Seattle, WA , June, 2004, 396 pp. Cited in USFWS 2008.

Goetz, F., E. Jeanes, G. Hart, C. bel, J. Starkes, and E. Conner. 2003. Behavior of anadromous bull trout in the Puget Sound and Pacific Coast of Washington. Estuarine Research Federation Conference. September 2003, Seattle, WA.

Golder Associates, Inc. 2011. Geophysical Investigation for Admiralty Inlet Turbine Project. Prepared for Public Utility District No. 1 of Snohomish County (Snohomish PUD). September 6, 2011. Survey Dates: May 25-26, 2011.

Good, T.P., J.A. June, M.A. Etnier, and G. Broadhurst. 2009. Ghosts of the Salish Sea: threats to marine birds in Puget Sound and the Northwest Straits from derelict fishing gear. Marine Ornithology 37: 67-76.

Good, T.P., R.S. Waples, and P. Adams (Eds.). 2005. Updated status of federally listed ESUs of West Coast salmon and steelhead. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS-NWFSC-66. 598 p.

Greene, H.G. 2011. Habitat characterization of the SnoPUD turbine site – Admiralty Head, Washington State, Technical Report, June 1, 2011.

Greene, H.G. 2012. Review of ROV Video Collected Within the Tidal Turbine Box Offshore of Admiralty Head, WA, Memorandum, October, 2012.

Groot C. and L.Margolis. 1991. Pacific salmon life histories. UBC Press, Vancouver, BC, Canada.

Gustafson R.G., W.H.Lenarz, B.B. McCain, C.C. Schmitt, W.S. Grant, T.L. Builder, and R.D. Methot. 2000. Status review of Pacific hake, Pacific cod, and walleye pollock from Puget Sound, WA . U.S. Dept. Commerce, NOAA Tech. Memo. NMFS-NWFSC- 44. Available online at: www.nwfsc.noaa.gov/publications/techmemos/tm44 and www.nwfsc.noaa.gov/publications/techmemos/tm44/environment.htm. Accessed October 2007.

Hall, A. 2004. Seasonal abundance, distribution, and prey species of harbour porpoise (Phocoena phocoena) in southern Vancouver Island waters. MSc thesis, UBC. Cited in Tollit et al. 2010.

Halvorsen, MB, TJ Carlson, AE Copping. 2011. Effects of Tidal Turbine Noise on Fish Hearing and Tissues Draft Final Report Environmental Effects of Marine and Hydrokinetic Energy. Department of Energy under Contract DE-AC05-76RL01830, Pacific Northwest National Laboratory Sequim, WA .

Hart, J.L. 1973. Pacific Fishes of Canada. Fisheries Research Board of Canada Bulletin 180. Cited in 74 FR 18516.

Hastings, M.C. and A.N. Popper. 2005. Effects of Sound on Fish. (Subconsultants) Submitted by Jones & Stokes to California Dept. of Transportation Contract No. 43A0139. Task Order 1.

Hauser, D.D.W. 2006. Summer space use of southern resident killer whales (Orcinus orca) within Washington and British Columbia inshore waters. M.S. thesis, University of Washington, Seattle, WA . Cited in NMFS 2008c.

Hay, D.E., and McCarter, P.B. 2000. Status of the eulachon Thaleichthys pacificus in Canada. Department of Fisheries and Oceans Canada, Canadian Stock Assessment Secretariat, Research Document 2000-145. Ottawa, Ontario. Online at http://www.dfo-mpo.gc.ca/csas/csas/DocREC/2000/PDF/2000_145e.pdf. and cited in NMFS 2010b.

Heimlich-Boran, J.R. 1988. Behavioral ecology of killer whales (Orcinus orca) in the Pacific Northwest. Canadian Journal of Zoology 66:565-578. Cited in Wiles 2004 and NMFS 2008c.

Hubbs, C.L. 1925. A revision of the osmerid fishes of the North Pacific. Proceedings of the Biological Society of Washington 38: 49-56.

Huff, M., P. Jodice. J. Baldwin, S. Miller. R.Young, K. Ostom, C.J. Ralph,, M.G. Raphael, C. Strong, C. Thompson, G. Falxa, D. Evans Mack; K. Nelson. 2003. Marbled Murrelet Effectiveness Monitoring Northwest Forest Plan - 2002 Annual Summary Report (Version 2).

Interagency Committee for Outdoor Recreation. 2002. Washington State Comprehensive Outdoor Recreation Planning Document (SCORP): 2002-2007. Olympia, WA . October 2002.

Israel, J.A. and B. May. 2007. Mixed Stock Analysis of Green Sturgeon from Washington State Coastal Aggregations. Final Report. Genomic Variation Laboratory, University of California-Davis, Davis, CA.

Jeffries, S., H. Huber, J. Calambokidis, and J. Laake. 2003. Trends and status of harbor seals in Washington State: 1978-1999. J. Wildl. Manage. 67(1):208-219.

Jeffries, S.J., P. Gearin, H.R. Huber, D.L. Saul, and Darrell A. Pruett. 2000. Atlas of Seal and Sea Lion Haulout Sites in Washington. February 2000.

Johnson, D.W. 2006. Predation, habitat complexity, and variation in density-dependent mortality of temperate reef fishes. Ecology 87: 1179-1188. Cited in 74 FR 18516.

Johnson, S.Y., C. J. Potter, J.M. Armentrout, J.J. Miller, C. Finn, and C.S. Weaver. 1996. The southern Whidbey Island fault: An active structure in the Puget Lowland, Washington, Geol. Soc. Am. Bull., 108 (3), 334-354.

Jørgensen, R., Olsen, K.K., Falk-Petersen, I.B. & Kanapthippilai, P. 2005. Investigations of Potential Effects of Low Frequency Sonar Signals on Survival, Development and Behaviour of Fish Larvae and Juveniles. Norway: Norwegian College of Fishery Science, University of Tromsø. Cited in Popper and Hastings 2009.

Kelly, J.T., A.P. Klimleya, & C.E. Crocker. 2007. Movements of green sturgeon, Acipenser medirostris, in the San Francisco Bay estuary, California. Environmental Biology of Fishes (2007) 79:281-295.

Krahn, M.M., M.J. Ford, W.F. Perrin, P.R. Wade, R.P. Angliss, M.B. Hanson, B.L. Taylor, G.M. Ylitalo, M.E. Dahlheim, J.E. Stein, and R.S. Waples. 2004. 2004 status review of southern resident killer whales (Orcinus orca) under the

Endangered Species Act. NOAA Technical Memorandum NMFS-NWFSC-62, U.S. Department of Commerce, Seattle, WA . Cited in NMFS 2008c.

Lea, R.N., McAllister, R.D., and D.A. VenTresca. 1999. Biological aspects of nearshore rockfishes of the genus Sebastes from central California. Fish Bull. 177: 1-109.

Lindley, S.T., M.L. Moser, D.L. Erickson, M. Belchik, D.W. Welch, E.L. Rechisky, J.T. Kelly, J. Heublein, and A.P. Klimley. 2008. Marine Migration of North American Green Sturgeon. Trans. Am. Fish. Soc. 137(1):182-194.

Love, M.S. 1996. Probably more than you want to know about the fishes of the Pacific Coast. Really Big Press, Santa Barbara, California, 215 p. Cited in 74 FR 18516.

Love, M.S., and M. Yoklavich. 2008. Habitat characteristics of juvenile cow cod, Sebastes levis (Scorpaenidae), in Southern California. Environmental Biology of Fishes 82: 195-202. Cited in 74 FR 18516.

Love, M.S., M. Carr, and L. Haldorson. 1991. The ecology of substrate-associated juveniles of the genus Sebastes. Env. Bio. Fish. 79: 533-545. Cited in 74 FR 18516.

Love, M.S., M.M. Yoklavich, and L. Thorsteinson. 2002. The rockfishes of the Northeast Pacific. University of California Press, Berkeley, California. Cited in 74 FR 18516.

Mathews, N.J.C. and A.E. Burger. 1998. Diving depth of a marbled murrelet. Northwestern Naturalist 79(2):70-71. Cited in. USFWS letter to the District dated February 25, 2010.

MBC Applied Environmental Sciences. 1987. Ecology of Important Fisheries Species Offshore California. Minerals Management Service, Pacific Outer Continental Shelf Region. Washington, D.C. MMS 86-0093, 252 p. Cited in 74 FR 18516.

McAllister, D.E. 1963. A revision of the smelt family, Osmeridae. National Museum of Canada, Biological Series 71, Bulletin No. 191:1-53.

McCallister, M.A. 2012. Northwest Underwater Construction, LLC, ROV Survey, Memorandum, September 26, 2012.

McCurdy, R. 2007. President, Puget Sound Pilots. Personal communication with Snohomish Public Utility District.

20130809-3010 FERC PDF (Unofficial) 08/09/2013

McGary, N. and J. Lincoln. 1977. Tide Prints: surface tidal currents in Puget Sound. University of Washington Press. Cited in Polagye et al. 2007.

Mecklenburg, C., T. Mecklenburg, and L. Thorsteinson. 2002. Fishes of Alaska. Bethesda: American Fisheries Society. Cited in 74 FR 18516.

Merkel, T.J. 1957. Food habits of the king salmon Oncorhynchus tshawytscha. Calif. Fish Game 43: 249-270. Cited in 74 FR 18516.

Miller, B.S., and S.F. Borton. 1980. Geographical distribution of Puget Sound fishes: Maps and data source sheets. Univ. of Washington Fisheries Research Institute, 3 vols. Cited in Palsson 2009.

Miller, D.J. and J.J. Geibel. 1973. Summary of blue rockfish and lingcod life histories; a reef ecology study; and giant kelp, Macrocystis pyrifera, experiments in Monterey Bay, California. Fish Bulletin: 137. Cited in 74 FR 18516.

Minerals Management Service (MMS). 2007. Draft Programmatic EIS for alternative energy development and production and alternative use of facilities on the Outer Continental Shelf. U.S. Department of the Interior. March 2007. [Online] URL: http://ocsenergy.anl.gov/documents/dpeis/ index.cfm. Accessed June 2007.

Mofjeld, H.O., and Larsen, L.H. 1984. Tides and tidal currents in the inland waters of Western Washington. NOAA Tech. Memo. ERL PMEL-56 (PB84-237379), Seattle, 52 pp.

Morejohn, G.V. 1979. The natural history of Dall's porpoise in the North Pacific Ocean. In: Winn, H. E. and B. L. Olla (eds.), Behavior of Marine Mammals, p. 45-83. Plenum Press, New York - London.

Morejohn, G.V., J.T. Harvey, and L.T. Krasnow. 1978. The importance of Loligo opalescens in the food web of marine vertebrates in Monterey Bay, California. In C. W. Recksiek and H.W. Frey (eds.), Biological, oceanographic, and acoustic aspects of the market squid, Loligo opalescens Berry, p. 67-98. Cited in 74 FR 18516.

Moser, H.G., and G.W. Boehlert. 1991. Ecology of pelagic larvae and juveniles of the genus Sebastes. Environ. Biol. Fishes 30: 203-224. Cited in 74 FR 18516.

Moyle, PB. 1976. Inland fishes of California. University of California Press, Berkeley, CA.

Myers, J.M., R.G. Kope, G.J. Bryant, D. Teel, L.J. Lierheimer, T.C. Wainwright, W.S. Grant, F.W. Waknitz, K. Neely, S.T. Lindley, and R.S. Waples. 1998. Status Review of Chinook Salmon from Washington, Idaho, Oregon, and California. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS-NWFSC-35, 443 p.

National Academy of Science (NAS). 2003. Ocean Noise and Marine Mammals. Prepared by the Committee on Potential Impacts of Ambient Noise in the Ocean on Marine Mammals, Ocean Studies Board, Division on Earth and Life Studies. The National Academies Press, WA , D.C. [Online] URL: http://www.nap.edu/catalog.php?record_ id=10564. Accessed 10/21/08.

National Marine Fisheries Service (NMFS). 1991. Recovery Plan for the Humpback Whale (Megaptera novaeanglia). Prepared by the Humpback Whale Recovery Team for the National Marine Fisheries Service, Silver Spring, MD. 105 pgs.

National Marine Fisheries Service (NMFS). 2005b. Status review update for Puget Sound steelhead. July 26, 2005.

National Marine Fisheries Service (NMFS). 2007b. Green Sturgeon (Acipenser medirostris). [Online] URL: http://www.nmfs.noaa.gov/pr/species/fish/greensturgeon.htm. Accessed October 11, 2007.

National Marine Fisheries Service (NMFS). 2007c. Species of Concern - Green Sturgeon (Acipenser medirostris) Northern DPS. [Online] URL: http://www.nmfs.noaa.gov/pr/pdfs/species/greensturgeon_detailed.pdf. Accessed October 17, 2007.

National Marine Fisheries Service (NMFS). 2008a. Recovery Plan for Southern Resident Killer Whales (Orcinus orca). National Marine Fisheries Service, Northwest Region, Seattle, WA .

National Marine Fisheries Service (NMFS). 2008b. Recovery Plan for the Steller Sea Lion (Eumetopias jubatus). Revision. National Marine Fisheries Service, Silver Spring, MD. 325 pages.

National Marine Fisheries Service (NMFS). 2008c. Recovery Plan for Southern Resident Killer Whales (Orcinus orca). National Marine Fisheries Service, Northwest Region, Seattle, WA .

National Marine Fisheries Service (NMFS). 2008e. Recovery Plan for the Steller Sea Lion (Eumetopias jubatus). Revision. National Marine Fisheries Service, Silver Spring, MD. 325 pages.

National Marine Fisheries Service (NMFS). 2009a. Endangered and threatened wildlife and plants: proposed threatened status for southern distinct population segment of eulachon. Federal Register (Docket No. 080229343-81352-02); 13 March 2009; 74(48):10857-10876.

National Oceanic and Atmospheric Administration (NOAA). 2007a. Coast Pilot 7 - 39th Edition. Office of Coast Survey, National Ocean Service, Silver Spring, Maryland.

National Oceanic and Atmospheric Association (NOAA). 2009b. California Sea Lion (Zalophus californianus). [Online] URL: http://www.nmfs.noaa.gov/pr/species/mammals/pinnipeds/californiasealion.htm. Accessed July 28, 2009.

National Oceanic and Atmospheric Association (NOAA). 2009c. Northern Elephant Seal (Mirounga angustirostris). Available online at: www.nmfs.noaa.gov/pr/species/ mammals/pinnipeds/northernelephantseal.htm. Accessed July 27, 2009.

National Oceanic and Atmospheric Association (NOAA). 2009d. Dall's Porpoise (Phocoenoides dalli). Available online at: www.nmfs.noaa.gov/pr/species/mammals/ cetaceans/dallsporpoise.htm. Accessed July 27, 2009.

National Oceanic and Atmospheric Association (NOAA). 2009e. Minke Whale (Balaenoptera acutorostrata). Available online at: www.nmfs.noaa.gov/pr/species/mammals/ cetaceans/minkewhale.htm. Accessed July 27, 2009.

National Park Service (NPS). 2006. Ebey's Landing National Historical Reserve General Management Plan. Available online at: http://www.nps.gov/ebla/parkmgmt/planning.htm. Accessed January 2, 2013.

National Park Service (NPS). 2003a. Ebey's Landing National Historical Reserve. An analysis of land use change and cultural landscape integrity. April 2003.

National Park Service (NPS). 2003b. Ebey's Landing National Historical Reserve. Naturalist's Guide Spring and Summer, Fall and Winter.

Northwest Fisheries Science Center. 2008. Summary Information on 2008 Southern Resident Killer Whale Births and Deaths. Conservation Biology Division. October 28, 2008. [Online] URL: http://www.nwfsc.noaa.gov/research/divisions/cbd/marine_mammal/documents/salmon_killer_whale_summary_sheet_oct28.pdf. Accessed: December 21, 2009.

Northwest Power and Conservation Council (NWPCC). 2004. Lower Columbia Salmon Recovery and Fish and Wildlife Subbasin Plan, Lower Columbia province plan. June 2004. Online at: http://www.nwcouncil.org/fw/subbasinplanning/lowerColumbia/plan/RP%20Overview.pdf.

Northwest Straits Foundation (NWSF). 2007. Derelict fishing gear priority ranking project [Unpublished report]. Mt. Vernon, WA: NWSF. 40 pp. Cited in Good et al. 2009.

Northwest Straits Foundation (NWSF). 2011. Program Accomplishments 2002-Present. [Online] URL: http://www.derelictgear.org/Progress.aspx. Accessed February 2011.

Northwest Straits Foundation (NWSF). 2012. Program Accomplishments 2002-Present. [Online] URL: http://www.derelictgear.org/Progress.aspx. Accessed January 2012.

Northwest Straits. 2009. Northwest Straits marine conservation initiative. [Online] URL: http://www.nwstraits.org/. Accessed: September 2009.

O'Connell, V.M. 1987. Reproductive seasons for some Sebastes species in southeastern Alaska. Cited in 74 FR 18516.

OrcaNetwork.org. 2007. Whale sightings occurring from 2001-2007. Available online at: orcanetwork.org/. Accessed November 2007.

Orr, J.W., M.A. Brown, D.C. Baker. 2000. Guide to Rockfishes (Scorpaenidae) of the Genera Sebastes, Sebastolobus, and Adelosebastes of the Northeast Pacific Ocean, Second Edition. NOAA Technical Memorandum NMFS-AFSC-117. Cited in 74 FR 18516.

Osborne, R.J. Calambokidis, and E.M. Dorsey. 1988. A guide to marine mammals of greater Puget Sound. Island Publishers, Anacortes, WA. 191 pages.

Pacific Fishery Management Council (PFMC). 1998. The Coastal Pelagic Species Fishery 206 Management Plan: Amendment 8. Pacific Fishery Management Council, Portland, Oregon (December 1998). http://www.pcouncil.org/cps/cpsfmp.html.

Pacific Fishery Management Council (PFMC). 2000. Amendment 14 to the Pacific Coast Salmon Plan (1997): Incorporating the regulatory impact review/initial regulatory flexibility analysis and final supplemental environmental impact statement. Pacific Fishery Management Council.

20130809-3010 FERC PDF (Unofficial) 08/09/2013

Pacific Fishery Management Council (PFMC). 2003. Fishery management plan and environmental impact statement of U.S. West Coast fisheries for highly migratory species. Also, Appendix F: U. S. West Coast highly migratory species life history and essential fish habitat. Available online at: www.pcouncil.org/hms/fmp/HMS_AppF.pdf. Accessed September 2007.

Pacific Fishery Management Council (PFMC). 2008. Pacific Coast groundfish fishery management plan for the California, Oregon, and Washington groundfish fishery as amended through Amendment 19. July 2008.

Palsson W.A., T. Tsou, G.G. Bargmann, R.M. Buckley, J. E. West, M.L. Mills, Y.W. Cheng, and R.E. Pacunski. 2009. The Biology and Assessment of Rockfishes in Puget Sound. Marine Resources Unit. May 2009.

Palsson, W.A., J.C. Hoeman, G.G. Bargmann, and D. E. Day, D.E. 1997. 1995 status of Puget Sound bottomfish stocks (revised). WDFW Report No. MRD97-03. Available from Washington Department of Fish and Wildlife, Olympia, WA . Cited in Gustafson et al., 2000.

Palsson, W.A., W.T. Northup, and M. Barker. 1998. Puget Sound groundfish management plan. Washington Department of Fish and Wildlife, 43 p.

Pentilla, D. 2007. Marine forage fishes in Puget Sound. Puget Sound Nearshore Partnership Report No. 2007-03. Published by Seattle District, Army Corps of Engineers, Seattle, WA. Online at http://www.pugetsoundnearshore.org/technical_papers/marine_fish.pdf.

Pleyte, K.A., R.B. Phillips, and S. Duncan. 1992. Phylogenetic analysis of the genus Salvelinus from the first internal transcribed spacer of ribosomal DNA. Molecular Phylogenetics and Evolution 1:223-230.

Polagye B., B. Van Cleve, A. Copping, and K. Kirkendall, eds. 2010. Environmental Effects of Tidal Energy Development Proceedings of a Scientific Workshop. NOAA Technical Memorandum NMFS F/SPO-116.

Polagye, B., and J. Thomson, NNMREC. 2010. Admiralty Inlet Water Quality Survey Report: April 2009 - February 2010. University of Washington, Seattle, WA . May 29, 2010.

Polagye, B., and Thomson, J. 2012. Tidal energy resource characterization: methodology and field study in Admiralty Inlet, Puget Sound, US. Submitted to Proc. IMechE, Part A: J. Power and Energy.

Polagye, B., C. Bassett, J. Wood, and S. Barr. (2013) A framework for detection of tidal turbine sound: A pre-installation case study for Admiralty Inlet, Puget Sound, WA (USA), Submitted to *IEEE J. Ocean. Eng.*

Polagye, B., Cavagnaro, R., Wood, J., and Tollit, D. 2012b. A study of harbor porpoise responsiveness to vessel traffic noise. In preparation.

Polagye, B., M. Kawase, and P. Malte (2009) In-stream tidal energy potential of Puget Sound, Washington, Proc. IMechE, Part A: J. Power and Energy, 223(5).

Polagye, B., M. Previsic, and R. Bedard. 2007. Tidal In-Stream Energy Conversion (TISEC): Survey and Characterization of SnoPUD Project Sites in the Puget Sound. EPRI North American Tidal In Stream Power Feasibility Demonstration Project: EPRI 2007.

Polenz, M., S.L. Slaughter, and G.W. Thorsenn. 2005. Geologic Map of the Coupeville and Part of the Port Townsend North 7.5-minute Quadrangles, Island County, Washington. Washington State Department of Natural Resources. Washington Division of Geology and Earth Resources, Geologic Map GM-58.

Popper, A.N. and M.C. Hastings. 2009. The effects of anthropogenic sources of sound on fishes. Jour. Fish. Biol. 75, pp. 455-489.

Raphael, M.G.; J. Baldwin, G.A. Falxa, M.H. Huff, M. Lance, S.L. Miller; S.F. Pearson, C.J. Ralph, C. Strong; C. Thompson. 2007. Regional population monitoring of the marbled murrelet: field and analytical methods. Gen. Tech. Rep. PNW-GTR-716. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 70 p.

Richardson, W.J., C.R. Greene, Jr., C.I. Malme, and D.H. Thomson. 1995. Marine Mammals and Noise. Academic Press, London.

Rieman, B.E., and J.D. McIntyre. 1993. Demographic and habitat requirements for conservation of bull trout. General Technical Report INT-302, U.S. Department of Agriculture Forest Service, Intermountain Research Station, Ogden, Utah.

Roberts, D.A. 1979. Food Habits as an ecological partitioning mechanism in the nearshore rockfishes (Sebastes) of Carmel Bay, California. Master of Arts, San Francisco State University/Moss Landing Marine Laboratories. Cited in 74 FR 18516.

Rosenthal, R.J., L. Haldorson, L.J. Field, V. Moran-O'Connell, and M.G. LaRiviere. 1982. Inshore and shallow offshore bottomfish resources in the southeastern Gulf of Alaska, Alaska Coastal Research, Sitka. Cited in 74 FR 18516.

Ruggerone, G.T., T.P. Quinn, I. McGregor and T.D. Wilkinson. 1990. Horizontal and vertical movements of maturing steelhead trout, Oncorhynchus mykiss, in Dean and Fisher channels, British Columbia. Canadian Journal of Fisheries and Aquatic Sciences 47: 1963-1969.

Schultz, L.P., and A.C. DeLacy. 1935. Fishes of the American Northwest. Journal of Pan-Pacific Research Institute 10: 365-380.

Scott, W.B., and E.J. Crossman. 1973. Freshwater fishes of Canada. Fisheries Research Board of Canada Bulletin No. 184.

Seattle Audubon Society. 2007. Marbled murrelet - Birdweb. Online: http://www.birdweb.org/birdweb/bird_details.aspx?id=224. Accessed November 2007.

Shared Strategy for Puget Sound (SSPS). 2007. Puget Sound Salmon Recovery Plan. Shared Strategy Development Committee. Plan adopted by the National Marine Fisheries Service. January 19, 2007.

Skinner, J.E. 1982. Fish and wildlife problems and study requirements in relation to North Coast water development. California Department of Fish and Game Water Projects Branch Report No. 5. Skinner. 1962. Cited in NMFS 2008a.

Southall Brandon L., A. Bowles, W. Ellison, J. Finneran, R. Gentry, C. Greene Jr., D. Kastak, D. Ketten, J. Miller, P. Nachtigall, J. Richardson, J. Thomas, and P. Tyack. 2007. Marine mammal noise exposure criteria: initial scientific recommendations.

Speich, S.M. and Wahl, T.R. 1995. Marbled murrelet populations of Washington - Marine habitat preferences and variability of occurrence. Chapter 30 in USDA Forest Service Gen. Tech. Report PSW-152.

Stahlmann, A., and T. Schlurmann. 2010, Physical modeling of scour around tripod foundation structures for offshore wind energy converters. Coastal Engineering (2010): v.2.

Steiger, G.H. and J. Calambokidis. 1986. California and Northern Sea Lions in Southern Puget Sound, Washington. The Murrelet. 67:93-96.

Strong, C.S. 1995. Distribution of marbled murrelets along the Oregon coast in 1992. Northwest. Nat. 76:99-105.

Sylwester, R. and D.P. Findley. 2011. Geophysical Investigation for Admiralty Inlet Turbine Project. Prepared for Snohomish County PUD by Golder Associates, Inc.

Thompson, S., D. McDermond, U. Wilson, and K. Montgomery. 1985. Rhinoceros auklet burrow count on Protection Island, Washington. Murrelet 66:62-65.

Tollit, D.J., E. Philpott, R. Joy, B. Polagye, and J. Thomson. 2010. Admiralty Inlet Hydrophone Monitoring Study: 2009/2010 Deployments - Final Report June 15th 2010. Prepared for Snohomish PUD June 18, 2010.

Tollit, D.J., J.D. Wood, S. Veirs, Berta, and H. Garret. 2010a. Admiralty Inlet Pilot Project Marine Mammal Pre-installation Field Studies - Final Report June 15, 2010.

Tollit, D., E. Philpott, and J. Thomson. 2010b. Admiralty Inlet Hydrophone Study: 2009/2010 POD Deployments - Final Report June 18, 2010.

U.S. Commission on Ocean Policy. 2004. An ocean blueprint for the 21st Century. Washington, D.C. 2004.

U.S. Department of Energy (DOE). 2009. Report to Congress on the potential environmental effects of marine and hydrokinetic energy technologies. Wind and Hydropower Technology Program, Washington, DC.

U.S. Department of the Navy (DON). 2006. Marine resources assessment for the Pacific Northwest operating area. Pacific Division, Naval Facilities Engineering Command, Pearl Harbor, Hawaii. Contract No. N62470-02-D-9997, CTO 0029. Prepared by Geo-Marine, Inc., Plano, Texas.

U.S. Department of the Navy (DON). 2006. Marine resources assessment for the Pacific Northwest operating area. Pacific Division, Naval Facilities Engineering Command, Pearl Harbor, Hawaii. Contract No. N62470-02-D-9997, CTO 0029. Prepared by Geo-Marine, Inc., Plano, Texas.

U.S. Energy Information Administration (EIA). 2013. Frequently Asked Questions. http://www.eia.gov/tools/faqs/. Accessed May 28, 2013.

U.S. Fish and Wildlife Service (USFWS). 1997. Recovery plan for the threatened marbled murrelet (Brachyramphus marmoratus) in Washington, Oregon, and California. Portland, Oregon. 203 pp.

U.S. Fish and Wildlife Service (USFWS). 2000. Recovery plan for the golden paintbrush (Castilleja levisecta). U.S. Fish and Wildlife Service, Portland, OR. 51 pp.

U.S. Fish and Wildlife Service (USFWS). 2004. Draft recovery plan for the coastal-Puget Sound distinct population segment of bull trout (Salvelinus confluentus). Volume I (of II): Puget Sound management unit. Portland, Oregon. 289 + xvii pp.

U.S. Fish and Wildlife Service (USFWS). 2006. Designation of critical habitat for the marbled murrelet. Federal Register. Volume 71. No 176.

U.S. Fish and Wildlife Service (USFWS). 2007. 5-Year Review Summary and Evaluation for the golden paintbrush (Castilleja levisecta). Western Washington Fish and Wildlife Office, Lacey, WA. 39 pp.

U.S. Fish and Wildlife Service (USFWS). 2008. Biological Opinion, Manette Bridge Replacement Project, Kitsap County, WA . Federal Highway Administration, Olympia, WA . USFWS Log # 13410-2008-F-0160.

U.S. Fish and Wildlife Service (USFWS). 2008. Biological Opinion, Manette Bridge Replacement Project, Kitsap County, WA . Federal Highway Administration, Olympia, WA . USFWS Log # 13410-2008-F-0160.

U.S. Fish and Wildlife Service (USFWS). 2008. Biological Opinion. USFWS Log# 13410-2007-F-0641, Interstate-405, State Route 520 to Interstate-5 Improvement Project King and Snohomish Counties, Washington. December 2008.

U.S. Fish and Wildlife Service (USFWS). 2008. Biological Opinion. USFWS Log# 13410-2007-F-0641, Interstate-405, State Route 520 to Interstate-5 Improvement Project King and Snohomish Counties, Washington. December 2008.

U.S. Geological Society (U.S.G.S.). 2012b. Web Soil Survey. Online: http://websoilsurvey.nrcs.usda.gov. Accessed December 11, 2012.

U.S. Geological Survey (U.S.G.S.). 2012a. Seismic hazards investigation in Puget Sound: Puget Sound earthquake origin and occurrence. Online: http://walrus.wr.usgs.gov/ships/pastquak.html. Accessed December 11, 2012.

Van Eenennaam, J.P., J. Linares, S.I. Doroshov, D.C. Hillemeier, T.E. Willson, and A.A. Nova. 2006. Reproductive conditions of the Klamath River green sturgeon. Trans. Am. Fish. Soc. 135(1):151-163.

20130809-3010 FERC PDF (Unofficial) 08/09/2013

Volk, E.C. 2000. Using otolith strontium to infer migratory histories of bull trout and Dolly Varden from several Washington State rivers. Submitted to Olympic National Park in fulfillment of Contract #2550041. Washington Department of Fish and Wildlife, Olympia.

Wahl, Terence R., Steven M. Speich. 1994. Distribution of Foraging Rhinoceros Auklets in the Strait of Juan de Fuca, WA . Northwestern Naturalist, Vol. 75, No. 2. (Autumn, 1994), pp. 63-69.

Washington Department of Fish and Wildlife (WDFW) and Oregon Department of Fish and Wildlife (ODFW). 2008. Summary of Questions and Requested Information.

Washington Department of Fish and Wildlife (WDFW). 2008. Preliminary draft for Fish and Wildlife Commission. Oncorhynchus mykiss: assessment of Washington State's steelhead populations and programs. Washington Department of Fish and Wildlife Olympia, WA . February 1, 2008.

Washington Department of Fish and Wildlife (WDFW). 2010b. 2010 Puget Sound Commercial Salmon Regulations. Revised July 7, 2010.

Washington Department of Fish and Wildlife (WDFW), FishPro Inc., and Beak Consultants. 1997. Grandy Creek trout hatchery biological assessment. Washington Department of Fish and Wildlife, Olympia, WA . Cited in USFWS 2008.

Washington Dept. of Fish and Wildlife (WDFW). 2006. Fish and wildlife geographic information system digital data documentation. Olympia, WA.

Washington Dept. of Fish and Wildlife (WDFW). 2007. Marine protected areas within Puget Sound: Admiralty Head marine preserve. Olympia, WA.

Washington Dept. of Fish and Wildlife (WDFW). 2011. Washington State Sport Catch Report 2007. WDFW, September 2011. Olympia, WA.

Washington Dept. of Fish and Wildlife (WDFW). 2011b. Final Puget Sound Rockfish Conservation Plan. WDFW, March, 2011. Olympia, WA.

Washington Dept. of Fish and Wildlife (WDFW). 2011c. Final Environmental Impact Statement for the Puget Sound Rockfish Conservation Plan. WDFW, March, 2011. Olympia, WA.

Washington Department of Fisheries and Wildlife. Undated. Washington State Surf Smelt Fact Sheet. Downloaded at http://wdfw.wa.gov/publications/01219/wdfw01219.pdf, August 2013.

Washington Department of Natural Resources (WSDNR). 1997. Field Guide to Selected Rare Vascular Plants of Washington - Golden Paintbrush (Castilleja levisecta).

Washington GAP Analysis Project. 1996. Washington Vegetation Zones, Version 6, August 1996.

Washington Parks and Recreation Commission. 2008. Central Whidbey State Parks: Land Classes, Resource Issues and Management Approaches. Olympia, WA.

Weinrich, M.T., M.R. Schilling, and C.R. Belt. 1992. Evidence for acquisition of navel feeding behavior: lobtail feeding in humpback whales, Megaptera novaeangliae. Anim. Behav. 44:1059-1072.

West, J.E., R.M. Buckley, and D.C. Doty. 1994. Ecology and habitat use of juvenile rockfishes (*Sebastes* Spp.) associated with artificial reefs in Puget Sound, Washington. Bulletin of Marine Science, 55(2-3): 344-350.

Whale Museum. 2009a. Whale watching in the San Juan Islands. Web site: http://www.whale-museum.org/education/library/whalewatch/watchmain.html.

Whale Museum. 2009b. Review of historical information and site-specific synthesis. The Whale Museum, SMRU Ltd., Orca Network. October 2009.

Wiles, G.J. 2004. Washington State status report for the killer whale. Washington Department of Fish and Wildlife, Olympia. 106pp.

Wilson, M.F., R.H. Armstrong, M.C. Hermans, and K. Koski. 2006. Eulachon: a review of biology and an annotated bibliography. Alaska Fisheries Science Center Processed Report 206-12. Auke Bay Laboratory, Alaska Fish. Sci. Cent., NOAA, Natl. Mar. Fish. Service, Juneau, AK. Online at http://www.afsc.noaa.gov/publications /ProcRpt/PR%202006-12.pdf.

Wilson, U.W. 1977. A study of the biology of the rhinoceros auklet on Protection Island, Washington. Unpubl. M.S. thesis. Univ. Washington. Seattle. 98 pp.

Yamanaka, K.L., L.C. Lacko, K. Miller-Saunders, C. Grandin, J.K. Lochead, J.C. Martin, N. Olsen and S.S. =Wallace. 2006. A review of quillback rockfish Sebastes maliger along the Pacific coast of Canada: biology, distribution and

20130809-3010 FERC PDF (Unofficial) 08/09/2013

abundance trends. Canadian Science Advisory Secretariat Research Document 2006/077. 58 p. Cited in Palsson 2009.

20130809-3010 FERC PDF (Unofficial) 08/09/2013

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APPENDIX A

LICENSE ARTICLES RECOMMENDED BY STAFF

We recommend including the following license articles in any license issued for the project:

Article 2XX. *Administrative Annual Charges*. The licensee shall pay the United States annual charges as determined in accordance with the provisions of the Commission's regulations in effect from time to time, effective as of the date of commencement of project operation, to reimburse the United States for the cost of administration of Part 1 of the Federal Power Act. The authorized installed capacity for that purpose is 600 kilowatts (kW). Under the regulations currently in effect, projects with authorized installed capacity of less than or equal to 1,500 kW will not be assessed an annual charge.

Article 2XX. *Exhibit Drawings*. Within 45 days of the date of issuance of this license, the licensee shall file the approved exhibit drawings in aperture card and electronic file formats.

(a) Three sets of the approved exhibit drawings shall be reproduced on silver or gelatin 35mm microfilm. All microfilm shall be mounted on type D (3-1/4" X 7-3/8") aperture cards. Prior to microfilming, the FERC Project-Drawing Number (i.e., P-12690-# through P-12690-#) shall be shown in the margin below the title block of the approved drawing. After mounting, the FERC Drawing Number shall be typed on the upper right corner of each aperture card. Additionally, the Project Number, FERC Exhibit (i.e., F-1, G-1, etc.), Drawing Title, and date of this license shall be typed on the upper left corner of each aperture card.

Two of the sets of aperture cards shall be filed with the Secretary of the Commission, ATTN: OEP/DHAC. The third set shall be filed with the Commission's Division of Dam Safety and Inspections Portland Regional Office.

(b) The licensee shall file two separate sets of exhibit drawings in electronic raster format with the Secretary of the Commission, ATTN: OEP/DHAC. A third set shall be filed with the Commission's Division of Dam Safety and Inspections Portland Regional Office. Exhibit F drawings must be separated from other project exhibits and identified as Critical Energy Infrastructure Information (CEII) material under 18 C.F.R. § 388.113(c) (2012). Each drawing must be a separate electronic file, and the file name shall include: FERC Project-Drawing Number, FERC Exhibit, Drawing Title, date of this license, and file extension in the following format [P-12690-#, G-1, Project Boundary, MM-DD-YYYY.TIF]. Electronic drawings shall meet the following format specifications:

IMAGERY - black & white raster file

FILE TYPE – Tagged Image File Format, (TIFF) CCITT Group 4
RESOLUTION – 300 dpi desired, (200 dpi min)
DRAWING SIZE FORMAT – 24" X 36" (min), 28" X 40" (max)
FILE SIZE – less than 1 MB desired

Each Exhibit G drawing that includes the project boundary must contain a minimum of three known reference points (i.e., latitude and longitude coordinates, or state plane coordinates). The points must be arranged in a triangular format for GIS geo-referencing the project boundary drawing to the polygon data, and must be based on a standard map coordinate system. The spatial reference for the drawing (i.e., map projection, map datum, and units of measurement) must be identified on the drawing and each reference point must be labeled. In addition, each project boundary drawing must be stamped by a registered land surveyor.

(c) The licensee shall file two separate sets of the project boundary data in a geo-referenced electronic file format (such as ArcView shape files, GeoMedia files, MapInfo files, or a similar GIS format) with the Secretary of the Commission, ATTN: OEP/DHAC. The filing shall include both polygon data and all reference points shown on the individual project boundary drawings. An electronic boundary polygon data file(s) is required for each project development. Depending on the electronic file format, the polygon and point data can be included in a single file with multiple layers. The geo-referenced electronic boundary data file must be positionally accurate to ±40 feet in order to comply with National Map Accuracy Standards for maps at a 1:24,000 scale. The file name(s) shall include: FERC Project Number, data description, date of this license, and file extension in the following format [P-12690, boundary polygon/or point data, MM-DD-YYYY.SHP]. The data must be accompanied by a separate text file describing the spatial reference for the geo-referenced data: map projection used (i.e., UTM, State Plane, Decimal Degrees, etc.), the map datum (i.e., North American 27, North American 83, etc.), and the units of measurement (i.e., feet, meters, miles, etc.). The text file name shall include: FERC Project Number, data description, date of this license, and file extension in the following format [P-12690, project boundary metadata, MM-DD-YYYY.TXT].

Article 2XX. *Documentation of Project Financing*. At least 90 days before starting construction, the licensee shall file with the Commission, for approval, the licensee's documentation for the project financing. The documentation must show that the licensee has acquired the funds, or commitment for funds necessary to construct and operate the project in accordance with this license. The documentation must include, at a minimum, financial statements, including a balance sheet, income statement, and a statement of actual or estimated cash flows over the license term which provide evidence that the licensee has sufficient assets, credit, and projected revenues to cover project construction, operation, maintenance and removal expenses, and any other estimated project liabilities and expenses.

The financial statements must be prepared in accordance with generally accepted accounting principles and signed by an independent certified public accountant. The licensee shall not commence construction associated with the project before the filing is approved.

Article 2XX. *Project Land Rights Progress Report*. No later than four years after license issuance, the licensee shall file a report with the Commission describing the status of acquiring title in fee or the rights for all the lands within the project boundary. The report must provide an overview map of each parcel and summary table identifying the licensee's rights over each parcel within the project boundary. The report shall also include specific supporting documentation showing the status of the land rights on all parcels of land within the project boundary that: (1) have been acquired up to the date of filing of the report, including pertinent deeds, lease agreements, and/or bill of sale information that specifically verify the licensee's rights; and (2) the licensee's plan and schedule for acquiring all remaining project lands prior to the five-year deadline, including a history of actions taken, current owner information, the type of ownership to be acquired whether in fee or by easement, and the timeline for completing property acquisition.

Article 3XX. *Start of Construction*. The licensee shall commence construction of the project works within two years from the issuance date of the license and shall complete construction of the project within five years from the issuance date of the license.

Article 3XX. *Cofferdam and Deep Excavation Construction Drawings*. Should construction require cofferdams or deep excavations, the licensee shall: (1) review and approve the design of contractor-designed cofferdams and deep excavations prior to the start of construction; and (2) shall ensure that construction of cofferdams and deep excavations is consistent with the approved design. At least 30 days before starting construction of any cofferdams or deep excavations, the licensee shall submit one copy to the Commission's Division of Dam Safety and Inspections (D2SI)-(Fill in appropriate RO) Regional Engineer and two copies to the Commission (one of these copies shall be a courtesy copy to the Commission's Director, D2SI), of the approved cofferdam and deep excavation construction drawings and specifications, and the letters of approval.

Article 3XX. *Contract Plans and Specifications*. At least 60 days prior to the start of any construction, the licensee shall submit one copy of its plans and specifications and supporting design document to the Commission's Division of Dam Safety and Inspections (D2SI) Portland Regional Engineer, and two copies to the Commission (one of these shall be a courtesy copy to the Director, D2SI). The submittal to the D2SI Portland Regional Engineer must also include as part of preconstruction requirements: a Quality Control and Inspection Program, Temporary Construction Emergency Action Plan, and Soil Erosion and Sediment Control Plan. The licensee may not begin construction until the D2SI Portland Regional Engineer has reviewed and commented on

the plans and specifications, determined that all preconstruction requirements have been satisfied, and authorized start of construction.

Article 3XX. *As-built Drawings*. Within 90 days of completion of construction of the facilities authorized by this license, the licensee shall file for Commission approval, revised Exhibits A, F, and G, as applicable, to describe and show those project facilities as built. A courtesy copy shall be filed with the Commission's Division of Dam Safety and Inspections (D2SI) Portland Regional Engineer, the Director, D2SI, and the Director, Division of Hydropower Administration and Compliance.

Article 3XX. *Navigation Safety Plan*. Upon license issuance, the licensee shall implement the *Navigation Safety Plan*, filed February 14, 2013. This plan may not be amended without prior Commission approval.

Article 3XX. *Hazard Identification and Risk Assessment*. At least 90 days prior to the start of in-water construction, the licensee shall file with the Commission for approval a Hazard Identification and Risk Assessment to minimize potential hazards to PC Landing Corporation's fiber optic cable during project installation, maintenance, and removal activities. This assessment shall include and describe: (a) operational procedures for installing, maintaining, and removing the project turbines; (b) criteria for weather and wave conditions that must exist before marine operations can occur; (c) redundancy in the use of equipment and/or vessels; (d) criteria for aborting the operations; and (e) an established "port of refuge," located at least two (2) kilometers away from the PC-1 cable, in the event of unanticipated adverse weather or other event.

The licensee shall include with the assessment, documentation of consultation with the U.S. Coast Guard, the U.S. Army Corps of Engineers, and PC Landing Corporation; copies of comments and recommendations on the completed assessment after it has been prepared and provided to the consulted entities; and specific descriptions of how the entities' comments are accommodated by the assessment. The licensee shall allow a minimum of 30 days for consulted entities to comment and make recommendations before filing the assessment with the Commission. If the licensee does not adopt a recommendation, the filing shall include the licensee's reasons based on project-specific information.

The Commission reserves the right to require changes to the assessment. In-water construction shall not begin until the assessment is approved by the Commission. Upon Commission approval, the licensee shall implement the procedures contained in the assessment, including any changes required by the Commission.

Article 3XX. *Removal of Obstructions to Navigation*. If the Corps determines that the project presents an unreasonable obstruction to the free navigation of navigable waters, the licensee shall, upon due notice from the Corps and upon Commission

approval, remove, relocate, or alter the structural work or obstructions caused thereby, without expense to the United States.

Article 3XX. *Annual Performance Report and Certification*. Following start of operations and by December 31 of each year, the licensee shall submit one copy of a report describing the project's performance to the Commission's Division of Dam Safety and Inspections (D2SI)-Portland Regional Engineer, and two copies to the Commission (one of these shall be a courtesy copy to the Director, D2SI). The report shall include: (1) the adequacy of project monitoring and operations; (2) the findings of inspections; and (3) a summary of the major maintenance and repairs performed during the previous year. The report shall certify that the project features are being operated, monitored, inspected, and maintained in accordance with the license and approved plans.

Article 4XX. *Project and Public Safety Plan*. Upon license issuance, the licensee shall implement the Project and Public Safety Plan, filed February 14, 2013. This plan may not be amended without prior Commission approval.

Article 4XX. *Project Removal and Site Restoration Plan.* The *Project Removal and Site Restoration Plan*, filed December 7, 2012, is approved with the following modifications: (1) the licensee shall file a detailed timeline for the removal and site restoration activities with the Commission 6 months prior to license expiration; and (2) the licensee shall develop the timeline after consultation with the National Marine Fisheries Service, U.S. Fish and Wildlife Service, U.S. Coast Guard, Washington Department of Natural Resources, Washington Department of Fish and Wildlife, and Washington Department of Ecology. The licensee's filing shall include documentation of consultation, copies of comments and recommendations, and specific descriptions of how the agencies comments are accommodated. If the licensee does not adopt an agency's recommendation, the filing shall include the licensee's reasons based on project specific information.

In addition, the license shall file a report documenting completion of project removal and site restoration activities with the Commission prior to license expiration. The licensee shall provide the report to the National Marine Fisheries Service, U.S. Fish and Wildlife Service, U.S. Coast Guard, Washington Department of Natural Resources, Washington Department of Fish and Wildlife, and Washington Department of Ecology for review, and allow the agencies 30 day to comment before filing the report with the Commission. The report shall include documentation of consultation, copies of comments and recommendations, and specific descriptions of how the agencies comments are accommodated. If the licensee does not adopt an agency's recommendation, the report shall include the licensee's reasons based on project specific information.

Article 4XX. *Emergency Shutdown Plan.* At least 60 days before starting construction, the licensee shall file with the Commission, for approval a revised

Emergency Shutdown Plan The plan shall be based on the Emergency Shutdown Plan filed with Commission on February 14, 2013 and shall include measures (such as notification of Coast Guard, deployment of buoys or warning devices, etc.) to keep the area near the turbines during an emergency clear of unnecessary traffic and prevent further interaction with the turbine until the shutdown is completed. The licensee shall prepare the plan after consultation with the United States Coast Guard. The licensee shall allow a minimum of 30 days for the United States Coast Guard to comment and to make recommendations before filing the plan with the Commission. If the licensee does not adopt a recommendation, the filing shall include the licensee's reasons based on project-specific information.

Article 4XX. *Horizontal Directional Drilling Plan.* Upon license issuance, the licensee shall implement the Horizontal Directional Drilling Plan, filed March 1, 2012, with the following modification.

In the event that horizontal directional drilling is required to be extended beyond the specified 12-daytime hours (e.g., 7:00 am to 7:00 pm) into evening or early morning hours, the licensee shall implement noise abatement contingency measures, such as the placement of temporary sound barrier (or appropriate alternative), to reduce noise impacts on neighboring residences. Contingency measures must be readily available to maintain sound levels below 55 dB at both the east and west property boundaries of the HDD drill site. Any implementation of contingency measures shall be reported within 48 hours to the Commission's Division of Dam Safety and Inspections (D2SI) – Portland Regional Engineer.

Article 4XX. *Invasive Plant Management Plan*. To control the introduction and spread of invasive plants on project lands during site construction and project removal, the licensee shall: (1) use gravel, rock, or other fill material from a weed free source; (2) revegetate disturbed areas with species native to Keystone Spit, with the source material (seeds or cuttings) collected from Keystone Spit; (3) ensure that no imported soil, fertilizer, or tackifiers will be used in revegetating disturbed areas; and (4) inspect any fill and disturbed areas for invasive plants annually, between early and mid-June and again in August, and eradicate any detected invasive plants promptly. Within six months of completing site revegetation efforts, the licensee shall file a report documenting compliance with the above provisions and annually thereafter until the native vegetation has become established and is free of invasive plants.

Article 4XX. *Water Quality Monitoring Plan.* Upon license issuance, the licensee shall implement the *Water Quality Monitoring Plan*, filed December 7, 2012, with the following modification. This plan may not be amended without prior Commission approval.

The licensee shall file notify the Commission's Division of Hydropower Administration and Compliance and the Commission's Division of Dam Safety and

20130809-3010 FERC PDF (Unofficial) 08/09/2013

Inspections (D2SI) – Portland Regional Engineer within 24 hours of a frac-out or other release of grout material to waters into Admiralty Inlet that results in turbidity levels exceeding 250 NTUs, any adverse environmental effects, and the steps taken to correct the problem.

Article 4XX. *Acoustic Monitoring Plan.* Upon license issuance, the licensee shall implement the *Acoustic Monitoring and Mitigation Plan*, filed on February 14, 2013. This plan may not be amended without prior Commission approval.

Article 4XX. *Benthic Habitat Monitoring and Mitigation Plan.* The Benthic Habitat Monitoring and Mitigation Plan, filed November 16, 2012, is approved and shall be implemented with the following modification: within 6 months of license issuance, the licensee shall file specific scour thresholds (i.e., depth and width measurements of scour as measured from the turbine footings) that will trigger the installation of scour protection measures on the sea bed. The licensee shall consult with National Marine Fisheries Service, U.S. Fish and Wildlife Service, U.S. Coast Guard, Washington Department of Natural Resources, Washington Department of Fish and Wildlife, and Washington Department of Ecology in the development of the specific triggers requiring scour mitigation. In addition, the licensee shall notify the Commission within 10 days of when such triggers may have been met, the effects of the scour, and the licensee's plans for mitigating any such effects.

.Article 4XX. *Near-Turbine Monitoring and Mitigation Plan.* Upon license issuance, the licensee shall implement the Near-Turbine Monitoring and Mitigation Plan, filed November 16, 2012. This plan may not be amended without prior Commission approval.

Article 4XX. *Marine Mammal Monitoring and Mitigation Plan.* Upon license issuance, the licensee shall implement the Marine Mammal Monitoring and Mitigation Plan, filed November 16, 2012. This plan may not be amended without prior Commission approval.

Article 4XX. *Derelict Gear Monitoring Plan.* Upon license issuance, the licensee shall implement the Derelict Gear Monitoring Plan, filed December 7, 2012. This plan may not be amended without prior Commission approval.

Article 4XX. *In-water Construction Schedule*. No in-water construction shall be conducted between October 15 and July 15 to protect. Work may be conducted within this window upon mutual agreement with the National Marine Fisheries Service, U.S. Fish and Wildlife Service, Washington Department of Fish and Wildlife, Washington Department of Ecology, Washington Department of Natural Resources, the Tulalip Tribes, Suquamish Tribe, Swinomish Indian Tribal Community, and Sauk-Suiattle Tribe. If work is conducted within the work window, the licensee shall notify the Commission no later than 10 days after each such incident.

20130809-3010 FERC PDF (Unofficial) 08/09/2013

Article 4XX. *Reservation of Authority to Prescribe Fishways*. Authority is reserved to the Commission to require the licensee to construct, operate, and maintain, or to provide for the construction, operation, and maintenance of such fishways as may be prescribed by the Secretary of the Interior pursuant to section 18 of the Federal Power Act.

Article 4XX. *Interpretation and Education Plan.* Within six months of license issuance, the licensee shall develop and file for Commission approval an Interpretation and Education Plan for the installation of an interpretive display at a publicly accessible site within view of the turbine locations at Fort Casey State Park, subject to state approval, that describes the project, the potential ocean energy resource in Puget Sound, and the natural and cultural environment of the project area. If a suitable site at the park is not available, another appropriate location may be proposed.

The licensee shall include with the plan, documentation of consultation with the U.S. National Park Service, Washington State Parks and Recreation Commission, Washington Department of Fish and Wildlife, Ebey's Landing Historical Reserve Trust Board, and Island County Marine Resources Committee; copies of comments and recommendations on the completed plan after it has been prepared and provided to the consulted entities; and specific descriptions of how the entities' comments are accommodated by the plan. The licensee shall allow a minimum of 30 days for consulted entities to comment and to make recommendations before filing the plan with the Commission. If the licensee does not adopt a recommendation, the filing shall include the licensee's reasons based on project-specific information.

The Commission reserves the right to require changes to the plan. Upon Commission approval, the licensee shall implement the plan, including any changes required by the Commission.

Article 4XX. *FERC Form 80 Exemption*. There is little or no potential for recreation facilities within the project boundary. Therefore, upon the issuance date of the license, the licensee is exempt from 18 § C.F.R. 8.11, the filing of the FERC Form 80 recreation report, for the Admiralty Inlet Project.

Article 4XX. *Cultural Resources.* Prior to beginning any land-clearing or land-disturbing activities within the project boundary, other than those specifically authorized in this license, the licensee shall consult with the Washington State Historic Preservation Officer (SHPO). If the licensee discovers previously unidentified archeological or historic properties during the course of constructing, maintaining, or removing project works or other facilities at the project, the licensee shall stop all land-clearing and land-disturbing activities in the vicinity of the properties and consult with the Washington SHPO.

If a discovered cultural resource is determined to be eligible for the National Register of Historic Places, the licensee shall file for Commission approval a historic properties management plan. The plan shall be prepared by a qualified cultural resource specialist after having consulted with the SHPO. The plan shall include the following items:

(1) a description of each discovered property indicating whether it is listed on or eligible to be listed on the National Register of Historic Places;

(2) a description of the potential effect on each discovered property;

(3) proposed measures for avoiding or mitigating effects;

(4) documentation of the nature and extent of consultation; and

(5) a schedule for mitigating effects and conducting additional studies.

The Commission may require changes to the plan. The licensee shall not begin land-clearing or land-disturbing activities, other than those specifically authorized in this license, or resume such activities in the vicinity of a property discovered during construction, until informed by the Commission that the requirements of this article have been fulfilled.

Article 4XX. *Use and Occupancy*. (a) In accordance with the provisions of this article, the licensee shall have the authority to grant permission for certain types of use and occupancy of project lands and waters and to convey certain interests in project lands and waters for certain types of use and occupancy, without prior Commission approval. The licensee may exercise the authority only if the proposed use and occupancy is consistent with the purposes of protecting and enhancing the scenic, recreational, and other environmental values of the project. For those purposes, the licensee shall also have continuing responsibility to supervise and control the use and occupancies for which it grants permission, and to monitor the use of, and ensure compliance with the covenants of the instrument of conveyance for, any interests that it has conveyed, under this article. If a permitted use and occupancy violates any condition of this article or any other condition imposed by the licensee for protection and enhancement of the project's scenic, recreational, or other environmental values, or if a covenant of a conveyance made under the authority of this article is violated, the licensee shall take any lawful action necessary to correct the violation. For a permitted use or occupancy, that action includes, if necessary, canceling the permission to use and occupy the project lands and waters and requiring the removal of any non-complying structures and facilities.

(b) The type of use and occupancy of project lands and waters for which the licensee may grant permission without prior Commission approval are: (1) landscape plantings; (2) non-commercial piers, landings, boat docks, or similar structures and

facilities that can accommodate no more than 10 water craft at a time and where said facility is intended to serve single-family type dwellings; (3) embankments, bulkheads, retaining walls, or similar structures for erosion control to protect the existing shoreline; and (4) food plots and other wildlife enhancement. To the extent feasible and desirable to protect and enhance the project's scenic, recreational, and other environmental values, the licensee shall require multiple use and occupancy of facilities for access to project lands or waters. The licensee shall also ensure, to the satisfaction of the Commission's authorized representative, that the use and occupancies for which it grants permission are maintained in good repair and comply with applicable state and local health and safety requirements. Before granting permission for construction of bulkheads or retaining walls, the licensee shall: (1) inspect the site of the proposed construction, (2) consider whether the planting of vegetation or the use of riprap would be adequate to control erosion at the site, and (3) determine that the proposed construction is needed and would not change the basic contour of the impoundment shoreline. To implement this paragraph (b), the licensee may, among other things, establish a program for issuing permits for the specified types of use and occupancy of project lands and waters, which may be subject to the payment of a reasonable fee to cover the licensee's costs of administering the permit program. The Commission reserves the right to require the licensee to file a description of its standards, guidelines, and procedures for implementing this paragraph (b) and to require modification of those standards, guidelines, or procedures.

(c) The licensee may convey easements or rights-of-way across, or leases of project lands for: (1) replacement, expansion, realignment, or maintenance of bridges or roads where all necessary state and federal approvals have been obtained; (2) storm drains and water mains; (3) sewers that do not discharge into project waters; (4) minor access roads; (5) telephone, gas, and electric utility distribution lines; (6) non-project overhead electric transmission lines that do not require erection of support structures within the project boundary; (7) submarine, overhead, or underground major telephone distribution cables or major electric distribution lines (69-kV or less); and (8) water intake or pumping facilities that do not extract more than one million gallons per day from a project impoundment. No later than January 31 of each year, the licensee shall file three copies of a report briefly describing for each conveyance made under this paragraph (c) during the prior calendar year, the type of interest conveyed, the location of the lands subject to the conveyance, and the nature of the use for which the interest was conveyed.

(d) The licensee may convey fee title to, easements or rights-of-way across, or leases of project lands for: (1) construction of new bridges or roads for which all necessary state and federal approvals have been obtained; (2) sewer or effluent lines that discharge into project waters, for which all necessary federal and state water quality certification or permits have been obtained; (3) other pipelines that cross project lands or waters but do not discharge into project waters; (4) non-project overhead electric

transmission lines that require erection of support structures within the project boundary, for which all necessary federal and state approvals have been obtained; (5) private or public marinas that can accommodate no more than 10 water craft at a time and are located at least one-half mile (measured over project waters) from any other private or public marina; (6) recreational development consistent with an approved report on recreational resources of an Exhibit E; and (7) other uses, if: (i) the amount of land conveyed for a particular use is five acres or less; (ii) all of the land conveyed is located at least 75 feet, measured horizontally, from project waters at normal surface elevation; and (iii) no more than 50 total acres of project lands for each project development are conveyed under this clause (d)(7) in any calendar year. At least 60 days before conveying any interest in project lands under this paragraph (d), the licensee must submit a letter to the Director, Office of Energy Projects, stating its intent to convey the interest and briefly describing the type of interest and location of the lands to be conveyed (a marked Exhibit G map may be used), the nature of the proposed use, the identity of any federal or state agency official consulted, and any federal or state approvals required for the proposed use. Unless the Director, within 45 days from the filing date, requires the licensee to file an application for prior approval, the licensee may convey the intended interest at the end of that period.

(e) The following additional conditions apply to any intended conveyance under paragraph (c) or (d) of this article:

(1) Before conveying the interest, the licensee shall consult with federal and state fish and wildlife or recreation agencies, as appropriate, and the State Historic Preservation Officer.

(2) Before conveying the interest, the licensee shall determine that the proposed use of the lands to be conveyed is not inconsistent with any approved report on recreational resources of an Exhibit E; or, if the project does not have an approved report on recreational resources, that the lands to be conveyed do not have recreational value.

(3) The instrument of conveyance must include the following covenants running with the land: (i) the use of the lands conveyed shall not endanger health, create a nuisance, or otherwise be incompatible with overall project recreational use; (ii) the grantee shall take all reasonable precautions to ensure that the construction, operation, and maintenance of structures or facilities on the conveyed lands will occur in a manner that will protect the scenic, recreational, and environmental values of the project; and (iii) the grantee shall not unduly restrict public access to project waters.

(4) The Commission reserves the right to require the licensee to take reasonable remedial action to correct any violation of the terms and conditions of this article, for the protection and enhancement of the project's scenic, recreational, and other environmental values.

(f) The conveyance of an interest in project lands under this article does not in itself change the project boundaries. The project boundaries may be changed to exclude land conveyed under this article only upon approval of revised Exhibit G drawings (project boundary maps) reflecting exclusion of that land. Lands conveyed under this article will be excluded from the project only upon a determination that the lands are not necessary for project purposes, such as operation and maintenance, flowage, recreation, public access, protection of environmental resources, and shoreline control, including shoreline aesthetic values. Absent extraordinary circumstances, proposals to exclude lands conveyed under this article from the project shall be consolidated for consideration when revised Exhibit G drawings would be filed for approval for other purposes.

(g) The authority granted to the licensee under this article shall not apply to any part of the public lands and reservations of the United States included within the project boundary.

20130809-3010 FERC PDF (Unofficial) 08/09/2013

APPENDIX B

STAFF RESPONSES TO COMMENTS ON THE ENVIRONMENTAL ASSESSMENT FOR THE ADMIRALTY INLET PILOT TIDAL PROJECT NO. 12690

The EA for Admiralty Inlet was issued on January 15, 2013. Comments on the EA were due by February 14, 2013. Written comments on the EA were filed by Washington DFW on February 13, 2013; North American Submarine Cable Association, Snohomish PUD, Whidbey Environmental Action Network, PC Landing, Suquamish Tribe, Washington DNR, Point No Point Treaty Council, National Park Service, and Tulalip Tribes on February 14, 2013; and Washington State Ferries and Orca Conservancy on February 26, 2013. Snohomish PUD filed responses to comments on March 8, 2013.

We summarize below the comments received; provide responses to those comments; and indicate, where appropriate, how we modified the text of the final EA. The comments are grouped by topic for convenience.

In addition, in its February 14, 2013 comment letter, Snohomish PUD requested a number of minor technical modifications, corrections, and clarifications which do not alter our analysis of effects on environmental resources. The comment letter also included other, more substantive changes that would require further consideration or analysis. Only the substantive comments are addressed below; the remainder of Snohomish PUD's recommended changes have been incorporated in the EA as appropriate.

General Comments

Comment 1: Whidbey Environmental Action Network stated that any license issued by the Commission for the proposed project should explicitly state that it does not constitute approval of a larger-scale facility.

Response 1: This EA considers the effects of Snohomish PUD's proposal for two turbines. Developing a larger project would require another review process and authorization by the Commission, including multiple opportunities for public comment.

Comment 2: The Point No Point Treaty Council and PC Landing requested that the Commission prepare an Environmental Impact Statement for the proposed project.

Response 2: An EIS is not necessary. This EA thoroughly considers the potential effects on marine mammals, fish, fishing, benthic communities, threatened and endangered species, navigation, submerged cables, terrestrial vegetation, water quality, aquatic species, wildlife, recreation and more. Although we identified potential for modest impacts to some resources, we identified no impacts as significant. The CEQ regulations state that determinations of whether a project will have significant impacts on the environment depend on both "context" and "intensity of the impacts."[105] The context for this proposal is that the project would occupy a small portion of Admiralty Inlet for a short time period. The intensity of the impact is low and any associated risk would be reduced through monitoring, adaptive management, consultation with experts, and safeguards.

Comment 3: The Environmental Protection Agency recommended that the final EA include an analysis of the non-renewable fossil fuel generation displacement.

Response 3: An estimate of the offset of amount of fuel and carbon dioxide displaced by the project has been added to the "Need for Power" section.

Federal Power Act

Comment 4: In multiple, detailed comments Snohomish PUD asked that the MARC, or Marine Aquatic Resource Committee, be listed in the document as serve as the consulting and approving body for monitoring plan assessment and adaptation.

Response 4: As requested, the MARC is identified as Snohomish PUD's proposed consultation body. However, the parties with which Snohomish PUD would be required to consult under any license would be determined on an issue-by-issue basis taking into consideration the Commission's responsibilities and authorities under the Federal Power Act and other statutes.

Comment 5: Snohomish PUD argues that FWS does not have jurisdiction to reserve fish passage authority because the project does not involve upstream or downstream passage.

Response 5: This is a legal matter to be addressed by the project license. The draft articles include a reservation of authority as a matter of practice.

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[105] 40 C.F.R. § 1508.27(b) (2011).

20130809-3010 FERC PDF (Unofficial) 08/09/2013

Marine Resources

Comment 6: The Suquamish Tribe stated they do not believe the proposed near-turbine monitoring equipment is sensitive enough to monitor fish, fish behavior, and fish losses. This in their view is problematic for numerous species of fish that reside or migrate through the proposed project area that are listed under the Endangered Species Act. The Point No Point Treaty Council stated that it is concerned that the monitoring proposed by Snohomish PUD would not adequately monitor behavior changes in fish and observe fish take. The Point No Point Treaty Council expressed concern that the focus of monitoring efforts on fish was not as great as that on marine mammals.

Response 6: Snohomish PUD has proposed a comprehensive suite of studies for both fish and marine mammals, designed in consultation with agency and other experts. For fish, Snohomish PUD would use a combination of stereo-optical and acoustic cameras. The stereo-optical cameras would capture still images out to a distance from about 3 to 7 m, while the acoustic camera would extend the view. The stereo-optical camera would be assisted by a strobe light and would support 3-dimensional imagery. Active sonar would likely be added for a later study. This and other monitoring equipment on the turbines would enable Snohomish PUD to monitor (1) current velocity, direction, time of day, and season; (2) species presence or absence; (3) any interactions with the turbine rotor (aggregation, strike, passage); (4) fish turbine avoidance; and (5) artificial reef effects

Combining the use of advanced technology and current scientific knowledge with and adaptive management, these plans adequately maximize the chance of success at acquiring the necessary information.

Comment 7: Washington DNR states that there is a surf smelt spawning area at Admiralty Head and seeks assurance that the project will not affect surf smelt through complete avoidance. Snohomish PUD requested flexibility to alter the work window with approval of the MARC.

Response 7: Discussion of the surf smelt spawning and project construction has been incorporated in the FEA. The construction methods proposed by Snohomish PUD would avoid adverse effects on surf smelt spawning. We have modified our recommendation to provide the requested flexibility.

Comment 8: The Orca Conservancy opposes the installation of the turbines because of potential adverse effects on the endangered southern resident killer whales. The Orca Conservancy generally describes environmental stressors (e.g., alteration of currents and sediments, toxicity of paints, EMF, interference with animal movements, etc.) that should

be considered in the EA based on findings from installing wind turbines at sea and suggests that noise pollution could displace southern resident killer whales from Admiralty Inlet. The Orca Conservancy specifically cites to a study of killer whale distribution in the Broughton Archipelago in British Columbia, Canada following the installation of high-amplitude, acoustic harassment devices at aquaculture farms to deter seal predation on pen-reared salmon (Morton and Symonds 2002). The study showed a decline in use of the area by killer whales until after the devices were removed. The Orca Conservancy asserts that additional research and data collection on the effects of tidal turbines on killer whales should be gathered before installing these devices in critical habitat or areas of concern and that another site should be considered.

Response 8: The EA examines the very environmental stressors identified by the Orca Conservancy on killer whales and other environmental resources. The analysis considers relevant information from a variety of sources, including that gained from the installation of wind turbines.

The EA specifically considers potential noise effects on southern killer whale use of Admiralty Inlet. There are significant differences between the acoustic harassment devices used in Canada and the tidal turbines, which question the applicability of the cited study. The acoustic harassment devices installed at the salmon farms emitted a 10 kHz signal at 194 dB (re: 1 μPa @ 1 m) at 1 meter under water. The tidal turbines would be installed at much greater depths (about 58 meters). Even at peak tidal velocity, the turbines are not expected to emit a signal of this magnitude. As discussed in section 3.3.2, modeling indicates that marine mammals are not likely to detect turbine noise beyond a few meters. Therefore, turbine noise levels are not likely to rise to levels that would harass killer whales except very close to the turbines, and noise levels are not expected to displace killer whales.

Regardless, staff recommends implementing Snohomish PUD's monitoring plan to monitor turbine noise levels and determine if southern resident killer whales are reacting to the turbines.

Recreational Resources

Comment 9: The National Park Service supports staff's recommendation in the draft EA to install an interpretive display at Fort Casey State Park. The National Park Service stated that Snohomish PUD should develop an interpretation and education plan that would include: an interpretive display near the project area; additional methods of reaching the public; and collaboration with the Trust Board of Ebey's Landing National Historical Reserve Education and Interpretation Program, Washington State Parks, and the Island County Marine Resources Committee.

Response 9: The final EA clarifies staff's recommendation that Snohomish PUD install the interpretive display in consultation with the stakeholders. We do not recommend requiring an additional outreach program. We did not receive enough proposed detail to shape such a requirement. Further, the small scale and limited operational time do not appear to warrant more extensive measures.

Land and Ocean Use

Comment 10: PC Landing again reports being excluded from early discussions of the applicant's proposal, which foreclosed their opportunity to influence the siting of the turbines.

Response 10: As mentioned by Snohomish PUD in its response to comments, the initial preliminary permit for the project appeared in the Federal Register in June 2006 and PC landing has been commenting to the Commission record since June 2011. Of course, it is desirable to have all interested stakeholders engaged in a process as early as possible. Nonetheless, PC Landing has had, and has taken full advantage of multiple opportunities to raise its concerns and have them heard and considered. For example, we held a technical meeting on August 6, 2012, focusing almost exclusively on issues raised by PC Landing. We have fully considered PC Landing's information and issues in our analysis in developing our recommendations. The issue of alternative sites is addressed with comment 14.

Comment 11: PC Landing stated that the applicant cannot guarantee that "liveboat" installation techniques will be used instead of anchors.

Response 11: If licensed as recommended, the "live boat installation techniques" will be required by the license, and the licensee would be required to follow those requirements or be subject to penalties enforced by the Commission.

Comment 12: PC Landing stated that failure of the turbine, such as has occurred with a turbine in the Bay of Fundy, may lead to unknown effects that could threatened its cable. Therefore, the project does not fit a pilot license.

Response 12: As required by NEPA, this EA considers those identifiable potential effects raised by PC Landing. The fact that Snohomish PUD's technology supplier had a turbine failure at another site, does not automatically exclude it from consideration as a pilot project.

Comment 13: PC Landing stated that staff did not thoroughly look at options for moving the turbines farther from the communications cable while still achieving testing goals.

Response 13: Contrary to PC Landing's assertion, Commission staff and this EA considered alternative locations as requested by PC Landing. On August 6, 2012, we held a technical conference to discuss benefits of alternative sites, which resulted in Snohomish PUD moving the turbines to increase the separation from PC-1 North to 170 and 249 meters rather than 104 and 150 meters. Our analysis of potential effects of the proposed project and those further from PC Landing's cable is detailed in section 3.3.6.2.

Comment 14: PC Landing states that the EA could not evaluate the suitability of the substrate because the soil underneath the cobble sea floor is unknown, that the amount of scour cannot be determined because the final designs and substrate are unknown, that the EA does not specify thresholds for scour mitigation or differential settling mitigation, and that the PC-1 North telecommunications cable may be impacted if the turbines topple.

Response 14: Snohomish PUD has designed the project based on conservative assumptions. Regardless, if the project were licensed, the Commission would require that the licensee file final plans and specifications for approval before authorizing construction to begin. The licensee would be required to provide a final design that included footings with an adequate level of safety for whatever substrates could be encountered.

Although available information indicates that scouring and erosion would be limited to the area of the turbine footings, monitoring efforts would confirm the analysis and allow the licensee to take corrective action before reaching the fiber optic cable. To further ensure timely implementation of corrective actions, we are now recommending that the "Benthic Habitat Monitoring and Mitigation Plan" be revised to include specific thresholds for when mitigation actions would be needed (i.e., depth and width measurements of scour, as measured from the turbine footings).

According to Snohomish PUD, the turbines were designed for a maximum slope of five degrees. We expect Snohomish PUD to design the monitoring systems to detect settling that would threaten design requirements described in its May 1, 2012 Supporting Design Report and to take necessary corrective actions.

Even if the turbines were to topple as proffered by PC Landing, they would not affect the fiber optic cable. The total height of the turbine is approximately 20 feet and the distance between the cable and the closest turbine is approximately 550 feet, more than enough

distance to prevent any direct impact, as well as any indirect scouring effect. The alarm system would alert Snohomish PUD and corrective actions could be implemented before any scour reached the cable. Recovery efforts would be carried out in accordance with all requirements in the license, including a prohibition on the use anchors. In the unlikely event of prolonged recovery efforts and documented erosion, scour-protection measures could be applied that would prevent damage to the cable.

Comment 15: PC Landing stated that the EA did not assign a risk to moving the turbines closer to the shipping lanes.

Response 15: Admiralty Inlet is heavily traveled by ships and barges. Interactions of the turbines and shipping traffic primarily involves the catenary between tugs and barges in tow, but could include some minor disruption of traffic patterns during installation. The American Waterways Operators state that tugs frequently pass through the project area and under certain conditions slack lines might extend deep enough to snag on the turbines. The Coast Guard expressed concern about moving the turbines closer to the shipping channel.

Our analysis indicates a low probability of a slack cable between a tug and barge snagging on the project turbines. Nonetheless, moving the turbines into or close to the shipping channels increases the possibility by the sheer volume of traffic close to the turbines.

Comment 16: PC Landing stated that preparing a Hazard Identification Risk Assessment (HIRA) post-licensing would violate NEPA and would not satisfy the FCC's request that any license issued show no material risk to PC Landing. PC Landing stated that the EA fails to consider hazards resulting from the extreme marine environment in Admiralty Inlet.

Response 16: We analyzed a range of potential mechanisms of risk to the PC-1 North cable from the proposed project, such as emergency anchoring and effects on cable repair, and found the risks to be minor. The HIRA is a proposed tool to further reduce any risk to the cable. We analyzed the benefits of using such a tool. The Commission commonly defers implementation details to a post-license process involving consultation with concerned stakeholders and Commission approval. Our recommendation is consistent with that practice and NEPA.

We analyzed the effect of weather, particularly extreme weather, on the construction, operations, and safety of the proposed project throughout the environmental assessment, including in the context of potential issues such as turbine deployment and shutdown.

Comment 17: PC Landing stated that the EA tacitly rejected moving the turbines because of a potential cable crossing.

Response 17: In the EA, we did not describe the potential cable crossing as having a major adverse effect on moving the turbines, but we did include it in a list of complicating factors.

Comment 18: PC Landing raised a concern that staff did not take into account industry separation standards in its review. PC Landing stated that staff should have considered and required the use guidelines developed by the International Cable Protection Committee, the State of Oregon, the UK Crown Estate, and UK Marine Management.

The North American Submarine Cable recommended that the Commission convene a joint public process with the Federal Communications Commission to confirm applicable guidelines on separation between current and future marine energy projects and undersea fiber optic cables. Congressman Ed Whitfield, Chairman of the Subcommittee on Energy and Power, and Congressman, Greg Walden, Chairman of the Subcommittee on Communications and Technology also suggest that the agencies work together on the practices for separation distance or a memorandum of understanding to provide certainty to the telecommunications and marine and hydrokinetic energy industries. The Congressmen also express the hope that approval of the project would not establish a precedent for separation distances. The FCC asked the Commission to designate a representative to the FCC's Communications Security, Reliability, and Interoperability Council (CSRIC), a Federal Advisory Committee, to participate in discussion of separation distances. PC Landing suggests that these standard setting discussions be completed before the Commission takes action on the Admiralty Inlet proposal.

Response 18: The guidelines cited are recommendations, general statements, and analyses transferred from other industries and locations. Our assessment is informed by the relevant information from these sources, but we evaluate needs on a project and site-specific basis. Based on our assessment of the risks to PC-1 North from the installation, operation, maintenance, and removal of the project, along with staff's recommended measures, we indicate that those risks are small.

Issuing a license for this small, short term, test project would not serve as precedent for separation distance for future project proposals. Future project proposals would also be evaluated on a site-specific basis.

We have designated a representative to the FCC's CSRIC, and we are committed to a constructive dialogue on this issue. However, given the minimal risk to the PC-1 North

cable, it would be imprudent to delay a decision on this proposal to the conclusion of these broader discussions.

Comment 19: Washington DNR requests that the Commission require Snohomish PUD to obtain and secure the necessary property rights for the project.

Response 19: If the project is licensed, Standard Article 5 of the license order will require that Snohomish PUD obtain all necessary rights for the project.

Comment 20: Washington State Ferries would like to see an evaluation of effects to ferry operations during the installation of the cable linking the turbines to the shore facilities. Washington State Ferries also states that the summer months are the busiest months for passenger ferry traffic and that any interruption to ferry traffic would directly affect ferry operations and the local economy. Therefore, it states installation activities should be coordinated with Washington State Ferries.

Response 20: The final EA has been revised to include an additional discussion of potential installation effects on ferry traffic and recommend coordination with Washington State Ferries.

Comment 21: The Suquamish Tribe, the Point No Point Treaty Council (Jamestown S'Kallam Tribe and the Port Gamble Indian Community), and the Tulalip Tribe stated that the proposed project is located in the usual and accustomed fishing grounds in which their treaty fishing rights should not be impaired, limited, and/or eliminated. The Point No Point Treaty Council also noted that the Tribes fish for subsistence in the location of the proposed project and that the current restrictions on salmon fishing in the proposed project area is a temporary agreement and may not be in place for the requested term of the proposed project license (ten years). The Point No Point Treaty Council commented that the statement that individuals could fish near the turbines, "at their own risk," minimalized their concerns and implied limitation of access to usual and accustomed fishing grounds.

Response 21: Our analysis showed that the effects on all forms of fishing, tribal and non-tribal, treaty and non-treaty, subsistence, and salmon (should the fishery be reopened) would be minimal. The project would be short-term, occupy an extremely small portion of Admiralty Inlet, and would have few, if any effects on individual fish and no effects at the population scale. We agree that the statement that individuals could fish, "at their own risk," was poorly phrased and detracted from our overall assessment that the effect of the proposed project would be minimal. We have deleted it.

Comment 22: The U.S. Environmental Protection Agency requested that the Commission give full consideration to the Northwest Tribes initiative known as "Treaty Rights at Risk."

Response 22: According to their web site (http://treatyrightsatrisk.org/), this initiative focused on protecting salmon habitat. The proposed project would have minimal effect on salmon habitat and is intended to provide information to help determine whether or not larger tidal energy projects would have effects on salmon habitat.

Cultural Resources

Comment 23: Snohomish PUD stated that our draft license article on page A-208 would compel the District to develop an historic properties management plan or HPMP, either prior to the start of any new land-clearing or ground disturbing activity, or afterward, while on page 154 we indicated that an HPMP would be required only if a previously unidentified historic property were found.

Response 23: The statement on page 154 was incorrect. We have corrected the draft article to state that an HPMP would only need to be prepared by Snohomish PUD in the case of the discovery of a cultural resource that is determined to be eligible for the National Register of Historic Places.

Developmental Analysis

Comment 24: PC Landing stated that the EA did not address the cost to PC Landing in the case of a cable break of their PC-1 North Cable.

Response 24: We did not discuss the cost of repairing the cable because our analysis did not indicate that repairing the cable was a likely outcome of any of the proposals under consideration.

Draft License Articles

Comment 25: Snohomish PUD requested that staff delete the draft license article on Cofferdam and Deep Excavation Construction Drawings because they do not anticipate applying these methods.

Response 25: The article addressing Cofferdam and Deep Excavation Construction Drawings is a standard article for license's that addresses proposed construction in the water or deep excavations. While the installation procedures for the Admiralty Inlet Project do not include a cofferdam or deep excavation, it is not known if either might be required because of unforeseen circumstance during construction, or during future operations or maintenance. Therefore, we recommend including the article in any license, but also recommend modifying the proposed language to be more flexible. Please note that the first word in the draft article is "should". Hence, if neither a cofferdam nor deep excavation is required during the life of the license, then fulfillment of Article 3XX would not be required.

Comment 26: Snohomish PUD requested that staff delete the draft license article on Use and Occupancy because Snohomish PUD does not own the project lands and the project is temporary.

Response 26: Requiring a licensee to obtain prior Commission approval for every use or occupancy of project land would be unduly burdensome. This recommended article allows the licensee to grant permission, without prior Commission approval, for the use and occupancy of project lands and waters for such minor activities as landscape planting and erosion control. Such uses of project lands, no matter how limited, must be consistent with the purposes of protecting and enhancing the scenic, recreational, and environmental values of the project. Therefore, we continue to recommend including the article in any license.

20130809-3010 FERC PDF (Unofficial) 08/09/2013

Document Content(s)

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Appendix L

FERC PLAN REQUIRING CONTRACTOR INPUT

Note:
One of the conditions of the anticipated Federal Energy Regulatory Commission (FERC) license is Article-3XX Hazard Identification and Risk Assessment (attached below). While the DISTRICT has included DRAFT version of the proposed document in this appendix, further refinements specific to the CONTRACTOR's proposed means and methods will be required together with consultation with the DISTRICT, OpenHydro and groups identified below. The CONTRACTOR shall participate in this refinement process.

PROPOSED FERC LICENSE ARICLE:

Article 3XX. *Hazard Identification and Risk Assessment*. At least 30 days prior to the start of in-water construction, the licensee shall file with the Commission for approval a Hazard Identification and Risk Assessment to minimize potential hazards to PC Landing Corporation's fiber optic cable during project installation, maintenance, and removal activities. This assessment shall include and describe: (a) operational procedures for installing, maintaining, and removing the project turbines; (b) criteria for weather and wave conditions that must exist before marine operations can occur; (c) redundancy in the use of equipment and/or vessels; (d) criteria for aborting the operations; and (e) an established "port of refuge," located at least two (2) kilometers away from the PC-1 cable, in the event of unanticipated adverse weather or other event.

The licensee shall include with the assessment, documentation of consultation with the U.S. Coast Guard, the U.S. Army Corps of Engineers, and PC Landing Corporation; copies of comments and recommendations on the completed assessment after it has been prepared and provided to the consulted entities; and specific descriptions of how the entities' comments are accommodated by the assessment. The licensee shall allow a minimum of 30 days for consulted entities to comment and make recommendations before filing the assessment with the Commission. If the licensee does not adopt a recommendation, the filing shall include the licensee's reasons based on project-specific information.

The Commission reserves the right to require changes to the assessment. In-water construction shall not begin until the assessment is approved by the Commission. Upon Commission approval, the licensee shall implement the procedures contained in the assessment, including any changes required by the Commission.

ADMIRALTY INLET PILOT TIDAL ENERGY PROJECT
FERC PROJECT NO. P-12690-005

Hazard Identification and Risk Assessment (HIRA) (Article-3XX)

Prepared by:

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JANUARY, 2014

Table of Contents

1.0 HIRA Safety Plan 2
1.1 Vessel Evacuation 2
1.2 Adverse Weather 2
1.3 Equipment & Machinery Safety 2
1.4 Personal Protective Equipment 2
1.5 Weight Handling 3
1.6 Safety Precautions Plan 3
1.6.1 General Precautions 3
1.6.2 Special Safety Precautions 4
1.6.3 Medical Emergency 5
1.6.4 Vessel Fire 5
1.6.5 Man Overboard 5
1.6.6 Hydraulic Leak 6
2.0 Hazard Identification and Risk Assessment (HIRA) 6
2.1 Introduction 6
2.2 HIRA Structure 7
2.2.1 Hazard Identification 7
2.2.2 Risk Assessment 7
2.2.3 Risk Analysis 7
2.2.4 Hazard Severity 7
2.2.5 Hazard Probability 8
2.2.6 Risk Assessment Code (RAC) 8
3.0 Additional Considerations 21
3.1 Construction Conditions 21
3.1.1 Notifications 21
3.1.2 General Conditions 21

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1.0 Hazard Identification and Risk Assessment (HIRA) Safety Plan

This section contains details regarding personnel safety requirements, emergency procedures, environmental protection issues, communication procedures, and standard operational procedures for marine vessels relative to installation activities. It is intended to give a general overview of operation practices while performing system deployment and installation tasks. These processes are assumed to be fully understood and employed by installation personnel in conjunction with the submitted and approved HIRA.

1.1 Vessel Evacuation

If any emergency dictates evacuation, this will be coordinated by the Vessel Captain and the Installation Director. Evacuation drills will be conducted on-board the vessel for all passengers prior to commencing any installation or deployment activity.

1.2 Adverse Weather

The Vessel Captain Installation Director will determine what action is to be taken during a period of adverse weather. All personnel working on-deck will wear personal protective equipment including personal flotation devices (PFDs).

Offshore operations will not commence unless the sea state is SS3 or below. Weather will be monitored daily. In the event that conditions do not allow the start of operations on a particular day, the installation and support vessel(s) will remain in port. If the weather deteriorates while offshore to the point that operations must be called off, the installation and support vessel(s) will return to port to wait for suitable conditions.

1.3 Equipment & Machinery Safety

Vessel personnel shall ensure that all equipment is operated in a manner that will protect personnel, equipment, and the environment. Personnel operating deployment equipment and machinery shall receive training on proper equipment use, machine safety features, and operating precautions prior to use.

All major equipment shall have warning signs clearly posted to indicate potential hazards. All access panels shall have warning signs indicating the hazards inside. Operating voltages and maximum working parameters shall be clearly posted on all equipment. Cranes shall have maximum lift amounts at given extensions stenciled in a highly visible location. Winches shall have maximum working loads and line speeds (in feet per minute) in a visible location at the winch and at the control panels.

1.4 Personal Protective Equipment

The wearing of hard hats in identified areas of potential head injury is mandatory. The designated Safety Observer shall identify work areas and tasks where hard hats are required. Work gloves will be worn to protect from hand injury.

DRAFT

All personnel while working on the aft deck will wear a U.S. Coast Guard approved work vest or float coats. All personnel shall be required to wear approved protective eye wear in areas of potential eye hazard. Hearing protection shall be mandatory and worn in designated areas or for specific tasks.

Respiratory protection devices shall be worn by personnel when engineering controls are not feasible and exposure to concentrations of toxic dust, fumes, or mists is possible. Respiratory devices are only to be used by qualified personnel.

Sturdy leather work shoes or boots with a substantial sole and sides that protect the foot are required for all employees. Steel-toed shoes will be required where a risk of foot injury is present. Athletic type/design shoes, sandals, open toed shoes, etc. are not acceptable. All personnel shall wear clothing suitable for their work.

1.5 Weight Handling

Weight handling procedures and weight handling equipment shall adhere to ABS Standards aboard all Vessels. All equipment shall be pre-certified prior to installation or deployment activities.

1.6 Safety Precautions Plan

The personnel involved with the offshore work will attend a mandatory safety briefing conducted on the project vessel prior to the start of operations each day. Multiple safety briefings must be held because there will not be a time when all personnel will be together prior to the start of field operations, and each operation has special safety considerations that will be required to be discussed. Safety briefings will be held prior to: 1) mobilization; 2) quayside during tow-trials; and 3) system installation. Cruise discussions will be held immediately following each safety briefing.

1.6.1 General Precautions

Safety is the responsibility of each and every member of the installation and deployment activities. Each person has the obligation to halt any operation that they deem unsafe. The loads to be handled and equipment to be utilized are standard for the contractor personnel and vessel members that will be involved. Only qualified personnel will operate the heavy lift equipment. This includes the deck cranes, A-Frame, cable engines, mooring capstans and the ROV lift equipment. This will be their only function while deck operations are taking place. In addition, persons experienced with the type of offshore work that will be conducted will be tasked to be

DRAFT

deck operations leaders for each vessel. These persons may be different from day to day. They will direct all deck operations, and will ensure that all operations are conducted in a safe manner.

1.6.2 Special Safety Precautions

Crane Operations – The mobilization crane at the quayside and on the project vessels will be fully functional at the start of operations. The crane certifications will be current prior to the start of operations. It is possible that a failure with the crane could occur, but all project personnel will be directed to not go beneath the crane or load during crane operations. Also, no unnecessary personnel will be present on the vessel deck when crane operations are in progress. All crane operations will be performed and directed by qualified personnel. All personnel required on the deck, at the direction of the deck leader, will wear hard-hats, safety shoes and buoyant safety vests. The designated safety observer and deck leader will observe the crane and surrounding area during lifts. Finally, the loads that the crane will be moving will be below the safe working limits of the crane that will be used.

Electrical Shock (Umbilical) – All of the electrical cables that run on the deck or run from the deck equipment/instruments to the water will be monitored with a Ground Fault Interrupter (GFI). Personnel will be instructed to not touch any cables when operations are in progress. All cables will be handled with power off.

Tensioned Lines – Tensioned lines will be monitored by the safety observer and deck leader. Project personnel will be directed to not stand near, nor cross over any lines or cables under tension.

Premature Release of Object being lifted – Refer to crane and A-frame operation discussions in this plan. Project personnel will be directed to not go near or under objects being lifted. Tag lines will be used to enable control of the objects at a safe distance. Work will not be conducted on any hardware while the hardware is suspended.

Deck Work (Man Overboard) – All personnel near the back deck of any of the vessels, or any other areas unprotected with bulwarks, are required to wear Coast Guard approved buoyant safety work vests or float coats. This includes any work performed in small inflatable boats. See section 1.6.5 below for man overboard emergency procedures.

Personnel Caught in Cable or Line Bights (Subsea) – Lines and cables that are being utilized will be closely monitored by the submerged divers to avoid entanglement or cutting off their air supply. Divers will be directed to stay clear of any working line or cable, whenever possible.
Personnel Caught in Cable or Line Bights (On Deck) – Lines and cables that are being utilized will be monitored by the safety observer and deck leader. Project personnel will be

directed to not stand near any working line or cable, especially not in the bight of any line or cable.

ROV A-Frame Operations – The ROV and deployment A-frame will be fully functional and load tested to ABS standards prior to the start of operations. It is possible that a failure with the A-frame could occur, but all personnel will be directed to not go beneath the A-frame or load that the A-frame is moving. No unnecessary personnel will be present near the stern when A-frame operations are in progress. All A-frame operations will be performed and directed by qualified personnel.

Line Entanglement – Certain phases of the project necessitate having more than a single line in the water. Therefore, the possibility exists of lines getting tangled. The consequence of this is possible equipment damage or loss should a line break. Deployment plans will minimize the number of lines over the side of the ship. Additionally, where possible the lines will be tended from different sides of the ship to mitigate this risk. Real time monitoring by ROV(s) or divers shall be utilized during all of the installation and deployment activities.

1.6.3 Medical Emergency

Blank "Accident Report" forms will be taken to the offshore work site. This form will be completed for anyone injured while performing project related duties. The following gives the steps that will be taken in case of a medical emergency:

- Call local Coast Guard for assistance (marine band Channel 16 or cellular phone). The local Coast Guard will be aware of the offshore operations that will be conducted. Depending upon the location of the nearest Coast Guard vessel or helicopter, and nature of the injury, the Coast Guard may direct project personnel to transport the injured person via ship to the nearest port and a waiting ambulance.
- Notify District personnel of the emergency immediately.
- Have transportation for the victim from shore to nearest medical facility arranged.

1.6.4 Vessel Fire

Notice of fire will be made by sounding vessel alarm, and vessel's public address system. Crew members on the vessel are trained in basic fire extinguishing techniques and all vessels will carry Coast Guard required firefighting equipment. Project participants will be notified of what to do in the case of a fire during the mandatory safety briefings.

1.6.5 Man Overboard

Project participants will be notified at the mandatory safety briefings of what procedures they should follow in the case of a person inadvertently entering the water from a vessel. In summary, the following steps will be taken:

DRAFT

- Yell "MAN OVERBOARD" and notify the deck leader and Safety Observer.
- Person seeing the man overboard continuously points to the person and keeps track of the victim's location.
- The deck leader and Safety Observer will immediately inform the operator of the vessel.
- Propulsion of the vessel is stopped (if applicable) and the vessel signals man overboard by three long blasts on the vessel's whistle; repeat several times.
- All vessel personnel are alerted of the man overboard by the Vessel Intercom System
- A life ring is thrown to the person in the water.
- All personnel available point to and keep track of the person in the water.
- If necessary, a small boat is dispatched to recover the person.
- Medical procedures are followed as appropriate.

1.6.6 Hydraulic Leak

Drip pans and absorbent material will be provided for areas where hydraulic connections are made. A canister will also be provided for waste. This canister will be properly marked. All spills; oil or otherwise, will be cleaned up immediately for safety and to protect the environment.

2.0 Hazard Identification and Risk Assessment (HIRA)

2.1 Introduction

The main challenge during any marine operation is how to prepare, prevent, mitigate, respond, and recover from potential hazards. When evaluating a marine installation or deployment activity, the following questions must be evaluated at each subsequent process:

- What hazards exist in the processes?
- How frequently do they occur?
- How severe can their impact be on the vessels, equipment, and the environment?
- Which hazards pose the greatest threat to the project and surrounding assets?

This Hazard Identification and Risk Assessment (HIRA) document attempts to assist project personnel in answering these questions in order to better improve project safety by providing a tool that can be used to assess the consequences and frequency of individual hazards. The purpose of this is to identify which hazards should be the focus of installation personnel at a particular point in time. This HIRA is intended to be an ongoing process. When hazards are identified as having a high level of risk, personnel should attempt to minimize this risk through prevention, preparedness, mitigation, response and recovery measures.

2.2 HIRA Structure

This document is structured to provide information on the identified hazards and their associated risks while providing guidance on how to mitigate the potential for individual risks. The primary steps in developing this HIRA are identified below.

2.2.1 Hazard Identification

This step in the HIRA process aims to identify the individual hazards relevant to each process in the marine operations. This requires a systematic review of all hazards and their causes in order to determine whether they impose a potential threat to the given operation. Since there are many different ways to determine how a hazard may occur and to categorize its impact, this step may require the consultation with government agencies, insurance companies, and marine consultants.

2.2.2 Risk Assessment

During this step of the HIRA process, the level of risk for each hazard is examined. This will involve the evaluation of potential scenarios that could occur as shown in the individual installation and deployment storyboards, Project plans, and Specifications.

2.2.3 Risk Analysis

The information collected in the risk assessment step will be examined using the HIRA methodology. The desired outcome of the risk analysis is the identification of which hazards should be considered a priority for project personnel at the particular point in time based on their frequency and potential consequences.

Since the HIRA is an ongoing process it will require the project personnel to closely monitor and manage the evolution of potential hazards and their associated risks. Changes in hazard frequency or mitigation methodology may reduce the risk of potential hazards, while identifying other areas as sources of hazards. The goal of the HIRA is the thorough examination of project hazards and their associated risk through an evolving collaborative effort by project personnel, outside agencies, and other interested parties.

2.2.4 Hazard Severity

A Risk Analysis for each phase of project execution is based on Hazard Severity. This is an assessment of the potential consequence that can occur as a result of a hazard and is defined by the degree of injury, illness, property damage, loss of assets (time, money, personnel), or effect on the operation or task. Consideration must be given to exposure potential. For example, the more resources exposed to a hazard, the greater the potential severity. Severity categories are assigned Roman numerals according to the following criteria:

- **Category I** – Loss of ability to accomplish mission. Death or permanent total disability. Loss of a mission-critical system or equipment. Major facility damage. Severe environmental damage. Mission critical security failure. Unacceptable collateral damage.
- **Category II** – Significantly degraded mission capability or unit readiness. Permanent

partial disability or severe injury or illness. Extensive damage to equipment or systems. Significant damage to property or the environment. Security failure. Significant collateral damage.

- **Category III** – Degraded mission capability or unit readiness. Minor damage to equipment, systems, property, or the environment. Minor injury or illness.
- **Category IV** – Little or no adverse impact on mission capability or unit readiness. Minimum threat to personnel, safety, or health. Slight equipment or systems damage, but fully functional and serviceable. Little or no property or environmental damage.

2.2.5 Hazard Probability

This is an assessment of the likelihood that a potential consequence may occur as a result of a hazard and is defined by assessment of such factors as location, exposure (cycle or hours of operation), affected populations, experience, or previously established statistical information. Probability categories are assigned a letter according to the following criteria:

- **Category A** – Likely to occur immediately or within a short period of time. Expected to occur frequently to an individual item or person; or continuously over a service life for an inventory of items or group.
- **Category B** – Probably will occur in time. Expected to occur several times to an individual item or person; or frequently over a service life for an inventory of items or group.
- **Category C** – May occur in time. Can reasonably be expected to occur sometime to an individual item or person; or several times over a service life for an inventory of items or group.
- **Category D** – Unlikely to occur, but not impossible.

2.2.6 Risk Assessment Code (RAC)

Combine the severity with the probability to determine the risk assessment code (RAC) or level of risk for each hazard, expressed as a single Arabic number. A RAC matrix is provided in Table 1. Hazards given a RAC of 1 or 2 shall undergo further evaluation, analysis in attempt to lower the risk. Hazards with a final RAC of 1 or 2 must be approved by the district and additional involved parties identified in the project roster. See Table 2 for the Hazards Analysis.

Table 1 – Risk Assessment Codes

HAZARD SEVERITY	Hazard PROBABILITY			
	Category A	**Category B**	**Category C**	**Category D**
Category I	1	1	2	3
Category II	1	2	3	4
Category III	2	3	4	5
Category IV	3	4	5	5

RAC Definitions

1 – Critical risk

2 – Serious risk

3 – Moderate risk
4 – Minor risk
5 – Negligible risk

Table 2 contains a list of hazards unique to this particular project. See the "Additional Recommendations" section of this document for procedures that will be followed to reduce the potential risks associated with the offshore project operations.

DRAFT

Table 2 – General Shipboard Operations Hazards Analysis								
Project Title: SnoPUD Tidal Energy Project Reference: Enclosure:							Date Worksheet Prepared: 12/20/13	
Step 1. Identify Hazards			Step 2. Assess Hazards		Step 3. Make Risk Decisions		Step 4. Implement Controls	Step 5. Supervise
Operation Phases	Hazards	Causes	Initial RAC		Develop Controls	Residual RAC	How to Implement	How to Supervise
General Shipboard Operations	1.Drowning	-Man overboard -Falling into water quayside.	I/C	**2**	1. PFD's required any time personnel are on the main deck of project vessels, further referred to as the back-deck (BD) while underway (U/W). 2. Two man rule applies to BD while U/W. 3. Notify Vessel Bridge prior to working and upon completion of work on BD while UW. 4. Limit BD operations to a maximum of Sea State (SS), SS-3. At the discretion of the Cruise Leader, MVI Master, and Safety Observer SS-4 may be worked in situations for example "only one factor such as wave height (long period swell) exceeds SS-3 but wind is mid to low SS-3 or less. 5. Vessel provided Life Ring mounted on BD. 6. Pier side the vessel gangway will be utilized to embark and disembark the vessel. If it is necessary during mobilization/de-mobilization to board the vessel via pier ladder and/or fender a PFD will in all cases be worn and the two man rule applies (second employee in area and watching). 7. PFD's will be worn when working on top or over the edge of the pier curb. 8. Life lines and/or safety netting if required to be lowered in support of	II/D	**4**	1. All Installation participants will read and sign the approved safety plan acknowledging that they understand the potential hazard and agree to adhere to the methods of control (listed in Steps 3) for prevention. The cruise director is responsible to maintain the signature sheet and file with the cruise plan. 2. Controls 5-8 and 10 will be briefed by the cruise leader prior to mobilization and de-mobilization. Controls 1-10 will be briefed by the SO prior to commencing each weekly U/W operation. Vessel Master will brief vessel specific man overboard and abandon ship procedures as they apply to riders prior to each U/W. 3. All crew members have the responsibility and accountability to themselves and other crewmembers to follow the established controls and also have stop work authority in any situation regardless if covered within this document should they feel an unsafe condition exists. 4. IRT control #8. Deck Leader will assign a watch to warn other	1. Cruise Leader and the Safety Observer will ensure controls are adhered too.

DRAFT

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Operation Phases	Hazards	Causes	Initial RAC		Develop Controls	Residual RAC	How to Implement	How to Supervise
					operations will be reinstalled immediately following completion. 9. If affected by seasickness remove yourself from the watch bill. Stay in a safe place off of the weather decks. Seek medical assistance. 10. Alcoholic beverages and non-prescription drugs are prohibited onboard the vessel.		personnel/limit access when condition exists. Rope off the area when possible. 5. IRT control #8. The procedures within reference (a) and (b) shall be followed.	
	Trips and Falls	1. Spills 2. Moving environment 3. Deck protrusions & trip hazards 4. Gear Adrift 5. Wet deck's 6. Rushing	I/C	**2**	1. Good housekeeping. Rope off area of spill and promptly clean up. 2. Secure Operations IAW #4 above. a. If affected by seasickness remove yourself from the watch bill. Stay in a safe place off of the weather decks. Seek medical assistance. 3. Limit, mark and remove promptly. 4. Secure (rope off) access to surrounding area prior to opening and until closed. 5. Properly stow/secure equipage. Secure for sea. 6. Non-skid, proper footwear. 7. Slow deliberate pace. 8. Jewelry such as rings or dangling jewelry should not be worn aboard ship. 9. Cables, hose's (hydraulic, LP/HP gas will be whenever practical and possible run above deck and in any situation properly secured. HP gas hoses shall be married to a proper strain relief and made fast to	II/C	**3**	1. All Installation participants will read and sign the approved safety plan acknowledging that they understand the potential hazard and agree to adhere to the methods of control (listed in Steps 3) for prevention. The cruise director is responsible to maintain the signature sheet and file with the cruise plan. a. Vessel Master and/or Cruise Leader will brief crew of trip hazards that are new and or unusual. b. Illuminate back deck when working in darkness.	1. Cruise Leader and the Safety Observer will ensure controls are adhered to.

DRAFT

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Operation Phases	Hazards	Causes	Initial RAC		Develop Controls	Residual RAC	How to Implement	How to Supervise
					permanent fixtures on both ends.			
	Fire	Alpha, Bravo, and Charlie due to sources of each.	I/C	**2**	1. Good Housekeeping 2. Approved Electrical Procedures 3. Smoking designated areas only. 4. Hot work permits are required by the Vessel prior to any welding, cutting and/or grinding. 5. Vessel firefighting equipment, plan and vessel crew qualification. 6. Proper Hazmat MSDS and storage. 7. Portable fire extinguisher required in mobilized ISO vans that utilize electrical power.	II/C **3**	1. All Installation participants will read and sign the approved safety plan acknowledging that they understand the potential hazard and agree to adhere to the methods of control (listed in Steps 3) for prevention. The cruise director is responsible to maintain the signature sheet and file with the cruise plan. 2. Vessel Master and Cruise Leader will brief rider's responsibility IRT control #3-6.	1. Vessel Master, Cruise Leader, and Safety Observer will ensure controls are adhered too.
	Release of potential/stored Energy	Maintenance, repair, and troubleshooting of equipment and machinery where the unexpected energizing, movement, or release of stored energy during maintenance could cause injury to employees or damage to equipment.	I/A	**1**	1. Lockout/Tag out Procedures will be followed IRT Control of Hazardous Energy LOCKOUT/TAGOUT.	IV/D **5**	1. All Installation participants will read and sign the approved safety plan acknowledging that they understand the potential hazard and agree to adhere to the methods of control (listed in Steps 3) for prevention. The cruise director is responsible to maintain the signature sheet and file with the cruise plan. 2. Supervisors will ensure employees are trained and qualified in the use of Lockout/Tag out procedures. 3. Vessel engineer will be	1. Cruise Leader will ensure controls are adhered to.

DRAFT

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Operation Phases	Hazards	Causes	Initial RAC		Develop Controls	Residual RAC	How to Implement	How to Supervise
							responsible for Lock Out/Tag Out of the vessels permanently installed equipment and machinery. 4. Cruise leader will ensure mobilized equipment and machinery is isolated as required using the approved lockout/tag out program.	
	Hearing Loss	Noise >85db associated with Industrial Environment.	II/A	**1**	1. Establish areas that exceed the Permissible Exposure Limit (PEL) and brief participants. 2. Provide adequate hearing protection. 3. During mobilization/demobilization employees shall wear hearing protection as required when operating tools such as grinders. Double hearing protection is required for impact tools.	III/C **4**	1. All Installation participants will read and sign the approved safety plan acknowledging that they understand the potential hazard and agree to adhere to the methods of control (listed in Steps 3) for prevention. The cruise director is responsible to maintain the signature sheet and file with the cruise plan. 2. Project Manager shall ensure project plans are designed so that exposures over the Permissible Exposure Limit (PEL) are addressed and controls are met to eliminate the hazard. 3. IRT control #1 the cruise leader will request a noise survey to be conducted by the Safety Observer. 2 The crew briefed by the Cruise Leader concerning areas >85db. 4. Once baselines are established for	1. Cruise Leader will ensure control #2 and #3 is adhered too.

DRAFT

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Operation Phases	Hazards	Causes	Initial RAC		Develop Controls	Residual RAC	How to Implement	How to Supervise
							systems additional noise surveys are not required following mobilization if modifications and/or additional noise emitting equipment are not affected.	
	Loss of eyesight or damage to eye	Personnel employed in eye-hazardous areas or operations	I/B	**1**	1. Personnel exposed to light radiation from welding/cutting shall utilize appropriate eye (shield) protection. 2. Personnel exposed to potential flying debris such as grinding, hammering, sawing, chipping and drilling shall utilize approved safety glasses, goggles, and/or shields. 3. Emergency eyewash facilities shall be provided in areas where the eyes of any employee may be exposed to corrosive materials. All such emergency facilities are located where they are easily accessible to those in need.	I/D	**4**	1. All Installation participants will read and sign the approved safety plan acknowledging that they understand the potential hazard and agree to adhere to the methods of control (listed in Steps 3) for prevention. The cruise director is responsible to maintain the signature sheet and file with the cruise plan. 2. Vessel Master will ensure control #3 is established and location briefed at mobilization and weekly underway safety briefs. 3. Supervisor will ensure employees	1. Cruise Leader and Safety Observer will ensure controls are adhered too while UW.

DRAFT

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Operation Phases	Hazards	Causes	Initial RAC		Develop Controls	Residual RAC	How to Implement	How to Supervise
							have access to approved eye protection.	
	Personnel injury	Power and hand tools	I/B	**1**	1. Contractor submitted plan regarding the safe operation of hand and power tools.	III/CI **4**	1. All Installation participants will read and sign the approved safety plan acknowledging that they understand the potential hazard and agree to adhere to the methods of control (listed in Steps 3) for prevention. The cruise director is responsible to maintain the signature sheet and file with the cruise plan.	1. Cruise Leader, and Safety Observer will ensure controls are adhered too.
	Personnel injury	Line Handling	I/B	**1**	1. Personnel handling lines will be trained to do so with due regard to synthetic line snapback and associated bight areas. 2. Personnel shall not step into any bight of line, step over any line, straddle any line or place themselves in any bight areas. 3. Rings, loose clothing, dangling jewelry shall not be worn when handling lines. 4. Do not wear gloves when line handling when the gloves could be caught in the bight.	II/C **3**	1. All Installation participants will read and sign the approved safety plan acknowledging that they understand the potential hazard and agree to adhere to the methods of control (listed in Steps 3) for prevention. The cruise director is responsible to maintain the signature sheet and file with the cruise plan. 2. Supervisors will ensure employees are trained to handle lines.	1. Vessel Master, Cruise Leader, Deck Leader and the Safety Observer will ensure controls are adhered too.
	Personnel	Projectile Hazards	I/A	**1**	1. Adequately secure for sea.	II/D **4**	1. All Installation participants will	1. Vessel Master, Cruise Leader,

DRAFT

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Operation Phases	Hazards	Causes	Initial RAC		Develop Controls	Residual RAC	How to Implement	How to Supervise
	injury	Improper equipment stowage			2. Sliding drawers within tool chests and similar fixtures will be secured using locks or battens.		read and sign the approved safety plan acknowledging that they understand the potential hazard and agree to adhere to the methods of control (listed in Steps 3) for prevention. The cruise director is responsible to maintain the signature sheet and file with the cruise plan.	and the Safety Observer will ensure controls are adhered too.
	Personnel injury	Working aloft Includes A-Frame	I/A	**1**	1. Vessel Captain and Cruise director must approve personnel to go aloft. 2. Personnel will complete any Vessel specific working aloft check sheets prior to going aloft.	III/D **5**	1. All Installation participants will read and sign the approved safety plan acknowledging that they understand the potential hazard and agree to adhere to the methods of control (listed in Steps 3) for prevention. The cruise director is responsible to maintain the signature sheet and file with the cruise plan.	1. Vessel Master, Cruise Leader, Deck Leader and the Safety Observer will ensure controls are adhered too
	Loss of eyesight or damage to eye	Personnel employed in eye-hazardous areas or operations	B/I	**1**	1. Personnel exposed to light radiation from welding/cutting shall utilize appropriate eye (shield) protection. 2. Personnel exposed to potential flying debris such as grinding, hammering, sawing, chipping and drilling shall utilize approved safety glasses, goggles, and/or shields. 3. Emergency eyewash facilities shall be provided in areas where the eyes of any		1. All crew members' will read and sign the approved safety plan acknowledging that they understand and agree to adhere to the controls listed. 2. Vessel Master will ensure control #4 is established and location briefed at mobilization and weekly underway safety briefs. 3. Supervisor will ensure employees	1. Vessel Master, Cruise Leader, and Safety Observer will ensure controls are adhered too while UW. 2. During mobilization/de-mobilization the Vessel Master, Cruise Leader and Safety observer will periodically monitor the working areas.

DRAFT

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Operation Phases	Hazards	Causes	Initial RAC		Develop Controls	Residual RAC	How to Implement	How to Supervise
					employee may be exposed to corrosive materials. All such emergency facilities are located where they are easily accessible to those in need.		have access to approved eye protection.	
	Heat Stress Index	Excessive heat and humidity on work decks	C/II	**3**	Measure temperature and humidity. Provide water and electrolyte liquids on deck for personnel.	D/II **4**	1. All crew members' will read and sign the approved safety plan acknowledging that they understand and agree to adhere to the controls listed in Step's 3-5. 2. Adhere to Instructions provided in the Heat Stress Index. Monitor air temperature and humidity. Avoid or minimize work on during hot humid days. 3. Monitor air temperature and humidity.	Deck leader and Safety Observer will insure that work personnel take breaks and drink liquids.
A-Frame & Winch Operations	Severe personal injury and /or property damage.	1. Inattention to details. 2. Rushing	D/I	**3**	1. A-Frame and the Winches will be load tested during mobilization 2. All A-Frame and winch operations have been described in detail in the contractor submitted plan. 3. Calibrated load cells used to measure loads 4. Personnel shall stay clear of bight areas IRT rigging failure and associated release of stored energy.	D/II **4**	1.Follow plan as devised 2. Use only certified hardware for operations	1. Vessel Master, Cruise Leader, Deck Leader and the Safety Observer will ensure controls are adhered too during operations
Crane,	Severe	- Lack of a	I/B	**1**	1. Train, qualify personnel	IV/D **5**	1. All crewmembers will read and sign the approved safety plan	1. Cruise Leader, Deck Leader and

DRAFT

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Step 1. Identify Hazards			Step 2. Assess Hazards		Step 3. Make Risk Decisions		Step 4. Implement Controls	Step 5. Supervise
Operation Phases	Hazards	Causes	Initial RAC		Develop Controls	Residual RAC	How to Implement	How to Supervise
Weight Handling Equipment (WHE) operations	personal injury and /or Property damage.	training/qualification ion program. -Inattention to details. -WHE failure. -Lack of a standard. - Swinging loads. -Overloading -Pinch points			and operate in accordance with contractor submitted Weight Handling Equipment plan. 2. During mobilization/demobilization Cranes leased/contracted will be signaled (rigger in charge) by the contracted crane personnel or the vessel's crew. 3. Rigging gear shall conform to the inspection and testing criteria or ABS standards shall be followed in situations not addressed within contractor submitted WHE plan. 4. Vessel bridge will be informed prior to and upon completion of weight handling evolutions performed at sea and the bridge watch will provide and maintain stable course/speed and notify (barring risk of collision) BD of required changes of course/speed prior to execution. 5. Steel toe safety shoes, and hard hats required. Eye and hearing protection as necessary. 6. Use tag lines to control all loads. 7. Personnel shall stay clear of suspended load. Never get under the load or between load and fixed object (pinch point). 8. When using VHF radios, sound powered or other headset type communications for directing (with the		acknowledging that they understand the potential hazard and agree to adhere to the methods of control for prevention. The cruise leader is responsible to maintain the signature sheet and file with the cruise plan. 2. Supervisors ensure personnel involved in WHE evolutions are qualified. 3. Rigger in charge (RIC) will brief crane and/or WHE evolution assignments and safety prior to start of evolution. 4. Deck Leader will brief evolution and safety prior to start of operations. 5. All crew members have the responsibility and accountability to themselves and other crewmembers to follow the established controls and also have stop work authority in any situation regardless if covered within this document should they feel an unsafe condition exists.	the Safety Observer will ensure controls are adhered too.

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Table 2 – General Shipboard Operations Hazards Analysis								
Project Title: SnoPUD Tidal Energy Project Reference: Enclosure:							Date Worksheet Prepared: 12/20/13	
Step 1. Identify Hazards			Step 2. Assess Hazards		Step 3. Make Risk Decisions		Step 4. Implement Controls	Step 5. Supervise
Operation Phases	Hazards	Causes	Initial RAC		Develop Controls	Residual RAC	How to Implement	How to Supervise
					operator) the movement of objects or equipment the communications shall be formal (repeated back prior to movement. Prior to moving loads inform (verbally) all involved personnel prior to the movement such as coming up/down, slewing port/starboard, and booming up/down etc.			
Fork Lift Operation	Severe personal injury and /or property damage.	1. Lack of a training/qualification. 2. Inattention to details. 3. Rushing 4. Blind Spots 5. Walking large loads	I/A	**1**	1. Train and qualify personnel. 2. Follow applicable fork lift operating manuals. 3. Only licensed personnel shall operate Fork Lifts. 4. Use Spotter	III/C **4**	1. All Installation participants will read and sign the approved safety plan acknowledging that they understand the potential hazard and agree to adhere to the methods of control (listed in Steps 3) for prevention. The cruise director is responsible to maintain the signature sheet and file with the cruise plan.	1. Cruise Leader and Safety Representative will periodically monitor the work area.
Vessel Ops	Dynamic Positioning System Malfunction	Mechanical or System failure	C/III	**4**	1. One failure of a system component will not affect DP-1 vessel. When one component fails, check with vessel captain and prepare calmly and efficiently to halt operations until component is repaired. 2. Employ redundant vessels to provide navigational control	D/III **5**	1. Be prepared to stop operations at all times, and retrieve system overboard 2. Use secondary support vessels to assist down vessel. 3. Return to quayside to make repairs.	Deck manager and Captain remain in constant contact during operations

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Table 2 – General Shipboard Operations Hazards Analysis

Project Title: SnoPUD Tidal Energy Project Reference: Enclosure:							Date Worksheet Prepared: 12/20/13	
Step 1. Identify Hazards			Step 2. Assess Hazards		Step 3. Make Risk Decisions		Step 4. Implement Controls	Step 5. Supervise
Operation Phases	Hazards	Causes	Initial RAC		Develop Controls	Residual RAC	How to Implement	How to Supervise
Cable Installation	Weather		B/III	**3**	Do not start operation when weather is SS 3 or above Vessel can hold station up to Sea State 4	C/3 **4**	Review 3-5 day weather forecast	Review 3-5 day weather forecast
Turbine Installation	Weather		B/III	**3**	Do not start operation when weather is SS 3 or above Vessel can hold station up to Sea State 4	C/3 **4**	Review 3-5 day weather forecast	Review 3-5 day weather forecast
Cable Connection Operation	Weather		B/III	**3**	Do not start operation when weather is SS 3 or above Vessel can hold station up to Sea State 4	C/3 **4**	Review 3-5 day weather forecast	Review 3-5 day weather forecast
Installation Ops	Lifting Equipment Structural Failure		C/II	**3**	Test lifting components during Mob operation	D/II **4**	Will test crane, A-Frame, winches, and components in accordance with ABS requirements	Supervise load test, and use certified test weights.
Deck Operations	Turbine Failure	Failure of electrical components	D/II	**4**	Test components on ship before beginning installation Always monitor Turbine from installer during deployment When possible, monitor Turbine from the Power Control & Conditioning Building	D/III **5**	Shore crew will inform ship crew if system fails May fix/replace components with spares Recover Turbine prior to deployment Return to quayside for repairs	Maintain constant communication between ship and shore.
Deck Operations	Component Failure	Shackle or line failure	D/II	**4**	All lifting hardware has been tested and tagged by supplier All components designed to ABS standards	D/III **5**	Normally 2 lines are secured to overboard system at all times in case of failure of individual component	Repair or replace failed component If repair is not possible, recover system and install Temporary array.
					Accept Risks: Yes Higher Authority Required: No		Lessons Learned:	

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3.0 Additional Considerations

In addition to the mitigation efforts identified in the hazard analysis shown above, there are several recommended "Best Marine Practices (BMPs)" that should be incorporated in to the installation and deployment activities. These BMPs will bolster the overall effectiveness of the HIRA in addition to the general safety requirements discussed at the beginning of this document.

3.1 Construction Conditions

3.1.1 Notifications

In accordance with the Project Schedule, contractors shall notify the USCG, other government agencies, and additional private parties identified in writing of expected installation and deployment activities well in advance of such Project work. As a part of the notification, contractors shall provide, in general, all information listed below no later than six (6) weeks prior to the start of work. Contractors shall schedule meetings with key Project personnel, DISTRICT and other outside agencies early in the project development to discuss potential impacts on waterway issues and to coincide with the submission of Project information.

Contractors must issue a Notice to Mariners at least 30 days prior to commencing any installation or deployment activities. The USCG, Washington State Ferry system, and Cable owners must be notified no less than 72 hours in advance to request issuance of a Broadcast Notice to Mariners (BNM).

Deviations from the Project plans that require review by the District or other agencies including private companies must be requested and shall be kept to a minimum. The District may deny, approve or approve with conditions any such request.

3.1.2 General Conditions

The contractor, at a minimum shall adhere to the following items to reduce the overall project risk.

- **Advance Notification –** The contractor must notify the District at least three (3) weeks in advance of any substantial changes to plans already submitted that impact vessel traffic.
- **Commercial Vessel Traffic** – No commercial vessels are to be impeded by the proposed work without prior coordination with waterway users.
- **Tug Support** – The contractor must determine the need for tugs to provide for safety and expeditious movement of work vessels during operations by evaluating the construction plans. District review of the plans may result in requirements for tugs in addition to those identified by the contractor.
- **Mooring Plans –** Anchors and anchor lines will not be permitted at the Turbine installation site or in areas that may interfere with the safe movement of commercial vessels. Mooring plans for work anywhere associated with the Project must be submitted for review by the District no later than six (6) weeks prior to start of work. Permanent

anchors and buoys used to mark deployment locations shall not be placed within 1500 meters of known underwater hazards.

- **Compliance with Navigation Rules** – All vessels used during the installation and deployment activities should display day shapes as prescribed in the U.S. Coast Guard Publication "Navigation Rules, International-Inland, COMDTINST M16672.2C". All equipment must be marked with fixed white lights at night, even with other lights used to illuminate the work area. Such nonstandard lighting must also be reviewed by the District to insure that lights will not be placed so as to blind approaching vessel operators. If any vessels used are Coast Guard inspected vessels, they must comply with all applicable Federal and State Regulations. The point of contact for vessel inspection requirements is U.S. Coast Guard Marine Safety Office.
- **Communications** – When working in either the main navigation channel or secondary navigation channel, the contractor must maintain radio contact on Marine Channel 13 and 14 (156.65 and 156.7 MHz) with the Coast Guard VTS to keep abreast of vessel traffic movements at all times. Coordination with VTS is necessary each day to confirm vessel transit schedules in the area of work. Contractors shall maintain contact and coordinate with VTS via Channel 14 VHF-FM Radiotelephone indicating where equipment will be immediately located.
- **Slow Bell/No Wake** – Contractor may request a slow bell from the Coast Guard Vessel Traffic Service (VTS) to avoid problems from vessel wakes.
- **Marine Equipment –** Contractors shall provide the District with detailed information regarding tugs, barges, anchoring/mooring equipment and locations, contact names and telephone/pager numbers for project engineers/managers and other emergency personnel. In order to better evaluate any channel constrictions, the dimensions of the work vessel(s) used are critical. Furthermore, the District should be provided with a means to contact the vessels and persons in charge. Notice is made to the maritime community of the hours of operation so start and finish dates/times should also be submitted in accordance with the Project plans.
- **Marine Species –** Contractor must coordinate with the resource agency requirements regarding work windows or construction methods required to avoid potential impacts to marine species.

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Appendix M

ISLAND COUNTY PERMITS

While the DISTRICT has received the Conditional Shorelines Permit from Island County, that decision is currently under appeal as of 11/2/2014. The appealed permit is included in this Appendix and the building permits have yet to be released. The Contract Plans and Specifications represent the permit conditions expected in all the Island County permits. Should a material difference arise between the conditions outlined in the final permits from Island County and those included in the Contract Plans and Specifications, the DISTRICT recognizes this as a potential change condition.

ISLAND COUNTY
PLANNING & COMMUNITY DEVELOPMENT

PHONE: (360) 679-7339 ■ from Camano (360) 629-4522, Ext. 7339 ■ from S. Whidbey (360) 321-5111, Ext. 7339 FAX: (360) 679-7306 ■ 1 NE 6th Street, P. O. Box 5000, Coupeville, WA 98239-5000
Internet Home Page: http://www.islandcounty.net/planning/

STAFF REPORT & DECISION
SNOHOMISH PUD – ADMIRALTY INLET TIDAL TURBINE GENERATOR PILOT PROJECT

SHORELINE CONDITIONAL USE – S-CUP 0089/13

I – PROJECT SUMMARY

The applicant is seeking permit approval to temporarily install two tidal turbine generators in Admiralty Inlet to gather data informing the technical, economic, and environmental viability of tidal energy generation.

This is a 10-year project to construct, operate and remove the turbines, with an objective to obtain 5-years of operational data within this 10-year period. The construction of this project can be separated into three categories, (1) onshore improvements, (2) cable lay, and (3) turbine deployment.

Onshore improvements consist of the construction of a 24x30' control building, constructed using conventional timber framing methods. Upon completion of the 10-year FERC Pilot License, this building will be converted to a residential garage for the property owner's use. The building and fenced area will enclose power conditioning equipment. A power cable will be installed below-grade outside the building and eventually to a Horizontally Directionally Drilled (HOPE) conduit.

Two cables, one for each turbine, will be laid primarily from barges equipped with tooling specifically designed for this purpose.

The two turbines with one cable attached to each will be separately installed around slack tide. The combined mass of the turbine and the ballasted sea base (concrete filled tubular steel), weighing approximately 300-tons, will rest on the sea floor. No piles or other foundation elements are required.

II – PERMIT DATA

Permit Types	S-CUP
Permit Numbers	089-12 S-CUP
Date of Complete Application	04/20/2012
Recommendation	Approved with conditions
Applicant/Owner	Jessie Valentine
Agent	Snohomish PUD

III – SITE DATA

Address	None assigned in Assessor database
Location	Central Whidbey Island & Admiralty Inlet
Parcel Number(s)	S6370-00-61001-0, S6370-00-62001-0
Parcel Area(s)	S6370-00-61001-0: 0.48 acres S6370-00-62001-0: 0.57 acres
Zone Designation	Rural (R), area seaward of OHWM is not zoned
RAID Designation	N/A
Allowable Density	Rural (R): 1 DU/5 AC
Critical Areas/Overlays	Fish & Wildlife Habitat Conservation Area, wetlands, Shoreline Jurisdiction, vicinity of cultural resources, flood hazard area, feeder bluff
Shoreline Environment	Shoreline Residential (SR), Aquatic (A)

IV – STAFF CONTACTS

Department	Name	Phone	Email
Planning	Jason Johnson	360-678-7822	ja.johnson@co.island.wa.us
Public Health	Aneta Hupfauer	360-678-7995	anetah@co.island.wa.us
Public Works	John Bertrand	360-678-7812	johnb@co.island.wa.us
Building	Tamra Patterson	360-678-7806	tamrap@co.island.wa.us

V – REGULATORY COMPLIANCE

Island County considered the following regulatory requirements during the review of this proposal. Only major issues, errors in the development proposal, and justification of conditions are discussed below. Staff finds that all other aspects of the proposed development comply with applicable laws, rules, codes, and requirements.

Regulatory Requirement	Complies (Y/N)	Comments
Flood Damage Prevention – ICC 14.02A	Yes	Project complies, with conditions of approval.
Critical Areas, Fish & Wildlife Habitat Conservation Areas – ICC 17.02	Yes	No permanent alteration of FWHCAs is proposed by the applicant. Temporary alterations will be restored to a pre-development condition upon completion of the project. The permanent equipment shelter is not within the FWHCA and will be converted to a residential garage at the project conclusion.
Rural Zone – ICC 17.03.060	Yes	No generating equipment is to be located within Zoned areas of Island County. Minor Utilities are

		Permitted Uses in the Rural Zone.
Non-Residential Design, Landscape and Screening Guidelines – ICC 17.03.180.P	Yes	Project complies, with conditions of approval.
Parking, Access, and Circulation – ICC 17.03.180.Q	Yes	Project complies, with conditions of approval.
Signs and Outdoor Lighting Standards – ICC 17.03.180.R	Yes	Project complies, with conditions of approval.
Island County Shoreline Master Program (SMP)	Yes	Project complies, with conditions of approval.
Shoreline Use Classification – ICC 17.05.070	Yes	Utilities are listed as Permitted in the Shoreline Residential Environment and as Conditional in the Aquatic Shoreline Environment.
Shorelines of Statewide Significance – ICC 17.05.080	Yes	Project complies, with conditions of approval.
General Shoreline Use Requirements – ICC 17.05.090	Yes	Project complies, with conditions of approval.
Review criteria for conditional use permits – WAC 173-27-160	Yes	Project complies, with conditions of approval.
Public Works	Yes	See attached memo dated May 23, 2012 from John Bertrand of Island County Public Works.
Public Health	Yes	See attached memo dated May 11, 2012 from Aneta Hupfauer of Island County Public Health.
Building	Yes	See attached memo dated May 8, 2012 from the Island County Building Inspector/Plans Examiner.

VI – FINDINGS

A – Project Description

1. The applicant is seeking permit approval to temporarily install two tidal turbine generators in Admiralty Inlet to gather data informing the technical, economic, and environmental viability of tidal energy generation.
2. This is a 10-year project to construct, operate and remove the turbines, with an objective to obtain 5-years of operational data within this 10-year period. The construction of this project can be separated into three categories, (1) onshore improvements, (2) cable lay, and (3) turbine deployment.

3. Onshore improvements consist of the construction of a 24x30' control building, constructed using conventional timber framing methods. Upon completion of the 10-year FERC Pilot License, this building will be converted to a residential garage for the property owner's use. The building and fenced area will enclose power conditioning equipment. A power cable will be installed below-grade outside the building and eventually to a Horizontally Directionally Drilled (HOPE) conduit.
4. Two cables, one for each turbine, will be laid primarily from barges equipped with tooling specifically designed for this purpose.
5. The two turbines with one cable attached to each will be separately installed around slack tide. The combined mass of the turbine and the ballasted sea base (concrete filled tubular steel), weighing approximately 300-tons, will rest on the sea floor. No piles or other foundation elements are required.

B – Non-Residential Design, Landscape and Screening Guidelines – ICC 17.03.180.P

1. Building design in this project has been reviewed and received approval under the design guidelines of ICC 17.04A – Ebey's Landing National Historical Reserve Design Review and Community Design Standards. ICC 17.04A has design guidelines which are more stringent than, and compliant with, the building design guidelines of ICC 17.03.180.P.
2. Visible site modifications for this project have been designed to be indistinguishable from standard rural residential development. Further, the equipment shed has been designed for conversion to a residential garage by the landowner upon project completion. The proposed development visible from the ground will be, to all external appearances, indistinguishable from standard rural residential development and will not serve to detract or stand out from the surrounding rural character.

C – Parking, Access, and Circulation – ICC 17.03.180.Q

1. Off-street parking for maintenance vehicles in provided.
2. Vehicular access to the equipment shelter is indistinguishable from a standard rural residential driveway.

D – Signs and Outdoor Lighting Standards – ICC 17.03.180.R

1. No signage is planned for this site.
2. Conditions of Approval will require that outdoor lighting shall be either full cut-off, fully shielded, flush mounted, or hooded and oriented towards the ground.
3. Conditions of Approval will require that all other outdoor lighting standards shall be followed.

E – Shorelines of Statewide Significance – ICC 17.05.080

1. This is a pilot project to advance a form of clean, renewable energy generation. The objective of the project is to advance the technology of tidal energy production. This objective recognizes statewide interest as well as national interest.

2. The project elements located in the shoreline area will not be visible upon project completion. The turbines and cables will be on the sea floor. The bore pit and trenches will be underground, therefore preserving the natural character of the shoreline.
3. The purpose of the project is to advance the technology of tidal energy production by studying environmental and other data outcomes. This will provide benefits long after project completion, as it will provide information for future tidal proposals to draw/ram.
4. The project is designed to be as environmentally benign as possible. The electrical transmission cables will be placed in a conduit installed underground by horizontally directionally drilling. This will prevent any effects to the shoreline environment. The bore pit located approximately 80' landward of the OHWM will be filled and restored after drilling is complete, with care taken to avoid sediment transport to surface water.
5. The project is located on private property. It will not affect the property owner's use of the shoreline, and will not affect any public shorelines in the vicinity.
6. The project is located on private property and will not result in any increase or decrease in recreational opportunities.

F – General Shoreline Use Requirements – ICC 17.050.090

1. This project can meet general shoreline use requirements with conditions of approval.

G – Shoreline Conditional Use Review Criteria WAC 173-27-160

1. The purpose of a Conditional Use Permit is to provide a system within the Shoreline Master Program that allows flexibility in the application of use regulations in a manner consistent with the policies of RCW 90.58.020. In authorizing a Conditional Use, special conditions may be attached to the permit by Island County or the Washington State Department of Ecology to prevent undesirable effects of the proposed use or to assure consistency with the Shoreline Management Act and Island County's Shoreline Master Program.
2. The Washington State Department of Ecology adopted specific approval criteria that must be considered when reviewing applications for Shoreline Conditional Use Permits. In order to demonstrate compliance with these criteria they have been addressed on an item by item basis as follows:

WAC 173-27-160(1)(a): The proposed use is consistent with the policies enumerated in RCW 90.58.020 and Island County's Master Program.	Island County has determined that the project is consistent with the policies enumerated in RCW 90.58.020 and the Island County Shoreline Master Program.
WAC 173-27-160(1)(b): The proposed use will not interfere with the normal public use of public shorelines.	A portion of the development will be located on private property and the remainder will be underwater. This project will not interfere with the normal public use of the public shorelines.
WAC 173-27-160(1)(c): The proposed use of the site and design of the project is compatible with the other authorized uses within the area and with uses planned for	The project is consistent with this standard. Visible project components will be of a rural residential character. Non-visible uses in the Aquatic Environment are water-

the area under Island County's Comprehensive Plan and Shoreline Master Program.	dependent.
WAC 173-27-160(1)(d): The proposed use will cause no significant adverse effects to the shoreline environment in which it is to be located.	Extensive environmental review has been conducted on this project. Intensive and ongoing environmental monitoring during this project is planned, and this monitoring is considered a critical component for project success by all parties involved. Project is temporary in nature, all components save for the garage/shelter are slated for removal from the shoreline environment upon project completion.
WAC 173-27-160(1)(e): The public interest will suffer no detrimental effect.	The proposed development will further the public interest. This is a pilot project to advance a form of clean, renewable energy generation. The objective of the project is to advance the technology of tidal energy production. This objective recognizes statewide interest as well as national interest.
WAC 173-27-160(2): In the granting of all Conditional Use Permits, consideration shall be given to the cumulative impact of additional requests for like actions in the area. For example if conditional use permits were granted for other developments in the area where similar circumstances exist, the total of the conditional uses shall also remain consistent with the policies of RCW 90.58.020 and shall not produce substantial adverse effects to the shoreline environment.	Additional requests for like actions will depend on the outcome of this pilot project and the goals and objectives of the parties conducting this project. It is not anticipated that further requests for similar pilot projects will be proposed. It is possible, if this project proves successful, that larger scale projects of a similar nature may be proposed in this area in the future. The approvability of such projects will be dependent on local, state, and federal regulations.
WAC 173-27-160(4): Uses which are specifically prohibited by Island County's Master Program may not be authorized through a Conditional Use Permit.	The Island County SMP does not specifically prohibit the uses in question in either the Shoreline Residential or the Aquatic Shoreline Environments.

Based on the analysis outlined above, Island County concludes that the applicant's proposal complies with all applicable Shoreline Conditional Use approval criteria.

VIII – DECISION

Based upon the above review, Island County concludes that the proposed development is consistent with Washington State Department of Ecology regulations, Island County's Shoreline Master Program, Island County's Shoreline Use Regulations, and Island County's Critical Areas regulations, as well as all other applicable regulatory

requirements, and ***recommends approval*** of Shoreline Conditional Use Permit application S-CUP 089/12, subject to the following conditions of approval:

IX – CONDITIONS OF APPROVAL

1. All work, construction, and mitigation shall conform to the submitted Biological Assessment (including Appendix Draft Biological Assessment) prepared for Public Utility District No. 1 of Snohomish County Admiralty Inlet Pilot Tidal Project by Wetland Resources, Inc., dated April 11, 2012, except that minor non-substantive changes may be made if necessary to comply with the requirements of another permitting agency.
2. All work, construction, and mitigation shall conform to the submitted NEPA Environmental Assessment, prepared by the Office of Energy Projects and U.S. Department of Energy, dated January 15, 2013, except that minor non-substantive changes may be made if necessary to comply with the requirements of another permitting agency.
3. All work, construction, and mitigation shall conform to the submitted SEPA Addendum to the submitted NEPA Environmental Assessment, prepared by Snohomish PUD, dated August 27, 2013, except that minor non-substantive changes may be made if necessary to comply with the requirements of another permitting agency.
4. Any temporary alterations to the Fish & Wildlife Habitat Conservation Area must be restored to a pre-development condition upon completion of the project.
5. All work, construction, and mitigation shall conform to the approved plot plans, except that minor non-substantive changes may be made if necessary to comply with the requirements of another permitting agency.
6. Conditions in the attached memo dated May 23, 2012 from John Bertrand of Island County Public Works/Engineering are hereby adopted as Conditions of this Approval.
7. Conditions in the attached memo dated May 11, 2012 from Aneta Hupfauer of Island County Public Health are hereby adopted as Conditions of this Approval.
8. Conditions in the attached memo dated May 8, 2012 from the Island County Building Inspector/Plans Examiner are hereby adopted as Conditions of this Approval.
9. With the exception of the work shown in the approved plans, no clearing, construction or development activities are permitted within 75 feet of the Ordinary High Water Mark.
10. With the exception of the work shown in the approved plans, no clearing, construction or development activities are permitted on steep slopes or within 100 feet of steep slopes.
11. The applicant shall comply with all local, state, and federal flood-plain development regulations. Prior to starting any work or construction activities, the applicant shall obtain all required flood development permits and approvals.
12. Erosion and Sedimentation Control Best Management Practices shall be employed during all development activity. No materials shall be stored or stockpiled seaward of the Ordinary High Water Mark, within Critical Areas, or in any unpaved Critical Areas buffers.
13. All construction and demolition debris shall be disposed of at a site approved by Island County Public Works Department. Treated wood must be separated and disposed of at an Island County transfer station. There shall be no dumping or disposing of debris on the beach or in the waters of the state.

14. Applicant bears the full responsibility of notifying site crews of all permit conditions, and shall be held fully accountable for any activity that results in on- or off-site violations, hazards or damages.
15. No shoreline development rights under this permit shall be transferred by sale, lease, or other conveyance of any interest without prior County notification in order to determine if any new owner or operator can meet the terms and conditions of this permit.
16. All shoreline and overwater activities shall be restricted to reasonable hours and/or days of operation when necessary to protect residents and properties from adverse impacts such as noise, light, and glare.
17. The entirety of the attached document, Inadvertent Archaeological and Historic Resources Discovery Plan for Island County, is hereby adopted into this decision by reference. All terms of this adopted document constitute Conditions of Approval for this decision. Compliance with all applicable laws pertaining to archaeological resources (RCW 27.53, 27.44 and WAC 25-48) and human remains (RCW 68.50) is required. Failure to comply with the terms of this adopted attached document, Inadvertent Archaeological and Historic Resources Discovery Plan for Island County, could constitute a misdemeanor and possible civil penalties and/or constitute a Class C Felony.
18. No equipment or vehicles shall be parked or stored within Critical Areas or in unpaved portions of the Critical Area buffer.
19. The conditions of approval identified in this decision are subject to change if any information provided by the applicant or their authorized representative is found to be inaccurate.
20. This project is required to comply with Washington State and Island County water quality standards, Washington State and Federal laws and regulations protecting archaeological sites and resources and all other pertinent laws, rules, regulations, codes, and ordinances.
21. Applicant shall contact the State Department of Fish and Wildlife (WDFW) to determine if a Hydraulic Project Approval (HPA) permit is required. Contact Doug Thompson at (360) 466-4345 x251 or by email at thompdst@dfw.wa.gov.
22. If approved, this permit is valid for a period of two (2) years. The construction, use, work, or activity authorized by this permit shall be commenced within two years of the effective date of this permit. Island County *may* authorize a single extension for a period not to exceed one year based on reasonable factors, if a request for extension has been filed before the expiration date and notice of the proposed extension is given to parties of record and the department.
23. Construction pursuant to a Shoreline Conditional Use Permit shall not begin or be authorized until twenty-one (21) days from the date the final order granting the permit is filed with the Washington State Department of Ecology pursuant to RCW 90.58.140(6), or until all review proceedings are terminated if such proceedings were initiated within twenty-one (21) days from the date of such filing, except as provided in RCW 90.58.140(5)(a) and (b).
24. Issuance of a shoreline permit shall in no way be construed as excusing the applicant from compliance with any other local, state, or federal statutes, ordinances, or regulations applicable to the proposed substantial development.

X – APPEALS

Administrative decisions of the Director on Type II applications shall be final and conclusive unless within fourteen (14) days following mailing of the Director's decision, a

written statement of appeal, accompanied by a fee except when submitted by a County Department, is filed with the Hearing Examiner by the Applicant, a Department of the County, or any Aggrieved Person. A more comprehensive statement setting forth in detail alleged errors and/or the basis for appeal must be submitted by the appealing Person or Department within thirty (30) days following mailing of the Director's decision, or the appeal is not properly filed and will be dismissed without Hearing. The appeal of a Type II decision shall be an Open Record Appeal.

SIGNED THIS 5th DAY OF DECEMBER 2013

Jason Johnson

Jason Johnson, Associate Planner

Attachments:

- Admiralty Inlet Pilot Tidal Project – Cable Lay Plan & Details – Drawing P-6 – dated 4/12/2012
- Admiralty Inlet Pilot Tidal Project – Architectural Floor Plan – Drawing A-1 – dated 4/12/2012
- Admiralty Inlet Pilot Tidal Project – Architectural Elevations – Drawing A-2 – dated 4/12/2012
- Admiralty Inlet Pilot Tidal Project – Architectural Perspectives – Drawing A-3 – dated 4/12/2012
- Tidal Generation Research Project – BSA Map – Drawing BSA-2 – dated 4/11/2012
- Attached memo dated May 23, 2012 from John Bertrand of Island County Public Works
- Attached memo dated May 11, 2012 from Aneta Hupfauer of Island County Public Health, OUTSTANDING BALANCE STATEMENT INCLUDED
- Attached memo dated May 8, 2012 from the Island County Building Inspector/Plans Examiner
- Inadvertent Archaeological and Historic Resources Discovery Plan for Island County Biological
- Assessment (including Appendix Draft Biological Assessment) prepared for Public Utility District No. 1 of Snohomish County Admiralty Inlet Pilot Tidal Project by Wetland Resources, Inc., dated April 11, 2012, ADOPTED BY REFERENCE.
- NEPA Environmental Assessment, prepared by the Office of Energy Projects and U.S. Department of Energy, dated January 15, 2013, ADOPTED BY REFERENCE
- SEPA Addendum to the submitted NEPA Environmental Assessment, prepared by Snohomish PUD, dated August 27, 2013, ADOPTED BY REFERENCE

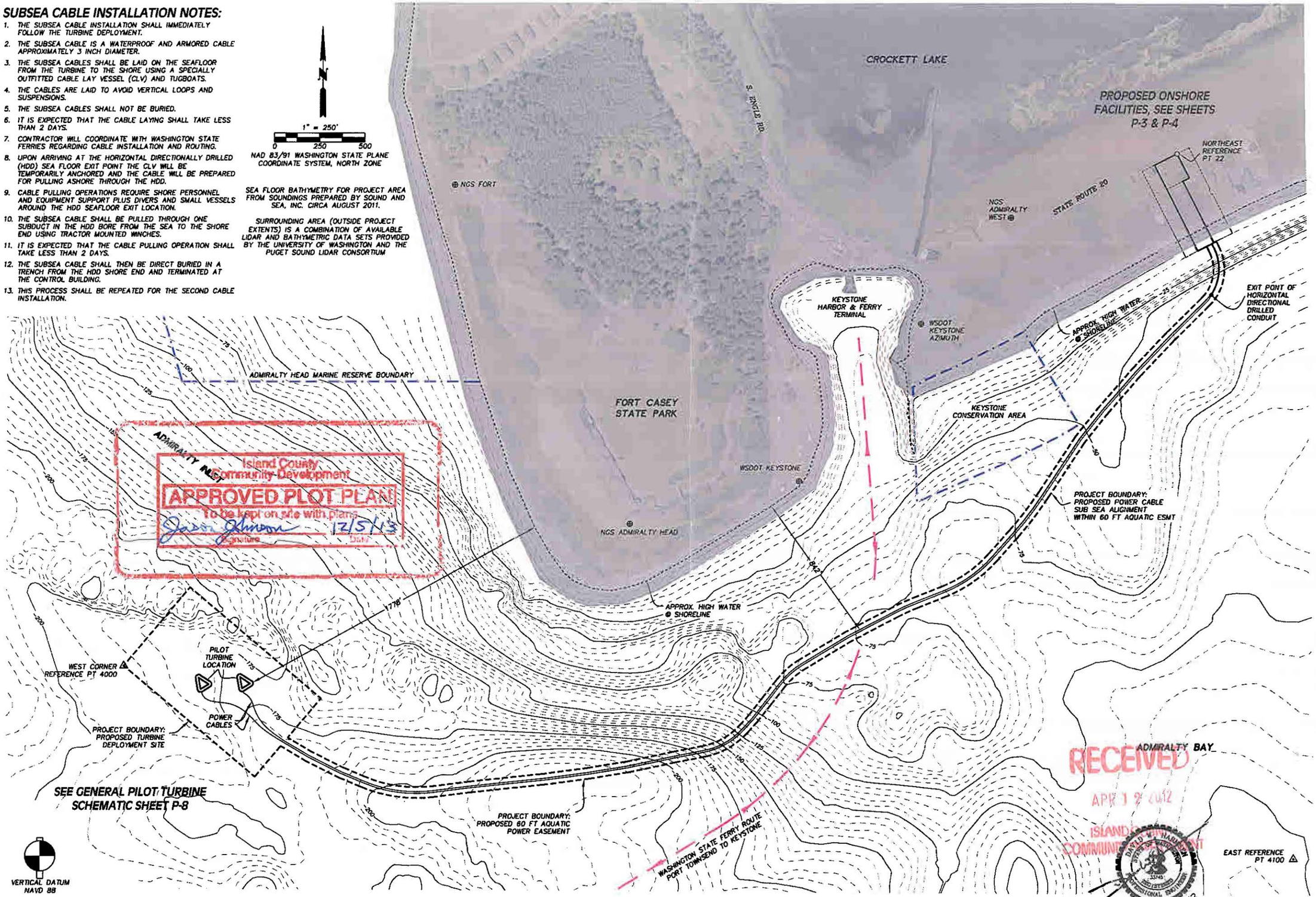
SUBSEA CABLE INSTALLATION NOTES:

1. THE SUBSEA CABLE INSTALLATION SHALL IMMEDIATELY FOLLOW THE TURBINE DEPLOYMENT.
2. THE SUBSEA CABLE IS A WATERPROOF AND ARMORED CABLE APPROXIMATELY 3 INCH DIAMETER.
3. THE SUBSEA CABLES SHALL BE LAID ON THE SEAFLOOR FROM THE TURBINE TO THE SHORE USING A SPECIALLY OUTFITTED CABLE LAY VESSEL (CLV) AND TUGBOATS.
4. THE CABLES ARE LAID TO AVOID VERTICAL LOOPS AND SUSPENSIONS.
5. THE SUBSEA CABLES SHALL NOT BE BURIED.
6. IT IS EXPECTED THAT THE CABLE LAYING SHALL TAKE LESS THAN 2 DAYS.
7. CONTRACTOR WILL COORDINATE WITH WASHINGTON STATE FERRIES REGARDING CABLE INSTALLATION AND ROUTING.
8. UPON ARRIVING AT THE HORIZONTAL DIRECTIONALLY DRILLED (HDD) SEA FLOOR EXIT POINT THE CLV WILL BE TEMPORARILY ANCHORED AND THE CABLE WILL BE PREPARED FOR PULLING ASHORE THROUGH THE HDD.
9. CABLE PULLING OPERATIONS REQUIRE SHORE PERSONNEL AND EQUIPMENT SUPPORT PLUS DIVERS AND SMALL VESSELS AROUND THE HDD SEAFLOOR EXIT LOCATION.
10. THE SUBSEA CABLE SHALL BE PULLED THROUGH ONE SUBDUCT IN THE HDD BORE FROM THE SEA TO THE SHORE END USING TRACTOR MOUNTED WINCHES.
11. IT IS EXPECTED THAT THE CABLE PULLING OPERATION SHALL TAKE LESS THAN 2 DAYS.
12. THE SUBSEA CABLE SHALL THEN BE DIRECT BURIED IN A TRENCH FROM THE HDD SHORE END AND TERMINATED AT THE CONTROL BUILDING.
13. THIS PROCESS SHALL BE REPEATED FOR THE SECOND CABLE INSTALLATION.

1" = 250'
0 250 500
NAD 83/91 WASHINGTON STATE PLANE COORDINATE SYSTEM, NORTH ZONE

SEA FLOOR BATHYMETRY FOR PROJECT AREA FROM SOUNDINGS PREPARED BY SOUND AND SEA, INC. CIRCA AUGUST 2011.

SURROUNDING AREA (OUTSIDE PROJECT EXTENTS) IS A COMBINATION OF AVAILABLE LIDAR AND BATHYMETRIC DATA SETS PROVIDED BY THE UNIVERSITY OF WASHINGTON AND THE PUGET SOUND LIDAR CONSORTIUM



Island County
Community Development
APPROVED PLOT PLAN
To be kept on site with plans
Jason Simon 12/5/13
Signature Date

RECEIVED
APR 12 2012
ISLAND COUNTY
COMMUNITY DEVELOPMENT

DAVID W. HARRISON — STATE OF WASHINGTON — 33745 — REGISTERED PROFESSIONAL ENGINEER
4-11-12

PERMIT REVIEW SET - NOT FOR CONSTRUCTION

No	DATE	BY	DESCRIPTION	ENGR	CHKR	APVD
			REVISIONS			

SNOHOMISH COUNTY PUD
PUBLIC UTILITY DISTRICT No. 1

WO	
TASK	PERMIT
SCALE	AS NOTED
DFTR	JTF
CHKR	DWH
ENGR	DWH
APVD	
DATE	04-12-12

ADMIRALTY INLET PILOT TIDAL PROJECT
CABLE LAY PLAN & DETAILS

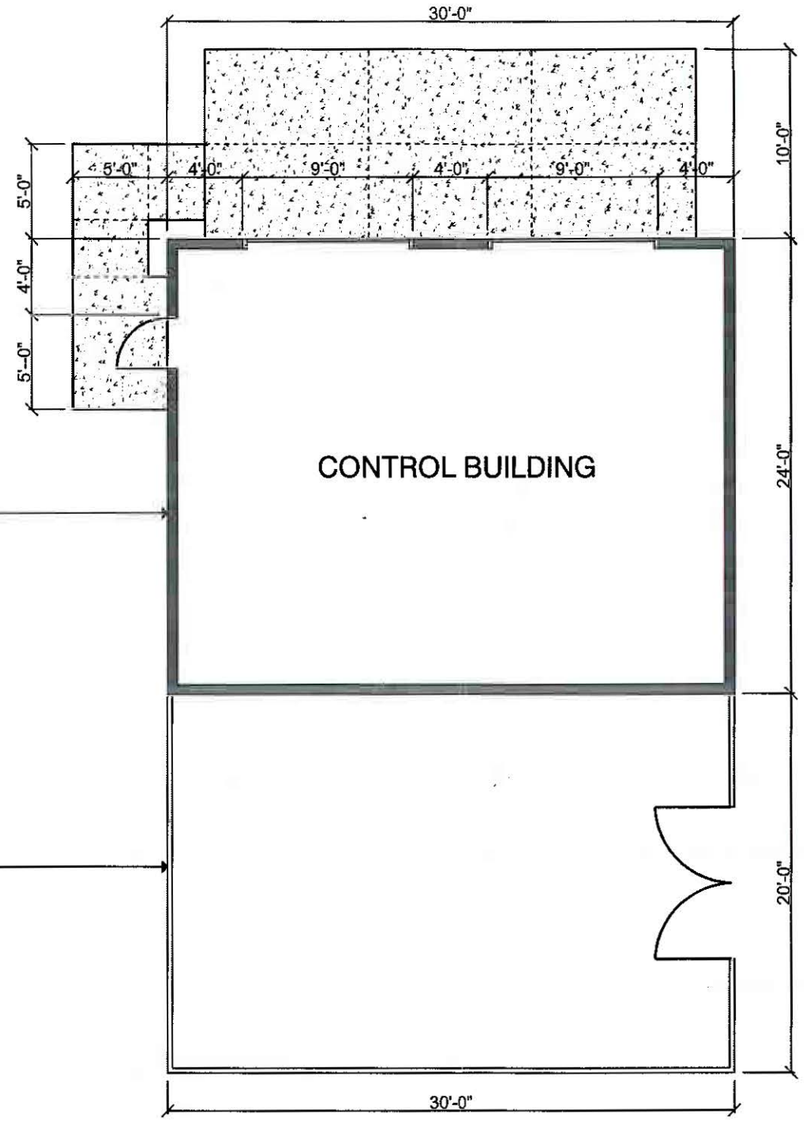
SEC 22, T 31N, R 1E, W.M.
ISLAND COUNTY, WA

REV	DRAWING
0	P-6

LAWHEAD
ARCHITECTS
P.S.

TYPICAL WALL CONSTRUCTION:
- CEMENT FIBER SIDING
- BUILDING PAPER
- PLYWOOD SHEATHING
- 2x6 WOOD STUD WALLS, – TYP.
- R-19 INSULATION
- VAPOR BARRIER
- GWB

WOOD FENCE



Island County
Community Development
APPROVED PLOT PLAN
To be kept on site with plans
Jason Johnson 12/5/13
Signature Date

RECEIVED
APR 12 2012
ISLAND COUNTY
COMMUNITY DEVELOPMENT

1 FLOOR PLAN 1/8" = 1'-0"

N

PERMIT REVIEW SET - NOT FOR CONSTRUCTION

811 Know what's below. Call before you dig.

No.	DATE	BY	DESCRIPTION	ENGR	CHKR	APVD
			REVISIONS			

SNOHOMISH COUNTY PUD
PUBLIC UTILITY DISTRICT No. 1

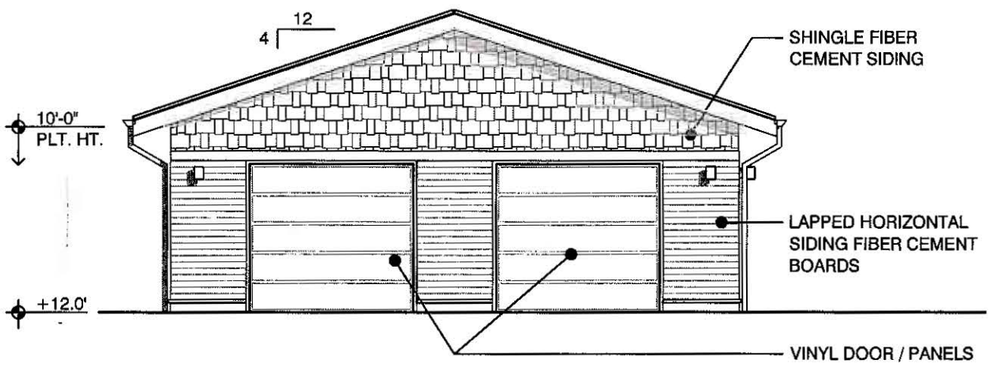
WO	
TASK	PERMIT
SCALE	AS NOTED
DFTR	LAWHEAD
CHKR	
ENGR	
APVD	
DATE	04-12-12

ADMIRALTY INLET PILOT TIDAL PROJECT
ARCHITECTURAL FLOOR PLAN

SEC 22, T 31N, R 1E, W.M.
ISLAND COUNTY, WA

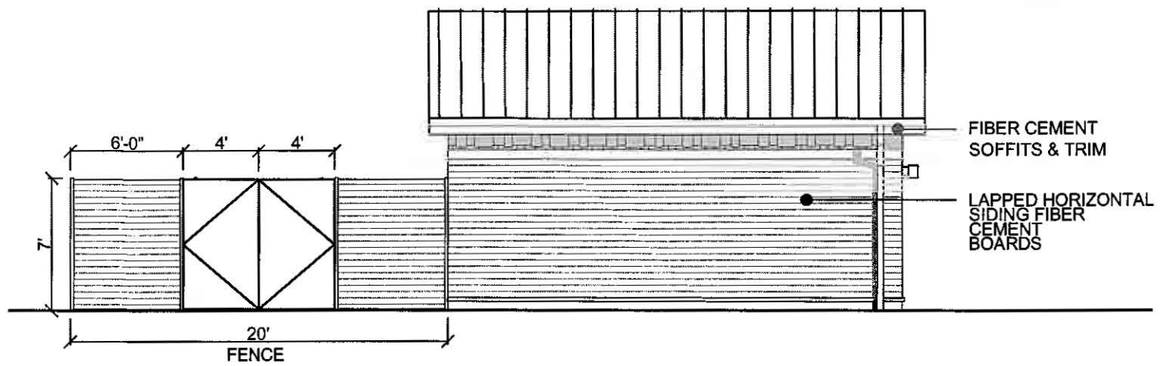
REV	DRAWING
0	A-1

LAWHEAD
ARCHITECTS
P.S.



1 NORTH ELEVATION

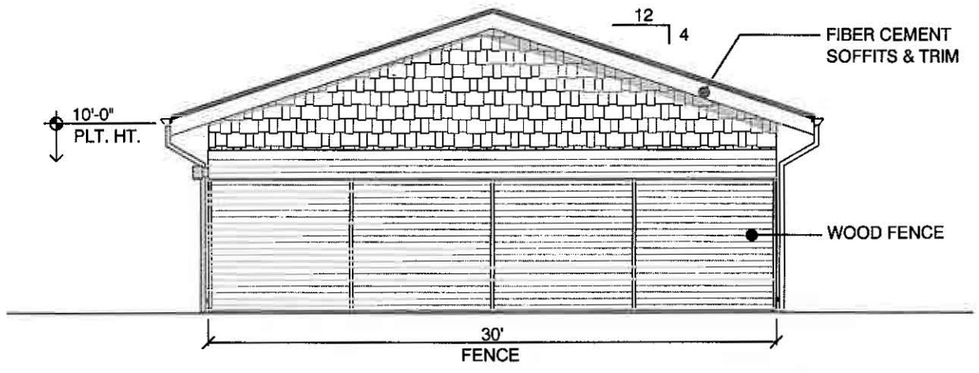
1/8" = 1'-0"



2 EAST ELEVATION

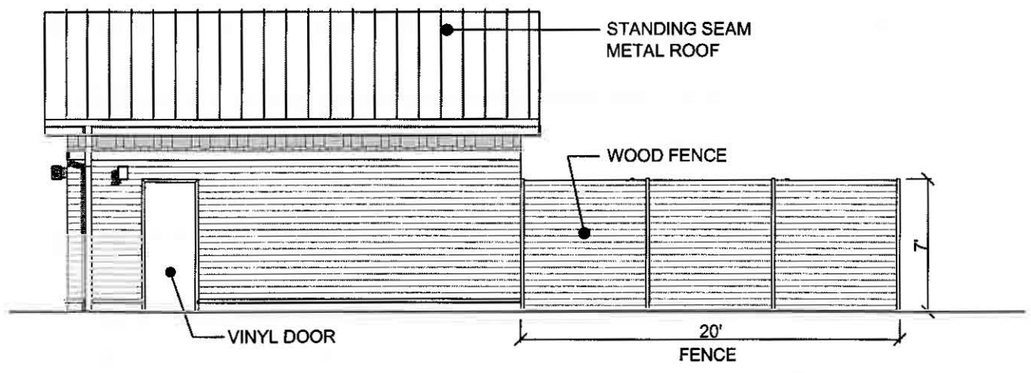
1/8" = 1'-0"

NOTE: EXTERIOR COLORS
SIDING & SOFFITS, AND TRIM COLORS TO BE **EARTH TONE** PER EBEY'S LANDING NATIONAL HISTORICAL RESERVE DESIGN GUIDELINES (P.52, ITEM 3)



3 SOUTH ELEVATION

1/8" = 1'-0"



4 WEST ELEVATION

1/8" = 1'-0"

Island County
Community Development
APPROVED PLOT PLAN
To be kept on site with plans
Jason Johnson 12/5/13
Signature Date

RECEIVED
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ISLAND COUNTY
COMMUNITY DEVELOPMENT

PERMIT REVIEW SET - NOT FOR CONSTRUCTION

811 Know what's below. Call before you dig.

No	DESCRIPTION REVISIONS	DATE	BY	ENGR CHKR APVD

SNOHOMISH COUNTY PUD
PUBLIC UTILITY DISTRICT No. 1

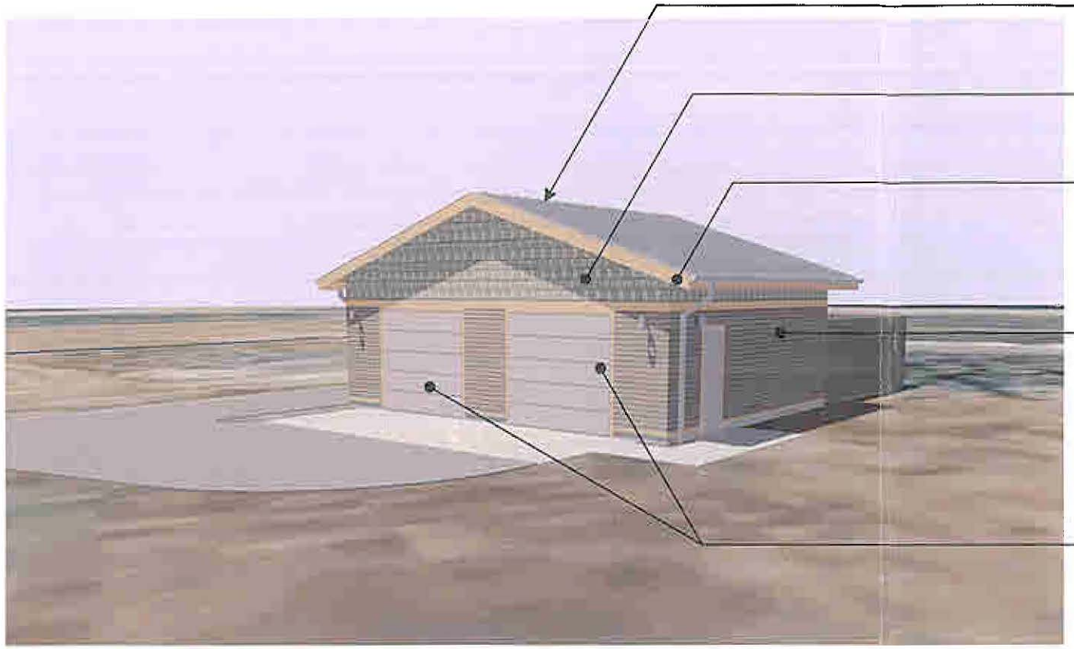
WO	
TASK	PERMIT
SCALE	AS NOTED
DFTR	LAWHEAD
CHKR	
ENGR	
APVD	
DATE	04-12-12

ADMIRALTY INLET PILOT TIDAL PROJECT
ARCHITECTURAL ELEVATIONS

SEC 22, T 31N, R 1E, W.M.
ISLAND COUNTY, WA

REV	DRAWING
0	A-2

LAWHEAD
ARCHITECTS
P.S.



1 NW CORNER PERSPECTIVE

NOTE: EXTERIOR COLORS
SIDING & SOFFITS, AND TRIM COLORS TO BE **EARTH TONE** PER EBEY'S LANDING NATIONAL HISTORICAL RESERVE DESIGN GUIDELINES (P.52, ITEM 3)

Island County
Community Development
APPROVED PLOT PLAN
To be kept on site with plans
Jason Johnson 12/5/13
Signature Date

2 SE CORNER PERSPECTIVE

RECEIVED
APR 19 2012
ISLAND COUNTY
COMMUNITY DEVELOPMENT

PERMIT REVIEW SET - NOT FOR CONSTRUCTION

811 Know what's below. Call before you dig.

No.	DESCRIPTION	DATE	BY	ENGR CHKR APVD
	REVISIONS			

SNOHOMISH COUNTY PUD
PUBLIC UTILITY DISTRICT No. 1

WO	
TASK	PERMIT
SCALE	AS NOTED
DFTR	LAWHEAD
CHKR	
ENGR	
APVD	
DATE	04-12-12

ADMIRALTY INLET PILOT TIDAL PROJECT
ARCHITECTURAL PERSPECTIVES

SEC 22, T 31N, R 1E, W.M.
ISLAND COUNTY, WA

REV	DRAWING
0	A-3

CROCKETT LAKE

ORDINARY HIGH WATER MARK CROCKETT LAKE

Island County
Community Development
APPROVED PLOT PLAN
To be kept on site with plans
Jason Johnson 12/5/13
Signature Date

200' BUFFER

STATE ROUTE 20 (LAKE AVENUE)

SAW CUT PAVEMENT

1 P-4

2 P-4

3 P-4

TRENCH TO GRID

POWER CONDUIT CONNECTION TO PSE GRID

30 FT FRONT YARD BLDG SETBACK

BUILDING EASEMENT

CONC. WALKWAY

CONC. APRON

24X30 FT CONTROL BUILDING

GRAVEL

12 FT WIDE GRAVEL ACCESS

PROPERTY LINE

SEE SHEET A-2 FOR DETAILED BUILDING LAYOUT

CONTROL BUILDING

ELECTRICAL CONDUIT TO CONTROL BLDG

WOOD FENCE

5X10 FT CONCRETE VAULT

BURIED ELECTRICAL CABLING

TBM 3

APPROXIMATE 200 FT SHORELINE SETBACK. ACTIVITIES SOUTH OF THIS LINE FALL IN SHORELINE JURISDICTION.

DRAINFIELD

EX. 20 FT POWER EASEMENT AFN 4298907

PROJECT LIMITS

PROJECT LIMITS

TRENCH

BORE PIT

10 FT X 20 FT HDD BORE PIT SHEET P-5.

SEAWARD FACE OF HDD BORE PIT LOCATED 75 FEET FROM TOE OF BANK AT SHORELINE

75' BUFFER

HDD CONDUIT AND CABLE SEE SHEET P-5.

ORDINARY HIGH WATER MARK ADMIRALTY BAY

TOP OF BANK

TOE OF BANK

APPROX MLW = 1.4'

APPROX MLLW = -1.1'

APPROX EXTREME LOW TIDE = -5.3'

ADMIRALTY BAY

Scale 1" = 60'

0 60 120

LEGEND

ORDINARY HIGH WATER MARK

BUFFER

RECEIVED
APR 19 2012
ISLAND COUNTY
COMMUNITY DEVELOPMENT

TIDAL GENERATION RESEARCH PROJECT

BSA MAP

REV / DRAWING	0 / BSA-2
DATE	4/11/2012
APVD	
ENGR	
CHKR	
DFTR	JL
SCALE	1"=60'
TASK	
WO	

SNOHOMISH COUNTY PUBLIC UTILITY DISTRICT NO. 1

Wetland Resources
9505 19TH AVE SE, SUITE 106
EVERETT, WA 98208
TEL: 425.337.3174
FAX: 425.337.3045

REVISIONS

No	DATE	BY	DESCRIPTION	ENGR	CHKR	APVD

ISLAND CO[illegible] PUBLIC WORKS
ROADS DIVISION
P.O. BOX 5000, COUPEVILLE, WA 98239
(360) 679-7331

William E. Oakes, P.E., Director/County Engineer
Connie W. Bowers, P.E., Assistant County Engineer

May 23, 2012

TO: Jennifer Hagenow

FROM: John Bertrand, Development Coordinator

SUBJECT: S-CUP 089/12–Jesse Valentine/Snohomish PUD
Shoreline Conditional Use Permit application
Parcels S6370-00-61001-0 and S6370-00-62001-0 and Admiralty Inlet
Coupeville, WA 98239

Public Works has visited the site and reviewed the information submitted for the above referenced application, for consistency with our development standards, and has the following comments:

- A feasibility study known as the"Admiralty Inlet Pilot Tidal Project"is being proposed for both the relatively flat, onshore upland area of the two above referenced lots as well as a nearby off-shore area of Admiralty Inlet. To that end, the applicants Jesse Valentine and the Snohomish PUD are proposing to install a temporary, submarine tidal generator system offshore within Admiralty Inlet next to those two above referenced parcels, and to locate a Control Building and grid connection point for this system within a structure housed upon one of those two parcels.
- As mentioned above, most of this system will be submarine, and it will consist of pilot turbines located to the west-southwest of Fort Casey Park, connected to the south of Fort Casey and the Keystone Ferry Dock with an array of submerged cables that will lead onshore to the east of the Keystone Ferry Dock to the Control Building referenced above and connect to a power grid there.
- Not only is the onshore portion of the site relatively flat, it is clearly located away from any area that has been identified as being either unstable per the Washington State Department of Ecology Coastal Zone Atlas or a geologically hazardous area per Island County Code.
- The Control Building, the only actual above-ground component of this temporary electrical-generating system will be less than 1,000 square feet in size and surrounded by some paving that will be less than 3,000 square feet in size as well. Furthermore, as this lot is located outside of any Critical Drainage Area and is very close to the shoreline along a beach, it is basically underlain by very sandy beach soils, and this structure and its surrounding paved areas may therefore be routed into and/or sheet flow onto that underlying sandy soil per the Drainage Narrative submitted with this application.
- Note that there are very few residences along this particular section of beach, and that portions of this beach area are also therefore currently covered with dune grasses, etc.

With the above stated, we have No Objection to approval of the above referenced development proposal, S-CUP 089/12, provided that the following conditions are met:

May 23, 2012

- The approved work shall only involve the minimal excavation necessary for installation of this new electricity-generating system throughout its run, and it must follow the engineered "Admiralty Inlet Pilot Tidal Project" plans generated for it by Harmsen ansd Associates. Inc. They will also need to be the Engineer of Record for the project and certify that this system gets installed in substantial conformance to these approved plans.
- Whatever dune grass cover is located along this beach area that gets disturbed during this system's installation must be restored to pre-development conditions.
- Any erosion and sedimentation control (ESC) Best Management Practices (BMPs) not proposed but still nonetheless needed must be employed, as applicable, to capture stormwater runoff, minimize soil erosion, and prevent sediment runoff. It is the applicant's responsibility to make sure that he is in compliance with all ESC BMP requirements. Any BMPs needed shall be properly installed and maintained, as applicable, until all work is completed at the site, in addition to any other requirements contained within this permit.

Please feel free to call me at extension 7812 or e-mail me at johnb@co.island.wa.us if you have any questions regarding the above comments.

ISLAND COUNTY PUBLIC HEALTH
ALWAYS WORKING FOR SAFER AND HEALTHIER COMMUNITIES

ISLAND COUNTY PUBLIC HEALTH

P.O. Box 5000
Coupeville, WA 98239
www.islandcountyhealth.org

TO: Jennifer Hagenow, Planning & Community Department

FROM: Aneta Hupfauer, Land Use Coordinator AH

DATE: May 11, 2012

RE: SCUP Valentine - SCUP 089/12
Parcel Nos. S6370-00-61001-0 & S6370-00-62001-0

After reviewing the referenced proposal, this office offers the following:

1. The applicant is proposing to install tidal generators in Admiralty Inlet with control building located on the referenced parcels.

2. The proposal will not be plumbed for potable water or sewage disposal system.

This office has no objection to the approval of the referenced proposal.

Please note that the current fee for Public Health review is $79 per hour. The current amount is $19.75 (see attached invoice) but it may change if additional review is required. The review fee must be paid prior to permit issuance.

The above comments are subject to change as additional information is received about the proposal. If you have any questions regarding the above comments, please feel free to contact me at 360-678-7995 or AnetaH@co.island.wa.us.

/ah

Cc: file

ISLAND COUNTY HEALTH DEPARTMENT

P.O. BOX 5000 COUPEVILLE, WA 98239
(360) 679-7350, 321-5111, 629-4522
OAK HARBOR OFFICE 240-5554 (Ext.) 7672

ITEMIZED BILLING STATEMENT

Date: Friday, May 11, 2012

Application No. SCUP 089/12

Applicant: Valentine, Jessie

Date	Time (Hrs)	Fee	Comment
5/11/2012	0.25	$19.75	Plan review
Total:	0.25	$19.75	

If you have any questions regarding the above invoice, please contact Aneta Hupfauer, Land Use Coordinator, at 360-678-7995 or AnetaH@co.island.wa.us

ISLAND COUNTY
PLANNING & COMMUNITY DEVELOPMENT

PHONE: (360) 679-7339 ■ from Camano (360) 629-4522 ■ from S. Whidbey (360) 321-5111
FAX: (360) 679-7306 ■ P. O. Box 5000, Coupeville, WA 98239-5000
Internet Home Page: http://www.islandcounty.net/planning/

May 8, 2012

TO: Jennifer Hagenow

FROM: Tamra Patterson, Plans Examiner/Building Insp.

SUBJECT: S-CUP 089/12, Jessie Valentine
Install temporary tidal generators (2) in Admiralty Inlet
Parcel #S6370-00-61001-0 and S6370-00-62001-0

The building department has reviewed the package information submitted and has no objections with the following comment:

1. A building permit will be required for the garage prior to construction.
2. Per FEMA DFirm map #0220E, this addition will be in Flood Zone AE and will require a Flood Development Permit (FDP) for the proposed garage. This can be submitted at the time of the building permit submittal. The base flood elevation is 15 feet NAVD88.
3. A Habitat Impact Assessment per the FEMA Region 10 Floodplain Managements and the Endangered Species Act, section 7.7, specific to the garage construction should be submitted with the flood development permit.

Please feel free to contact me at (360) 678-7806, or email tamrap@co.island.wa.us, if you have any questions regarding these comments.

ISLAND COUNTY
PLANNING & COMMUNITY DEVELOPMENT
PHONE: (360) 679-7339 ■ from Camano (360) 629-4522, Ext. 7339 ■ from S. Whidbey (360) 321-5111, Ext. 7339 FAX: (360) 679-7306 ■ 1 NE 6th Street, P. O. Box 5000, Coupeville, WA 98239-5000

Internet Home Page: http://www.islandcounty.net/planning/

Inadvertent Archaeological and Historic Resources Discovery Plan for Island County

In the event that any ground-disturbing activities or other project activities related to this development or in any future development uncover protected cultural material (e.g., bones, shell, antler, horn or stone tools), the following actions will be taken:

1. When an unanticipated discovery of protected cultural material (see definitions below) occurs, the property owner or contractor will completely secure the location and contact:
    a. The property owner and project manager;
    b. A professional archaeologist;
    c. The Department of Archaeology and Historic Preservation (DAHP) (Gretchen Kaehler, 360-586-3088, 360-628-2755 cell);
    d. The Swinomish Indian Tribal Community (Larry Campbell, 360-840-4127);
    e. The Tulalip Tribes (Richard Young, 360-716-4635); Scott Schuyler, Upper Skagit Tribe (360-854-7090, cell 360 630 3680),
    f. Jackie Ferry, Samish Tribe (360-293-6404 x215), and Tara Duff, Stillaguamish Tribe (360-652-7362), Kerry Lyste, Stillaguamish Tribe (360-652-7362 ext. 226)
    g. Island County Community Development Department (360-679-7339).
2. If the discovery is human remains, the property owner or contractor will stop work in and adjacent to the discovery, completely secure the work area by moving the land-altering equipment to a reasonable distance, and will immediately contact:
    a. The property owner;
    b. The Island County Sheriff's Department (360-629-4523 x7310) and;
    c. The Island County Coroner, Robert Bishop (360679-7358) to determine if the remains are forensic in nature;
    d. If the remains are not forensic in nature the Department of Archaeology and Historic Preservation (DAHP) (Gretchen Kaehler 360-586-3088 and Guy Tasa 360-586-3534); will take the lead on determining the appropriate method of treatment for the remains and will consult with the affected tribes;
    e. A professional archaeologist; and
    f. Island County Planning and Community Development (360-679-7339).
3. Cultural material that may be protected by law could include but is not limited to:
    a. Buried layers of black soil with layers of shell, charcoal, and fish and mammal bones (Figure 1).
    b. Non-natural sediment or stone deposits that may be related to activity areas of people;

c. Stone, bone, shell, horn, or antler tools that may include projectile points (arrowheads),scrapers, cutting tools, wood working wedges or axes, and grinding stones (Figures 2 and 3);
d. Stone tools or stone flakes (Figures 2 and 3);
e. Buried cobbles that may indicate a hearth feature (Figure 4);
f. Old ceramic pieces, metal pieces, tools and bottles (Figures 5 and 6); and
g. Perennially damp areas may have preservation conditions that allow for remnants of wood and other plant fibers; in these locations there may be remains including:
    - Fragments of basketry, weaving, wood tools, or carved pieces; and
    - Human remains.

4. **COMPLIANCE WITH ALL APPLICABLE LAWS PERTAINING TO ARCHAEOLOGICAL RESOURCES (RCW 27.53, 27.44 and WAC 25-48) AND WITH HUMAN REMAINS (RCW 68.50) IS REQUIRED. FAILURE TO COMPLY WITH THESE REQUIREMENTS COULD RESULT IN A MISDEMEANOR AND POSSIBLE CIVIL PENALTIES AND/OR CONSTITUTE A CLASS C FELONY.**

Figure 1: Shell midden

Figure 2: Example of stone tool

Figure 3: Example of stone flake.

Figure 4: Example of hearth (oven) feature.

Figure 5: Example of historic artifacts from debris scatter.

Figure 6: Example of bottle from historic debris dump.

Appendix N

WSDOE PERMITS AND CONDITIONS

Water Quality Certification Order #9337 (401 Certification)
FERC Project #12690
Snohomish County PUD No. 1
December 3, 2013

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
Northwest Regional Office • 3190 160th Ave SE • Bellevue, WA 98008-5452 • 425-649-7000
711 for Washington Relay Service • Persons with a speech disability can call 877-833-6341

December 3, 2013

Kim Moore
Snohomish County PUD No. 1
PO Box 1107
Everett, WA 98206

RE: Water Quality Certification Order #9337
Federal Energy Regulatory Commission Project No. 12690
Admiralty Inlet Pilot Tidal Project, Admiralty Inlet, Island County, Washington

Dear Mr. Moore:

On February 9, 2012, Snohomish County PUD No. 1 submitted a Joint Aquatic Resource Permit Application (JARPA) to the Department of Ecology (Ecology) for a Section 401 Water Quality Certification (401 Certification) under the federal Clean Water Act for the proposed Admiralty Inlet Pilot Tidal project. A request to withdraw and re-apply for a 401 Certification was submitted on February 6, 2013.

On behalf of the State of Washington, Ecology certifies that the work described in the JARPA and the public notice complies with applicable provisions of Sections 301, 302, 303, 306 and 307 of the Clean Water Act, as amended, and applicable state laws. This certification is subject to the conditions contained in the enclosed Order.

If you have any questions, please contact Rebekah Padgett at (425) 649-7129. The enclosed Order may be appealed by following the procedures described in the Order.

Sincerely,

Erik Stockdale

Erik Stockdale, Section Manager
Shorelands and Environmental Assistance Program
Northwest Regional Office

ES:rrp:cja

Enclosure

By certified mail: 7011 0470 0003 3720 7752

cc: David Turner, Federal Energy Regulatory Commission
Randel Perry, U.S. Army Corps of Engineers
Jessica Spahr, Snohomish County PUD No. 1
Eric Schneider, Snohomish County PUD No. 1
Brady Scott, Washington Department of Natural Resources
Doug Thompson, Washington Department of Fish and Wildlife
Susan Cierebiej, Washington Department of Fish and Wildlife
Brock Applegate, Washington Department of Fish and Wildlife
Steven Jeffries, Washington Department of Fish and Wildlife
Timothy Romanski, U.S. Fish and Wildlife
Keith Kirkendall, National Marine Fisheries Service
Kim Hatfield, National Marine Fisheries Service
Brent Norberg, NOAA Fisheries
Alison Agness, NOAA Fisheries
Daryl Williams, The Tulalip Tribes
Tom Ostrom, Suquamish Tribe
Stan Walsh, Skagit River System Cooperative
LCDR Heather St. Pierre, U.S. Coast Guard
Susan Rosebrough, National Park Service

e-cc: David Pater – NWRO
Skip Albertson – HQ
Christopher Krembs – HQ
Norm Davis – NWRO
Sheila Hosner, Governor's Office of Regulatory Assistance
Jason Johnson, Island County Planning & Development
ja.johnson@co.island.wa.us
Dave Wechner, Island County Planning & Development
d.wechner@co.island.wa.us
Craig Trueblood, K&L Gates LLP craig.trueblood@klgates.com
Loree' Randall – HQ
Raman Iyer – NWRO
ecyrefedpermits@ecy.wa.gov

IN THE MATTER OF GRANTING A WATER QUALITY CERTIFICATION TO SNOHOMISH COUNTY PUD NO. 1 in accordance with 33 U.S.C. 1341 (FWPCA § 401), RCW 90.48.120, RCW 90.48.260 and Chapter 173-201A WAC	)))))))	**ORDER #9337** **FERC Project No. 12690** Admiralty Inlet Pilot Tidal Project; Admiralty Inlet, Island County, Washington.

TO: Kim Moore
Snohomish County PUD No. 1
PO Box 1107
Everett, WA 98206

On February 9, 2012, Snohomish County PUD No. 1 submitted a Joint Aquatic Resources Permit Application (JARPA) to the Department of Ecology (Ecology) for a Section 401 Water Quality Certification. A request to withdraw and re-apply for a 401 Certification was submitted on February 6, 2013. Public notices regarding the requests were distributed by Ecology for the above-referenced project pursuant to the provisions of Chapter 173-225 WAC on April 3, 2012 and March 8, 2013.

The pilot tidal energy proposal includes:

- Temporary placement of two 6-meter-diameter OpenHydro turbines on the seafloor at a water depth of approximately 58 meters.
- Installation of two 1.05-mile subsea transmission cables and a power control building.

The turbines would be located approximately ½ mile offshore of Whidbey Island, Island County, Washington, Admiralty Inlet, Section 22, T. 31 N., R. 1E., WRIA 6. The transmission cables landfall at 13254 State Route 20, Coupeville, Island County, Washington, Section 22, T. 31 N., R. 1E., WRIA 6.

AUTHORITIES:

In exercising authority under 33 U.S.C. § 1341, RCW 90.48.120, and RCW 90.48.260, Ecology has examined this application pursuant to the following:

1. Conformance with applicable water quality-based, technology-based, and toxic or pretreatment effluent limitations as provided under 33 U.S.C. §§ 1311, 1312, 1313, 1316, and 1317 (FWPCA §§ 301, 302, 303, 306 and 307);

2. Conformance with the state water quality standards contained in Chapter 173-201A WAC and authorized by 33 U.S.C. § 1313 and by Chapter 90.48 RCW, and with other applicable state laws; and

3. Conformance with the provision of using all known, available and reasonable methods to prevent and control pollution of state waters as required by RCW 90.48.010.

WATER QUALITY CERTIFICATION CONDITIONS:

Through issuance of this Order, Ecology certifies that it has reasonable assurance that the activity as proposed and conditioned will be conducted in a manner that will meet the applicable water quality standards and other appropriate requirements of state law. In view of the foregoing and in accordance with 33 U.S.C. § 1341, RCW 90.48.120, RCW 90.48.260 Chapter 173-200 WAC and Chapter 173-201A WAC, water quality certification is granted to the Applicant subject to the conditions within this Order.

Certification of this proposal does not authorize the Applicant to exceed applicable state water quality standards (Chapter 173-201A WAC), ground water standards (Chapter 173-200 WAC) or sediment quality standards (Chapter 173-204 WAC). Furthermore, nothing in this certification shall absolve the Applicant from liability for contamination and any subsequent cleanup of surface waters, ground waters or sediments occurring as a result of project construction or operations.

A. General Conditions:

A1. For purposes of this Order, the term "Applicant" shall mean Snohomish County PUD No. 1 and its agents, assignees and contractors.

A2. For purposes of this Order, all submittals required by its conditions shall be sent to Ecology's Northwest Regional Office, Attn: 401/CZM Federal Project Manager, 3190 160th Avenue SE, Bellevue, WA 98008-5452. Any submittals shall reference Order #9337 and FERC Project #12690.

A3. Work authorized by this Order is limited to the work described in the JARPA received by Ecology on February 9, 2012. The Applicant will be out of compliance with this Order and must reapply with an updated application if the information contained in the JARPA is voided by subsequent changes to the project not authorized by this Order.

A4. Within 30 days of receipt of an updated JARPA, Ecology will determine if the revised project requires a new water quality certification and public notice or if a modification to this Order is required.

A5. Copies of this Order shall be kept on the job site and readily available for reference by Ecology personnel, the construction superintendent, construction managers and lead workers, and state and local government inspectors.

A6. The Applicant shall provide access to the project site and all mitigation sites upon request by Ecology personnel for site inspections, monitoring, necessary data collection, and/or to ensure that conditions of this Order are being met.

A7. Nothing in this Order waives Ecology's authority to issue additional orders if Ecology determines that further actions are necessary to implement the water quality laws of the state. Further, Ecology retains continuing jurisdiction to make modifications hereto through supplemental order, if additional impacts due to project construction or operation are identified (*e.g.*, violations of water quality standards, downstream erosion, etc.), or if additional conditions are necessary to further protect water quality.

A8. The Applicant shall ensure that all appropriate project engineers and contractors at the project site have read and understand relevant conditions of this Order and all permits, approvals, and documents referenced in this Order. The Applicant shall provide Ecology a signed statement (see Attachment A for an example) from each project engineer and contractor that they have read and understand the conditions of this Order and the above-referenced permits, plans, documents and approvals. These statements shall be provided to Ecology before construction begins at the project or mitigation sites.

A9. This Order shall be rescinded if the Federal Energy Regulatory Commission does not issue authorization for the project.

A10. This Order does not authorize direct, indirect, permanent, or temporary impacts to waters of the state or related aquatic resources, except as specifically provided for in conditions of this Order.

A11. Failure of any person or entity to comply with this Order may result in the issuance of civil penalties or other actions, whether administrative or judicial, to enforce its terms.

B. Water Quality Condition:

B1. Admiralty Inlet is classified as "Extraordinary Quality" and the criteria of that class apply except as specifically modified by this Order. This Order does not authorize temporary exceedances of water quality standards beyond the limits established in WAC 173-201A-210(1)(e)(i).

B2. The Applicant shall conduct water quality sampling and monitoring as described in *Water Quality Monitoring Plan*, for the Admiralty Inlet Pilot Tidal Project, dated February 29, 2012, revised December 5, 2012, or as modified by this Order or revised and approved by Ecology.

B3. Water quality monitoring for turbidity shall be conducted during horizontal directional drilling (HDD) activity. Divers may conduct underwater visual monitoring or physical monitoring from a boat shall be conducted.

B4. Water quality monitoring for turbidity shall be conducted during cable removal, unless otherwise approved in writing by Ecology.

B5. Sampling for pH shall be conducted immediately if a frac-out or other release of grout material occurs during HDD activity.

B6. Oil sheen shall be visually monitored during all installation, maintenance, and removal activities.

B7. Reporting: If no exceedances are detected, results of water quality sampling, as determined by the Plan, shall be forwarded to Ecology on a monthly basis in accordance to Condition A2.

B8. Notification of exceedances: Notification of exceedances that are detected through water quality sampling shall be made to Ecology within 24 hours of occurrence. Notification shall be made with reference to Order #9337, Attn: 401/CZM Federal Project Manager, by telephone at (425) 649-7129 or (425) 649-7000, or by fax to (425) 649-7098. The Applicant shall, at a minimum, provide Ecology with the following information:

a. A description of the nature and cause of exceedance.

b. The period of non-compliance, including exact dates, duration, and times and/or the anticipated time when the Applicant will return to compliance.

c. The steps taken, or to be taken, to reduce, eliminate, and prevent recurrence of the non-compliance.

d. In addition, within five (5) days after notification of an exceedance, the Applicant shall submit a written report to Ecology that describes the nature of the exceedance, turbidity results and location, photographs, and any other pertinent information.

C. Conditions for Construction Activities:

General Conditions:

C1. Construction stormwater, sediment, and erosion control best management practices (BMPs; *e.g.*, filter fences, etc.) suitable to prevent exceedances of state water quality standards shall be in place before starting construction at the site.

C2. Sediment and erosion control measures shall be inspected and maintained prior to and during project implementation.

C3. All construction debris shall be properly disposed of on land so that it cannot enter a waterway or cause water quality degradation to state waters.

C4. Machinery and equipment used during construction shall be serviced, fueled, and maintained upland, unless otherwise approved by Ecology, in order to prevent contamination to any surface water.

C5. Wash water containing oils, grease, or other hazardous materials resulting from wash down of equipment or working areas shall be contained for proper disposal, and shall not be discharged into state waters or storm drains.

In-Water Conditions:

C6. Work in or near the water that may affect fish migration, spawning, or rearing shall cease immediately upon a determination by Ecology that fisheries resources may be adversely affected.

C7. Project activities shall be conducted to minimize siltation of the beach area and bed.

C8. The Applicant shall operate the barge(s) and tug in deep water so as to minimize nearshore propeller wash impacts such as suspension of nearshore sediments.

C9. Barges shall not be allowed to ground-out during construction.

C10. Transmission cables shall be laid on the seafloor from the horizontal directional drilling (HDD) exit point to the turbines. Cables shall not be buried in this segment, and trenching of the cable route may not be used for this project.

C11. Aquatic vegetation (eelgrass and kelp) shall be observed for presence prior to construction. If eelgrass and/or kelp are present, the boundaries shall be marked with floats, buoys, or other means as appropriate in order to restrict access and anchoring during construction.

C12. In-water work barges shall not be allowed to anchor in areas where aquatic vegetation is present.

D. Horizontal Directional Drilling Conditions

D1. The Applicant shall conduct HDD activity as described in *Preliminary Horizontal Directional Drilling Plan, Snohomish County Public Utility District No. 1 Tidal Project*, prepared by Sound & Sea Technology, Inc., dated August 29, 2011, or as modified by this Order or revised and approved by Ecology.

D2. Monitoring of pressure and volume shall be conducted in order to minimize the occurrence of a "fracout."

D3. If a fracout occurs, the Applicant shall stop or slow down HDD operations in order to allow the mud to seal the fracout.

D4. All HDD solids and drill tailings shall be placed into plastic-lined dumpsters or hoppers on the uplands and trucked off site to an approved upland disposal facility.

D5. HDD wastewater shall not be allowed to flow back into marine waters.

D6. Prior to reaching the exit point on the ocean floor, the drill string shall be flushed with freshwater and the drilling fluid changed from bentonite to freshwater.

D7. The Applicant shall submit an HDD Work Plan to Ecology per Condition A2 at least 30 days prior to start of horizontal directional drilling activity. The HDD Work Plan shall include drawings and a written description identifying construction detail methods and sequencing.

D8. The Applicant shall submit a Frac-Out and Surface Spill Contingency Plan (hereafter referred to as the 'Contingency Plan') to Ecology per Condition A2 at least 30 days prior to start of horizontal directional drilling activity. The Contingency Plan shall include:

a. Description of procedures for preventing drilling fluid losses or spills into the marine environment and fluid returns to the surface
b. Description of containment and cleanup procedures.

E. Operational Conditions:

E1. No oils, grease, or lubricants shall be utilized for the turbine, and no fluid or oil-filled equipment shall be located underwater.

E2. The use of antifouling paint on the turbines shall be minimized to the extent practicable, and antifouling paint shall be non-flaking.

E3. Coatings and paints shall be approved for use in the marine environment.

E4. All maintenance of the turbines or other in-water components shall be conducted out of the water and appropriate BMPs shall be implemented in order to protect water quality.

E5. If derelict gear is removed during the operation of the turbines, then removal of this gear shall be conducted in such a way as to minimize turbidity.

E6. Benthic habitat at the turbine site and along the cable route shall be monitored according to the *Benthic Habitat Monitoring and Mitigation Plan, Admiralty Inlet Tidal Energy Demonstration Project, Federal Energy Regulatory Commission Project No. 12690*, dated June 14, 2012 or as modified by this Order or revised and approved by Ecology.

a. Written reports shall be provided annually to Ecology per Condition A2 by March 31 for the prior calendar year of operation. The reports shall describe:
   i. Changes to colonization of the subsea base, power cables, and drill hole exit point.
   ii. Changes to seabed benthic habitat around the subsea base, including sediment scour and deposition.

b. If surveys indicate significant erosion at the contact points between the subsea base and seabed, Ecology shall be consulted to determine if project modifications are necessary.

E7. At the conclusion of the pilot, or prior to the expiration of the FERC Pilot License, the two turbines and two transmission cables shall be removed from Admiralty Inlet, unless otherwise approved by Ecology.

F. Plan Submittal Conditions:

F1. The Applicant shall develop and implement a Project Removal Plan for removal of the turbines and transmission cables. The Project Removal Plan shall be submitted to Ecology per Condition A2 for review and approval at least 60 days prior to removal and include the following:

a. Project removal timing and sequencing
b. Cable Removal: Method of cable removal, best management practices that will be implemented to protect water quality, and water quality monitoring for cable removal.
c. A plan for restoring the project area to pre-project conditions. This plan shall address the horizontal directional exit hole, as well as any erosion/sedimentation impacts caused by the cables.

F2. If the Applicant proposes leave the cables in place at the completion of the project, details of such proposal shall be included in the Project Removal Plan per F1.

G. Emergency/Contingency Measures:

G1. The Applicant shall develop and implement a Spill Prevention and Containment Plan for all aspects of this project.

G2. The Applicant shall have adequate and appropriate spill response materials on hand to respond to emergency release of petroleum products or any other material into waters of the state.

G3. Fuel hoses, oil drums, oil or fuel transfer valves and fittings, etc., shall be checked regularly for drips or leaks, and shall be maintained and stored properly to prevent spills into state waters.

G4. Any work that is out of compliance with the provisions of this Order, or conditions causing distressed or dying fish, or any discharge of oil, fuel, or chemicals into state waters, or onto land with a potential for entry into state waters, is prohibited. If these occur, the Applicant shall immediately take the following actions:

a. Cease operations at the location of the violation or spill.

b. Assess the cause of the water quality problem and take appropriate measures to correct the problem and/or prevent further environmental damage.

c. Notify Ecology of the failure to comply. All oil spills shall be reported immediately to Ecology's 24-Hour Spill Response Team at 1-800-258-5990, **and** within 24 hours of spills or other events to Ecology's 401/CZM Federal Project Manager at (425) 649-7129 or (425) 649-7000.

d. Submit a detailed written report to Ecology within five (5) days that describes the nature of the event, corrective action taken and/or planned, steps to be taken to prevent a recurrence, results of any samples taken, and any other pertinent information.

Compliance with this condition does not relieve the Applicant from responsibility to maintain continuous compliance with the terms and conditions of this Order or the resulting liability from failure to comply.

H. Timing Requirements

H1. All in-water work shall be completed by the work window identified in the most current Hydraulic Project Approval (HPA) issued for this project. Any project change that requires a new or revised HPA should also be sent to Ecology for review.

H2. This Order is valid for a period of 10 years from the date of the FERC Pilot License.

I. Reporting and Notification Requirement Conditions

I1. The Applicant shall provide to Ecology's 401/CZM Federal Permit Manager a copy of the FERC license within 2 weeks of receipt of the license. A copy shall be submitted per condition A2 above.

I2. Applicant shall provide notice to Ecology per Condition A2 for the following activities:

- At least 10 days prior to the pre-construction meeting.
- At least three (3) days prior to the start of construction
- Within 14 days after completion of construction at the project site.
- At least 10 days prior to any maintenance activity.
- At least 10 days prior to removal of the turbines and cables.

I3. If the project construction is not completed within 13 months of issuance of this Order, the Applicant shall submit per Condition A2 a written construction status report and submit status reports every 12 months until construction is complete.

YOUR RIGHT TO APPEAL

You have a right to appeal this Order to the Pollution Control Hearing Board (PCHB) within 30 days of the date of receipt of this Order. The appeal process is governed by Chapter 43.21B RCW and Chapter 371-08 WAC. "Date of receipt" is defined in RCW 43.21B.001(2).

To appeal you must do both of the following within 30 days of the date of receipt of this Order:

File your appeal and a copy of this Order with the PCHB (see addresses below). Filing means actual receipt by the PCHB during regular business hours.

Serve a copy of your appeal and this Order on Ecology in paper form - by mail or in person. (See addresses below.) E-mail is not accepted.

You must also comply with other applicable requirements in Chapter 43.21B RCW and Chapter 371-08 WAC.

ADDRESS AND LOCATION INFORMATION

Street Addresses	Mailing Addresses
Department of Ecology Attn: Appeals Processing Desk 300 Desmond Drive SE Lacey, WA 98503 **Pollution Control Hearings Board** 1111 Israel Road SW STE 301 Tumwater, WA 98501	**Department of Ecology** Attn: Appeals Processing Desk PO Box 47608 Olympia, WA 98504-7608 **Pollution Control Hearings Board** PO Box 40903 Olympia, WA 98504-0903

CONTACT INFORMATION

Please direct all questions about this Order to:

Rebekah Padgett
Department of Ecology
Northwest Regional Office
3190 160th Avenue SE
Bellevue, WA 98008
(425) 649-7129
rebekah.padgett@ecy.wa.gov

MORE INFORMATION

Pollution Control Hearings Board Website
www.eho.wa.gov/Boards_PCHB.aspx

Chapter 43.21B RCW - Environmental and Land Use Hearings Office – Pollution Control Hearings Board
http://apps.leg.wa.gov/RCW/default.aspx?cite=43.21B

Chapter 371-08 WAC – Practice And Procedure
http://apps.leg.wa.gov/WAC/default.aspx?cite=371-08

Chapter 90.48 RCW – Water Pollution Control
http://apps.leg.wa.gov/RCW/default.aspx?cite=90.48

Chapter 173-204 WAC – Sediment Management Standards
www.ecy.wa.gov/biblio/wac173204.html

Chapter 173-200 WAC – Water Quality Standards for Ground Waters of the State of Washington
www.ecy.wa.gov/biblio/wac173200.html

Chapter 173-201A WAC – Water Quality Standards for Surface Waters of the State of Washington
www.ecy.wa.gov/biblio/wac173201A.html

SIGNATURE

Erik Stockdale

Erik Stockdale, Section Manager
Shorelands and Environmental Assistance Program
Northwest Regional Office

DECEMBER 3, 2013

December 3, 2013

ATTACHMENT A

SNOHOMISH COUNTY PUD NO. 1
PUBLIC UTILITY DISTRICT NO. 1 OF SNOHOMISH COUNTY
– ADMIRALTY INLET PILOT TIDAL PROJECT
Water Quality Certification Order #9337

Statement of Understanding of
Water Quality Certification Conditions

I have read and understand the conditions of Order #9337 Section 401 Water Quality Certification for the Public Utility District No. 1 of Snohomish County – Admiralty Inlet Pilot Tidal Project. I have also read and understand all permits, plans, documents, and approvals associated with the project referenced in this Order.

_____ _____
Signature Date

_____
Title

_____
Company

Appendix O

WSDNR LEASE CONDITIONS

The final aquatic easement and lease offerings from the Washington State Department of Natural Resources have yet to be issued as of 1/2/2014. Should a condition in this offering arise that materially affects the methods for which the CONTRACTOR has evaluated their bid, the DISTRICT recognizes this as a potential change condition.

Appendix P

WSDOT PERMIT CONDITIONS

Access Connection Permit
Permit No: 48911/AC12060011

Access Connection Permit

Name and Address of Applicant:	Permit Number / Width / Surface
Jessie Valentine **4221 Shokowakan Road** **Clinton, WA 98272** Phone (Optional) **360 221-7271**	**48911 / AC12060011** Width **30 ft** **Asphalt**
	SR **20** / MP **13.280** / LT/RT **Right**
	LONGITUDE / LATITUDE / Region **Northwest**
	County **Island** / Tax Parcel Number **S6370-00-61001-0 & 61005**
	Government Lot Number **n/a**
	___ 1/4 of ___ 1/4 of S **22** ,T **31N** ,R **1**

Permit Category

- ☒ 1 - Minimum Connection
- ☐ 2 - Minor Connection
- ☐ 3 - Major Connection
- ☐ 4 - Temporary Connection

Current Highway Classification

- ☐ 1 - 1320' Minimum Approach Spacing Required
- ☒ 2 - 660' Minimum Approach Spacing Required
- ☐ 3 - 330' Minimum Approach Spacing Required
- ☐ 4 - 250' Minimum Approach Spacing Required
- ☐ 5 - 125' Minimum Approach Spacing Required

Access Connection meets current Department location, spacing, and design criteria: ☐ Conforming ☒ Non-Conforming ☐ Variance

The Applicant, hereinafter referred to as the "Grantee", having applied for a permit to construct/upgrade, use, and maintain an access connection to serve:

Build,use and maintain a Category 1 - (Nonconforming),Minimum Connection, Road Approach Design Template B1-C1 to Island County Parcels, S6370-00-61005-0,S6370-00-61001-0 and S6370-62001-0 to access a Snohomish County PUD control building and a Single Family Residence. The general site address for the project is 13254 State Route 20, Coupeville, WA. 98239

The Washington State Department of Transportation or its designee, herein after referred to as the "Department", hereby orders that this permit be granted, subject to the terms and provisions stated upon the General Provisions hereof and Exhibits attached hereto and by this reference made a part hereof:

Exhibit A - Special Provisions, pages 1 thru 5
Exhibit B - Site Plan, (by Grantee), sheet 1 of 1
Exhibit C - Right of Way Sheet titled,"Keystone Ferry Terminal To JCT. SR 525", sheet 1 of 1
Exhibit D - Road Approach Design Template B1-C1, sheet 1 of 1
Exhibit E - Lane Closure with Flagger, sheet 1 of 1
Exhibit F - Shoulder Closure, sheet 1 of 1

This permit shall be void unless the construction herein contemplated is started within 90 days of issuance and completed within 120 days of issuance, unless otherwise provided herein.

This permit is accepted and approved by the Grantee, subject to the terms and provisions as herein set forth.

PERMIT HOLDER	**DEPARTMENT OF TRANSPORTATION**
By: _____	By: _____
Title: _____	Title: **Eng, Services Mgr.**
Date: _____	Date: _____

General Provisions

1. The Permit Holder, its successors and assigns, agrees to protect the State of Washington, its officers and employees and save them harmless from all claims, actions or damages of every kind and description which may accrue to or be suffered by any person, persons, or property by reason of the acts or omissions of the Permit Holder, its assigns, agents, contractors, licensees, employees or any person whomsoever, in connection with Permit Holder's, its assigns', agents', contractors', licensees' or employees' construction, installation, maintenance, operation, use or occupancy of the right of way or in the exercise of this permit. In case any suit or action is brought against the State of Washington, its officers and employees, arising out of or by reason of any of the above causes, the Permit Holder, its successors or assigns will, upon notice of such action, defend the same at its sole cost and expense and satisfy any judgement against the State of Washington, its officers, or employees: PROVIDED, that if the claims or damages are caused by or result from the concurrent negligence of (a) the State of Washington's agents or employees and (b) the Permit Holder or Permit Holder's agents or employees, this indemnity provision shall be valid and enforceable only to the extent of the negligence of the Permit Holder or the Permit Holder's agents or employees.

   The Permit Holder, and on behalf of its assigns, agents, licensees, contractors and employees agrees to waive any claims for losses, expenses, damages or lost revenues incurred by it or its agents, contractors, licensees, employees or customers in connection with Permit Holder's, its assigns', agents', contractors', licensees' or employees' construction, installation, maintenance, operation, use or occupancy of the right of way or in the exercise of this permit against the State of Washington, its agents or employees except the reasonable costs of repair to property resulting from the negligent injury or damage to Permit Holder's property by the State of Washington, its agents, contractors or employees.

2. During the progress of the work, such barriers shall be erected and maintained as may be necessary or as may be directed for the protection of the traveling public; the barriers shall be properly lighted at night.

3. Except as herein authorized, no excavation shall be made or obstacle placed within the limits of the State highway in such a manner as to interfere with the travel over said road.

4. If the work done under this permit interferes in any way with the drainage of the State highway, the Permit Holder shall wholly and at its own expense make such provision as the Department may direct to take care of said drainage.

5. Permit Holder hereby authorizes the Department to enter upon their lands where necessary to construct or reconstruct the permitted access connection and/or construct and maintain traffic control devices and appurtenances.

6. The access connection shall be maintained between the right of way line and the shoulder line of said (highway, frontage service road of said highway, highway and/or frontage service road, "-" Line of said highway) by the Permit Holder, their heirs, successors or assigns.

7. On completion of said work herein contemplated, all rubbish and debris shall be immediately removed and the roadway and roadside shall be left neat and presentable and satisfactory to the Department.

8. The cost of construction or modification of a connection shall be the responsibility of the Permit Holder, including the cost of modification of any connection required as a result of changes on property site use in accordance with WAC 468-51-110.

9. The Department hereby reserves the right to order the change of location or the removal of any structure or structures authorized by this permit at any time, said change or removal to be made at the sole expense of the party or parties to whom this permit is issured, or their successors and assigns.

10. Existing permitted connections impacted by the Department's work program and which, in the consideration of the Department, necessitate modification, relocation, or replacement in order to meet current Department connection location, quantity, spacing, and design standards, shall be modified, relocated, or replaced in kind by the Department at no cost to the Permit Holder. The cost of further enhancements or modification to the altered, relocated, or replaced connections desired by the Permit Holder shall be the responsibility of the Permit Holder.

11. If any changes are made or proposed in the land use, intensity of development, type of traffic, or traffic flow of the property served by this connection permit, the Permit Holder is required to contact the Department to determine if further analysis is needed to determine if the change is significant and would require a new permit and modifications to the connection.

12. All such changes, reconstruction, or relocation by the Permit Holder shall be done in such manner as will cause the least interference with any of the Department's work, and the Department shall in no way be held liable for any damage to the Permit Holder by reason of any such work by the Department, its agents or representatives, or by the exercise of any rights by the Department upon roads, streets, public places, or structures in question.

13. This permit or privilege shall not be deemed or held to be an exclusive one and shall not prohibit the Department from granting other permits or franchise rights of like or other nature to other public or private companies or individuals, nor shall it prevent the Department from using any of its roads, streets, or public places, or affect its right to full supervision and control over all or any part of them, none of which is hereby surrendered.

14. The Department may revoke, amend, or cancel this permit or any of the provisions thereof at any time by giving written notice to the Permit Holder. The Permit Holder shall immediately remove all facilities from the right of way. Any facilities remaining upon the right of way 30 days after written notice of cancellation shall be removed by the Department at the Permit Holder's expense.

15. It is the responsibility of the apllicant or Permit Holder to obtain any other local permits or other agency approvals that may be required, including satisfaction of all environmental regulations. It is also the responsibility of the Permit Holder to acquire any property rights necessary to provide continuity from the applicant's property to the Department's right-of-way if the Permit Holder's property does not abut the right of way.

16. The party or parties to whom this permit is issued shall maintain at its or their sole expense the structure or object for which this permit is granted in a condition satisfactory to the Department.

17. Any breach of any of the conditions and requirements herein made, or failure on the part of the Permit Holder of this permit to proceed with due diligence and in good faith after its acceptance, with construction work hereunder, shall subject this permit to cancellation as herein provided.

18. This permit is subject to all applicable provisions of 468-51 WAC, 468-52 WAC, Chapter 47.50 RCW, Chapter 47.32 RCW, and/or Chapter 47.44 RCW, and amendments thereto.

Special Provisions for Highway Encroachments

Permit No. **48911**

Applicable provisions are denoted by ☒

☒ 1. No work provided for herein shall be performed until the Permit Holder is authorized by the following Department representative:

Kim Glass
Area 2 Asst. Maint. Supt.
(360) 961-2849

☒ 2. Prior to the beginning of construction, a preconstruction conference shall be held at which the Department and the Permit Holder and Permit Holder's engineer, contractor, and inspector shall be present.

☒ 3. Should the Permit Holder choose to perform the work outlined herein with other than its own forces, a representative of the Permit Holder shall be present at all times unless otherwise agreed to by the Department representative. All contact between the Department and the Permit Holder's contractor shall be through the representative of the Permit Holder. Where the Permit Holder chooses to perform the work with its own forces, it may elect to appoint one of its own employees engaged in the construction as its representative. Failure to comply with this provision shall be grounds for restricting any further work by the Permit Holder within the State right of way until said requirement is met. The Permit Holder, at its own expense, shall adequately police and supervise all work on the above described project by itself, its contractor, subcontractor, agent, and others, so as not to endanger or injure any person or property.

☒ 4. A copy of the permit must be on the job site and protected from the elements at all times during any of the construction authorized by said permit.

☒ 5. This permit does not give the Permit Holder or any agent or contractor of the Permit Holder any rights to cut, spray, retard, remove, destroy, damage, disfigure or in any way modify the physical condition of any vegetative material located on the highway right of way, except by written permission from the Department or for purposes as described by No. 6 if denoted below. All restoration shall be done to the satisfaction of the Department at the sole expense of the Permit Holder.

☒ 6. If necessary to increase sight distance, brush shall be removed from both sides of the access connection and stumps shall be removed. The indiscriminate cutting of merchantable timber or disfiguring of any feature of scenic value shall not be permitted.

☒ 7. The access connection(s) shall be constructed in accordance with the attached **Exhibit D**
Sufficient length of **N/A** diameter culvert pipe shall be placed in ditch and laid to a true line and grade.
The access connection(s) shall be surfaced to the limits as shown on the plan with a 150 millimeter (6 inch) minimum compacted depth of gravel base material and a 80 millimeter (3 inch) compacted depth of crushed surfacing top course. Asphalt paving will not be required. Finished grade of the access connection shall be in accordance with the profile control as shown on the attached plan. Directing of surface water from private property to Department right of way will not be permitted, unless otherwise approved by the Department.

☐ 8. The access connection(s) shall be constructed in accordance with the attached
Sufficient length of diameter culvert pipe shall be placed in ditch and laid to a true line and grade.
The access connection(s) shall be surfaced to the limits as shown on the plan with a 150 millimeter (6 inch) minimum compacted depth of gravel base material, a 80 millimeter (3 inch) minimum compacted depth of crushed surfacing top course, and paved with a 80 millimeter (3 inch) minimum compacted depth of Asphaltic Concrete Class B unless otherwise specified by the Department. Any existing oil mat on shoulder or roadway shall be removed and new pavement laid to a butt joint with existing pavement. Finished grade of new pavement shall be in accordance with the profile control as shown on attached plan. Directing of surface water from private property onto Department right of way will not be permitted, unless otherwise approved by the Department.

☒ 9. All buildings and appurtenances shall be so located at a distance from the right of way line of any State Highway that none of the right of way therefore is required for use of the patrons or customers of any such establishment. Permit Holder shall comply with local building codes. Set-back requirements for the location of buildingts in relation to the right of way line are a function of local authorities, and they should be consulted regarding requirements that must be adhered to.

☒ 10. The Permit Holder agrees to schedule the work herein referred to and perform said work in such a manner as not to delay the Department's contractor in the performance of his contract.

☒ 11. Work within the right of way shall be restricted to between the hours of **7:00 AM** and **4:00 PM** and / or , and no work shall be allowed on the right of way Saturday, Sunday, or holidays, unless authorized by the Department. Any lane closures must be submitted for approval in advance of use. The hours of permitted closure may differ from the above noted hours.

☒ 12. The shoulders, where disturbed, shall be surfaced with crushed surfacing top course **3 "** minimum compacted depth, or as directed by the Department. The surface of the finished shoulder shall slope down from the edge of pavement at the rate of 5% unless otherwise directed. The restored shoulder must not have any strips or sections less than 0.6 meters (2 feet) wide. The restored shoulder shall be surfaced with **HMA - 3"**

☒ 13. The Permit Holder shall be responsible for constructing and maintaining the access connection(s) and appurtenances between the shoulder line of the highway and the right of way line inclusive of surfacing and drainage. The Department has the right to inspect all installations at the time of construction and at any time afterward and to require that necessary changes and repairs be made. Unsatisfactory work will be corrected by the Department, at the Permit Holder's expense, or access may be removed at the Permit Holder's expense. Directing of surface water from private property onto Department right of way will not be permitted.

☒ 14. The access aconnection shall be sufficiently surfaced back an adequate distance from the edge of the pavement to prevent any tracking of material onto the highway. Any tracking of material onto the highway shall be subject to enforcement of Chapter 46.61.655 RCW and shall be immediately cleaned up by the Permit Holder or the Permit Holder's agent.

☐ 15. Standard highway warning signs designated as "Truck Crossing" sign, plate W8-6, shall be placed and maintained at Permit Holder's expense on each side of the access connection. Signs shall be in evidence only when access is actually being used. If necessary, flagmen shall be provided. Sufficient parking space shall be provided by the Permit Holder outside Department right of way so no vehicles will be parked on said right of way.

☐ 16. All manholes, valve covers, and like appurtenances shall be constructed at such an elevation to conform to the shoulder slope from the edge of pavement or as directed by the Department.

☒ 17. All slopes, slope treatment, top soil, ditches, pipes, etc., disturbed by this operation shall be restored to their original cross section and condition. All hazards shall be marked by warning signs, barricades, and lights. If necessary, flagmenshall be employed for the purpose of protecting the traveling public. Roadside operations shall be specified by the Department's representative.

☒ 18. During the construction and/or maintenance of this facility, the Permit Holder shall comply with the Manual on Uniform Traffic Control Devices for Streets and Highways, (Federal Highway Administration) and Washington modifications thereto. If determined necessary by the Department, the Permit Holder shall submit a signing and traffic control plan to the Department's representative for approval prior to construction or maintenance operations. No lane closures shall be allowed except as approved by the Department representative. Approvals may cause revision of special provisions, including hours of operation.

☐ 19. Bond coverage required to ensure proper compliance with all terms and conditions of said permit will be furnished by a Blanket Surety Bond held by the Department at the Olympia Service Center.

☒ 20. A surety bond in the amount of **$2,000.00** written by a surety company authorized to do business in the State of Washington shall be furnished to ensure compliance with any and all of the terms and conditions of this permit and shall remain in force until all work under this permit has been completed and approved by the Department.

☒ 21. Relative to advertising adjacent to all State highways, we wish to call your attention to the Sceni Vistas Act of 1971, Chapter 47.42 RCW and State Transportation Commission ruling Chapter 468-66 WAC. Violation of this section of the statutes will be sufficient cause for cancellation of this permit. On-premise signs are allowed.

☒ 22. The Permit Holder shall notify the Department's representative upon completion of the work under this permit so that a final inspection can be made.

☒ 23. The responsibility of the Permit Holder for proper performance, safe conduct, and adequate policing and supervision of the project shall not be lessened or otherwise affected by Department approval of plans, specifications, or work, or by the presence at the work site of Department representatives, or by compliance by the Grantee with any requests or recommendations made by such representatives.

☒ 24. All material and workmanship shall conform to the Washington State Department of Transportation Standard Specifications for Road, Bridge and Municipal Construction, current edition, and amendments thereto, and shall be subject to inspection by the Department.

Special Provisions for Highway Encroachments

Permit No. 48911

Applicable provisions are denoted by (X)

☒ 25. **WAC 468-51-100 NONCONFORMING CONNECTION PERMITS.**
The department may issue a permit for a connection not meeting department location and spacing criteria standards if it finds that a conforming connection is not attainable at the time of the permit application submittal and that denial would leave the property without a reasonable access to the public road system. This permit is Nonconforming because it does not meet driveway spacing requirements per WSDOT standards.

☒ 26. **WAC 468-51-110 CHANGES IN PROPERTY SITE USE**
This permit is issued exclusively to build, use, and maintain a Nonconforming Category 1 (minimum connection) Noncommercial Road Approach Design Template D1 for a SNO-PUD Control Building (converted back to a garage) and one Single Family Residence (SFR) located on Island County Tax Parcels S6370-00-61005-0, S6370-00-62001-0 and S6370-00-61001-0.

The connection permit is issued to the permittee for a particular type of land use generating specific projected traffic volumes at the final stage of the proposed development. Any changes made in the property use, construction of additional residential dwellings more than what is currently proposed, and/or construction of commercial buildings, and/or if there should be a discernible increase in the projected traffic volumes for the existing permitted use, a revised permit for such access shall be obtained from this office at that time.

☒ 27. **WAC 468-51-130 CLOSURE OF UNPERMITTED CONNECTIONS**
The current access connection was in existence prior to July 1, 1990 and is considered to be a "Grandfathered" approach. However, this connection does not meet minimum acceptable standards of highway safety, nor does it reflect the current proposed use, and must be upgraded as per Exhibit D, sheet 1 of 1.

☒ 28. **WAC 468-52-040 ACCESS CONTROL CLASSIFICATION SYSTEM AND STANDARDS**
All permits issued on Class 2 highways except for any Variance permits issued on Class 2 highways, are automatically designated as nonconforming connection. This requirement is based on one of the conditions of Class 2 highways which states "The access connection shall continue until such time that other reasonable access to a highway with a less restrictive access control classification or access to the general street system becomes available and is permitted."

As per **WAC 468-52-040 (2) (b) (ii) (E):**
"No additional access connections to the state highway shall be provided for newly created parcels resulting from property divisions. All access for such parcels shall be provided by internal road networks. Access to the state highway will be at existing permitted connection locations or at revised connection locations, as conditions warrant."

Access for any future subdivisions of the subject properties will only be permitted through the subject driveway located at MP 13.28(R) and no additional access points to SR 20 will be allowed from Island County Tax Parcel S6370-00-61005-0, S6370-00-62001-0 and S6370-00-61001-0. Any future development of these properties or any contiguous parcels under the same ownership will require an internal road network which will be the sole responsibility of the property owner(s).

☒ 29. The Permit Holder shall notify the Department's representative (listed in Special Provision #1, page 1), in writing or by fax, three working days prior to the beginning of construction.

☒ 30. The Permit Holder shall notify the Department's representative (listed in Special Provision #1, page 1), in writing or by fax, as to the name, address and telephone number of the contractor, if the work is to be done by other than its own forces.

☒ 31. The Permit Holder shall be responsible for securing all necessary permits from the Washington State Department of Ecology, the Washington State Department of Fish and Wildlife and/or the U.S. Army Corps of Engineers prior to beginning of construction. The Permit Holder shall provide copies of said permits to the WSDOT office issuing this permit.

☒ 32. The Permit Holder shall obtain and comply with all other federal, state and local permits which may be required (including, as necessary, Section 7 Endangered Species Act compliance). The Permit Holder shall provide copies of said permits to the WSDOT office issuing this permit.

☒ 33. During construction of this approach, the Permit Holder shall comply with the Washington State Department of Transportation Highway Runoff Manual and implement Best Management Practices (BMP's) as detailed in the manual to mitigate erosion.

☒ 34. At the Pre-Construction Conference, it will be determined if a Traffic Control Plan (TCP) will be required for the construction of this access connection. If so required, the Contractor shall submit the TCP(s) to the Department's Representative. The TCP shall be Approved by the WSDOT Construction Traffic Coordination Office (C.T.C.O.) prior to construction or maintenance operations on State right-of-way. During construction and/or maintenance of this facility, the Permit Holder shall comply with the approved traffic control plans. Any deviation from these traffic control plans will require approval by the Department's representative prior to construction or maintenance operations.

☒ 35. During construction and/or maintenance of this facility, the Permit Holder shall comply with the traffic control plans attached as an exhibit to this permit. Any deviation from these traffic control plans will require approval by the Department's representative prior to construction or maintenance operations.

Special Provisions for Highway Encroachments

Permit No. 48911

Applicable provisions are denoted by (X)

☒ 36. If a mailbox is to be placed adjacent to the roadway, and within State Right of Way, for this access it shall conform to the materials, spacing, and other requirements as shown in Exhibit B, sheets 3 and 4 (Standard Plans) attached to this permit. It is the responsibility of the property owner to place the mailbox in accordance to these Standard Plans and the United States Postal Service delivery regulations.

☒ 37. The Department will require a Certified Traffic Control Supervisor be on the project whenever traffic control labor is required, or as approved by the Department. The requirements of the Traffic Control Supervisor shall conform to Section 1-10.2(1) and Section 1-10.2(1) B of the WSDOT Standard Specifications for Road, Bridge and Municipal Construction. The Traffic Control Supervisor shall be certified by one of the following:

American Traffic Safety Services Association
15 Riverside Parkway, Suite 100
Frederickson, VA 22406-1002
(540) 368-1711
Certification Ext. 127
Recertification Ext. 134

Sverdrup Civil, Inc.
C/o Traffic Control Supervisors Seminar
600 108th Ave. N.E.
Bellevue, WA 98004
(425) 452-8000

The Northwest Laborers-Employees Training Trust
27055 Ohio Ave.
Kingston, WA 98346
(360) 297-3035

Evergreen Safety Council
401 Pontius Ave. N.
Seattle, WA 98109
1-800-521-0778 or (206) 382-4090

Transportation Consulting NW
1607 E. Main
Auburn, WA 98002
(253) 931-0506

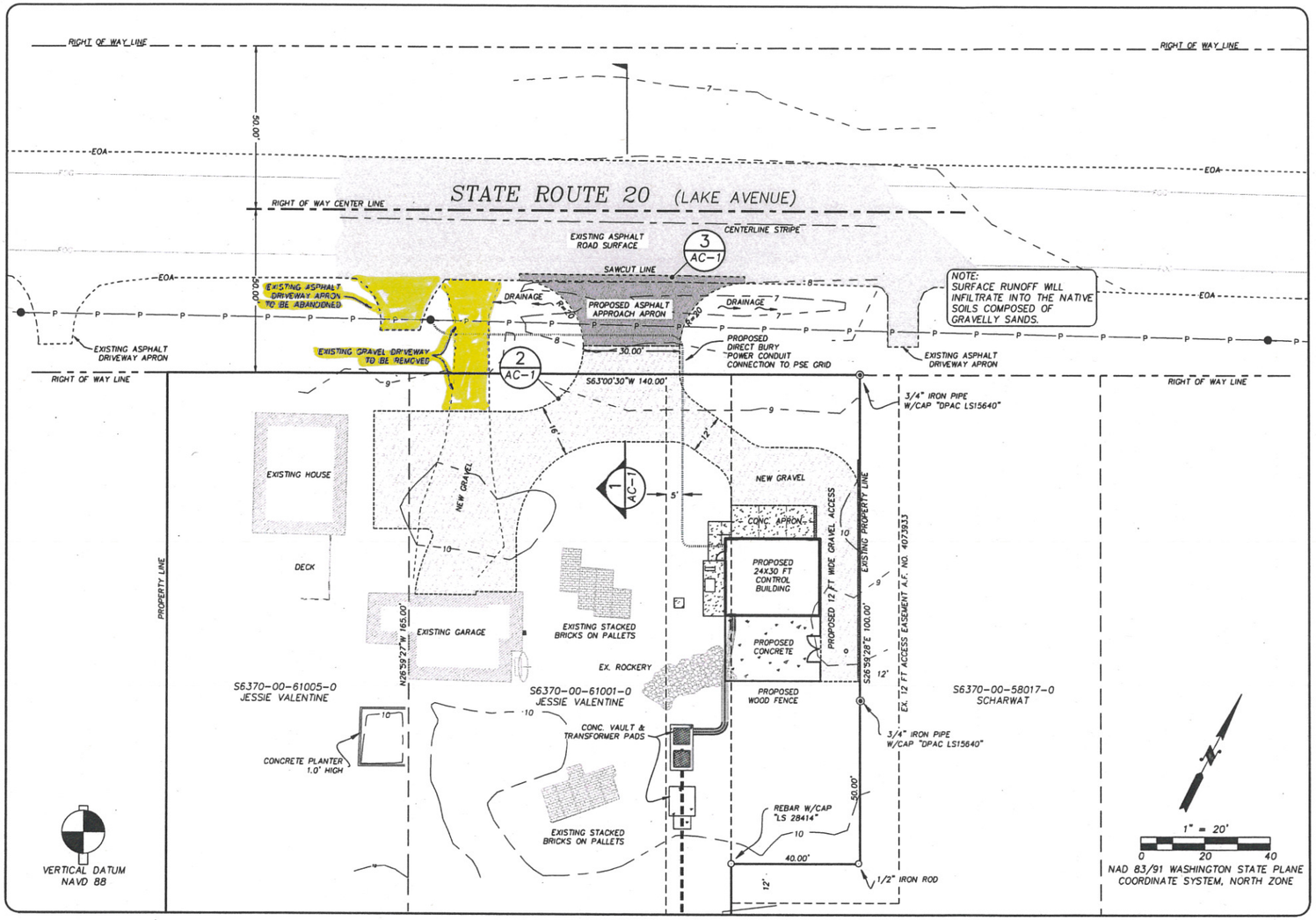
☒ 38. The construction safety zone for this access installation will be **8 feet** measured from the outside edge of the traveled way.

During non-working hours equipment and materials shall not be within the construction safety zone.

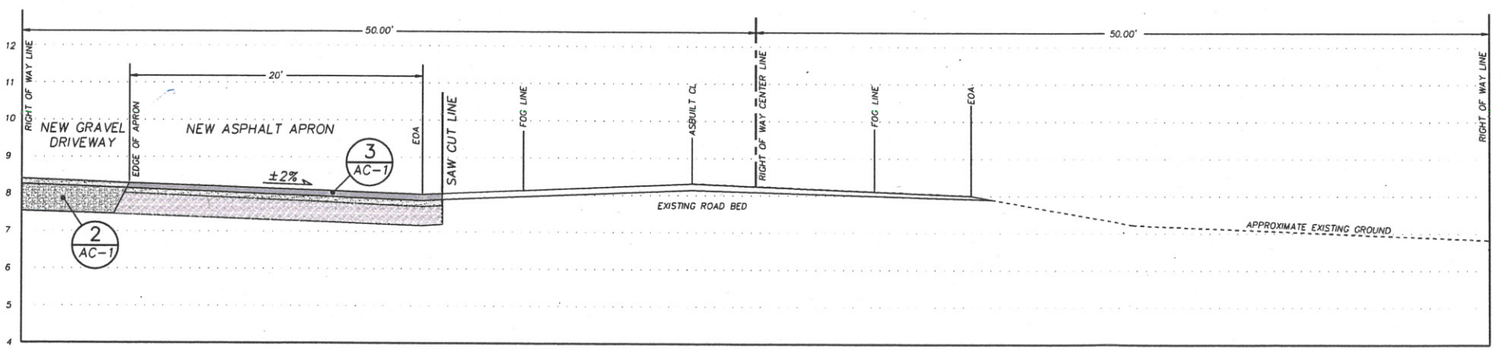
During actual hours of work, only materials necessary to the construction shall be within the construction safety zone and only construction vehicles absolutely necessary to construction shall be allowed within the construction safety zone or allowed to stop or park on the shoulder of the roadway. The Permit Holder's nonessential vehicles and employee's private vehicles shall not be permitted to park within the construction safety zone at any time.

Flaggers and spotters shall possess a current flagging card issued by the State of Washington, Oregon, or Idaho. The flagging card shall be immediately available, upon the person of the flagger, and shown upon request by the Contracting Agency. Workers engaged in flagging or traffic control shall wear reflective vests, hard hats, and must use standard 24" Stop/Slow paddle.

☒ 39. Deviation from the above requirements shall not occur unless the applicant or Permit Holder has requested the deviation in writing and the Department's representative has provided written approval.



SITE PLAN
SCALE 1"= 20'



1 AC-1 ROAD CROSS SECTION
SCALE 1"= 5' H / 1"=2' V

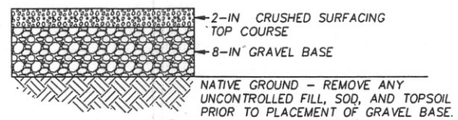
VICINITY MAP
T 31N, R 1E, W.M. WHIDBEY ISLAND, WA.
1"=400'

PROPERTY USE & TRAFFIC INFORMATION

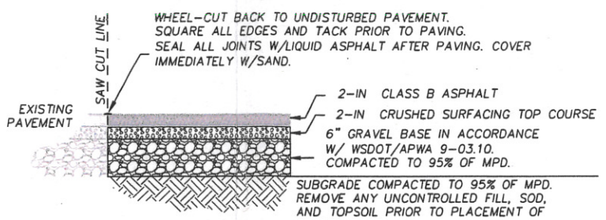
1. THIS PROJECT IS IS PROPOSED AS UTILITY RESEARCH TO EXPLORE THE FEASIBILITY OF TIDAL ENERGY AS A POWER GENERATION SOURCE IN AN AREA OF KNOWN ACTIVE TIDAL ENERGY. AT THE END OF THE PILOT STUDY SUB-SEA TURBINES AND ASSOCIATED INFRASTRUCTURE WILL BE REMOVED FROM THE STUDY SITE. THE ACCESS AND ASSOCIATED CONTROL BUILDING WILL BE RETAINED BY THE PROPERTY OWNER FOR RESIDENTIAL USE.
2. ONCE IN OPERATION, PUD EXPECTS AVERAGE VEHICLE TRIPS TO THE CONTROL BUILDING WILL BE ONCE PER WEEK.
3. ONCE THE PILOT PROJECT IS COMPLETED AND THE CONTROL BUILDING CONVERTED TO A GARAGE, THE MAXIMUM EXPECTED ADT IS 8.57 FOR A SINGLE FAMILY RESIDENCE.

SITE PLAN INFORMATION (PER WAC 468-51-060):

1. RIGHT OF WAY SHOWN FOR THIS PROJECT FROM RIGHT OF WAY PLANS TITLED "SR 20 MP 12.91 TO MP 16.31: KEYSTONE FERRY TERMINAL TO JCT. SR 525" APPROVED MARCH 11, 1977.
2. STATE ROUTE NUMBER: 20 (SR 20 SPUR TO KEYSTONE FERRY TERMINAL)
3. COUNTY OR LOCAL ROAD NAME: LAKE AVENUE (PLAT OF CHICAGO)
4. SECTION TOWNSHIP & RANGE:
5. HIGHWAY PAVEMENT TYPE: ASPHALT
6. CROSS SECTION: SEE DETAIL 1, THIS SHEET.
7. POSTED SPEED LIMIT: 50 MPH (BOTH DIRECTIONS)
8. APPROXIMATE MILE: 13.1
9. APPROXIMATE HIGHWAY ENGINEER'S STATION: 26+40
10. JESSIE L. VALENTINE HOLDS CONTIGUOUS OWNERSHIP OF ISLAND COUNTY PARCEL NUMBERS S6370-00-61005-0, S6370-00-61001-0 AND S6370-62001-0 AS DESCRIBED BELOW. NOTE NO PROJECT ACTIVITY IS TO OCCUR ON S6370-00-61005-0.
11. THE GENERAL SITE ADDRESS FOR THIS PROJECT IS 13254 STATE ROUTE 20, COUPEVILLE, WA 98239.



2 AC-1 GRAVEL SURFACE DETAIL
NOT TO SCALE



3 AC-1 ASPHALT PAVING DETAIL
NOT TO SCALE

811 Know what's below. Call before you dig.

REVIEW SET-WSDOT ACCESS

EXHIBIT "B"
Sheet 1 of 1

No	DATE	BY	DESCRIPTION REVISIONS	ENGR	CHKR	APVD
1	7/12	JTF	REVISED ACCESS LOCATION PER WSDOT AND SNOPUD REVIEW			

SNOHOMISH COUNTY PUD
PUBLIC UTILITY DISTRICT No. 1

WO	
TASK	PERMIT
SCALE	AS NOTED
DFTR	JTF
CHKR	DWH
ENGR	DWH
APVD	
DATE	04-24-12

TIDAL GENERATION RESEARCH PROJECT
WSDOT ACCESS SITE PLAN

SEC 22, T 31N, R 1E, W.M.
ISLAND COUNTY, WA

REV	DRAWING
0	AC-1

REGION NO.	STATE	FED. AID PROJECT NO.	SHEET NO.
10	WASH.	F-020( )	

T.3IN.R.IE.W.M.

WHIDBEY ISLAND

SECTION 22 AND SECTION 23

CROCKETT LAKE

26+00

27+13.90 A.P.

32+43.11 A.P.

38+48.35 P.I.

48+91.41 A.P.

55+07.87 A.P.

57+00

*S 65°W *1,888.2'

*S 64°35'13"W *812.56'

*S 64°W *745.8'

*N81°E *3,350.8'

GOV'T MEANDER LINE

TRACT "T"

J.C. KELLOGG D.L.C. No. 46

TRACT "Q"

EXIST. R/W

SR 20

TO AB BASE S 58°11'50"W 1513.6'

N 27° 57'14" W 1549.3'

N64°22'59"E

N73°23'05"E

N77°12'32"E

N80°02'30"E

62.5'

37.5'

TO SR 525

TO KEYSTONE FERRY

N62°02'46"E

N62°52'09"E *30

EXIST. R/W

R=2200.00'

36+75.17 P.C.

40+20.81 P.T.

TRACT "A"

TR. "B"

TR. "C"

TR. "D"

KEYSTONE DRIVE

(PRIVATE ROAD)

WASHINGTON AVE. (VAC.)

CHICAGO AVE. (VAC.)

13TH ST. (VAC.)

12TH ST. (VAC.)

*N61°30'E *2361.48'

*N63°E *284.42'

*N73°15'E *1,240.8'

*N30°30'E *1832.8'

GOV'T MEANDER LINE

TRACT "A"

PLAT BOUNDARY AND LINE OF ORDINARY HIGH TIDE ESTABLISHED FROM U.S.C.&G.S. ADMIRALTY HEAD TIDAL BENCH MARK NUMBER 4.

ADMIRALTY BAY

C.S.	Project	P	Adv	Sec
1895	#L9310	09	IL	10

REVISED	BY	DATE
RIGHT OF WAY CHECKED		

DRAWN	
TRACED	
CHECKED	
PROJ. ENGR.	
DES. ENGR.	

E.L.	10-10-76

MP 12.91 TO MP 16.34
SR 20 KEYSTONE FERRY TERMINAL TO JCT. SR 525
ISLAND COUNTY
SHEET 4 OF 9 SHEETS

LEGEND

PROPERTY OWNERSHIP NUMBERS
PROPERTY LINES
SCALE IN FEET 100' 50' 0' 100'

○ PLAT OF CHICAGO
○ KEYSTONE SHORES DIVISION No. 1

PARCEL No.	NAME	TOTAL AREA	R/W	LT. REMAINDER RT.	EXCESS	EASMT.
OWNERSHIPS						

All Plans are subject to change
Parties seeking precise, current information should consult the official plan on file in the Department of Transportation in Olympia

NOTE = ALL BEARINGS AND DISTANCES PRECEDED BY AN ASTERISK ARE TAKEN FROM TITLE REPORTS AND/OR PLAT MAPS

NOTE:
WSDOT'S OWNERSHIP SHOULD BE VERIFIED. PROPERTY RIGHTS SHOWN MAY NOT HAVE BEEN ACQUIRED BY WSDOT.

EXHIBIT "C"
Sheet 1 of 1

12067
SR 20 MP 12.91 TO MP 16.34
KEYSTONE FERRY TERMINAL TO JCT. SR 525
ISLAND COUNTY

RIGHT OF WAY PLAN
STATION 26+00 TO STATION 57+00

WASHINGTON STATE HIGHWAY COMMISSION
DEPARTMENT OF HIGHWAYS
OLYMPIA, WASHINGTON
W. A. BULLEY DIRECTOR OF HIGHWAYS

John N. Cooper
ROADWAY DEVELOPMENT ENGINEER

APPROVED March 11, 1977
SHEET 4 OF 9 SHEETS

Letter 3-16-77	4-8-77	Revised exist. R/W on it. sta. 32+43.11 to 37+00.	TG
DRAWER 20	SHORT	DATE	SEQUENCE 08	SUBSEQUENT APPROVAL	BY

R/W

SR 20/

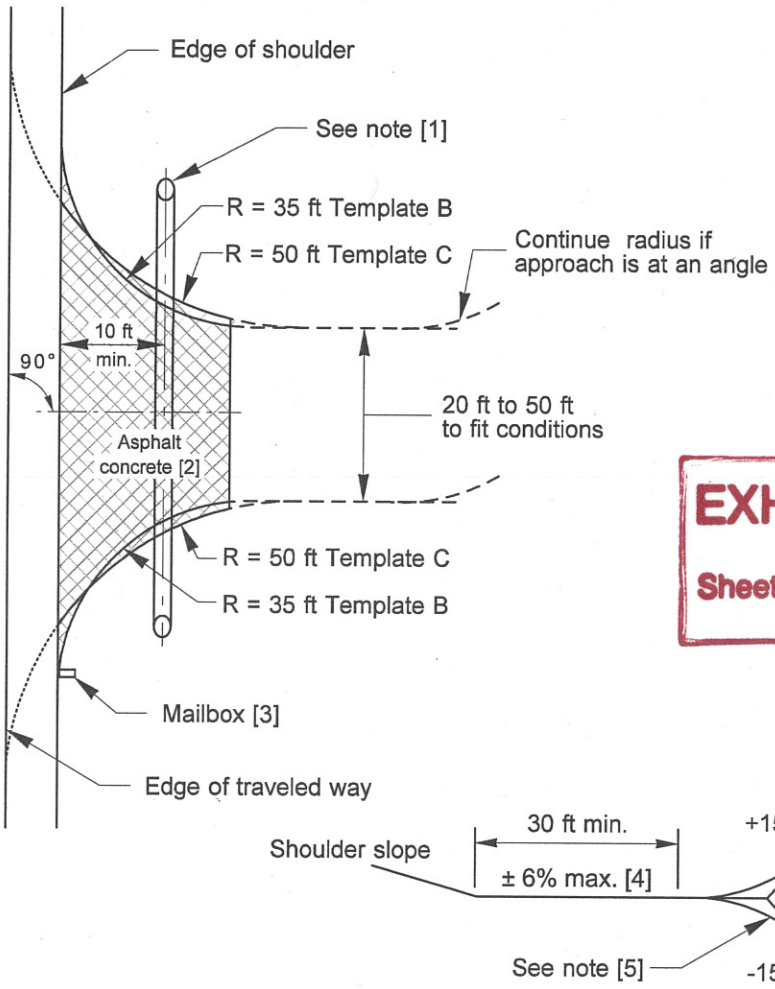


EXHIBIT "D"
Sheet 1 of 1

Notes:

[1] Culvert pipe with beveled end treatment (see Chapter 1600).

[2] When the travel lanes are bituminous, a similar type may be used on the approaches.

[3] For mailbox location, see Chapter 1600.

[4] ±8% difference from shoulder slope.

[5] Vertical curves not to exceed a 31/4-inch hump or a 2-inch depression in a 10-foot chord.

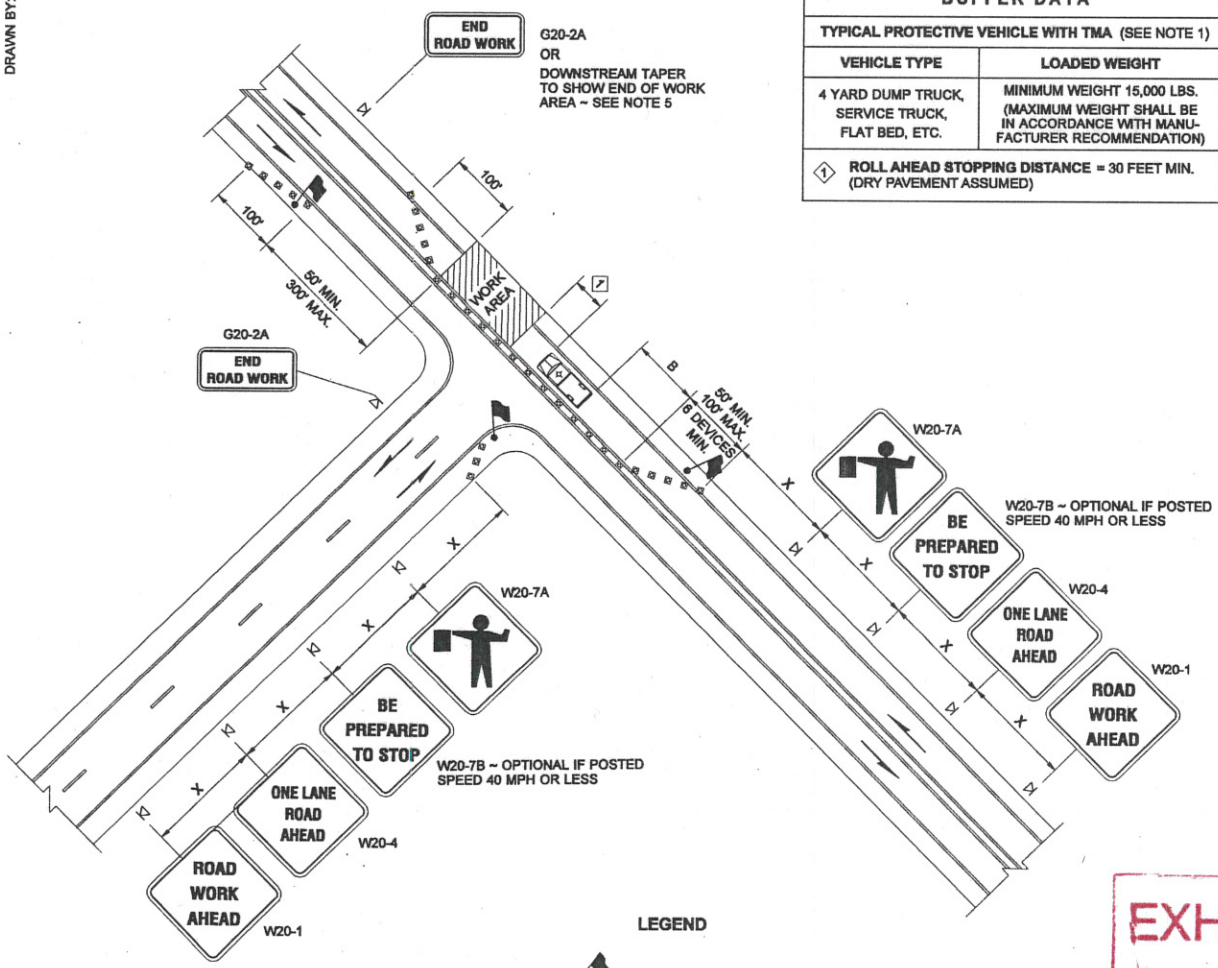
Road Approach Design Templates B1 and C1

Exhibit 1340-4

DRAWN BY: ELENA BRUNSTEIN

LONGITUDINAL BUFFER SPACE = B									
POSTED SPEED (MPH)	25	30	35	40	45	50	55	60	65
LENGTH B (FEET)	155	200	250	305	360	425	495	570	645

BUFFER DATA	
TYPICAL PROTECTIVE VEHICLE WITH TMA (SEE NOTE 1)	
VEHICLE TYPE	LOADED WEIGHT
4 YARD DUMP TRUCK, SERVICE TRUCK, FLAT BED, ETC.	MINIMUM WEIGHT 15,000 LBS. (MAXIMUM WEIGHT SHALL BE IN ACCORDANCE WITH MANUFACTURER RECOMMENDATION)
① ROLL AHEAD STOPPING DISTANCE = 30 FEET MIN. (DRY PAVEMENT ASSUMED)	



LEGEND

- FLAGGING STATION
- SIGN LOCATION
- CHANNELIZING DEVICES
- PROTECTIVE VEHICLE ~ RECOMMENDED

NOTES

1. A Protective Vehicle is recommended regardless if a Truck Mounted Attenuator (TMA) is available; a work vehicle may be used. When no TMA is used, the Protective Vehicle shall be strategically located to shield workers, with no specific Roll-Ahead distance.
2. Night work requires additional roadway lighting at flagging stations. See WSDOT Standard Specifications for additional details.
3. Extend Channelizing Device taper across shoulder ~ recommended.
4. Sign sequence is the same for both directions of travel on the roadway.
5. Channelizing Device spacing for the downstream taper option shall be 20' O.C.
6. For signs size refer to Manual on Uniform Traffic Control Devices (MUTCD) and WSDOT Sign Fabrication Manual M55-05.

SIGN SPACING = X (1)		
RURAL HIGHWAYS	60 / 65 MPH	800' ±
RURAL ROADS	45 / 55 MPH	500' ±
RURAL ROADS & URBAN ARTERIALS	35 / 40 MPH	350' ±
RURAL ROADS, URBAN ARTERIALS, RESIDENTIAL & BUSINESS DISTRICTS	25 / 30 MPH	200' ± (2)
URBAN STREETS	25 MPH OR LESS	100' ± (2)
ALL SIGNS ARE BLACK ON ORANGE UNLESS DESIGNATED OTHERWISE		

(1) ALL SIGN SPACING MAY BE ADJUSTED TO ACCOMMODATE INTERCHANGE RAMPS, AT-GRADE INTERSECTIONS, AND DRIVEWAYS.

(2) THIS SIGN SPACING MAY BE REDUCED IN URBAN AREAS TO FIT ROADWAY CONDITIONS.

EXHIBIT "E"
Sheet 1 of 1

THEODORE J. TREPANIER
STATE OF WASHINGTON
25335
REGISTERED
PROFESSIONAL ENGINEER
EXPIRES AUGUST 9, 2007

NOTE: THIS PLAN IS NOT A LEGAL ENGINEERING DOCUMENT UNLESS IT BEARS THE ENGINEER'S SEAL AND SIGNATURE. IF SIGNED BY THE ENGINEER AND APPROVED FOR PUBLICATION, IS KEPT ON FILE AT THE WASHINGTON STATE DEPARTMENT OF TRANSPORTATION. A COPY MAY BE OBTAINED UPON REQUEST.

LANE CLOSURE WITH FLAGGER CONTROL

STANDARD PLAN K-20.40-00

SHEET 1 OF 1 SHEET

APPROVED FOR PUBLICATION

Ken L. Smith — STATE DESIGN ENGINEER — 02-15-07 — DATE

Washington State Department of Transportation

DRAWN BY: ELENA BRUNSTEIN

LONGITUDINAL BUFFER SPACE = B									
POSTED SPEED (MPH)	25	30	35	40	45	50	55	60	65	70
LENGTH B (FEET)	155	200	250	305	SEE STD. PLAN K-40.20					

BUFFER DATA	
TYPICAL PROTECTIVE VEHICLE WITH TMA (SEE NOTE 1)	
VEHICLE TYPE	LOADED WEIGHT
4 YARD DUMP TRUCK, SERVICE TRUCK, FLAT BED, ETC.	MINIMUM WEIGHT 15,000 LBS. (MAXIMUM WEIGHT SHALL BE IN ACCORDANCE WITH MANUFACTURER RECOMMENDATION)
① ROLL AHEAD STOPPING DISTANCE = 30 FEET MIN. (DRY PAVEMENT ASSUMED)	

MINIMUM TAPER LENGTH = L (FEET)										
SHOULDER WIDTH (FEET)	POSTED SPEED (MPH)									
	25	30	35	40	45	50	55	60	65	70
6	63	90	123	160						
8	84	120	164	214	SEE STD. PLAN K-40.20					
10	105	150	204	267						
LESS THAN 6	3 DEVICES MINIMUM, SPACED 10' O.C.									

CHANNELIZING DEVICE SPACING		
POSTED SPEED (MPH)	IN TAPER (FEET)	IN TANGENT (FEET)
35 / 40	30	60
25 / 30	20	40

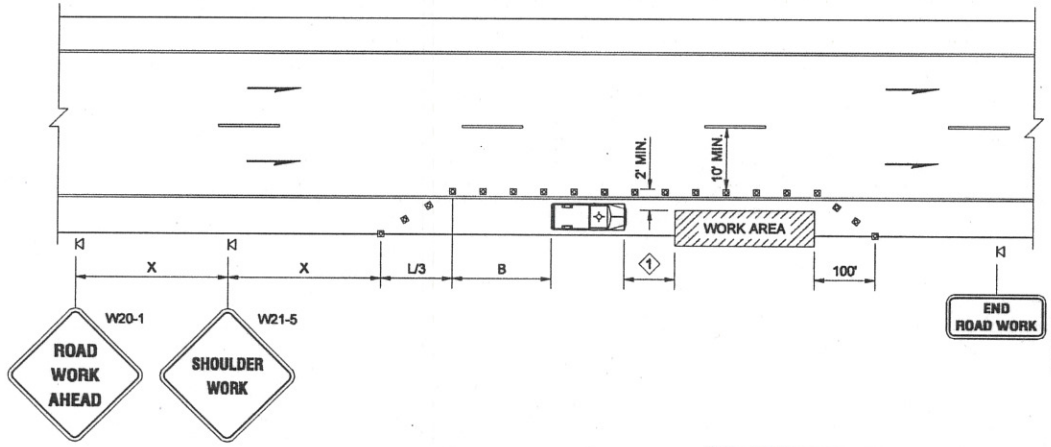
NOTES

1. A Protective Vehicle is recommended regardless if a Truck Mounted Attenuator (TMA) is available; a work vehicle may be used. When no TMA is used, the Protective Vehicle shall be strategically located to shield workers, with no specific Roll-Ahead distance.
2. Channelizing Device spacing for the downstream taper option shall be 20' O.C.
3. For signs size refer to Manual on Uniform Traffic Control Devices (MUTCD) and WSDOT Sign Fabrication Manual M55-05.

SIGN SPACING = X (1)		
RURAL ROADS & URBAN ARTERIALS	35 / 40 MPH	350' ±
RURAL ROADS, URBAN ARTERIALS, RESIDENTIAL & BUSINESS DISTRICTS	25 / 30 MPH	200' ± (2)
URBAN STREETS	25 MPH OR LESS	100' ± (2)
ALL SIGNS ARE BLACK ON ORANGE UNLESS DESIGNATED OTHERWISE		

(1) ALL SIGN SPACING MAY BE ADJUSTED TO ACCOMMODATE INTERCHANGE RAMPS, AT-GRADE INTERSECTIONS, AND DRIVEWAYS.

(2) THIS SIGN SPACING MAY BE REDUCED IN URBAN AREAS TO FIT ROADWAY CONDITIONS.



LEGEND

- SIGN LOCATION
- CHANNELIZING DEVICES
- PROTECTIVE VEHICLE ~ RECOMMENDED

EXHIBIT "F"
Sheet 1 of 1

THEODORE J. TREPANIER
STATE OF WASHINGTON
25335
REGISTERED
PROFESSIONAL ENGINEER
EXPIRES AUGUST 9, 2007

NOTE: THIS PLAN IS NOT A LEGAL ENGINEERING DOCUMENT BUT AN ELECTRONIC DUPLICATE. THE ORIGINAL SIGNED BY THE ENGINEER AND APPROVED FOR PUBLICATION, IS KEPT ON FILE AT WSDOT HEADQUARTERS. THIS PLAN IS FOR INFORMATION. A COPY MAY BE OBTAINED UPON REQUEST.

SHOULDER CLOSURE ~ LOW SPEED ROADWAY (40 MPH OR LESS) STANDARD PLAN K-40.40-00

SHEET 1 OF 1 SHEET

APPROVED FOR PUBLICATION

Ken L. Smith — STATE DESIGN ENGINEER — 02-15-07 — DATE

Washington State Department of Transportation

Washington State Department of Transportation

Individual Bond for Agreement

Bond No. _____

KNOW ALL MEN BY THESE PRESENTS: That we, _____

of Island County _____ as Principal, and

_____ as Surety, are jointly and severally bound unto the STATE OF WASHINGTON

in the sum of $5,000.00 DOLLARS, for payment of which to the State of Washington, we jointly and severally bind ourselves, our heirs, executors, administrators, and assigns, firmly by these presents.

WHEREAS, the Principal in pursuance of its operations has requested the permission of the Washington State Department of Transportation, to construct improvements within the state's right of way, and

WHEREAS, the Washington State Department of Transportation, has agreed to allow the Principal to construct these improvements on a portion of State Route No. 20 in Island County, Washington, under the provisions of the agreement between these two parties hereinafter identified as agreement number AC 12060011 .

NOW, THEREFORE, the condition of this obligation is such that if all the conditions of said agreement including the proper restoration of slopes, slope treatment, topsoil, landscape treatment, drainage facilities and cleanup of right of way, are complied with according to the terms contained in said agreement by said Principal, through a period ending not more than one year(s) after date of completion of construction and upon receipt of a written discharge from the State, then this obligation shall become null and void, otherwise this bond to remain in full force and effect.

WITNESS our hands and seals this _____ day of _____ , _____ .

NOTE: Please **type or print below the signatures** the names of parties executing this Bond, together with official title of each.

Principal: _____

Address:

Telephone: _____

_____

By: _____

Title: _____

Surety: _____

Address:

Telephone: _____

_____

By: _____

Title: _____

WASHINGTON STATE DEPARTMENT OF TRANSPORTATION

_____

By: _____

Title: _____

Date: _____

DOT Form 224-049 EF
Revised 6/95

Washington State Department of Transportation

ASSIGNMENT OF SAVING ACCOUNT/ CERTIFICATE OF DEPOSIT

This assignment is for the purpose of fulfilling the requirement of bonding collateral for Access Connection Permit No 48911 / AC12060011. The undersigned does hereby assign, transfer, and set over unto the State of Washington all right and title to the sum of $ 5000.00 on Account No. _____ at the _____ Branch, of_____ Bank, in the name of _____ with full power and authority to demand, collect, and receive said deposit and to give receipt and acquittance therefore for the uses and purposes prescribed above. It is understood and agreed that _____ Branch, of _____ Bank holds the Certificate covering said account in its possession and agrees to hold $ 5000.00 until a release of this assignment from the State of Washington is received. The interest shall be payable to _____ (Assignee). Signed and dated at _____, Washington this _____ day of _____, 20___.

Signature _____

Address _____

_____

ACCEPTANCE

The undersigned hereby accepts the foregoing Assignment of Savings Account/Certificate of Deposit, Account or Certificate Number _____, in the amount of $_____ this _____ day of _____, 200___.

Bank _____

Signature _____

Title _____

Appendix Q

WASHINGTON STATE DEPARTMENT OF FISH AND WILDLIFE (WDFW) PERMIT CONDITIONS

The final approval and associated conditions are not available as of 11/2/2014. The Contract Plans and Specifications represent the conditions expected in the WDFW issued Hydraulic Project Approval (HPA). Should a material difference arise between the conditions outlined in the final HPA from those included in the Contract Plans and Specifications, the DISTRICT recognizes this as a potential change condition.

Washington Department of FISH and WILDLIFE

HYDRAULIC PROJECT APPROVAL

RCW 77.55.021 - See appeal process at end of HPA

North Puget Sound
16018 Mill Creek Boulevard
Mill Creek, WA 98012-1296
(425) 775-1311

Issue Date: January 13, 2014
Project Expiration Date: January 12, 2019

Control Number: 128821-1
FPA/Public Notice #: N/A

PERMITTEE	AUTHORIZED AGENT OR CONTRACTOR
Snohomish County PUD No.1 ATTENTION: Craig Collar PO Box 1107 Everett, WA 98206 425-783-1825 Fax: 425-391-6977	

Project Name: Admiralty Inlet Pilot Tidal Project

Project Description: The Public Utility District No. 1 of Snohomish County, Washington (Snohomish PUD) filed an application with the Federal Energy Regulatory Commission (FERC) for a 10-year license to construct and operate its proposed Admiralty Inlet Pilot Tidal Project. The 600-kilowatt (kW) project will be located on the east side of Admiralty Inlet in Puget Sound, Washington, about 1 kilometer west of Whidbey Island, entirely within Island County, Washington

Project involves placement, operation, monitoring, evaluation, and removal of two 6-meter diameter Open Hydro turbines in Admiralty Inlet in 58 meters water depth. Two parallel transmission cables will be installed within one or two horizontally drilled conduits extending from an on shore location east of the Coupeville-Port Townsend ferry terminal to an exit point(s) on the sea floor at the 19 meter depth contour. From the exit point, the cables will be laid across the sea floor to their connection with the turbines.

PROVISIONS

1. The project may begin immediately and shall be completed by January 12, 2019.

2. Work below the ordinary high water line shall not occur from February 15 through July 14 of any year for the protection of migrating juvenile salmonids.

3. Work below the ordinary high water line shall not occur from December 15 through December 31 and from January 1 through March 31 of any year for the protection of rock sole spawning beds.

4. NOTIFICATION REQUIREMENT: The Area Habitat Biologist (AHB) listed below shall receive written notification (FAX or mail) from the person to whom this Hydraulic Project Approval (HPA) is issued (permittee) or the agent/contractor no less than three working days prior to the start of construction activities. The notification shall include the permittee's name, project location, starting date for work, and the control number for this HPA.

5. Work shall be accomplished per plans and specifications submitted with the JARPA and approved by the Washington Department of Fish and Wildlife (WDFW), entitled "SNOHOMISH COUNTY PUBLIC UTILITY DISTRICT NO. 1 ADMIRALTY INLET PILOT TIDAL PROJECT, WHIDBEY ISLAND, WASHINGTON", sheets P1-P8 of 8, dated April 12, 2012, and as modified per plans submitted to FERC in connection with the Final Environmental Assessment for Hydropower License, Admiralty Inlet Tidal Energy Project, No. 12690-005, dated August 9, 2013, except as modified by this Hydraulic Project Approval. A copy of these plans shall be available on site during construction. (In the event that FERC does not adopt the Plans as identified within the FERC EA, or materially modifies the Plans, the District must consult with WDFW regarding the modification to the Plans.)

HORIZONTAL DIRECTIONAL DRILLING

6. Two electrical transmission cables, each approximately 2 inches diameter, shall be installed by horizontal directional drilling (HDD) from an onshore location east of the Coupeville-Port Townsend ferry terminal to a minimum depth of 18 meters, and then laid directly on the sea floor to their connection with the turbines as shown on sheet P5, entitled "ADMIRALTY INLET PILOT TIDAL PROJECT HORIZONTAL DIRECTIONAL DRILLING PLAN AND DETAILS", dated April 12, 2012, and sheet P6 entitled, "ADMIRALTY INLET PILOT TIDAL PROJECT CABLE LAY PLAN AND DETAILS", dated April 12, 2012. (These plans were included in the FERC EA, and in the event that FERC does not adopt these plans or materially modifies these plans, the District must consult with WDFW regarding the modification of these plans.)

7. A mixture of bentonite clay and water as the drilling fluid shall be used as a lubricant for the drill head and pipe. As the HDD conduit path approaches the exit on the sea floor (approximately 100 feet from the exit), the drilling fluid shall be replaced with fresh water to remove mud from the conduit path and to ensure a clean exit.

8. The bentonite clay-water slurry and the spoils removed during the drilling shall be pumped from the bore pit to a holding tank or other upland containment area for separation and potential reuse of the bentonite clay. Waste water shall not be allowed to flow back into marine waters and non-toxic solids and drill tailings shall be disposed offsite at an approved upland location.

9. The HDD bore hole(s), approximately 203 meters long, shall be lined with two 6 - inch diameter HDPE pipe in the event two bore holes are required or lined with one 18 - inch diameter HDPE pipe in the event only one bore hole is required.

10. The drilling mud pressure and volume shall be continually monitored during drilling to ensure there are no leakages due to fractures (frac-outs).

11. In the event of a frac-out or other release of grout material, all work activities shall cease and the Area Habitat Biologist listed below shall be contacted immediately for additional approval to restore the sea floor and finish the project.

12. Two tempoary barge anchors for use to support the HDD and cable lay operations shall be used within the immediate area surrounding the HDD exit point.

13. The anchors and buoy system shall be installed and used in a manner that will not damage the bed or aquatic vegetation (eelgrass and kelp) as a result of anchor or chain movement for the life of the buoy system.

14. Diver support vessels and work barges, moored at the HDD exit point, shall not anchor or spud down in eelgrass and kelp.

15. To minimize and control potential sources of water quality impacts, Snohomish PUD shall implement the "HORIZONTAL DIRECTIONAL DRILLING PLAN", prepared by Sound & Sea Technology, Inc. dated August 29, 2011, or as modified by the HDD contractor with approval from WDFW.

TURBINE AND TRUNK CABLE INSTALLATION

16. Turbines shall be two 6 meter diameter OpenHydro turbines with a rotor diameter of 4.7 meters.

17. Turbines shall be installed at about the 58 meter depth contour approximately 1 kilometer offshore of Admiralty Head. Turbines shall be lowered vertically through the water column from the turbine installation barge to the seabed. Turbines shall not be dragged or pulled across the seabed.

18. Turbines shall be supported on a subsea foundation of tubular steel framres, 19.2 meters long by 18.0 meters wide, filled with concrete ballast.

19. The subsea foundation shall be supported on 3 steel gravity based legs or pedestals, approximately 2 meters in diameter, with a total seabed contact or interface area of no more than approximately 15 square meters.

20. Parallel trunk cables, mentioned above in provision #6, shall be laid across the seabed from the HDD exit point approximately 2200 meters to the turbine connection point. Cable installation work shall take place from a barge.

21. A cable connector shall be installed approximately 180 meters from the turbines to allow for turbine disconnection and removal. Following turbine removal the trunk cables shall be abandoned in place or removed depending upon final consultation with WDFW and other resource agencies.

22. Each cable, consisting of main and auxiliary conductors plus optical signal fibers, shall have an outside diameter of approximately 2 inches and a submerged weight of 18.4 kg per meter.

23. In areas where the cable service loops are proposed, additional weights shall be used to ensure the cable remains in close contact to the seabed. Weights shall consist of chain, cable, or other low vertical relief type structure necessary to keep the cable completely weighted to the seabed.

HABITAT AND WATER QUALITY

24. Eelgrass and kelp shall not be adversely impacted due to any project activities (e.g., barge shall not ground, equipment shall not operate, and other project activities shall not occur in eelgrass and kelp).

25. Project activities shall be conducted to minimize siltation of the beach area and bed.

26. No petroleum products or other deleterious materials shall enter surface waters.

27. Project activities shall not degrade water quality to the detriment of fish life.

28. If at any time, as a result of project activities, fish are observed in distress, a fish kill occurs, or water quality problems develop (including equipment leaks or spills), immediate notification shall be made to the Washington Military Department's Emergency Management Division at 1-800-258-5990, and to the Area Habitat Biologist listed below.

MITIGATION AND MONITORING

29. Potential impacts to fish life, marine mammals and other pelagic and benthic marine organisms shall be monitored during all phases of project construction, operation and removal per the following FERC Pilot License monitoring and mitigation plans submitted with the JARPA application and approved by the WDFW, entitled "ACOUSTIC MONITORING AND MITIGATION PLAN"; "BENTHIC HABITAT MONITORING AND MITIGATION PLAN"; "NEAR-TURBINE MONITORING AND MITIGATION PLAN"; "DERELICT GEAR MONITORING PLAN"; and "MARINE MAMMAL MONITORING AND MITIGATION PLAN", all plans dated September 5, 2012. (In the event that FERC does not adopt the Plans as identified within the FERC EA, or materially modifies the Plans, the District must consult with WDFW regarding the modification to the Plans.)

30. The power transmission cables and the HDD exit hole shall be monitored for changes in the benthic community as detailed in the FERC Pilot License, "BENTHIC HABITAT MONITORING AND MITIGATION PLAN", dated November 16, 2012, and received by E-mail dated November 22, 2013. Initial monitoring shall include quarterly monitoring for the first year (potentially two), then yearly thereafter, and shall include the turbine area and cable route. Changes in monitoring frequency shall be subject to review and adaptive changes as proposed by the MARC (including WDFW). (In the event that FERC does not adopt the Plans as identified within the FERC EA, or materially modifies the Plans, the District must consult with WDFW regarding the modification to

the Plans.)

31. A FERC Pilot License water quality monitoring plan, submitted by E-mail dated November 22, 2013, entitled "WATER QUALITY MONITORING PLAN for the ADMIRALTY INLET PILOT TIDAL PROJECT", dated February 29, 2012, and revised December 5, 2012, shall remain in effect during all phases of turbine installation and removal. (In the event that FERC does not adopt the Plans as identified within the FERC EA, or materially modifies the Plans, the District must consult with WDFW regarding the modification to the Plans.)

32. REPORTING REQUIREMENT: The permittee shall submit to the WDFW Habitat Biologist listed below, a calendar year annual report of all maintenance activities performed under this Hydraulic Project Approval by June 30 of the following year. At any time if problems are experienced with implementation of this HPA, either the permittee or WDFW may request a joint review meeting. The annual report shall include:

a. General: Reporting agency, contact person, address, telephone number, date of report, time period;

b. Summary: The control number for the HPA, a summary of monitoring results;

c. Problem(s) encountered: Provision violation, notification, corrective action, impacts to fish life and water quality problems, etc;

d. Recommendations for improvement of BMPs and mitigation;

e. List of individual activities completed and those planned for the current year: Brief description of each maintenance activity performed, and date each activity occurred.

PROJECT LOCATIONS

Location #1 Admiralty Inlet Pilot Tidal Energy

WORK START: January 13, 2014					WORK END: January 12, 2019	
WRIA:	Waterbody:			Tributary to:		
06.9081	Wria 06 Marine			Puget Sound		
1/4 SEC:	Section:	Township:	Range:	Latitude:	Longitude:	County:
All	22	31 N	01 E	N 48.152867	W 122.686162	Island

Location #1 Driving Directions

From I-5 take exit 230 for WA-20 toward Burlington/Anacores/Skagit Airport. Turn left at A Avon Cutoff/WA-20 W. Continure to follow WA-20 W. Turn left to stay on WA-20 W.

Issue Date: January 13, 2014
Project Expiration Date: January 12, 2019

Control Number: 128821-1
FPA/Public Notice #: N/A

Location #2 Admiralty Inlet Pilot Tidal Energy

WORK START: January 13, 2014					WORK END: January 12, 2019	
WRIA:	Waterbody:				Tributary to:	
06.9081	Wria 06 Marine				Puget Sound	
1/4 SEC:	Section:	Township:	Range:	Latitude:	Longitude:	County:
All	22	31 N	01 E	N 48.1533	W 122.68551	Island

Location #2 Driving Directions

From I-5 take exit 230 for WA-20 toward Burlington/Anacores/Skagit Airport. Turn left at A Avon Cutoff/WA-20 W. Continure to follow WA-20 W. Turn left to stay on WA-20 W.

Location #3 Admiralty Inlet Pilot Tidal Energy

WORK START: January 13, 2014					WORK END: January 12, 2019	
WRIA:	Waterbody:				Tributary to:	
06.9081	Wria 06 Marine				Puget Sound	
1/4 SEC:	Section:	Township:	Range:	Latitude:	Longitude:	County:
All	22	31 N	01 E	N 48.160396	W 122.664829	Island

Location #3 Driving Directions

APPLY TO ALL HYDRAULIC PROJECT APPROVALS

This Hydraulic Project Approval pertains only to those requirements of the Washington State Hydraulic Code, specifically Chapter 77.55 RCW (formerly RCW 77.20). Additional authorization from other public agencies may be necessary for this project. The person(s) to whom this Hydraulic Project Approval is issued is responsible for applying for and obtaining any additional authorization from other public agencies (local, state and/or federal) that may be necessary for this project.

This Hydraulic Project Approval shall be available on the job site at all times and all its provisions followed by the person(s) to whom this Hydraulic Project Approval is issued and operator(s) performing the work.

This Hydraulic Project Approval does not authorize trespass.

The person(s) to whom this Hydraulic Project Approval is issued and operator(s) performing the work may be held liable for any loss or damage to fish life or fish habitat that results from failure to comply with the provisions of this Hydraulic Project Approval.

Failure to comply with the provisions of this Hydraulic Project Approval could result in a civil penalty of up to one hundred dollars per day and/or a gross misdemeanor charge, possibly punishable by fine and/or imprisonment.

All Hydraulic Project Approvals issued under RCW 77.55.021 are subject to additional restrictions, conditions, or revocation if the Department of Fish and Wildlife determines that changed conditions require such action. The person(s) to whom this Hydraulic Project Approval is issued has the right to appeal those decisions. Procedures for

appeals are listed below.

MINOR MODIFICATIONS TO THIS HPA: You may request approval of minor modifications to the required work timing or to the plans and specifications approved in this HPA. A minor modification to the required work timing means up to a one-week deviation from the timing window in the HPA when there are no spawning or incubating fish present within the vicinity of the project. You may request subsequent minor modifications to the required work timing. A minor modification of the plans and specifications means any changes in the materials, characteristics or construction of your project that does not alter the project's impact to fish life or habitat and does not require a change in the provisions of the HPA to mitigate the impacts of the modification. Minor modifications do not require you to pay additional application fees or be issued a new HPA. To request a minor modification to your HPA, submit a written request that clearly indicates you are requesting a minor modification to an existing HPA. Include the HPA number and a description of the requested change and send by mail to: Washington Department of Fish and Wildlife, PO Box 43234, Olympia, Washington 98504-3234, or by email to HPAapplications@dfw.wa.gov. Do not include payment with your request. You should allow up to 45 days for the department to process your request.

MAJOR MODIFICATIONS TO THIS HPA: You may request approval of major modifications to any aspect of your HPA. Any approved change other than a minor modification to your HPA will require issuance of a new HPA. If you paid an application fee for your original HPA you must include payment of $150 with your written request or request billing to an account previously established with the department. If you did not pay an application fee for the original HPA, no fee is required for a change to it. To request a major modification to your HPA, submit a written request that clearly indicates you are requesting a major modification to an existing HPA. Include the HPA number, check number or billing account number, and a description of the requested change. Send your written request and payment, if applicable, by mail to: Washington Department of Fish and Wildlife, PO Box 43234, Olympia, Washington 98504-3234. If you are charging the fee to a billing account number or you are not subject to the fee, you may email your request to HPAapplications@dfw.wa.gov. You should allow up to 45 days for the department to process your request.

APPEALS INFORMATION

If you wish to appeal the issuance, denial, conditioning, or modification of a Hydraulic Project Approval (HPA), Washington Department of Fish and Wildlife (WDFW) recommends that you first contact the department employee who issued or denied the HPA to discuss your concerns. Such a discussion may resolve your concerns without the need for further appeal action. If you proceed with an appeal, you may request an informal or formal appeal. WDFW encourages you to take advantage of the informal appeal process before initiating a formal appeal. The informal appeal process includes a review by department management of the HPA or denial and often resolves issues faster and with less legal complexity than the formal appeal process. If the informal appeal process does not resolve your concerns, you may advance your appeal to the formal process. You may contact the HPA Appeals Coordinator at (360) 902-2534 for more information.

A. INFORMAL APPEALS: WAC 220-110-340 is the rule describing how to request an informal appeal of WDFW actions taken under Chapter 77.55 RCW. Please refer to that rule for complete informal appeal procedures. The following information summarizes that rule.

A person who is aggrieved by the issuance, denial, conditioning, or modification of an HPA may request an informal appeal of that action. You must send your request to WDFW by mail to the Washington Department of Fish and Wildlife HPA Appeals Coordinator, 600 Capitol Way North, Olympia, Washington 98501-1091; e-mail to HPAapplications@dfw.wa.gov; fax to (360) 902-2946; or hand-delivery to the Natural Resources Building, 1111 Washington St SE, Habitat Program, Fifth floor. WDFW must receive your request within 30 days from the date you receive notice of the decision. If you agree, and you applied for the HPA, resolution of the appeal may be facilitated through an informal conference with the WDFW employee responsible for the decision and a supervisor. If a resolution is not reached through the informal conference, or you are not the person who applied for the HPA, the HPA Appeals Coordinator or designee will conduct an informal hearing and recommend a decision to the Director or designee. If you are not satisfied with the results of the informal appeal, you may file a request for a formal appeal.

Issue Date: January 13, 2014 | Control Number: 128821-1

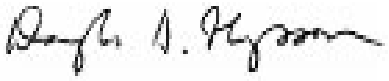
Project Expiration Date: January 12, 2019 | FPA/Public Notice #: N/A

B. FORMAL APPEALS: WAC 220-110-350 is the rule describing how to request a formal appeal of WDFW actions taken under Chapter 77.55 RCW. Please refer to that rule for complete formal appeal procedures. The following information summarizes that rule.

A person who is aggrieved by the issuance, denial, conditioning, or modification of an HPA may request a formal appeal of that action. You must send your request for a formal appeal to the clerk of the Pollution Control Hearings Boards and serve a copy on WDFW within 30 days from the date you receive notice of the decision. You may serve WDFW by mail to the Washington Department of Fish and Wildlife HPA Appeals Coordinator, 600 Capitol Way North, Olympia, Washington 98501-1091; e-mail to HPAapplications@dfw.wa.gov; fax to (360) 902-2946; or hand-delivery to the Natural Resources Building, 1111 Washington St SE, Habitat Program, Fifth floor. The time period for requesting a formal appeal is suspended during consideration of a timely informal appeal. If there has been an informal appeal, you may request a formal appeal within 30 days from the date you receive the Director's or designee's written decision in response to the informal appeal.

C. FAILURE TO APPEAL WITHIN THE REQUIRED TIME PERIODS: If there is no timely request for an appeal, the WDFW action shall be final and unappealable.

ENFORCEMENT: Sergeant Chandler (34) P3

Habitat Biologist Doug Thompson	360-466-4345		for Director WDFW

CC:

Appendix R

NOAA FISHERIES CONDITIONS

NMFS Consultation No: NWR-2013-9742
Biological Opinion

December 3, 2013

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
1201 NE Lloyd Boulevard, Suite 1100
Portland, OR 97232

December 3, 2013

ELECTRONICALLY FILED

Kimberly D. Bose
Secretary, Federal Energy Regulatory Commission
888 First St., N.E., Room 1 A
Washington, D.C. 20426

Re: National Marine Fisheries Service's Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Section 7(a)(4) Conference Report, Section 7(a)(2) Letter of Concurrence with "Not Likely to Adversely Affect" Determination, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation for the Admiralty Inlet Pilot Tidal Project, FERC No. 12690

NMFS Consultation Number NWR-2013-9742

Dear Ms. Bose:

The enclosed document contains a biological opinion prepared by National Marine Fisheries Service (NMFS) pursuant to Section 7(a)(2) of the Endangered Species Act (ESA), on the effects of Federal Energy Regulatory Commission (FERC) issuing a pilot license for the deployment and operation of a pilot tidal energy project by Snohomish Public Utility District, under the Federal Power Act (FPA).

In this opinion, NMFS concluded that the proposed action is not likely to jeopardize the continued existence of Puget Sound Chinook salmon evolutionarily significant unit (ESU); Hood Canal summer run chum salmon ESU; Puget Sound steelhead distinct population segment (DPS); Puget Sound/Georgia Basin canary rockfish; Puget Sound/Georgia Basin yelloweye rockfish; Puget Sound/Georgia Basin bocaccio; Southern Resident killer whales; or humpback whales; or result in the destruction or adverse modification of their designated critical habitats. NMFS also concurred that the proposed action is not likely to adversely affect Southern DPS pacific eulachon or Southern DPS American green sturgeon.

The critical habitat for Puget Sound/Georgia Basin rockfish species has been proposed but is not yet final. When NMFS designates critical habitat for PS/GB Rockfish, FERC may request, in writing, that NMFS to adopt the conference opinion as a biological opinion. If we review the proposed action and find there have been no significant changes to the action that would alter the contents of the conference opinion and no significant new information has been developed (including during the rulemaking process), then we may adopt the conference opinion as the biological opinion on the proposed action and no further consultation will be necessary.

FERC requested consultation for the Eastern Pacific DPS Steller sea lion. However, on November 4, 2013, NMFS published a final rule removing the eastern DPS of Steller sea lions from the List of Endangered and Threatened Wildlife under the ESA (78 FR 66140). The delisting of the DPS is effective as of December 4, 2013, therefore, section 7 consultation is no longer required, and the biological opinion does not analyze the effects of the proposed action on the eastern Steller sea lion DPS.

As required by Section 7 of the ESA, NMFS is providing an incidental take statement (ITS) with the biological opinion. The ITS provides reasonable and prudent measures necessary or appropriate to minimize the impact of incidental take associated with this action. The take statement sets forth nondiscretionary terms and conditions, including reporting requirements, that the Federal action agency must comply with to carry out the reasonable and prudent measures. Incidental take from actions that meet these terms and conditions will be exempt from the ESA's prohibition against the take of listed species, as long as the amount of incidental take authorized by this ITS is not exceeded.

The ITS does not provide take authorization for affected marine mammals (Southern resident killer whale and humpback whale) at this time. In accordance with the Marine Mammal Protection Act, an Incidental Harassment Authorization (IHA) or Letter of Authorization (LOA) is likely to be required for the installation and operation of the project. As IHAs or LOAs are for a limited term (1 or 5 years), it is standard practice for NMFS to issue these authorizations as close to the time when they are needed as possible. NMFS will issue a supplement to the biological opinion to amend the ITS once the IHA or LOA is issued.

This biological opinion also includes the results of our analysis of the action's likely effects on essential fish habitat (EFH) pursuant to Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA). NMFS does not have any MSA conservation recommendations as we have not identified any potential adverse effects on EFH.

Please direct questions regarding this biological opinion to Kim Hatfield, NMFS West Coast Region at 503-231-2315.

Sincerely,

William W. Stelle, Jr.
Regional Administrator

Cc: FERC Service List

UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

Snohomish Public Utility District	**) Snohomish PUD**
	) Admiralty Inlet Tidal Pilot Project
	) FERC No. P-12690

CERTIFICATE OF SERVICE

I hereby certify that I have this day served, by electronic mail, a letter to Kimberly D. Bose, Federal Energy Regulatory Commission from the National Marine Fisheries Service, the Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Section 7(a)(4) Conference Report, Section 7(a)(2) Letter of Concurrence with "Not Likely to Adversely Affect" Determination, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation for the Admiralty Inlet Pilot Tidal Project FERC No. 12690 (NMFS Consultation Number NWR-2013-9742) and this Certificate of Service to each person designated on the official service list compiled by the Commission in the above captioned proceeding.

Dated on December 3, 2013

Bonnie J. Hossack

Bonnie J. Hossack
Administrative Assistant

Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Section 7(a)(4) Conference Report, Section 7(a)(2) Letter of Concurrence with "Not Likely to Adversely Affect" Determination, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation.

Admiralty Inlet Pilot Tidal Project: FERC No. 12690-000
NMFS Consultation Number: NWR-2013-9742
Action Agency: Federal Energy Regulatory Commission

Affected Species and Determinations

ESA-Listed Species	Status	Is Action likely to Adversely Affect Species or Critical Habitat?	Is Action Likely to Jeopardize the Species?	Is Action Likely to Destroy or Adversely Modify Critical Habitat?
Puget Sound Chinook salmon (*Oncorhynchus tshawytscha*)	Threatened	Yes	No	No
Puget Sound Steelhead (*O. mykiss*)	Threatened	Yes	No	No
Hood Canal summer-run chum salmon (*O. keta*)	Threatened	Yes	No	No
Puget Sound/Georgia Basin Bocaccio (*Sebastes paucispinis*)	Endangered	Yes	No	No
Puget Sound/Georgia Basin Canary rockfish (*S. pinniger*)	Threatened	Yes	No	No
Puget Sound/Georgia Basin Yelloweye rockfish (*S. ruberrimus*)	Threatened	Yes	No	No
Southern DPS North American Green Sturgeon (*Ascipenser medirostris*)	Threatened	No	No	No
Southern DPS Pacific Eulachon (*Thaleicthys pacificus*)	Threatened	No	No	No
Southern Resident killer whale (*Orcinus orca*)	Endangered	Yes	No	No
Humpback whale (*Megaptera novaeangliae*)	Endangered	Yes	No	No

Fishery Management Plan that Describes EFH in the Project Area	Does the Action have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Pacific Coast Salmon	No	No
Pacific Groundfish	No	No
Coastal Pelagics	No	No

Consultation Conducted By: National Marine Fisheries Service
West Coast Region

Issued By:

William W. Stelle, Jr.
Regional Administrator

Date: December 3 2013

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Table of Contents

LIST OF FIGURES **5**

LIST OF TABLES **6**

LIST OF ABBREVIATIONS AND ACRONYMS **7**

1. INTRODUCTION **9**

1.1 BACKGROUND 9
1.2 CONSULTATION HISTORY 9
1.3 PROPOSED ACTION 11
1.3.1 Project Facilities 12
1.3.2 Project Installation and Removal 18
1.3.3 Project Operation 20
1.3.4 Project Maintenance 20
1.3.5 Turbine Shut Down 21
1.3.6 Removal of Project Components 22
1.3.7 Proposed Environmental Measures 23
1.3.8 FERC Staff Alternative 39
1.4 ACTION AREA 40

2. ENDANGERED SPECIES ACT: BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT **41**

2.1 APPROACH TO THE ANALYSIS 41
2.2 RANGEWIDE STATUS OF THE SPECIES AND CRITICAL HABITAT 43
2.2.1 Status of Listed Species 44
2.2.2 Status of Critical Habitat 55
2.3 ENVIRONMENTAL BASELINE 59
2.3.1 Tidal Currents 59
2.3.2 Benthic Habitat and Invertebrates 59
2.3.3 Marine Fishes 60
2.3.4 Marine Mammals 61
2.3.5 Vessel Activity 61
2.3.6 Sound 61
2.3.7 ESA-listed species occurrence and habitat use in the action area 62
2.4 EFFECTS OF THE ACTION ON SPECIES AND DESIGNATED CRITICAL HABITAT 69
2.4.1 Anthropogenic Sound 70
2.4.2 Habitat Alteration—Electromagnetic Fields 79
2.4.3 Habitat Alteration - Seafloor Structure 82
2.4.4 Marine debris entanglement 85
2.4.5 Blade Strike 86
2.4.6 Effects of the proposed action on Critical Habitat 95
2.5 CUMULATIVE EFFECTS 98
2.6 INTEGRATION AND SYNTHESIS 98
2.6.1 Salmonids 98
2.6.2 Rockfish 102

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

2.6.3 Puget Sound Chinook Salmon Critical Habitat 105
2.6.4 PS/GB Rockfish Proposed Critical Habitat 105
2.6.5 Marine Mammals (SR Killer Whales and Humpback whales).....105
2.6.6 SR Killer Whale Critical Habitat 107
2.7 CONCLUSION.....107
2.8 INCIDENTAL TAKE STATEMENT 109
2.8.1 Amount or Extent of Take 109
2.8.2 Effect of the Take.....113
2.8.3 Reasonable and Prudent Measures.....113
2.8.4 Terms and Conditions.....114
2.9 CONSERVATION RECOMMENDATIONS.....114
2.10 REINITIATION OF CONSULTATION 115
2.11 "NOT LIKELY TO ADVERSELY AFFECT" DETERMINATIONS 115
2.11.1 Southern DPS North American green sturgeon.....115
2.11.2 Southern DPS Pacific eulachon 115

3. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT CONSULTATION.....116

3.1 ESSENTIAL FISH HABITAT AFFECTED BY THE PROJECT.....116
3.2 ADVERSE EFFECTS ON ESSENTIAL FISH HABITAT.....116
3.3 ESSENTIAL FISH HABITAT CONSERVATION RECOMMENDATIONS 117
3.4 STATUTORY RESPONSE REQUIREMENT 117
3.5 SUPPLEMENTAL CONSULTATION.....117

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW118

4.1 UTILITY 118
4.2 INTEGRITY 118
4.3 OBJECTIVITY.....118

6. APPENDICES.....131

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

LIST OF FIGURES

Figure 1 Location of Admiralty Inlet Pilot Tidal Project....12
Figure 2 Illustration of the OpenHydro turbine 14
Figure 3 OpenHydro turbine plan, side and front view 15
Figure 4 Scaled cross section of Admiralty Inlet and one OpenHydro tidal turbine in the proposed location 15
Figure 5 Conceptual instrumentation layout (fixed and recoverable) on a 4th Generation turbine.16
Figure 6 Transmission cable route Note: Soundings in meters....17
Figure 7 OpenHydro Installation Barge....19
Figure 8 ROV image of cobble pavement bottom in project area 60
Figure 9. Depth distribution of juvenile salmon captured in the Georgia Strait and Puget Sound...63
Figure 10. Probability distribution of sound expected to be produced by a 6-meter turbine in Admiralty Inlet at one meter from the source....72
Figure 11. Distance from project center (mid-point between turbines) to Level B harassment threshold for broadband (25 Hz – 25 kHz) sound levels throughout the range of operating percentiles....76
Figure 12 Magnetic field declines with distance from cable surface.....80

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

LIST OF TABLES

Table 1 SR killer whale sightings in the project vicinity 67

Table 2. Standard grain size classification scheme, the Wentworth scale.....112

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

LIST OF ABBREVIATIONS AND ACRONYMS

AC	Alternating Current
AIS	Automatic Identification System
A/M	Amps per Meter
AMP	Adaptable Monitoring Package
BA	Biological Assessment
BRT	Biological Review Team
CDFO	Canada Department of Fisheries and Oceans
CFD	Computational Fluid Dynamics
CFR	Code of Federal Regulations
CH	Critical Habitat
CHART	Critical Habitat Analytical Review Team
Commission	FERC
CORPS	U.S. Corps of Engineers
dB	Decibel
DDT	Dichlorodiphenyltrichloroethane
DO	Dissolved Oxygen
DOE	Department of Energy
DPM/day	Detection Positive Minutes per Day
DPS	Distinct Population Segment
DQA	Data Quality Act
EA	Environmental Assessment
EFH	Essential Fish Habitat
EMEC	European Marine Energy Center
EMF	Electromagnetic Field Generation
ESA	Endangered Species Act
ESCA	Endangered Species Conservation Act
ESU	Evolutionarily Significant Unit
FEA	Final Environmental Assessment
FERC	Federal Energy Regulatory Commission
FHWG	Fisheries Hydroacoustic Working Group
FLA	Final License Application
GRP	Glass Reinforced Plastic
HAPC	Habitat Areas of Particular Concern
HCSR	Hood Canal Summer-Run
HDD	Horizontal Directional Drill
HUC5	Hydrologic Unit Code Fifth-Field
iE	Induced Electrical
ISAB	Independent Scientific Advisory Board
ITS	Incidental Take Statement
Km	Kilometer
kV	Kilovolt
kW	Kilowatt
kWh	Kilowatt-hours

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

MARC	Marine Aquatic Resource Committee
MLLW	Mean Lower Low Water
MMPA	Marine Mammal Protection Act
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MtDNA	Mitochondrial Deoxyribonucleic Acid
NMFS	National Marine Fisheries Service
NOAA	National Oceanic & Atmospheric Administration
NNMREC	Northwest National Marine Renewable Energy Center
NWSF	Northwest Straights Foundation
Opinion	Biological Opinion
PAM	Passive Acoustic Monitoring
PBDE	Polybrominated Diphenyl Ether
PC	Pacific Crossing
PCB	Polychlorinated Biphenyl
PCE	Primary Constituent Element
PDO	Pacific Decadal Oscillation
PFMC	Pacific Fishery Management Council
PHS	Priority Habitat and Species
PNNL	Pacific Northwest National Laboratory
PNPTT	Point No Point Treaty Tribes
PS	Puget Sound
PSE	Puget Sound Energy
PS/GB	Puget Sound/Georgia Basin
PSSHTRT	Puget Sound Steelhead Technical Recovery Team
PSTRT	Puget Sound Technical Recovery Team
PSWQAT	Puget Sound Water Quality Action Team
PVA	Population Viability Analysis
Re: 1μPa	Reference Pressure of 1 micro-Pascal
RMS	Root Mean Square
ROV	Remotely Operated Vehicle
RPA	Reasonable and Prudent Alternative
RPM	Reasonable and Prudent Measure
SCADA	Supervisory Control and Data Acquisition
SHPO	Washington State Historic Preservation Office
SNL	Sandia National Lab
Snohomish PUD	Snohomish Public Utility District
SPL	Sound Pressure Level
SR	Southern Resident
SR killer whale	Southern Resident killer whale
TRT	Technical Recovery Team
VSP	Viable Salmonid Population
USFWS	United States Fish & Wildlife Services
WDFW	Washington Department of Fish and Wildlife
WDNR	Washington Department National Resources
WDOE	Washington Department of Ecology

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

1. INTRODUCTION

This Introduction section provides information relevant to the other sections of this document and is incorporated by reference into Sections 2 and 3 below.

1.1 Background

National Marine Fisheries Service (NMFS) prepared the biological opinion (opinion) and incidental take statement (ITS) portions of this document in accordance with section 7of the Endangered Species Act (ESA) of 1973 (16 U.S.C. 1536), and implementing regulations at 50 CFR 402.

We also completed an essential fish habitat (EFH) consultation on the proposed action, in accordance with section 305(b)(of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1855(b)) and implementing regulations at 50 CFR 600 subpart K.

The opinion, ITS, and EFH conservation recommendations are each in compliance with the Data Quality Act (DQA) (44 U.S.C. 3504(d)(1) et seq.) and they underwent pre-dissemination review.

1.2 Consultation History

This biological opinion is based on information provided in the biological assessment (BA), revised on April 16, 2012 (Snohomish PUD 2012a); the final license application (FLA) filed with the Federal Energy Regulatory Commission (FERC) February 29, 2012 (Snohomish PUD 2012b) and the Final environmental assessment (FEA), dated August 9, 2013 (FERC 2013) and other sources of information.[1] A complete record of this consultation is on file at the NMFS West Coast Region Office in Portland, Oregon.

The following is a summary of the major steps in the FERC license process and the consultation history. NMFS has been engaged with FERC and the applicant throughout the development of the project offering technical assistance, with particular focus on the monitoring, mitigation and adaptive management plans developed to identify and minimize or mitigate for any adverse effects of the project.

- On December 30, 2009, the Commission issued a notice that Snohomish PUD filed a draft license application for the Admiralty Inlet Pilot Tidal Energy Project.
- NMFS filed a motion to intervene in the license process (NMFS 2010a) and submitted comments on the draft license application (NMFS 2010b)
- Snohomish PUD filed a FLA with FERC on February 29, 2012 (Snohomish PUD 2012b).
- NMFS filed 10(j) recommendations with FERC and included a list of ESA-listed species that may be affected by the project on May 23, 2012 (NMFS 2012).
- FERC requested formal consultation with NMFS on April 23, 2012 (FERC 2012). In the

[1] NMFS conducted abstract searches and literature review for the best available science using the resources available from the NMFS West Coast Region and Northwest Fish Science Center Libraries. NMFS also considered information from the Department of Energy (DOE) Tethys database, the Center for Whale Research and other sources as detailed in the Literature Cited section of this opinion and in the administrative record for this opinion on file in the Portland office of the National Marine Fisheries Service West Coast Region.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

request, FERC requested NMFS' concurrence with their determination that the proposed action was "not likely to adversely affect" Puget Sound Chinook salmon and its designated critical habitat; Hood Canal summer-run chum salmon and its designated critical habitat; Puget Sound steelhead, green sturgeon, bocaccio, canary rockfish, yelloweye rockfish, eulachon, and the North Pacific humpback whale; designated critical habitat for the Southern Resident killer whale (SR killer whale), and the marbled murrelet. FERC determined the proposed action "may adversely affect" the SR killer whale and Steller sea lion.[2] FERC also determined that the proposed action would not adversely affect EFH for any of the species located in the project area.

- On May 23, 2012, NMFS stated in a letter to FERC that formal consultation could not begin until the final monitoring and mitigation plans and the (turbine) blade strike analysis for the SR killer whale were completed (NMFS 2012). The blade strike analysis was completed and filed with the license application on March 1, 2012. On November 19, 2012, Snohomish Public Utility District (Snohomish PUD) filed the final Benthic Habitat, Acoustic, Marine Mammal, and Near-Turbine Monitoring and Mitigation Plans, which the Applicant developed in consultation with NMFS and other agencies. Snohomish PUD revised the Acoustic Monitoring plan and filed the updated version with FERC on February 14, 2013.
- After receiving the additional information NMFS requested, formal consultation began on February 22, 2013.
- On April 18, 2013, NMFS participated via phone in a FERC technical conference regarding Snohomish PUD's change from an electronic braking system to a manual brake, which was a significant change to the proposed in the draft environmental assessment prepared by FERC. Therefore, FERC included the change to the proposed action in their Final Environmental Analysis filed on August 9, 2013, and NMFS needed additional time to evaluate this significant change.
- In accordance with the Department of Commerce Secretarial Order 3206 (U.S. Department of Commerce and Department of Interior 1997),NMFS notified the following Tribal Governments of the ESA section 7 consultation for the proposed license: Jamestown S'Klallam, Lower Elwha-Klallam, Lummi Nation, Muckleshoot, Nisqually, Nooksack, Port Gamble S'Klallam, Puyallup, Samish, Sauk-Suiattle, Skokomish, Squaxin, Stillaguamish, Suquamish, Swinomish, and Upper Skagit by letters dated April 3, 2103 and the Tulalip Tribe in a letter dated April 9, 2013.
- The Tulalip Tribe requested government-to-government consultation in response to NMFS' notification. NMFS met with representatives of the Tulalip Tribe on August 19, 2013 to discuss the proposed action and receive their comments. The Tribe provided verbal comments, which NMFS has considered in its preparation of this biological opinion. NMFS recognizes that the Tribe has concerns that cannot be addressed under this ESA consultation.

[2] Steller sea lions were included in the consultation requested by FERC on April 23, 2013. On November 4, 2013, NOAA Fisheries published a final rule removing the eastern DPS of Steller sea lions from the List of Endangered and Threatened Wildlife under the ESA (NMFS 2013a). The delisting of the DPS becomes effective as of December 4, 2013, therefore, section 7 consultation is no longer required and this opinion does not address the eastern Steller sea lion DPS. The action area for this project does not include any designated critical habitat for Steller sea lion.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Further, NMFS notes that impacts to species not considered in this opinion such as halibut, would likely be identified through the proposed monitoring, which is part of the proposed action and addresses a wider range of marine species than just ones listed under the ESA or included in EFH. NMFS recognizes the Tribe's concerns about their treaty fishing rights however, they cannot be addressed through ESA consultation process.

- The Pacific Northwest National Laboratory (PNNL), in cooperation with Sandia National Laboratory, completed a supplemental analysis that refines the blade strike risk for SR killer whales using new data on the biomechanical properties of SR killer whale tissue. PNNL distributed a memo electronically on July 8, 2013 (PNNL 2013). The supplemental analysis included new data on the biomechanical properties of SR killer whale tissue, which were used to refine the strike model.
- On August 9, 2013, FERC issued a FEA (FERC 2013) for the proposed pilot license. This included a change in the proposed action with respect to the braking mechanism detailed in filings by Snohomish PUD following the Technical Conference held April 18, 2013.
- NMFS met with Tulalip Tribal representatives a second time on November 12, 2013. The Tribe provided verbal comments on the draft opinion, and discussed their comments with NMFS staff. NMFS has considered the comments and this biological opinion was modified where appropriate.

1.3 Proposed Action

"Action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies. Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration. There are no interrelated or interdependent actions.

The proposed action is the FERC's issuance of a 10-year pilot license for the proposed Admiralty Inlet Tidal Project No. 12690. The 600-kilowatt (kW) project to test two tidal power turbines would be located on the east side of Admiralty Inlet in Puget Sound, Washington, about 1 kilometer west of Whidbey Island, entirely within Island County, Washington (Figure 1). The proposed action is detailed in the Snohomish PUD's FLA (Snohomish PUD 2012b) and includes the FERC staff alternative described in FLA (FERC 2013). Although the license term is 10 years, the maximum amount of time that the turbines would be deployed is 5 years (Snohomish PUD 2012a, 2012b)

Any future development of tidal energy projects, including any activities beyond the proposed action for the 10-year duration of the pilot license would be subject to separate review and would need to obtain the necessary permits and authorizations (e.g. FERC license and any other applicable local, state or Federal authorizations). That is, any potential effects of deploying tidal turbines or other equipment beyond the 10-year term of the proposed action are not analyzed in this opinion.

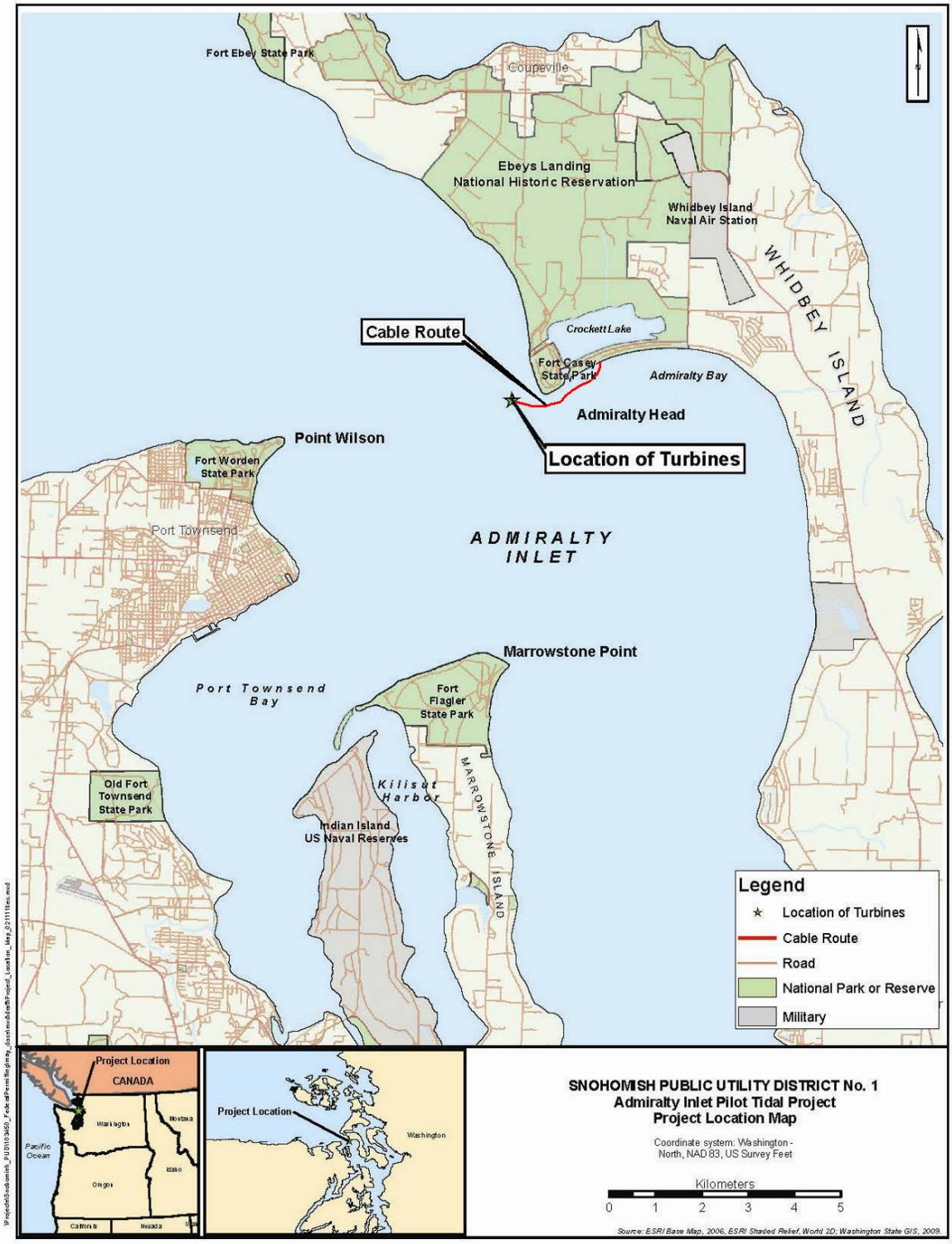


Figure 1 Location of Admiralty Inlet Pilot Tidal Project (Source FERC 2013)

1.3.1 Project Facilities

The Admiralty Inlet Project would consist of: (1) two 300-kilowatt (kW) OpenHydro tidal turbines, each about 6 meters high and mounted on a triangular subsea base, fitted with an adaptable monitoring package for environmental monitoring equipment, instrumentation to monitor turbine

vibration and the potential for differential settlement; (2) two 7,000-foot-long (2,200 meters), 4-kilovolt (kV) trunk cables, one extending from each turbine to the on-shore cable termination vault, each consisting of: a) high-power transmission core cables to transmit power from the turbine to shore; b) single mode fiber optic elements to convey turbine control and monitoring signals and environmental monitoring data between the turbines and the on-shore facilities; and c) low-power elements to provide power to the turbine control and monitoring system at the turbines; and (3) on-shore appurtenant facilities. The estimated annual generation of the project would be 244,000 kilowatt-hours (kWh).

1.3.1.1 Tidal Energy Devices

The OpenHydro turbine features a horizontal axis rotor with power take-off through a direct drive, permanent magnet generator (Figure 2). It is principally comprised of three components:

- Turbine rotor, which is an assembly of glass reinforced plastic (GRP) components including blades, inner and outer rings;
- Stator (generator), which is constructed from structural steel and GRP; and
- The external venturi (duct) which attaches to the stator and assembled from GRP or steel.

Each turbine would have a diameter of 6 meters and would be rated between 250-400 kW. The rotor on each turbine would have 10 blades (and the tips of the blades would be enclosed; see Figure 2). The actual diameter of the rotor (which comprises the blades and the center ring where they are attached) is about 4.7 meters. The rotor has an open center of about 2 meters. The following are the approximate dimensions of the turbine structures:

- Height of turbine structure (including foundation) - 13 meters above the seabed,
- Centerline of turbine - 10 meters above the seabed.

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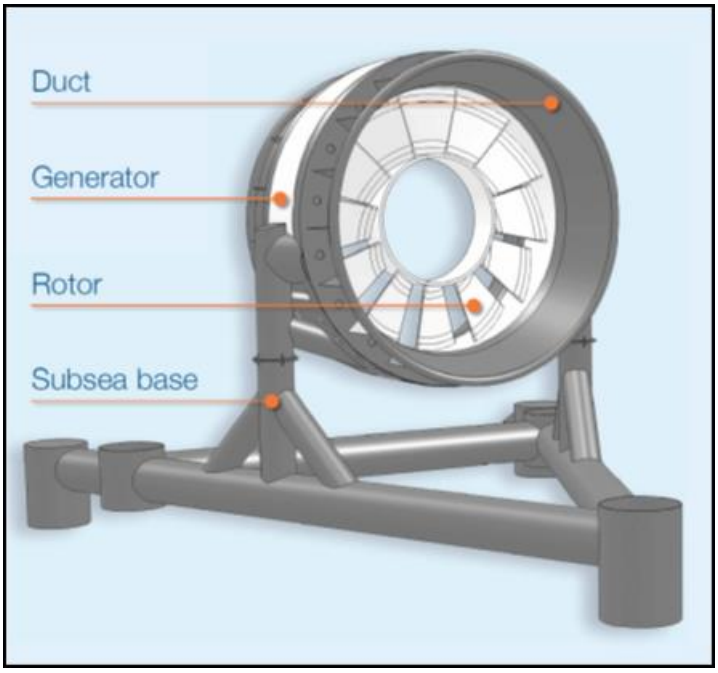

Figure 2 Illustration of the OpenHydro turbine (Source: FERC 2013)

1.3.1.2 Foundation

The turbines would be installed directly on the seabed at a depth of about 55 to 58 meters, with no part of the structure visible above the surface of the water. The subsea base would consist of a steel tubular frame filled with concrete and stone ballast. The base requires no pinning, piling, or drilling to secure the unit to the seabed. The structure would be weighted sufficiently to resist overturning and lateral forces.

The triangular foundation would be about 19.2 meters in length along a side and about 18.0 meters in total width. The total seabed interface area (contact footprint) for each turbine would be about 10 square meters. Figure 3 shows the plan, front, and side elevation views of the 6-meter turbine and subsea base.

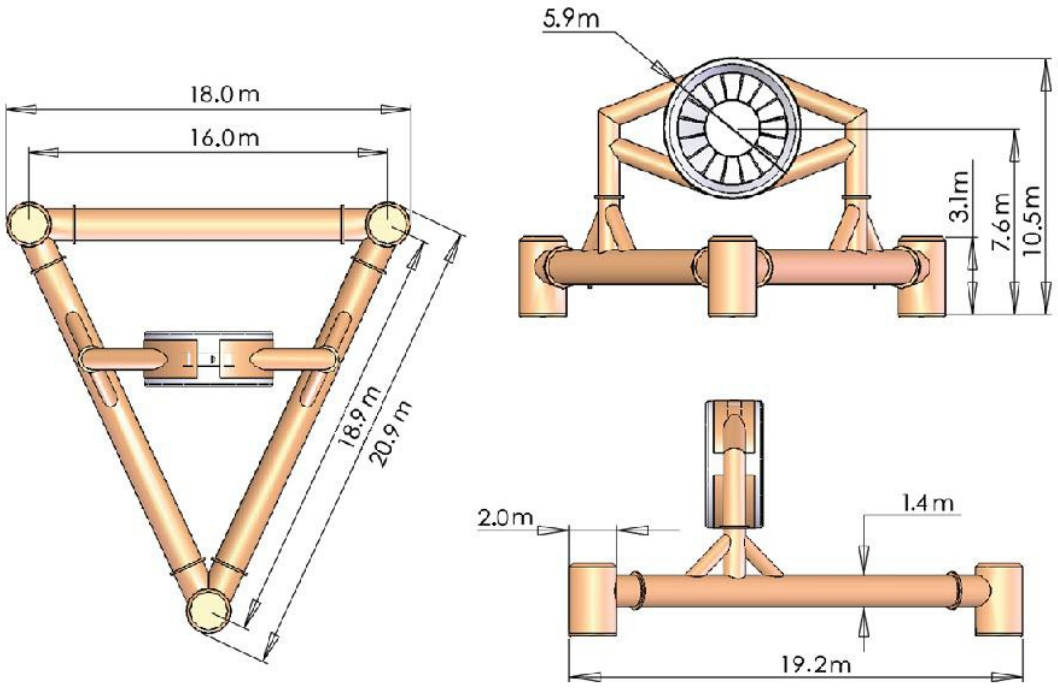

Figure 3 OpenHydro turbine plan, side and front view (Source: FERC 2013)

The total area occupied by the two turbines represents about 0.05 percent of the cross -sectional area of Admiralty Inlet. Figure 4 shows a scaled cross -section of Admiralty Inlet with one OpenHydro turbine depicted.

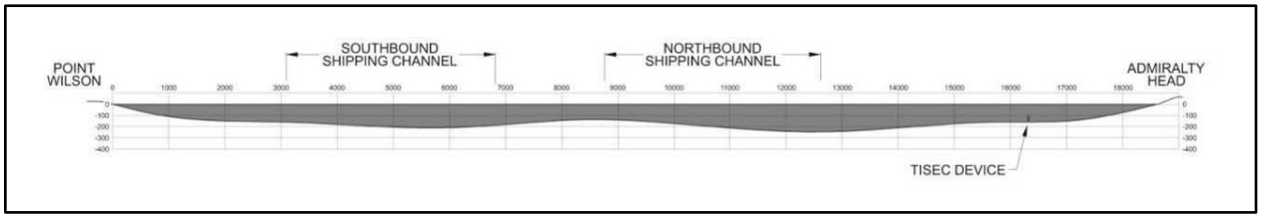

Figure 4 Scaled cross section of Admiralty Inlet and one OpenHydro tidal turbine in the proposed location (Source: Snohomish PUD 2012a)

The mass of the subsea base would depend on site conditions. Snohomish PUD estimates that the combined turbine and subsea base would have a total submerged weight of 253 metric tons, or a total dry weight of 386 metric tons.

No seabed preparation, multiple operations or drilling, piling or pinning work would be required. The subsea base foundation would be designed to penetrate the cobbled top layer of seabed to a depth no greater than 0.5 meters.

The turbine structures include an adaptable monitoring package (AMP) designed to support the monitoring and mitigation activities detailed in section 1.3.7. This is a collection of instruments including high-definition cameras and strobe lights along with other data collection components. Each turbine would have an AMP installed on the turbine structure as shown in Figure 5.

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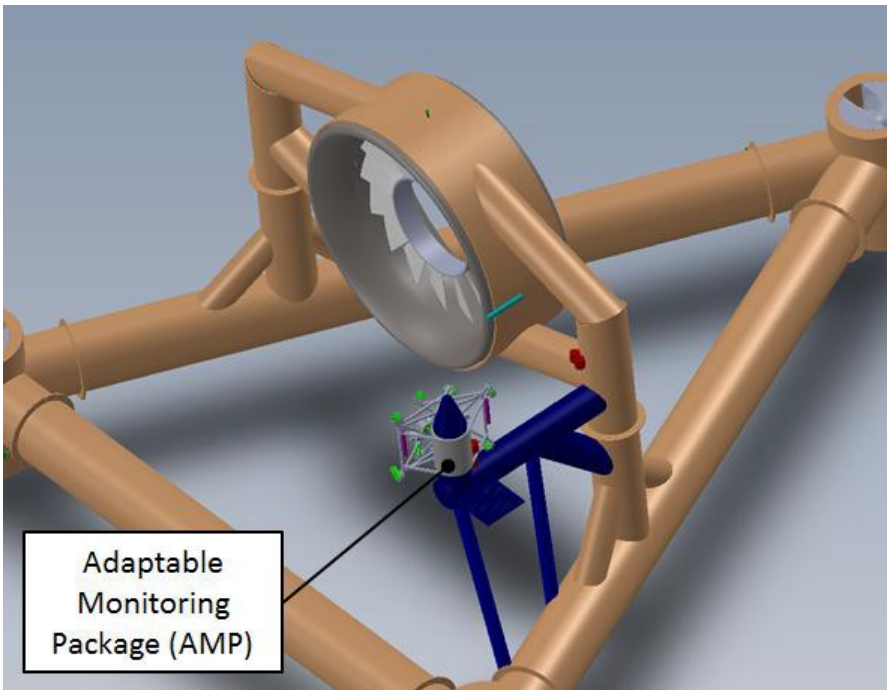

Figure 5 Conceptual instrumentation layout (fixed and recoverable) on a 4th Generation turbine[3]
(Source: Snohomish PUD 2012a)

1.3.1.3 Subsea Trunk Cables

The project would transmit electrical power generated from the OpenHydro turbines to the onshore electrical grid via two parallel subsea trunk cables. The cables would connect through the proposed control room to Puget Sound Energy's (PSE) electrical transmission grid. The shore landing, control room, and connection to the PSE grid are all on a private land holding within the Ebey's Landing National Historic Reservation, just east of Admiralty Head (section 1.3.1.4). The general configuration of the cable route and shore landing is shown in Figure 6. The two trunk cables would be routed through a single horizontal directional drill (HDD) bore from on land to a minimum depth of 18 meters. From the underwater HDD exit, the cables would continue on the surface of the seabed about 2 Km to the turbines.

[3] Although the image shown is a 4th generation turbine, the general dimensions of the subsea base and support structure are representative of the turbines that would be deployed in Admiralty Inlet.

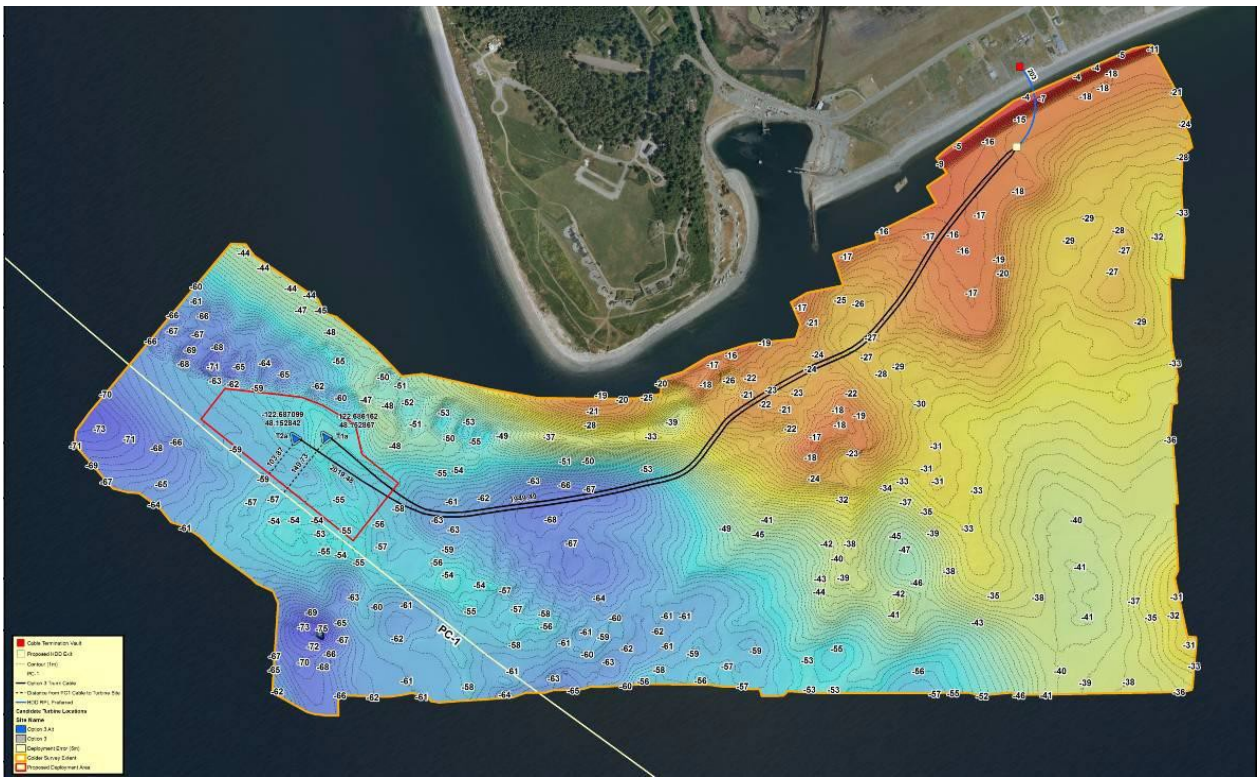

Figure 6 Transmission cable route Note: Soundings in meters (Source: FERC 2013)

The trunk cables would transmit power at 6 kV (or less), 3 phase Alternating Current (AC) on three dedicated cores in the trunk cables. Turbine control and monitoring signals and environmental data would be transmitted on dedicated single mode fiber optic elements within the trunk cables. Low voltage power for the turbine control and the environmental monitoring systems are provided by dedicated low power (2 kV or less) elements in the trunk cables.

The trunk cables would be installed from the turbines to the HDD exit point immediately following the turbine installation. The trunk cables are installed parallel to each other along the seabed surface for about 2 km. The cables would be installed separately, about two weeks apart due to the turbine installation sequence. About 180 meters from the turbines, each cable would have a cable connector that would allow for turbine disconnection and removal.

The cables are specifically designed with a high specific gravity to prevent movement on the sea floor given the high currents along the route. For reference, the cable used with the OpenHydro turbine deployed at EMEC had a submerged weight of 18.4 kilograms per meter and is of the same dimensions as the cable proposed for Admiralty Inlet. If there are areas where the cables would be suspended across depressions in the seabed or where gravel or sand waves are present, it could be pinned to the bottom with weighted sacks or other cable stabilization techniques used in the industry (FERC 2013).

1.3.1.4 Terrestrial Transmission Line and Grid Interconnection

Terrestrial components of the project would be located on private land:

- Shore landing cable leading to the Cable termination vault,
- Cable termination vault,
- Underground cable from the cable termination vault to the control room,
- Control room, and
- Underground cable from the control room to the PSE grid

1.3.2 Project Installation and Removal

The installation process would begin with the construction of the on-shore power control building, followed by HDD operations as detailed in the FLA HDD plan (Snohomish PUD 2012b). In summary, a drilling assembly comprised of the drill head and a drill string would be forwarded from the landside to the marine side exit point. The drill string would deliver Bentonite and clay drilling fluid that would be used as a lubricant for the drill head. As the drill assembly approached the exit point, this fluid would be replaced by water to achieve a mud-free exit. The void created by the drill string would be reamed as required to create a space suitable for conduit installation. Once the desired space is achieved, the conduit would be lowered from a vessel positioned near the exit point into the water and pulled through the void. The contractor would have the choice to either install one large conduit with a minimum of two sub-ducts or install two smaller conduits in separate drilling operations. The completion of the HDD would result in two conduits from shore to the pre-determined exit point. The entire HDD process would last about 45 days and includes the time to deploy, drill, demobilize, and conduct land restoration at the onshore location.

The cable laying process would begin during the flood tide. Two tugboats would be used to direct the cable laying barge from the turbine site toward shore over the cable route to the HDD sea floor exit point. A third tugboat would provide standby assistance in case of a problem with one of the other two tugboats. A remotely operated vehicle (ROV) would inspect the laying of the trunk cable along the sea floor. Once the trunk cable is close to the HDD sea floor exit point, the cable-laying barge would be anchored. The cable-laying barge would then pay out the remaining cable using floats to keep it on the surface. Assist boats would guide the trunk cable to the HDD sea floor exit point, where it would be attached to a pulling cable and pulled through the conduits to shore. Divers would monitor the trunk cable installation through the HDD conduit. After the trunk cables are pulled through the conduit and exit on shore, they would connected to the cable termination vault. At sea, installation of the cables, which occurs concurrently with the installation of the turbines, would take up to 6 days.

The turbines would be installed when conditions are deemed optimal. Optimum conditions for installation include a tidal speed of less than 1.5 knots and wind speed less than 20 miles per hour, and any other criteria defined in a post-licensing Hazard Identification and Risk Assessment. The installation process would be the same for both turbines, but would occur about 30 days apart. The project's installation would require a turbine installation barge (see Figure 7), two tugboats, an ROV with its own support vessel, and small support vessels. The turbine would be suspended in the center of the turbine installation barge. The turbine installation barge would be towed to the installation site by a tugboat during the ebb tide. The second tugboat would provide standby assistance to the first tugboat, if needed. Once the turbine installation barge is centered over the installation site, winches

onboard would slowly lower the turbine to the sea floor. An ROV would monitor the final placement of the turbine on the sea floor. The installation process for each turbine is expected to take less than one hour; the entire operation, which occurs concurrently with the cable laying, would take place over a period of up to 6 days.

An umbilical cable stored on the turbine would be connected to the previously installed trunk cable within 24 to 48 hours of turbine deployment. Each cable would be retrieved and brought aboard a barge where their flanged termination housings would be connected and then redeployed. The cable connection would require a construction barge, three tugboats, and an ROV with its own support vessel. Two tugboats would control the positioning of the barge during the cable connection operation. The third would provide standby assistance in case of a problem with one of the other tugboats. The flanged termination housings on the end of each cable would be connected and tested by personnel in the completed on-shore control building. The housing would be lowered to the seafloor by a tag line from the barge. The tugboats would direct the barge during redeployment to position and control the tension in the connected cables. The ROV would monitor the touchdown and record the final position of the housing and cables. The cable connection and redeployment operation is expected to take less than two hours for each turbine.

Figure 7 OpenHydro Installation Barge (Source: FERC 2013)

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Snohomish PUD proposed a Project Removal and Site Restoration Plan that details how the turbines, subsea bases, and other equipment would be removed at the conclusion of the 10-year license. The turbines and subsea bases would be removed by reversing the installation process. Snohomish PUD would either leave in place or remove the trunk cables based on recommendations from the Marine Aquatic Resource Committee (MARC; section 1.3.7.1). Snohomish PUD would remove all on-shore equipment according to the terms of the agreement(s) between Snohomish PUD and the private land owners. Snohomish PUD would also remove the terrestrial transmission line and other transmission equipment in accordance with the terms of the agreement with Puget Sound Energy. The control building would be converted to a garage for the adjoining residence.

1.3.3 Project Operation

The proposed project would operate using the natural tidal currents of Admiralty Inlet to turn two turbines to generate power. The OpenHydro System is designed to generate electrical output during a range of water currents present in a full tidal cycle, operating in a stationary orientation in both ebb and flood tides. The turbine converts the kinetic energy of water flowing in currents from 0.7 meters per second (m/s) to 3.4 m/s into rotational motion and delivers that energy through the rotors into the generator. The turbines will rotate about 70 percent of the time[4]. The turbines would be deployed for up to 5 years during the 10-year license term.

Manual controls located in the control building and remote web-based monitoring would be provided for turbine and grid connection functions. The system would be monitored continuously by Snohomish PUD personnel via an internet connection. Snohomish PUD would monitor real-time information on turbine operations transmitted to the control building through the fiber optic cables within the trunk cables. They would monitor electrical parameters of each turbine and would also monitor pre-set automatic alarm thresholds locally in the control room or remotely using the internet connection. A three-axis orthogonal accelerometer or approved alternate instrument would be mounted on the turbine to measure vibration in the x, y, and z axes, and would signal the operator to initiate shut down of the turbine(s) if excessive vibration is measured. An integrated tilt sensor or approved alternate instrument would be mounted on the turbine subsea base to monitor for any differential settling.

Snohomish PUD personnel would monitor for system alarms 24 hours per day, 7 days per week. Depending on the severity of the alarm, Snohomish PUD personnel would evaluate in real time whether any provisions of the project safeguard plans, such as shut down of the turbines should be implemented.

1.3.4 Project Maintenance

Although the OpenHydro turbines are designed to operate reliably with low maintenance demands, Snohomish PUD proposes to carry out monitoring, inspection, and maintenance measures for the term of the license. Snohomish PUD's staff or contractors would analyze data from the control systems and monitoring equipment on each turbine to detect any anomalies in configuration or operations. This effort would continue throughout the term of the installation. Snohomish PUD would use ROVs to inspect the installation four times during the first year and two times during each

[4] The turbines require a minimum current velocity of 0.7 m/s to operate. Velocities in the proposed turbine location are below this about 30 percent of the time (Snohomish PUD 2012a).

additional year of installation. They would assess the overall structural integrity of each turbine and its base, biological growth on the turbines and bases, condition of the turbine blades, condition of the anodes, position of the turbines on the sea floor, and the position and condition of the trunk cables.[5] Five years after deployment, the turbines would be removed from the water. All mechanical and electrical parts would be inspected and repaired or replaced as needed. The adaptable monitoring package (AMP), which is integral to the monitoring and mitigation plans (section 1.3.7.1) is attached to each turbine and would be recovered and redeployed using an ROV every three to six months as part of the standard maintenance cycle.

Inspection and maintenance documentation would be integral to the project and would be used to determine if modification of maintenance intervals or activities is warranted for the Admiralty Inlet project after the first two years of deployment. Maintenance records would be reviewed for any evidence that the system has degraded. A dedicated computer and data collection program would maintain records of maintenance and would include a real-time operational display and historical charts. The data would be available at remote locations over the internet. A schedule would be developed for periodic database archival.

As proposed by Snohomish PUD in the Project and Public Safety Plan, unscheduled maintenance operations could be triggered by a failure of the environmental monitoring equipment or an operational or structural problem with the turbine. In this type of an event, Snohomish PUD would likely use an ROV to inspect the turbine or equipment before making a decision on how to proceed. Snohomish PUD would mobilize an ROV, which would take one to four days. In the event that a component of the environmental monitoring equipment needed replacement, an unscheduled maintenance event to recover the AMP and replace it with a spare unit would take about 30 minutes once the ROV is deployed and the window for the repair to occur (dictated by appropriate tidal and weather conditions and the availability of a vessel) would be about one week. In the event a turbine failed, or the environmental monitoring equipment failed at a point between where the AMP connects to the power source and the shore, the turbine would be recovered to the surface as described in the Emergency Shutdown Plan and the Project Removal and Site Restoration Plan.

1.3.5 Turbine Shut Down

Snohomish PUD proposes in their Emergency Shutdown Plan to carry out the following procedures when a shutdown is required: (1) engage a mechanical brake via an ROV during the next slack tide with favorable ocean conditions (as detailed below), which would lock the turbine rotor in position and cease electrical generation; (2) electrically isolate the subsea systems from the grid; and (3) file a report with the Commission, agencies, and tribes detailing the measures undertaken during the shutdown.

[5] Inspections would be conducted on the following schedule: (1) immediately following installation of the tidal array; (2) following 1 month of operation; (3) following 3 months of operation; (4) following 6 months of operation; (5) following 9 months of operation; (6) following 12 months of operation; (7) following 18 months of operation; and (8) following 24 months of operation.

The most likely reasons that turbine rotation would need to cease occur under four circumstances, which are provided in Snohomish PUD's adaptive management procedures, are: (1) if a killer whale in the Salish Sea is found to have lacerations or discolorations within a week of a known transit through Admiralty Inlet, and a veterinarian and the MARC determine that the injuries may have been caused by the project; (2) if acoustic monitoring indicates received noise levels have the potential to injure marine mammals; (3) if monitoring suggests injuries or mortality of listed species beyond the levels considered in this biological opinion; and (4) if monitors detect vibration or differential settling in excess of design thresholds.

The initial proposed action included an electronic brake that would be engaged within 6-12 hours of a decision to shutdown, depending on tidal currents. However, OpenHydro and Snohomish PUD have determined that the use of an electronic braking system is no longer feasible due to advances in the OpenHydro turbine technology, which have increased turbine efficiency and power output. The electronic brake would not fully stop the turbine blades during higher tidal velocities, allowing the turbine blades to spin at a reduced speed and in the process, overheating and damaging the generator so that the unit was inoperable. The manual brake system, Snohomish PUD has proposed, would allow for a complete stop of the turbine blades under all tidal conditions without loss of subsequent power production capabilities (Snohomish PUD 2013a).

Snohomish PUD considered, but dismissed the use of an automated mechanical brake because of risk of damage from an unintended application of the brake. Snohomish PUD has experienced multiple events of unintended triggering of mechanical controls on sampling devices. Therefore, Snohomish PUD revised its proposed shutdown plan to include the use of a mechanical brake engaged by an ROV. The manual brake would completely stop all rotation of the turbine blades. This modification is included in the proposed action in the Final Environmental Assessment (EA) filed by FERC (FERC 2013).

As with the electronic brake, the mechanical break would have to be applied at slack tide, which could fall as much as five or six hours after a decision to shut down the turbines is made. The ROV will also need time to be brought to the site and deployed. Snohomish PUD estimates that 97% of the time, the brake would be engaged within 72 hours of a decision to stop the blades (Snohomish PUD 2013b). Although due to the sea conditions required to deploy the ROV and engage the manual brake, it could take up to four days to complete the shutdown.[6]

1.3.6 Removal of Project Components

After the 5 years of operation, project removal (before the end of the 10-year term of the pilot license) would be done in reverse of the installation process described above. Turbine removal, either at the end of the 5-year deployment or for any other purposes could take up to four weeks because it would require the installer barge and associated equipment and crew to be mobilized and acceptable tidal and weather conditions.

[6] Based on tidal current measurements and sea state conditions between August 2011 and May 2012, Snohomish PUD estimates that the probabilities that the mechanical brake for both turbines would be engaged within 24, 48, 72, and 96 hours of the decision to engage the brake are 90%, 97%, 99%, and 99.7%, respectively (Snohomish PUD 2013b).

1.3.7 Proposed Environmental Measures

Snohomish PUD proposes to construct and operate the project with the following environmental protection, mitigation, and enhancement measures:

- To monitor environmental effects, identify corrective actions, and mitigate for project effects, Snohomish PUD will carry out: (1) an Acoustic Monitoring and Mitigation Plan; (2) a Benthic Habitat Monitoring and Mitigation Plan; (3) a Marine Mammal Monitoring and Mitigation Plan; (4) a Near-Turbine Monitoring and Mitigation Plan; (5) a Derelict Gear Monitoring and Mitigation Plan; and (6) a Water Quality Monitoring and Mitigation Plan.
- To provide coordination, data reviews, and implementation of the above monitoring and mitigation plans Snohomish PUD will follow an Adaptive Management Framework that includes conferring with MARC, and receiving NMFS' approval, where appropriate.
- To avoid eelgrass beds and other sensitive near-shore habitats, Snohomish PUD will carry out a Horizontal Directional Drilling Plan that would deploy trunk cables from on land to a minimum depth of 18 meters off-shore.
- To minimize the introduction and spread of invasive plants on the land-based portion of the transmission line and around the control building, Snohomish PUD will carry out the following measures during site construction and project removal: (1) use gravel, rock, or other fill material from a weed free source; (2) revegetate disturbed areas with species native to Keystone Spit, with the source material (seeds or cuttings) collected from Keystone Spit; (3) ensure that no imported soil, fertilizer, or amendments will be used in revegetating disturbed areas; and (4) inspect any fill and disturbed areas for invasive plants annually, between early and mid-June and again in August, and eradicate any detected invasive plants promptly.
- To avoid adverse effects on marine fish species, Snohomish PUD will conduct marine installation during a Washington Department of Fish and Wildlife (WDFW) approved work window of July 16 to October 14, or outside this work window only by agreement with the MARC.
- To educate the public about the project, the potential ocean energy resource in Puget Sound and the natural and cultural environment of the project area, Snohomish PUD will develop and carry out an Interpretation and Education Plan that includes installation of an interpretive display at Snohomish PUD's headquarters or at another appropriate location agreed upon with stakeholders.
- To ensure safe operation of the project and protect the public, Snohomish PUD will carry out: 1) a Project and Public Safety Plan; 2) a Navigational Safety Plan; and 3) an Emergency Shutdown Plan.
- To avoid harming PC Landing's[7] international fiber optic cable (PC-1 North), located near the site, Snohomish PUD will conduct turbine installation and monitoring using "live-boat" techniques (i.e., without anchoring) and prepare and carry out a Hazard Identification and

[7] Pacific Crossing (PC) Landing Corporation owns a network of trans-pacific communications cables, including cables routed through Admiralty Inlet in Puget Sound.

Risk Assessment, developed in consultation with the U.S. Army Corps of Engineers (Corps), Coast Guard, and PC Landing, prior to marine operations that includes: (a) setting criteria for weather and wave conditions that must exist before marine operations occur; (b) using industry-approved equipment and redundancy in the use of equipment and vessels (e.g., tugboat with back-up engine; back-up tugboat for emergencies; towing gear, barge, winches, winch wire, and hydraulic lifting tools new or certified based on industry standards); (c) setting criteria for aborting operations; and (d) identifying an established "port of refuge," located away from PC-1, in the event of unanticipated adverse weather or other events that would cause installation or operations to be aborted

- To restore the project site to a pre-project condition at the end of the license term, if a new license is not sought or obtained, Snohomish PUD will carry out a Project Removal and Site Restoration Plan.

1.3.7.1 Adaptive Management and Mitigation Framework

Adaptive management to avoid, minimize and mitigate for potential impacts to ESA-listed marine species is a critical component of the proposed action. As noted above, Snohomish PUD has committed to carrying out adaptive management of the site based on results of pre- and post-installation monitoring. Snohomish PUD proposes to use an adaptive management framework (Appendix A of this opinion to modify project operations and monitoring and mitigation plans based on preliminary results. This adaptive management strategy would entail implementing and reviewing the various monitoring and mitigation plans with MARC consisting of representatives from state and Federal agencies and Tribes, including NMFS.

The purpose of MARC is to advise Snohomish PUD on aquatic resource issues related to construction, monitoring, and operation of the Admiralty Inlet Pilot Tidal Project. As a component of this purpose, the MARC would advise Snohomish PUD on implementation of the following monitoring and mitigation plans: (1) the Marine Mammal Monitoring Plan; (2) the Near-Field Monitoring Plan; (3) the Derelict Gear Monitoring and Removal Plan; (4) the Benthic Habitat Plan; and (5) the Acoustic Monitoring Plan.

Key functions of the MARC would be to:

- Review the results of studies, including pre-installation and monitoring, (e.g., interim, quarterly, annual, or final reports), and determine whether results are properly characterized;
- Use study results or other sources of new information to determine whether a change to project monitoring (e.g., study design, methods, or duration) is warranted or if existing monitoring approaches continue to be appropriate;
- Evaluate, propose an alternative, and/or approve, any changes in plans made by Snohomish PUD in response to studies; and
- In the event effects are identified that require modification to project operation or monitoring, provide Snohomish PUD with recommended measures to avoid, minimize, or mitigate for the effects.
- In the event that adverse effects are identified that require immediate response, provide Snohomish PUD with actions to address these effects.

The Adaptive Management Framework identifies the committee members, specifies the roll of the MARC, and details how the MARC shall conduct meetings. The framework also describes how members are to participate in the adaptive management process through deliberations, and how disputes will be resolved.

Snohomish PUD will follow the procedures described in the Adaptive Management Framework when conferring with the MARC on implementation of the Monitoring and Mitigation Plans and considering how to address the monitoring results. The framework and specific plans are included as Appendices A – F of this document and are part of the proposed action considered in this opinion, incorporated in their entirety, by reference here.

1.3.7.2 Monitoring and Mitigation Plan Summaries

The following section focuses on key features of the monitoring and mitigation plans. The hypotheses and objectives from the Monitoring and Mitigation Plans filed with FERC as a part of the FLA, and the revised plans filed with FERC on November 16, 2012 and February 14, 2013 are provided below along with the adaptive management triggers for each plan. As this section provides a summary of the plans, if there are any discrepancies, the language of the plans filed with FERC supersedes this summary. Any changes to or modifications of the approved monitoring and mitigation plans and mitigation actions requires NMFS' review and approval before filing with FERC.

Each of the plans combines three aspects of necessary mitigation in one document. Mitigation is achieved through first gathering information on project effects, then analyzing the information relative to the specific triggers in each plan. These triggers are thresholds for an effect on marine resources that requires implementation of the appropriate mitigation measures in the relevant plan. Thus, each plan is a package consisting of the three aspects, monitoring, adaptive management considerations (including mitigation triggers), and the mitigation for project effects.

ACOUSTIC MONITORING AND MITIGATION PLAN

As a means to ensure that the License provides proper resource protection, the goal of the Acoustic Monitoring and Mitigation Plan is to measure and describe the sound profile of the project and to modify the project or monitoring plan, or both, based on results of monitoring. To accomplish this, Snohomish PUD would investigate two hypotheses:

- Hypothesis 1: Turbine sound will vary with power generation state
- Hypothesis 2: Turbine sound may demonstrate a long-term variation due to wear on bearings or biofouling of the rotor and shroud.

Data to address these hypotheses would be collected by drifting hydrophones on the surface and cabled hydrophones on the turbine foundation, respectively. This information is essential to estimate the exposure of marine animals to turbine noise.

Reporting, Mitigation and Adaptive Management

Snohomish PUD would follow the procedures described in the Adaptive Management Framework when conferring with the MARC to consider modification of the project and/or this Plan in response to the results of acoustic monitoring efforts. This would include considering results from monitoring efforts and subsequent adjustments to monitoring, project operation, and removal methods. NMFS

would use the results of the Acoustic Monitoring and Mitigation Plan to evaluate the assumptions contained in its analyses under the Marine Mammal Protection Act (MMPA) and the Endangered Species Act.

The proposed Acoustic Monitoring and Mitigation Plan include the following specific triggers and mitigation actions.

Acoustic Adaptive Management and Mitigation Trigger 1:
If acoustic monitoring (drifting surveys or long-term monitoring) indicate received sound levels at any distance from the operating turbines has the potential to injure[8] marine mammals, Snohomish PUD will modify project operations to ensure that received levels are below this threshold. Snohomish PUD will develop modifications in consultation with the MARC and will obtain NMFS' approval for any specific mitigation measures. Until the modifications are implemented, Snohomish PUD will engage the manual brake on the turbines or take other actions to reduce received levels to below the Level A harm threshold. Snohomish PUD may also need to modify its monitoring plan if the information shows this is necessary for proper resource protection purposes.

Acoustic Adaptive Management and Mitigation Trigger 2:
If post-installation characterization surveys identify a larger area than the pre-installation estimate within which received sound levels exceed thresholds for Level B Harassment,[9] Snohomish PUD will coordinate with the MARC to determine if modifications to project operations are necessary to reduce the ensonified area to be consistent with the MMPA Authorization.[10] Snohomish PUD will develop modifications to the project and/or monitoring plan in consultation with the MARC, and will obtain NMFS' approval for any specific mitigation measures.

Acoustic Adaptive Management and Mitigation Trigger 3:
Within 120 days of completion of the surveys to characterize the turbines' sound profile, Snohomish PUD will present a final report to the MARC. The MARC will review this information and determine whether acoustic information is sufficient for decision-making purposes or whether additional data collection is required to ensure proper resource protection. If the MARC determines that additional data is needed, Snohomish PUD will collect the additional information.

Acoustic Adaptive Management and Mitigation Trigger 4:
Following the first quarter of turbine operation, turbine sound statistics will be reviewed by the MARC to establish triggers for further adaptive management (i.e., determine the level of increase recorded by long-term monitoring that triggers further analysis for shifts in the underlying ambient noise).

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[8] MMPA Level A threshold for sound is 180 dB_{rms} SPL for cetaceans and 190 dB_{rms} SPL for pinnipeds. Level A harassment is any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or marine mammal stock in the wild.

[9] MMPA Level B harassment is currently considered to occur for all exposures to sound above 120 dB_{rms} SPL. Level B harassment is defined as any act of pursuit, torment, or annoyance which has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering.

[10] Take authorization under the MMPA is a separate authorization from this ESA consultation. MMPA consultation must be completed and any necessary authorization obtained before project operations begin.

Acoustic Adaptive Management and Mitigation Trigger 5:
Based on the results of the turbine noise characterization, the MARC will establish a high-frequency limit for reporting root mean square (rms) sound pressure levels (SPL) for the four functional hearing groups of marine mammals.

By June 30 of each year of the license, Snohomish PUD will develop and file with the Commission an annual report fully describing its implementation of the Acoustic Monitoring and Mitigation Plan during the previous calendar year, the results of the monitoring, and a list of the proposed monitoring and mitigation activities during the current calendar year. Snohomish PUD will develop the report in consultation with the MARC. The Annual report will provide the following:

- A summary of actions implementing the Plan, including any modifications to the project, and the results of monitoring pursuant to this Plan.
- A summary of any issues or concerns identified by Snohomish PUD or other members of the MARC during the year regarding implementation of the Acoustic Monitoring and Mitigation Plan and results of the monitoring.
- A list of any changes to the Acoustic Monitoring and Mitigation Plan proposed by the MARC and how Snohomish PUD will address those proposed changes.
- A list of Acoustic Monitoring and Mitigation Plan activities planned for the current and next year.

As provided in the Adaptive Management Framework, the MARC will have at least 30 days to review and comment on a draft of the report prior to Snohomish PUD filing with the Commission (FERC). Modifications to the Acoustic Monitoring and Mitigation Plan will be implemented upon the Commission's approval. Snohomish PUD will provide copies of the final annual report to the members of the MARC. Snohomish PUD will also file MARC comments with the report itself.

MARINE MAMMAL MONITORING AND MITIGATION PLAN

The goal of the Marine Mammal Monitoring and Mitigation Plan is to detect and observe marine mammals in the project area, during turbine installation, operations, and removal in order to provide information about potential avoidance of the turbines, attraction to the turbines, or changes to an individual's activity state in response to the turbine. Another goal is to use this information to modify the project, if needed, to provide mitigation and resource protection.

The plan seeks to test three hypotheses, and, in doing so, reduce uncertainty around the interactions between marine mammals and tidal turbines. The hypotheses address three functional groups of marine mammals: pinnipeds[11] (specifically harbor seals and Steller sea lions), harbor porpoise,

[11] Pinnipeds were considered in the development of the monitoring and mitigation plans because the eastern DPS Steller sea lions were listed under the ESA until recently and because of need for permitting the project under the MMPA. Although the proposed license has elements that address effects on pinnipeds, they are not considered in our analysis of effects under ESA section 7(a)(2).

and killer whales (listed Southern Residents and unlisted transients). These species represent groups present in the project area at levels sufficient to allow robust analyses (Tollit et al., 2010a).

- Hypothesis 1: Pinnipeds may respond to the acoustic stressors from turbine operations or prey aggregations through attraction or avoidance.
- Hypothesis 2: Harbor porpoise may respond to the acoustic stressors or prey aggregations through attraction or avoidance. Their high rate of occurrence in the project area provides an opportunity to conduct studies with greater statistical power than for other marine mammals.
- Hypothesis 3: Killer whales may respond to the acoustic stressors or prey aggregations in the vicinity of the turbine through attraction, avoidance, or change in activity state. Their endangered and iconic status warrants special consideration.

To accomplish these goals, Snohomish PUD would carry out the Monitoring and Mitigation Plans and consult with the MARC to consider modification to the Plans and the project in response to the results of marine mammal or acoustic monitoring efforts. This plan would allocate a higher intensity of effort to observing the behavioral response of SR killer whales to the turbines than other marine mammals. Unlike pinniped and harbor porpoise monitoring, monitoring of SR killer whale would continue throughout the project lifetime and use shoreline observers, localizing hydrophones, and the near-turbine monitoring system. These tools would be used in a rapid-response mode[12] when killer whales (Southern Resident or transient) are moving through Admiralty Inlet. The objectives of gathering this information are both to learn more about the SR killer whale interaction with the turbines and to prevent harm through mitigation based on this information. Land and acoustic-based observations of marine mammals in the action area would complement efforts and expertise already in place, as represented by the Orca Network, Beam Reach Marine Science and Sustainability School, National Oceanic and Atmospheric Administration (NOAA) and the Whale Museum.

Additionally, during project installation and removal, Snohomish PUD would follow established regulations and guidelines for vessel operations around marine mammals. In addition; Snohomish PUD would follow project specific conditions for installation and removal. Specifically, if a listed cetacean occurred within 500 meters, or listed pinniped occurred within 100 meters of an installation or removal vessel, installation or removal operations would be halted. Once the listed cetacean or pinniped left the vicinity, installation or removal operations would resume.

Reporting, Mitigation and Adaptive Management

Pinnipeds and Harbor Porpoise

Snohomish PUD would begin pinniped surveys once the project was operational, with a preliminary, oral report made to the MARC within 60 days of turbine installation. On a quarterly basis, a report would be provided to the MARC describing the numbers and species of pinnipeds, (and harbor porpoises or other observed marine mammals), observed within the survey area and the device operating state during these observations. Snohomish PUD would provide final written and oral

[12] Rapid-response mode means that the specified monitoring actions would be initiated based on detection or report of SR killer whale in Admiralty Inlet as opposed to a pre-scheduled monitoring interval. It is expected that activities would commence within a few hours of the initial detection.

reports to the MARC within 120 days of survey completion (one calendar year of operation) describing the observations, any statistical modeling or interpretation, and results.

If the results of the Acoustic Monitoring and Mitigation Plan indicated the extent of detectable turbine noise was greater or less than indicated by pre-installation estimates analyzed in this opinion (i.e., Polagye et al., 2012), then the survey area could be expanded or contracted with the concurrence of the MARC. Mitigation triggers and actions for sound related effects are detailed in the section on the Acoustic Monitoring and Mitigation plan.

Pinnipeds are food motivated. If the Near-turbine Monitoring and Mitigation Plan indicates that prey are aggregating around the turbines after the first calendar year of pinniped observations is complete (and such aggregations did not occur during the first calendar year), a short-term pinniped study (e.g., 2+ weeks observations) would be conducted to evaluate whether prey aggregations are affecting behavior in the vicinity of the project.

If a statistically significant effect on echolocation activity were to be observed due to turbine operation, the MARC would determine whether a gradient study could be used to determine the spatial extent of this change. If the C-POD[13] information suggests that harbor porpoise echolocation is unchanged by the presence/operation of the turbines, then data collection with C-PODs would continue over the lifetime of the project, but without the same level of analysis.

Killer Whales

Snohomish PUD would make a preliminary oral report to the MARC within 7 days of each transit describing number of killer whales observed within the study area, the device operating state during these observations, and any notable behavioral changes. A final written and oral report would be presented to the MARC with 120 days of the end of each calendar year of operation.

If survey approach described here did not provide useful information about killer whale interactions with turbines, the MARC may modify the survey methodology.

If the results of the Acoustic Monitoring and Mitigation Plan indicated that, the extent of detectable turbine noise was greater or less than indicated by pre-installation estimates analyzed in this opinion (i.e., Polagye et al., 2012), then the survey area may be expanded or contracted with the concurrence of the MARC. In conjunction with the MARC and with NMFS approval, this information would be used to inform project modifications, where necessary, to provide mitigation and resource protection.

In implementing this Plan, Snohomish PUD would consult with the MARC as appropriate on the technical issues described above and data interpretation associated with the monitoring. Such consultation would include consideration of results from monitoring efforts, mitigation and subsequent adjustments to monitoring methods. In particular, Snohomish PUD would adopt the triggers and carry out the subsequent actions described below.

[13] A “C-POD” is passive acoustic monitoring technology that uses digital waveform characterization to select cetacean clicks and logs the time, center frequency, sound pressure level, duration, and bandwidth of each click.

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Marine Mammal Adaptive Management and Mitigation Trigger 1:
Based on the field test of observational protocols (e.g., scan sampling) in the fall of 2012, an optimized survey area (likely a circle with a radius of 500-1,000 m, centered on the turbines) and scan pattern will be submitted to the MARC for review and approval. The study area extent will balance the need for observations to be obtained both outside and inside the zone of audibility and the need for well-resolved observations of marine mammals in time and space. Similar changes to the monitoring protocols may be required for the seasonal sampling allocation (i.e., higher effort in the winter versus summer) and selection of focal groups for killer whale transits. If the results of these studies indicate any harm to marine mammals, Snohomish PUD will develop modifications to the project and/or this Plan in consultation with the MARC, and will obtain NMFS' approval for any specific mitigation measures.

Marine Mammal Adaptive Management and Mitigation Trigger 2:
If the results of the Acoustic Monitoring and Mitigation Plan indicate that the zone of audibility for turbine sound is greater than indicated by pre-installation estimates, the size of the study area may be increased to ensure that observations of marine mammal functional groups are obtained both outside and inside of the zone of audibility. If the results of these studies indicate any harm to marine mammals, Snohomish PUD will develop modifications to the project and/or this Plan in consultation with the MARC, will obtain NMFS' approval for any specific mitigation measures.

Marine Mammal Adaptive Management and Mitigation Trigger 3:
If porpoise presence or echolocation activity (defined by median detection positive minutes per day – DPM/day) shows a statistically significant change during the first calendar year of operation relative to annual median DPM/day from baseline observations at the 5% significance level, Snohomish PUD will consult with the MARC and determine if the change is biologically significant and if modification of the project or Monitoring and Mitigation Plan is necessary. Upon approval of revisions to the Plan by the MARC, Snohomish PUD shall file the revised Plan with the Commission. Upon Commission approval, Snohomish PUD shall implement the revised Plan. If the results of these studies indicated any harm to marine mammals, Snohomish PUD will develop modifications to the project in consultation with the MARC, will obtain NMFS' approval for any specific mitigation measures.

Marine Mammal Adaptive Management and Mitigation Trigger 4:
If shoreline observers note a strong avoidance response (defined as consistent and rapid movement away from the study area) for any marine mammal functional group, Snohomish PUD will consult with the MARC and determine if modification of the project or Monitoring and Mitigation Plan is necessary. Upon approval of revisions to the Plan by the MARC Snohomish PUD shall implement the revised Plan.

Marine Mammal Adaptive Management and Mitigation Trigger 5:
If a killer whale has been found to be injured (lacerations or discoloration to extremities) in the Salish Sea within a week of a known transit through Admiralty Inlet, Snohomish PUD will consult with the MARC to discuss whether the injury could have been caused by the project. An independent experienced veterinarian will be part of the MARC for these discussions. If the MARC determines that the injury was caused by the project, Snohomish PUD will immediately cease operation of the project and will not resume operations until NMFS approves the resumption of operations. The MARC will evaluate whether additional protective measures, if any, can be

implemented to protect killer whales. Upon the request of the MARC, Snohomish PUD will revise this Plan to implement additional measures to ensure effective protection of killer whales within the vicinity of a rotating hydrokinetic turbine. Upon approval of revisions to the Plan by the MARC and NMFS, Snohomish PUD shall implement the revised Plan.

Marine Mammal Adaptive Management and Mitigation Trigger 6:
If behavioral responses to the presence of the turbine by mid-frequency cetaceans[14] (Southern Resident and transient killer whales) within the survey area are reported, Snohomish PUD will convene a meeting of the MARC to evaluate whether modifications to the Plan or project operations are necessary. Upon approval of revisions to the Plan by NMFS, Snohomish PUD shall implement the revised Plan. If the results of these studies indicate any harm to marine mammals, Snohomish PUD will develop modifications to the project in consultation with the MARC, and obtain NMFS' approval for any specific mitigation measures.

Marine Mammal Adaptive Management and Mitigation Trigger 7:
Pinnipeds are food motivated. If the Near- turbine Monitoring and Mitigation Plan indicates that prey is aggregating around the turbines after the first calendar year of pinniped observations is complete (and such aggregations did not occur during the first calendar year), a short-term pinniped study (e.g., 2+ weeks observations) will be conducted to evaluate whether prey aggregations are affecting behavior in the vicinity of the project. The specific study scope will be developed in consultation with the MARC. If the results of these studies indicate any harm to marine mammals, Snohomish PUD will develop modifications to the project in consultation with the MARC, and will obtain NMFS' approval for any specific mitigation measures.

Marine Mammal Adaptive Management and Mitigation Trigger 8:
If harbor porpoise and pinniped scans overlapped to the point that harbor porpoise focal follows[15] are significantly reducing the effectiveness of pinniped observations, then, with the consent of the MARC, a separate observational team will be tasked for pinniped and harbor porpoise observations.

By June 30 of each year, Snohomish PUD will develop and file an annual report to FERC describing its implementation of the Plan during the previous calendar year and a list of the activities proposed for the current calendar year. The MARC would have at least 30 days to review and comment on a draft report prior to Snohomish PUD finalizing and filing the report with FERC. The annual report would provide the following:

- A summary of the monitoring results;
- A summary of any issues or concerns identified by members of the MARC during the year regarding implementation of the Plan;

[14] For the purposes of evaluating the effect of sound on cetaceans, biologists have developed a general classification regime based on each species' expected hearing frequency. Mid-frequency cetaceans are characterized by hearing capabilities ranging from 150 Hz to 160 kHz. Most toothed whales such as killer whales (range of 50 Hz to 100kHz) are considered mid-frequency cetaceans (Southall et al 2007).

[15] Focal follows are continuous observations that track and document an individual's activity for either a specific period of time or until the individual leaves the study area. These will be implemented in addition to the specified survey methods documenting group behavior.

- A list of any changes to the Plan and/or project operations proposed by consensus of the
- MARC during the year; and
- A list of Plan activities planned for the current year.

As described in the monitoring plan details, the MARC would also receive specific reports on each plan on the following schedule:

- Pinniped monitoring: Preliminary, oral report on sightings within first 60 days of turbine operation and quarterly, thereafter. Final report on pinniped response to turbine operation within 120 days of the end of the first calendar year of operation.
- Harbor porpoise monitoring: Preliminary, oral report on sightings within first 60 days of turbine operation and quarterly, thereafter. Final report on harbor porpoise response to turbine operation within 120 days of the end of the first calendar year of operation.
- Killer whale monitoring: Preliminary, oral report to the MARC within 7 days of each transit. Final report on killer whale activity and response to turbine operation within 120 days of each calendar year of operation.

NEAR-TURBINE MONITORING AND MITIGATION PLAN

The goal of the Near-Turbine Monitoring and Mitigation Plan is to confirm the environmental analyses, including effects on species listed under the ESA and/or species in the Washington State Priority Habitat and Species (PHS) List and, where possible, their designated critical habitat, and conduct any monitoring required by the ITS and terms and conditions of this opinion. The goal is also to mitigate for adverse effects, based on information gathered through this Plan. In implementing the plan, the following hypotheses would be tested:

- Hypothesis 1: Strobe illumination may result in a species-specific startle response, avoidance response, or attraction.
- Hypothesis 2: The turbines may attract marine animals due to the area of refuge offered by the low-velocity wake.
- Hypothesis 3: Marine animals are unlikely to pass through the rotor or open center during turbine operation. Investigation of this hypothesis will test the assumption that although listed and other aquatic species may be shown near the turbine rotor, these aquatic species will not be struck by a moving turbine rotor.
- Hypothesis 4: The turbines may attract marine animals due to an artificial reef effect.
- Hypothesis 5: Fish may avoid the turbine due to its pressure field or sound (particle velocity or acoustic pressure).

Additionally, in conjunction with the Marine Mammal Monitoring and Mitigation Plan, the plan would also test the assumption that there will be no interaction between marine mammals and the moving turbine rotor beyond that specified in the project Marine Mammal Protection Act authorization. This information would also inform, as needed, the development and implementation of adequate mitigation measures in consultation with the MARC.

To accomplish these goals, Snohomish PUD would:

1. Develop and test a system capable of identifying species composition and life stage in the direct vicinity of the turbine rotors and assessing the frequency with which targets pass through the turbine rotor;
2. Implement the tested system in conjunction with project installation;
3. Examine the potential for artificial lighting to affect behavior of fish;
4. Collect, manage, and analyze system data relevant to plan objectives;
5. Confer with the MARC to consider modification to this Plan and project operations in response to the collected and analyzed results; and
6. Use information collected by this system to inform, as needed, the development and implementation of adequate mitigation measures in consultation with the MARC and after NMFS' approval, including studies to assess artificial reef effects and avoidance behavior, and determine any necessary project modifications.

Near-turbine monitoring studies would be conducted in sequence on a seasonal basis during the first year of operation. The appropriate sampling structure for each seasonal sequence would be iteratively developed (in consultation with the MARC) from the starting point described in this plan. In other words, as information was developed by the project, study methods and analysis techniques would be likely to be refined. The seasonal study sequence would consist of:

- Presence/absence study to evaluate conditions (e.g., time of day, current velocity) for which species presence or absence was likely. A secondary objective of this study would be to determine the effectiveness of the camera system to identify species under different environmental conditions.
- Artificial lighting study to develop guidelines for strobe frequency, duration, and interval that allow for observation of interactions with the turbine rotor (aggregation, strike, passage) without altering marine animal behavior. This study would use an acoustic camera with a field of view similar to the optical camera.
- Turbine interaction study to evaluate the frequency and type of interactions between marine animals and the turbine rotor.

The results of each study would inform the next in the sequence. Given the time required to process and interpret collected data, the timing of the plans described in this section may need to be modified, in consultation with the MARC, to avoid prematurely committing resources to studies of unknown effectiveness. In addition to the three seasonal monitoring activities described above, the outlines of plans to study artificial reef behavior and avoidance behavior have also been developed. The specific timing and approach to implement these portions of the plan would be strongly influenced by the information gained from preceding studies.

Each turbine would be equipped with an imaging system for the proposed project. Cameras cannot be deployed to both sides of the rotor, as this would interfere with turbine recovery operations, but by deploying one turbine frame in a position rotated 180 degrees to the other, "upstream" and "downstream" observations would be possible on ebb and flood flows (albeit not for the same

turbine). Cameras are expected to capture images sufficient to identify adult fishes within about 5 meters of the camera location.

Reporting, Mitigation and Adaptive Management

Snohomish PUD would provide a preliminary oral report to the MARC within 15 days of study initiation to provide informal feedback on observations. Interim written and oral reports would be made to the MARC within 90 days of each survey completion. Snohomish PUD would provide a final report to the MARC within 120 days of the first year of operation, summarizing presence/absence trends.

Based on reported results, the MARC would determine an appropriate sampling and analysis approach for remainder of project to ensure resource protection.

If none of the common species of fish such as ratfish or dogfish were detected near the turbine, and if avoidance of the strobes could be eliminated as a plausible reason, then it would be likely that fish were avoiding the turbines. This result would suggest a need to monitor the distance over which avoidance occurred rather than proceeding to studies of interactions with the rotors.

In implementing this plan, Snohomish PUD would consult with the MARC as appropriate on the technical issues described above and data interpretation associated with the monitoring. Such consultation would consider results from the monitoring system test plan, subsequent adjustments to monitoring methods and, as needed, the development and implementation of adequate mitigation measures to avoid adverse impacts to aquatic resources. In particular, Snohomish PUD would adopt the triggers and subsequent actions described below.

Near-Turbine Adaptive Management Trigger 1:
If monitoring suggests injury or mortality to any ESA-listed species beyond that analyzed in the biological opinion and specified in the by other authorizations, the turbine brake will be applied and the project shut down. Snohomish PUD will notify the MARC within one week and coordinate with the MARC to determine if modifications to the Plan or project operations are necessary and if project operations can be restarted.

Near-Turbine Adaptive Management Trigger 2:
If monitoring shows any aquatic species passing through the turbine rotor (within the limits specified in the analyzed in this opinion), Snohomish PUD will notify the MARC within two weeks and coordinate with the MARC to determine if modifications to the Plan or project operations are necessary.

Near-Turbine Adaptive Management Trigger 3:
If monitoring detects any marine mammals in the camera field of view, Snohomish PUD will notify the MARC within two weeks and coordinate with the MARC to determine if modifications to this Plan, the Marine Mammal Monitoring and Mitigation Plan, or project operations are necessary.

Near-Turbine Adaptive Management Trigger 4:
If monitoring detects any diving seabirds in the camera field of view, Snohomish PUD will notify

the MARC within two weeks and coordinate with the MARC to determine if modifications to the Plan or project operations are necessary.

Near-Turbine Adaptive Management Trigger 5:
In the event of a monitoring system outage, the significance and immediacy of repair will depend on when the outage occurs within the life of the project and the information about environmental interactions that has been gathered to that time. The significance of an outage at an early stage of the project will also depend on whether endangered species, such as SR killer whales, are likely to be present in the project area during the outage[16].

By June 30 of each year, Snohomish PUD would develop and file an annual report to FERC that fully described its implementation of the plan during the previous calendar year and listed the proposed activities for the current calendar year. The MARC would have at least 30 days to review and comment on a draft report prior to Snohomish PUD finalizing and filing the report with FERC. The annual report would provide the following:

- A summary of the monitoring results.
- A summary of any issues or concerns identified by members of the MARC during the year regarding implementation of the plan.
- A list of any changes to the Plan or project proposed by consensus of the MARC during the year.
- A list of plan activities proposed for the current year.

BENTHIC HABITAT MONITORING AND MITIGATION PLAN

[16] As an example, if a monitoring system became inoperative within the first week of the turbine deployment and Southern Residents were frequently in the project area, this would be much more significant in terms of needing to take immediate action to ensure marine resource protection than if such an outage were to occur after four years of operation and monitoring and it was a time of year when marine mammals typically are not present. If the near-turbine monitoring package becomes inoperative, the default response of Snohomish PUD will be to mobilize a spare package and conduct an unscheduled maintenance intervention, changing out the inoperative package. The entire monitoring package (near-turbine monitoring, passive acoustic monitoring, etc.) is designed to be recovered to the surface, serviced, and reconnected to turbine power and data systems, as described in the Project Safeguard Plan. Snohomish PUD will change out the monitoring package as quickly as possible and appropriate, depending on the factors such as when the outage occurs, the availability of a vessel, and ocean conditions. Given the broad availability of vessels in Puget Sound that could support this type operation and the required ocean conditions, an unscheduled maintenance intervention would likely be completed within one week of the outage being detected. Simultaneously, Snohomish PUD will notify the MARC of the outage and unscheduled maintenance intervention. In the unlikely event that the fault is determined to be on the shore side of the wet-mate connection (i.e., not a fault in the recoverable monitoring package, but a component of the system between the wet-mate and shore station), then the affected turbine may need to be recovered to the surface to conduct repairs, as described in the Project Safeguard Plan. The decision as to whether immediate recovery of the turbine is necessary will depend on many factors, including the status of the instrumentation package on the other turbine, stage in the project, presence/absence of species of concern, and information collected to date about environmental interactions. In the interim, Snohomish PUD could continue to operate the turbines unless NMFS requests that turbine operations cease. If immediate recovery were necessary, it would be accomplished as soon as vessel mobilization and met-ocean conditions allowed with likely time frames of about 7 days although it could take up to 14 or more depending on the time needed to mobilize needed equipment.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

The goal of the Benthic Habitat Monitoring and Mitigation Plan is to describe the benthic habitat provided by the project and changes to the existing benthic habitat where the project directly contacts the seabed. To accomplish this goal, Snohomish PUD would evaluate three hypotheses:

- Hypothesis 1: The turbine will be colonized and provide artificial habitat that supports different benthic communities than are currently present in the project area.
- Hypothesis 2: The contact points between the turbines and the seabed will not result in deposition of fine sediments or scour.
- Hypothesis 3: The power cable and horizontal directional drill exit point will be colonized and are likely to return to pre-installation conditions over time.

To accomplish this goal, Snohomish PUD would 1) characterize colonization of the turbine structure, the subsea cable, and the horizontal directional drill exit point; 2) characterize scour and/or deposition where these structures contact the seabed; and 3) consult with the MARC to consider modification to this Plan in response to the results of benthic habitat monitoring efforts.

Reporting, Mitigation and Adaptive Management

The PUD would provide a preliminary, oral report to the MARC within 30 days of each ROV survey describing observations and presenting survey imagery/video. Snohomish PUD would provide written and oral reports describing the colonization of the subsea base to the MARC within 90 days of the conclusion of each calendar year of operation. If the general inspections of the turbine structure indicate that areas of the turbine were being colonized at a different rate or by different species than those that are the subject of focal monitoring, then, with the concurrence of the MARC, the focal monitoring areas would be adjusted to include these areas.

In implementing the benthic monitoring plan, Snohomish PUD would consult with the MARC as appropriate on the technical issues described above and data interpretation associated with the monitoring. Such consultation would include consideration of results from monitoring efforts and subsequent adjustments to monitoring methods. In particular, Snohomish PUD would adopt the triggers and carry out the subsequent actions described below.

Benthic Habitat Adaptive Management and Mitigation Trigger 1:
If ROV scans of the turbine foundation indicate areas of colonization significantly different from those selected for focal study, Snohomish PUD, with the concurrence of the MARC, will modify focal study locations to include these areas.

Benthic Habitat Adaptive Management and Mitigation Trigger 2:
If studies indicate that the species colonizing the turbines, the subsea cable, or the horizontal directional drill exit point are different from those on the seabed, Snohomish PUD will, after consultation with the MARC, take one or more of the following actions, as necessary:

- Modify the Monitoring and Mitigation Plan and/or sampling frequency to better understand colonization trends;
- Modify the project to mitigate for effects if necessary; and/or
- Conduct additional sampling or studies.

Similar provisions would apply if the species assemblage or density were markedly different from the pre- installation survey conditions.

Benthic Habitat Adaptive Management and Mitigation Trigger 3:
If surveys indicate significant erosion at the contact points between the subsea base and seabed, Snohomish PUD would conduct an evaluation of turbine stability, and consult with the MARC to determine if project modifications are necessary.

Benthic Habitat Adaptive Management and Mitigation Trigger 4:
Following turbine installation, the MARC will select 2-3 focal survey locations along the cable route to evaluate the rate at which the cables are colonized by marine life.

By June 30 of each year, Snohomish PUD would develop and file an annual report to FERC fully describing its implementation of the Plan during the previous calendar year and a list of the proposed activities during the current calendar year. The MARC would have at least 30 days to review and comment on a draft report prior to Snohomish PUD finalizing and filing the report with FERC. The annual report would provide the following:

- A summary of the monitoring results.
- A summary of any issues or concerns identified by members of the MARC during the year regarding implementation of the Plan.
- A list of any changes to the Plan or project proposed by consensus of the MARC during the year.
- A list of Plan activities planned for the current year.

DERELICT GEAR MONITORING PLAN

The Derelict Gear Monitoring Plan goal is to detect and remove any derelict gear that becomes snared or collected on any project structure. To accomplish this, Snohomish PUD would (1) examine all project structures during periodic ROV deployments; (2) remove any derelict gearlocated on project structures; and (3) consult with Admiralty Inlet MARC to consider modifications to this Plan, if needed, based on the results of derelict gear monitoring and removal efforts.

Reporting, Mitigation and Adaptive Management

In implementing this Plan, Snohomish PUD would consult with the MARC as appropriate on the technical issues described above and data interpretation associated with the monitoring. Such consultation would include consideration of results from monitoring efforts and subsequent adjustments to monitoring methods. In particular, Snohomish PUD would adopt the following triggers and subsequent actions:

Derelict Gear Adaptive Management Trigger 1:
If monitoring shows that derelict gear has become ensnared or collected on any project structure but no species are caught within it, Snohomish PUD will remove the derelict gear as soon as feasible, and notify the MARC within two weeks. Snohomish PUD will then, after consulting with

the MARC in accordance with the Adaptive Management Committee Plan, modify the project and/or monitoring plan if necessary.

Derelict Gear Adaptive Management Trigger 2:
If monitoring shows non-listed species found entangled or otherwise impinged at the project, Snohomish PUD will remove the derelict gear as soon as feasible, notify the MARC within two weeks, and provide a report to the MARC giving all available information on the case. Snohomish PUD will then, after consulting with the MARC in accordance with the Adaptive Management Committee Plan, modify the project and/or monitoring plan if necessary.

Derelict Gear Adaptive Management Trigger 3:
If monitoring shows marine mammals that are alive, but appearing debilitated, Snohomish PUD will record the sighting as part of their monitoring report as highlighted below in the Reporting Protocol for Injured or Stranded Marine Mammals. Snohomish PUD will then, after consulting with the MARC in accordance with the Adaptive Management Framework, modify the project and/or monitoring plan if necessary.

Derelict Gear Adaptive Management Trigger 4:
If monitoring shows live marine mammals observed entangled in fishing gear or marine debris, Snohomish PUD will immediately contact the marine mammal disentanglement network in Washington as detailed in the Reporting Protocol for Injured or Stranded Marine Mammals, and will provide a report to NMFS giving all available information on the case as noted in Trigger 5. The Snohomish PUD will also immediately contact the MARC, and after consulting with the MARC in accordance with the Adaptive Management Framework, modify the project and/or monitoring plan if necessary.

Derelict Gear Adaptive Management Trigger 5:
If monitoring shows protected species found entangled in derelict gear on a project structure, Snohomish PUD will notify the MARC within two business days or as otherwise specified in the ESA consultation, remove the derelict gear as soon as feasible, and will provide a report to NMFS giving all available information on the case as highlighted below in the Reporting Protocol for Injured or Stranded Marine Mammals. Snohomish PUD will then, after consulting with the MARC in accordance with the Adaptive Management Framework, modify the project and/or monitoring plan if necessary.

Snohomish PUD would follow the procedures described in the Adaptive Management Framework when consulting with the MARC on implementation of the Plan. By June 30 of each year, Snohomish PUD would develop and file an annual report to the Commission fully describing its implementation of the Plan during the previous calendar year and a list of the proposed activities during the current calendar year. The MARC would have at least 30 days to review and comment on a draft report prior to Snohomish PUD finalizing and filing the report with FERC. The annual report would provide the following:

- A summary of the monitoring results.
- A summary of the results of any derelict gear removal effort.
- A summary of any issues or concerns identified by members of the MARC during the year regarding implementation of the Plan.

- A list of any changes to the Plan proposed by consensus of the MARC during the year.
- A list of Plan activities planned for the current year.

1.3.8 FERC Staff Alternative

The staff alternative includes all of the measures included in Snohomish PUD's final license application (FLA) (Snohomish PUD 2012b) and revised monitoring plans submitted as supplements to the FLA (summarized in sections 1.3.1 – 1.3.7 and included as Appendices A-F of this opinion), with the following modifications and additional measures developed by FERC staff that would be included in the 10-year pilot license. These measures and actions are part of the proposed action and are included in NMFS' analysis of effects in this opinion.

- Include in the Project Removal and Site Restoration Plan provisions for filing for FERC approval: (1) a specific timeline for the removal and site restoration activities 6 months prior to license expiration; (2) documentation of consultation with the MARC regarding planned removal and site restoration activities 6 months prior to license expiration; and (3) documentation of completion of project removal and site restoration activities prior to license expiration.
- Include in the Emergency Shutdown Plan a provision for preventing interaction with the turbines or turbine shutdown equipment while the mechanical brake is being deployed.
- Include in the HDD Plan provisions to implement noise abatement measures in the event HDD processes extend into the nighttime hours.
- Include in the Benthic Habitat Monitoring and Mitigation Plan a provision to : (1) identify specific depth and width measurements of scour, as measured from the turbine footings, that would trigger the installation of scour protection measures on the sea bed; (2) develop the triggers in consultation with NMFS, U.S. Fish and Wildlife Service (USFWS), U.S. Coast Guard, Washington Department of Natural Resources (WDNR), WDFW, and Washington Department of Ecology (WDOE); and (3) notify the Commission within 10 days of when such triggers are met and the licensee's plans for mitigating any such effects.
- Develop and implement an Interpretation and Education Plan for the installation of an interpretive display at Fort Casey State Park, subject to state approval, describing the project, the potential ocean energy resource in Puget Sound, and the natural and cultural environment of the project area.
- Halt work if previously unidentified archeological or historic properties are discovered and develop protective measures in consultation with the Washington State Historic Preservation Office (SHPO).
- Include a reservation of authority for the Corps of Engineers to require removal, relocation, or other alteration if the project becomes an unreasonable obstruction to free navigation of navigable waters.
- Coordinate project installation and maintenance activities with Washington State Ferries to avoid potential disruptions to scheduled ferry service.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

1.4 Action Area

"Action area" means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02).

The proposed action area includes the footprint of the turbines[17] and an area around the center of the turbine location to a distance of 3 kilometers (km). This distance is chosen because it is the furthest extent at which sound pressure levels from turbine operation would be at or above 120 dB (re 1µPa), the NMFS Level B Harassment threshold for marine mammals. The distance to the 120 dB threshold is determined by the maximum sound level produced by the turbines under the highest tidal current velocities, which would be 172 dB (re 1µPa).[18] At the 172 dB (re 1µPa) source level, sound would be at or above 120 dB (re 1µPa) for a distance of 3km from the turbines (source). This assessment is discussed in detail in Section 2.4.1 - Sound. Thus, the loudest sound level, 172 dB, would occur (rarely) at the turbines, and dissipate to a maximum of 120 dB no farther than 3 km from the turbines. NMFS chose sound as the key project effect for determining the extent of the action area because the effect of sound will be felt farther than any of the other potential effects.

The action area encompassing the subsea transmission cables is 20 meters wide; as the subsea transmission cables would be spaced about 6 meters apart. The 20-meter wide corridor for the action area for the cables allows NMFS to analyze any effect on the surrounding habitat.

[17] As described in Section 1.3, the project components include two turbines, a subsea cable, and a terrestrial transmission line (including the cable termination vault and Power Conditioning and Control building).

[18] The maximum level (172 db re: 1µPa) was modeled to occur under current velocities of about 3.6 m/s. This maximum velocity occurs less than 0.01 percent of the time during operation of the turbines and is only sustained for about 5 minutes.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

2. ENDANGERED SPECIES ACT: BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. Section 7(a)(2) of the ESA requires Federal agencies to consult with the United States Fish and Wildlife Service, NMFS, or both, to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or adversely modify or destroy their designated critical habitat. Section 7(b)(3) requires that at the conclusion of consultation, the Service provide an opinion stating how the agencies' actions will affect listed species and their critical habitat. If incidental take is expected, section 7(b)(4) requires the consulting agency to provide an incidental take statement (ITS) that specifies the impact of any incidental taking and includes reasonable and prudent measures to minimize such impacts. NMFS did not include an ITS for marine mammals at this time because any taking of these listed species must first be authorized under the Marine Mammal Protection Act (MMPA) with the issuance of an incidental harassment authorization or letter of authorization for SR killer whales and humpback whales.

2.1 Approach to the Analysis

Section 7(a)(2) of the ESA requires Federal agencies, in consultation with NMFS, to insure that their actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. The jeopardy analysis considers both survival and recovery of the species. The adverse modification analysis considers the impacts on the conservation value of designated critical habitat. Species and designated critical habitat occurring in the action area for which NMFS has determined the proposed action may affect but is "not likely to adversely affect" are discussed in detail in section 2.11 of this opinion.

"To jeopardize the continued existence of a listed species" means to engage in an action that would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR 402.02).

This biological opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 C.F.R. 402.02. Instead, we have relied upon the statutory provisions of the ESA to complete the following analysis with respect to critical habitat.[19]

NMFS will use the following approach to determine whether the proposed action is likely to jeopardize listed species or destroy or adversely modify designated critical habitat:

- **Identify the rangewide status of the species and critical habitat likely to be adversely affected by the proposed action.** This section (2.2) describes the current status of each listed species and its critical habitat relative to the conditions needed for recovery. For listed salmon and steelhead, NMFS has developed specific guidance for analyzing the status of the

[19] Memorandum from William T. Hogarth to Regional Administrators, Office of Protected Resources, NMFS (Application of the "Destruction or Adverse Modification" Standard Under Section 7(a)(2) of the Endangered Species Act) (NMFS 2005a).

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

listed species' component populations in a "viable salmonid populations" paper (VSP; McElhany et al. 2000). The VSP approach considers the abundance, productivity, spatial structure, and diversity of each population as part of the overall review of a species' status. For listed salmon and steelhead, the VSP criteria therefore encompass the species' "reproduction, numbers, or distribution" (50 CFR 402.02). In describing the rangewide status of listed species, we rely on viability assessments and criteria in technical recovery team documents and recovery plans, where available, that describe how VSP criteria are applied to specific populations, major population groups, and species. We determine the rangewide status of critical habitat by examining the condition of its physical or biological features (also called "primary constituent elements" or PCEs in some designations) which were identified when the critical habitat was designated.

- **Describe the environmental baseline in the action area.** The environmental baseline (Section 2.3) includes the past and present impacts of Federal, state, or private actions and other human activities in the action area. It includes the anticipated impacts of proposed Federal projects that have already undergone formal or early section 7 consultation and the impacts of state or private actions that are contemporaneous with the consultation in process.
- **Analyze the effects of the proposed action on both species and their habitat.** In this step (Section 2.4), we consider how the proposed action would affect the species' reproduction, numbers, and distribution or, in the case of salmon and steelhead, their VSP parameters. We also evaluate the proposed action's effects on critical habitat features.
- **Describe any cumulative effects in the action area.** Cumulative effects (Section 2.5), as defined in our implementing regulations (50 CFR 402.02), are the effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area. Future Federal actions that are unrelated to the proposed action are not considered because they require separate section 7 consultation.
- **Integrate and synthesize the above factors to assess the risk that the proposed action poses to species and critical habitat**. In this step (Section 2.6), we add the effects of the action (Section 2.4) to the environmental baseline (Section 2.3) and the cumulative effects (Section 2.5) to assess whether the action could reasonably be expected to: (1) reduce appreciably the likelihood of both survival and recovery of the species in the wild by reducing its numbers, reproduction, or distribution; or (2) reduce the conservation value of designated or proposed critical habitat. These assessments are made in full consideration of the status of the species and critical habitat (Section 2.2).
- **Reach jeopardy and adverse modification conclusions**. In this step (Section 2.7), we state our conclusions regarding jeopardy and the destruction or adverse modification of critical habitat are presented in Section 2.7. These conclusions flow from the logic and rationale presented in Section 2.6 (Integration and Synthesis).
- **If necessary, define a reasonable and prudent alternative to the proposed action.** If, in completing the last step in the analysis, we determine that the action under consultation is likely to jeopardize the continued existence of listed species or destroy or adversely modify designated critical habitat, we must identify a reasonable and prudent alternative (RPA) to the action. The RPA must not be likely to jeopardize the continued existence of listed species nor adversely modify their designated critical habitat and it must meet other regulatory requirements.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

2.2 Rangewide Status of the Species and Critical Habitat

This Opinion examines the status of each species that would be affected by the proposed action. The status is the level of risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. The species status section helps to inform the description of the species' current "reproduction, numbers, or distribution" as described in 50 CFR 402.02. The opinion also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the current function of the essential physical and biological features that help to form that conservation value.

Climate Change

One factor affecting the status of all ESA listed species in Puget Sound and aquatic habitat at large is climate change. Several studies have revealed that climate change has the potential to affect ecosystems in nearly all tributaries throughout the state (Battin et al. 2007; ISAB 2007). While the intensity of effects will vary by region (ISAB 2007), climate change is generally expected to alter freshwater aquatic habitat (water yield, peak flows, and stream temperature). As climate change alters the structure and distribution of rainfall, snowpack, and glaciations, each factor will in turn alter riverine hydrographs. Given the increasing certainty that climate change is occurring and is accelerating (Battin et al. 2007), NMFS anticipates that salmonid habitats will be affected and this in turn is likely to affect the distribution and productivity of salmon populations in the region. Climate and hydrology models project significant reductions in both total snow pack and low-elevation snow pack in the Pacific Northwest over the next 50 years (Mote and Salathé 2009) changes that will shrink the extent of the snowmelt-dominated freshwater habitat available to salmon. Such changes may restrict our ability to conserve diverse salmon life histories and to make recovery targets for these salmon populations more difficult to achieve.

In Washington State, most models project warmer air temperatures, increases in winter precipitation, and decreases in summer precipitation. Average temperatures in Washington State are likely to increase 0.1-0.6ºC per decade (Mote and Salathé 2009). Warmer air temperatures will lead to more precipitation falling as rain rather than snow. As the snow pack diminishes, seasonal hydrology will shift to more frequent and severe early large storms, changing stream flow timing and increasing peak river flows, which may limit salmon survival (Mantua et al. 2009). The largest driver of climate-induced decline in salmon populations is projected to be the impact of increased winter peak flows, which scour the streambed and destroy salmon eggs (Battin et al. 2007).

Higher water temperatures and lower spawning flows, together with increased magnitude of winter peak flows are all likely to increase salmon mortality. Higher ambient air temperatures will likely cause water temperatures to rise (ISAB 2007). Salmon and steelhead require cold water for spawning and incubation. As climate change progresses and stream temperatures warm, thermal refugia will be essential to persistence of many salmonid populations. Thermal refugia are important for providing salmon and steelhead with patches of suitable habitat while allowing them to undertake migrations through or to make foraging forays into areas with greater than optimal temperatures. To avoid waters above summer maximum temperatures, juvenile rearing may be increasingly found only in the confluence of colder tributaries or other areas of coldwater refugia (Mantua et al. 2009).

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Effects of climate change in marine environments include increased ocean temperature, increased stratification of the water column, and changes in intensity and timing of coastal upwelling. Hypotheses differ regarding whether coastal upwelling will decrease or intensify but, even if it intensifies, the increased stratification of the water column may reduce the ability of upwelling to bring nutrient-rich water to the surface. There are also indications in climate models that future conditions in the North Pacific region will trend towards conditions during warm phases of the Pacific Decadal Oscillation (PDO). Hypoxic conditions observed along the continental shelf in recent years appear related to shifts in upwelling and wind patterns, which may be related to climate change.

These continuing changes are expected to alter primary and secondary productivity, the structure of marine communities (particularly the distribution of predators and prey), and in turn, the growth, productivity, survival, and migrations of salmonids, although the degree of impact on listed salmonids currently is poorly understood. A mismatch between earlier smolt migrations (because of earlier peak spring freshwater flows and decreased incubation period) and altered upwelling may reduce marine survival rates. Ocean warming also may change migration patterns, increasing distances to feeding areas.

In addition, rising atmospheric carbon dioxide concentrations drive changes in seawater chemistry, increasing the acidification of seawater. This reduces the availability of carbonate for shell-forming invertebrates (e.g., pteropods, which are prey for some species of salmon and prey for some forage fish that are consumed by salmon), reducing their growth and survival. This process of acidification is underway, has been well documented along the Pacific coast of the United States, and is predicted to accelerate with increasing emissions.

Habitat improvement actions in the freshwater portion of the life cycle can help address the adverse impacts of climate change on salmon. Examples include restoring connections to historical floodplains and freshwater and estuarine habitats to provide fish refugia and areas to store excess floodwaters, protecting and restoring riparian vegetation to ameliorate stream temperature increases, and purchasing or applying easements to lands that provide important cold water or refuge habitat (Battin et al. 2007; ISAB 2007). Harvest management regimes and frameworks respond to changing conditions associated with climate change by incorporating uncertainty in environmental conditions and conservative assumptions about salmon survival in setting management objectives and allowable harvest levels. Managers revise management objectives on a regular basis to incorporate the most recent information on population productivity and capacity where that information is available.

2.2.1 Status of Listed Species

For Pacific salmon and steelhead, NMFS determines the status of the species by using four parameters to assess the viability of the populations that, together, constitute the species' spatial structure, diversity, abundance, and productivity (McElhany et al. 2000). These "viable salmonid population" (VSP) criteria therefore encompass the species' "reproduction, numbers, or distribution" as described in 50 CFR 402.02. When these parameters are collectively at appropriate levels, they maintain a population's capacity to adapt to various environmental conditions and allow it to sustain itself in the natural environment. These attributes are influenced by survival, behavior, and experiences throughout a species' entire life cycle, and these characteristics, in turn, are influenced by habitat and other environmental conditions.

"Spatial structure" refers both to the spatial distributions of individuals in the population and the processes that generate that distribution. A population's spatial structure depends fundamentally on habitat quality and spatial configuration and the dynamics and dispersal characteristics of individuals in the population.

"Diversity" refers to the distribution of traits within and among populations. These range in scale from DNA sequence variation at single genes to complex life history traits (McElhany et al. 2000).

"Abundance" generally refers to the number of naturally-produced adults (i.e., the progeny of naturally-spawning parents) in the natural environment (e.g., on spawning grounds).

"Productivity," as applied to viability factors, refers to the entire life cycle; i.e., the number of naturally-spawning adults produced per parent. When progeny replace or exceed the number of parents, a population is stable or increasing. When progeny fail to replace the number of parents, the population is declining. McElhany et al. (2000) use the terms "population growth rate" and "productivity" interchangeably when referring to production over the entire life cycle. They also refer to "trend in abundance," which is the manifestation of long-term population growth rate.

For species with multiple populations, once the biological status of a species' populations has been determined, NMFS assesses the status of the entire species using criteria for groups of populations, as described in recovery plans and guidance documents from technical recovery teams as well as other sources. Considerations for species viability include having multiple populations that are viable, ensuring that populations with unique life histories and phenotypes are viable, and that some viable populations are both widespread to avoid concurrent extinctions from mass catastrophes and spatially close to allow functioning as metapopulations (McElhany et al. 2000).

2.2.1.1 Status of Puget Sound Chinook Salmon

NMFS listed the Puget Sound Chinook (PS) salmon evolutionarily significant unit ESU[20]as threatened on March 24, 1999 (NMFS 1999). NMFS completed the most recent five-year review for the PS Chinook salmon ESU on December 7, 2011 and concluded that the species should remain listed as threatened (NMFS 2011a). The ESU encompasses all runs of Chinook salmon from rivers and streams flowing into Puget Sound, including the Strait of Juan de Fuca from the Elwha River eastward, and rivers and streams flowing into Hood Canal, South Sound, North Sound, and the Strait of Georgia in Washington. Also included in the ESU are 26 artificial propagation programs. NMFS adopted a recovery plan for the ESU in 2007. The recovery plan describes the population structure, identifies populations essential to recovery of the ESU, establishes recovery goals for most of the populations based largely on the recommendations of the Puget Sound Technical Recovery Team (PSTRT), and recommends habitat, hatchery, and harvest actions designed to contribute to the recovery of the ESU.

[20] An ESU, or evolutionarily significant unit, is a Pacific salmon population or group of populations that is substantially reproductively isolated from other conspecific populations and that represents an important component of the evolutionary legacy of the species.

Spatial Structure and Diversity

The PS Chinook salmon ESU includes 22 demographically independent populations, while 16 additional spawning aggregations or populations are thought to be extinct (Ruckelshaus et al. 2006). Nine of the extinct groups were probably early run (spring) forms, which differ from summer or fall Chinook salmon by having earlier river entry timing, longer holding periods prior to spawning, earlier spawn timing, and higher proportions of yearling emigrants that have an extended freshwater life-history strategy (Groot and Margolis 1991). Spring Chinook salmon no longer exist in the Hood Canal region or in most rivers in the Central/South Sound region. The loss of spring Chinook salmon populations significantly reduces the historical life-history diversity and spatial structure of the ESU, adding to its risk of extinction.

Fall Chinook populations in the Central/South Sound, Hood Canal and Strait of Juan de Fuca regions are sustained predominately by hatchery production. Indigenous fall Chinook in the Sammamish, Puyallup, Nisqually, and Skokomish watersheds have been extirpated due to habitat degradation, hatchery introgression and historical over-fishing. Most of the existing spawning aggregations in the Central/South Sound and Hood Canal regions are genetically similar, reflecting the extensive influence of transplanted hatchery releases, primarily from the Green River population (Ruckelshaus et al. 2006).

The PSTRT found that all 22 populations were at high risk (NMFS 2006a). Three of the five regions (Strait of Juan de Fuca, Georgia Basin, and Hood Canal) contain only two populations, both of which must become viable to recover the ESU (NMFS 2006a). Under the Puget Sound Salmon Recovery Plan, the Suiattle and one each of the early, moderately early, and late run-timing populations in the Whidbey Basin region, as well as the White and Nisqually (or other late-timed) populations in the Central/South Sound region must also achieve viability (NMFS 2006a).

Abundance and Productivity

Overall abundance of Chinook salmon in this ESU has declined substantially from historical levels of about 690,000 spawners in the early 1900s. In its 1998 status review, NMFS noted that the average run size (hatchery and natural) was about 240,000 fish with natural spawning escapement averaging 25,000 fish (Myers et al. 1998). Since 1998, natural spawning escapement has increased to an annual average of about 45,000 with increases observed in all life history types (spring, summer, and fall) (Ford 2011). Escapement trends are now predominately positive (1990-2009); based on NMFS' analysis, 21 of the 22 PS Chinook independent populations exhibit stable or increasing trends in escapement.

Trends in growth rate of return (i.e., recruits/spawners) and growth rate of escapement (i.e., spawners/spawners) are generally similar to or lower than those for trends in escapement. Nine populations exhibit a stable or increasing growth rate in natural-origin return and 17 populations exhibit a stable or increasing growth rate in natural-origin escapement. Growth rates for both natural-origin return and natural-origin escapement are declining for the Suiattle, South Fork Stillaguamish, Sammamish, Skokomish and Elwha populations. No clear patterns in escapement trends or growth rate are evident among the five major regions of Puget Sound (Ford 2011).

The most recent PS Chinook salmon status review concluded that populations are well below the TRT planning range for recovery escapement levels (Ford 2011). Most populations are also consistently below the spawner recruit levels identified by the TRT as consistent with recovery.

Across the ESU, most populations have declined in abundance somewhat since the last status review in 2005, and trends since 1995 are mostly flat. NMFS expects that many of the habitat and hatchery actions identified in the Puget Sound Chinook recovery plan will take years or decades to be implemented and to produce significant improvements in natural population attributes, and population trends are consistent with these expectations. Overall, the new information on abundance, productivity, spatial structure and diversity since the 2005 review does not indicate a change in the biological risk category since the time of the last BRT status review.

Limiting Factors
Several of the risk factors identified by Good et al. (2005) are still present, including widespread loss and degradation of habitat (Ford 2011). Habitat has been affected by land use activities including urbanization, forestry, and agriculture.

Recovery
The recovery plan for PS Chinook (SSPS 2007) identifies primarily freshwater and major river delta habitat recovery actions, as well as harvest and hatchery actions none of which is specific to the action area. The plan identifies key strategies for recovery of PS Chinook specific to nearshore and marine waters. These strategies include protection of key fresh and saltwater processes; restoring estuarine processes and habitat and marine shorelines outside major river deltas; protecting and restoring freshwater and saltwater quality and quantity; and reducing risk and damage from catastrophic events, non-indigenous species and other changes to food webs. Island County, where the action area is primarily located is focusing protection efforts on marine riparian areas, forage fish spawning beaches, eelgrass meadows, features which support sediment transport and high quality freshwater inputs, and habitat connectivity.

Summary
The Puget Sound Chinook ESU is declining in abundance and has made little progress toward meeting recovery criteria. Climate change impacts and widespread habitat loss and degradation are threats to persistence of the ESU. This ESU is at moderate risk of extinction and is listed as threatened.

2.2.1.2 Status of Hood Canal Summer-run Chum Salmon

NMFS originally listed this ESU as threatened on March 25, 1999 (NMFS 2011a). After completing our most recent five-year review for the Hood Canal summer run(HCSR) chum salmon ESU, NMFS concluded that the species should remain listed as threatened (NMFS 2011a). The HCSR chum salmon ESU includes all naturally spawned populations of summer-run chum salmon in Hood Canal and its tributaries as well as populations in Olympic Peninsula rivers between Hood Canal and Dungeness Bay, Washington. The ESU also includes eight artificial propagation programs: the Quilcene NFH, Hamma Hamma Fish Hatchery, Lilliwaup Creek Fish Hatchery, Union River/Tahuya, Big Beef Creek Fish Hatchery, Salmon Creek Fish Hatchery, Chimacum Creek Fish Hatchery, and the Jimmycomelately Creek Fish Hatchery summer-run chum hatchery programs.

Spatial Structure and Diversity.
The PSTRT designated two independent populations for the HCSR chum salmon, one which includes the spawning aggregations from rivers and creeks draining into the Strait of Juan de Fuca, and one which includes spawning aggregations within Hood Canal proper (Ford 2011). Of an estimated 16 historical stocks in the ESU, seven stocks are likely to have been extirpated or nearly extirpated.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Most of these extirpations have occurred in stocks on the eastern side of Hood Canal, generating additional concern for ESU spatial structure. The widespread loss of estuary and lower floodplain habitat was noted by the BRT as a continuing threat to ESU spatial structure and connectivity. Diversity has increased from the low values seen in the 1990s due to the reintroduction of one spawning aggregate in the Strait of Juan de Fuca and two in the Hood Canal population. This creates a more uniform abundance between populations and in the distribution of each population among spawning sites.

Abundance and Productivity.
In both the Hood Canal and Juan de Fuca populations, spawning abundance was relatively high in the 1970s, lowest during 1985−1999, and higher again for the 10-year period ending 2009 (Ford 2011). The overall trend in spawning abundance was generally stable for the Hood Canal population (for total spawners and for natural-origin spawners) and for the Strait of Juan de Fuca population (total spawners). There is a significant positive trend in the number of Strait of Juan de Fuca natural-origin spawners.

Limiting Factors.
For the Hood Canal population, WDFW and PNPTT (2000) concluded that low production appeared to be the result of the combined effects of habitat degradation, climate, increases in fishery exploitation rates, and the impacts associated with the releases of hatchery salmonids. Similarly, reductions in habitat quality, decreased stream flows, and fishery exploitation have resulted in low production for the Strait of Juan de Fuca population (WDFW and PNPTT 2000). Other factors affecting recovery included pinniped predation, reduced average spawning flows coupled with the increases in peak flows during incubation due to climate change, and depensatory mortality (WDFW and PNPTT 2000). At the ESU level, loss of channel complexity, altered sediment dynamics, riparian degradation, and estuarine and nearshore habitat loss and degradation limit viability (WDFW and PNPTT 2000; Brewer et al 2005).

Recovery
While there are no freshwater streams or estuaries of this unit in the action area, priority action recommendations developed in this Summer Chum Salmon Recovery Plan (Brewer et al 2005) will focus initially on the lower 1-2 miles of river and estuarine areas. Within the estuarine-marine environment, the most important factor for restoration is food, associated with loss of eelgrass, shoreline development, and loss of riparian corridors. Recovery actions focus on the freshwater areas and connected estuaries of Jimmycomelately, Chimacum and Salmon/Snow creeks that are outside the action area, on the Olympic peninsula to the east.

Summary
The Hood Canal summer-run chum ESU has shown increased abundance since listing in 1999 however, abundance and productivity have been down slightly over the past five years. Climate change impacts and widespread habitat loss and degradation are threats to persistence of the ESU. This ESU is at moderate risk of extinction and is listed as threatened.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

2.2.1.3 Status of Puget Sound Steelhead

NMFS first listed the Puget Sound steelhead distinct population segment (DPS) [21]as threatened on May 11, 2007 (NMFS 2006b). After completing our most recent five-year review for the PS steelhead DPS, NMFS concluded that the species should remain listed as threatened (NMFS 2011a). The DPS includes all naturally spawned anadromous summer and winter run steelhead populations, in streams in the river basins of Puget Sound, as well as the Green River summer and Hamma Hamma winter run steelhead hatchery stocks. The majority of hatchery stocks were not considered part of this DPS because the populations examined at the time were more than moderately diverged from the local native populations (Hard et al. 2007). Resident steelhead (i.e., rainbow trout) occur within the range of listed Puget Sound steelhead but are not part of the DPS due to marked differences in physical, physiological, ecological, and behavioral characteristics (NMFS 2006b).

The Puget Sound Steelhead Technical Recovery Team (PSSHTRT) was established to develop technical delisting criteria and guidance associated with development of a Puget Sound steelhead recovery plan. The PSSHTRT is in the process of identifying population structure for the Puget Sound Steelhead DPS. Once delineation and viability assessment of the populations are completed, a recovery plan will be developed for the DPS describing population structure, identifying populations essential to recovery, and establishing recovery goals based on the recommendations of the PSSHTRT.

Spatial Structure and Diversity

Steelhead are located in the majority of the larger tributaries in Puget Sound, Hood Canal, and the eastern Strait of Juan de Fuca. Washington Department of Fish and Wildlife (WDFW) has identified over 50 historical stocks. The definition of individual populations of steelhead within the DPS is being developed by the PSSHTRT. The PS steelhead BRT determined that lack of spatial structure posed moderate risk to the viability of the DPS due to reduced complexity and diminishing connectivity among populations (Hard et al. 2007). Large numbers of barriers, such as impassable culverts, together with declines in natural abundance, greatly reduce opportunities for movement and migrations between steelhead groups within watersheds.

The PS steelhead BRT concluded that the viability of PS steelhead is at moderate risk due to the reduced life history diversity of stocks and the potential threats posed by artificial propagation and harvest in the Puget Sound (Hard et al. 2007). The winter-run steelhead is the predominant life history type in Puget Sound, in part because there are relatively few basins with the flow and watershed characteristics necessary to establish the summer-run life history (NMFS 2011a). All of the historical summer-run stocks, which are concentrated in northern Puget Sound, are depressed. Numbers of naturally-produced steelhead are largely exceeded by those of hatchery fish that are either derived from out-of-DPS stocks (Skamania River summer run) or from within-DPS stocks that have diverged substantially from local populations (Chambers Creek winter run).

[21] A DPS, or a distinct population segment, is a vertebrate population or group of populations that is discrete from other populations of the species and significant in relation to the entire species.

Abundance and Productivity.
The risk of declining steelhead abundance to the viability of the DPS is high. The estimated peak run size from 1889 to 1920 ranged from 327,592 and 545,987 fish (Hard et al. 2007). By the early 1920s the commercial harvest was generally less than 10,000 fish and beginning in 1932, the commercial catch of steelhead was prohibited (Crawford 1979). Busby et al. (1996) estimated that 5-year average natural escapements ranged from less than 100 to 7,200, with total run sizes of 550 to 19,800, respectively. Adult returns in most populations have further declined in the last few years; recent means for many populations are 50 to 80 percent of the corresponding long-term means (Hard et al. 2007).

The risk to the viability of PS steelhead due to declining productivity is high. Ford (2011) estimated the exponential trend in the logarithm of natural-origin spawners for the years 1995 through 2009 and estimated that only three of 16 populations had positive growth rates. These data indicate relatively low abundance and declining trends in natural escapement throughout Puget Sound, particularly in southern Puget Sound and on the Olympic Peninsula (Ford 2011). Declines in natural production and productivity are most pervasive in southern Puget Sound, but occur throughout much of the DPS (Hard et al. 2007).

Limiting Factors.
The degradation and fragmentation of freshwater habitat, with consequent effects on connectivity, is a primary limiting factor and threat facing the Puget Sound Steelhead DPS (Ford 2011). Barriers to fish passage and adverse effects on water quality and quantity resulting from dams, the loss of wetland and riparian habitats, and agricultural and urban development activities have contributed and continue to contribute to the loss and degradation of steelhead habitats in Puget Sound. Specifically, steelhead are most dramatically affected by the number of large dams and impassable culverts in rivers feeding Puget Sound and increases in urban development resulting in changing of stream hydrology (Hard et al. 2007). Previous harvest management practices likely contributed to the historical decline of Puget Sound steelhead, but NMFS concluded that the elimination of the direct harvest of wild steelhead in the mid-1990s largely addressed this threat (NMFS 2006b). Predation by marine mammals (principally seals and sea lions) and birds as well as the extensive propagation of the Chambers Creek and Skamania hatchery steelhead stocks are also potential sources of concern.

Recovery
NMFS has not yet adopted a recovery plan for PS steelhead.

Summary
The Puget Sound steelhead DPS is at low abundance compared to historical levels, and recent data indicate continued downward trends. Climate change impacts, widespread habitat loss and degradation, freshwater passage barriers, and changes to stream hydrology are threats to persistence of the DPS.

2.2.1.4 Status of ESA-listed Rockfish Species

NMFS listed the Puget Sound/Georgia Basin (PS/GB) DPS of yelloweye rockfish and canary rockfish as threatened and of bocaccio as endangered under the ESA on April 27, 2010 (NMFS 2010c). NMFS determined that PS/GB DPS of bocaccio is at high risk of extinction throughout all of its range and that the PS/GB DPSs of yelloweye rockfish and canary rockfish are at moderate risk of extinction throughout all of their ranges (Drake et al. 2010). The PS/GB DPSs include all yelloweye

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

rockfish, canary rockfish and bocaccio found in waters of the Puget Sound, the Strait of Georgia, and the Strait of Juan de Fuca east of the Victoria Sill (Palsson et al 2009; Drake et al. 2010).[22]

Spatial Structure and Diversity.
Puget Sound can be subdivided into five interconnected basins separated by shallow sills: (1) The San Juan/Strait of Juan de Fuca basin, (2) Main Basin, (3) Whidbey Basin, (4) South Puget Sound, and (5) Hood Canal. Yelloweye rockfish spatial structure is likely threatened by a severe reduction of fish throughout all or portions of Hood Canal and the South Puget Sound, combined with the small home ranges of adults. Similarly, several historically large aggregations of canary rockfish in Puget Sound have been depleted by fisheries, including a historically occupied area in South Puget Sound (Drake et al. 2010). Bocaccio, which were once most abundant in the Central and South Puget Sound, are now rarely observed in these areas (Drake et al. 2010). For canary rockfish and bocaccio, some adults and pelagic juveniles are known to migrate long distances, which could help to reestablish aggregations of fish in formerly occupied habitat (Drake et al. 2010).

Size- and age-distributions of these species have become truncated, which is a form of lost diversity. Recreationally caught yelloweye rockfish, canary rockfish, and bocaccio spanned a broad range of sizes in the 1970s, but by the 2000s, there were fewer large (i.e., older) fish (Drake et al. 2010). Shifting the reproductive burden to smaller (younger) fish could alter the timing and condition of larval release and may reduce overall productivity due to lower fecundity in smaller, younger females.

Abundance and Productivity.
There are no reliable population estimates for any of the DPSs, although catch data indicate that each species' abundance has dramatically declined (Drake et al. 2010). Catches of yelloweye rockfish, canary rockfish, and bocaccio have declined as a proportion of the overall rockfish catch (Palsson et al. 2009; Drake et al. 2010). The total rockfish population in the Puget Sound region is estimated to have declined by 3 percent per year for the past several decades, which corresponds to an approximate 70 percent decline from 1965 to 2007 (Drake et al. 2010).

Life-history traits of yelloweye rockfish, canary rockfish and bocaccio suggest generally low levels of inherent productivity because individuals are long-lived and mature slowly, with sporadic episodes of successful reproduction (Tolimieri and Levin 2005; Drake et al. 2010). This naturally low-productivity can be exacerbated by truncated size and age distributions and the effects of fisheries, environmental toxicity, and habitat changes.

Long-term fishing reduced average ages and sizes of females resulting in lower productivity at the population level because larger and older females of various rockfish species have a higher weight-specific fecundity (number of larvae per unit of female weight) (Boehlert et al. 1982; Bobko and Berkeley 2004; Sogard et al. 2008). Maternal age and maturity also affect timing of parturition, which is crucial to achieving favorable oceanographic conditions for the small and vulnerable larvae (Washington et al. 1978). Larvae birthed during favorable oceanographic conditions are more likely to reach maturity (Sogard et al. 2008; Nichol and Pikitch 1994) and larger or older females provide

[22] The Victoria Sill extends from just south of the City of Victoria, British Columbia to the northern Olympic Peninsula.

more nutrients to larvae (Berkeley et al. 2004; Fisher et al. 2007), which likely enhances early growth rates (Berkeley et al. 2004), but may also negatively affect their growth and maturation by transferring contaminants to offspring (Palsson et al. 2009).

Limiting Factors.
The legacy of past overfishing and current bycatch mortality in recreational fisheries were determined to be the most serious threats to the listed rockfish populations (Drake et al. 2010). Loss of nearshore habitat within Puget Sound, low dissolved oxygen levels, chemical contamination, and high nutrient loading were also identified as threats. About 30 percent of the Puget Sound shoreline has been modified by humans, resulting in the loss of estuarine and tidal wetland habitat, and loss of eelgrass, kelp, and other submerged vegetation. Contaminants such as polychlorinated biphenyls (PCBs), chlorinated pesticides (e.g., DDT), and polybrominated diphenyl ethers (PBDEs) appear in rockfish collected near urban areas. Rockfish may experience reproductive impairment as a result of contaminant exposure, an effect that has been shown in English sole from Puget Sound (Landahl et al. 1997). Low dissolved oxygen (DO) levels in Hood Canal have resulted in episodic fish kills, (some of which killed large numbers of rockfish), in 2002, 2003, 2006 and 2010 (Palsson et al 2009, Cope and Roberts 2013).

Recovery
NMFS has not yet adopted a recovery plan for ESA-listed PS/GB rockfish species.

Summary
The three PS/GB rockfish DPS' are at low (canary and yelloweye) to very low (bocaccio) abundance compared to historical levels. Climate change impacts, bycatch mortality, loss of nearshore habitat and water quality degradation are likely to be the most serious threats to persistence of these rockfish populations.

2.2.1.5 Status of Southern Resident Killer Whales

NMFS listed the SR killer whale DPS as endangered under the ESA on November 18, 2005 (NMFS 2005b). Southern Residents are designated as depleted and strategic under the Marine Mammal Protection Act (NMFS 2003). NMFS issued the final recovery plan for Southern Residents in January 2008 (NMFS 2008). This section summarizes information taken largely from the recovery plan and recent five-year status review (NMFS 2011b) as well as new data that became available more recently.

Southern Resident killer whales are a long-lived species with late onset of sexual maturity (NMFS 2008). Mothers and offspring maintain highly stable social bonds throughout their lives, which is the basis for the matrilineal social structure in the SR killer whale population (NMFS 2008). Groups of related matrilines form pods. Three pods – J, K, and L – make up the SR killer whale DPS. All members of the DPS are individually identified in a photo-database by their uniquely shaped and scarred dorsal fins and saddle patches.

Spatial Distribution and Diversity

The SR killer whale DPS is composed of a single population that ranges as far south as central California and as far north as Southeast Alaska. From late spring to early autumn, Southern Residents spend considerable time in the Salish Sea, with concentrated activity around the San Juan Islands, and then move south into Puget Sound in early autumn. Pods make frequent trips to the outer coast during this time. Although the entire SR killer whale DPS has the potential to occur in Puget Sound at any time during the year, occurrence in this area is more likely from late autumn to early spring.

The estimated effective size of the population (the number of breeding individuals under ideal genetic conditions) is very small, <30 whales or about 1/3 of the current population size (Ford et. al. 2011). The small effective population size, the absence of gene flow from other populations, and documented inbreeding within each pod are hypothesized to elevate the risk from inbreeding and other issues associated with genetic deterioration (Ford et al. 2011). In addition, the small effective population size may contribute to the lower growth rate of the SR killer whale population in contrast to the Northern Resident population which has a higher growth rate (Ford et al. 2011, Ward et al. 2009).

Abundance and Productivity

As of September 2013, the SR killer whale population totaled 81 individuals (J Pod = 26, K Pod = 19, L Pod = 36). (Center for Whale Research 2013). Historical numbers of SR killer whales is estimated to range from 140 whales (based on public display removals; Olesiuk et al. 1990) up to 400 whales as used in Population Viability Analysis (PVA) scenarios (Krahn et al. 2004). Over the last 28 years (1983-2010), population growth has been variable, with an average annual population growth rate of 0.3 percent and standard deviation of ± 3.2 percent (NMFS 2011b).

A delisting criterion for the SR killer whale DPS is an average growth rate of 2.3 percent for 28 years (NMFS 2008). In light of the recent average growth rate of 0.3 percent for the single population in the DPS, this recovery criterion has not yet been met (NMFS 2011b). Several demographic factors are also cause for concern: the small number of breeding males (particularly in J and K pods), reduced fecundity, decreased sub-adult survivorship in L pod, and the total number of individuals in the population (NMFS 2008).

Limiting Factors

Several factors identified in the final recovery plan for SR killer whales may be limiting recovery. These are quantity and quality of prey (particularly their primary prey, Chinook salmon), exposure to toxic chemicals that accumulate in top predators, and disturbance from sound and vessels. Oil spills are also a risk factor. It is likely that multiple threats are acting in concert to impact the whales. Although it is not clear which threats are most significant to the survival and recovery of Southern Residents, all of the identified threats are potential limiting factors (NMFS 2008).

Recovery

NMFS adopted a recovery plan for SR killer whales in 2008. The recovery plan notes that there is uncertainty regarding which of the threats has caused the decline or which may have the most significant impact on recovery of the population. Management measures include rebuilding salmon and other prey populations, minimizing pollution and chemical contamination, minimizing

disturbance from vessels, protection from additional threats such as oil spills, infectious disease, and invasive species (NMFS 2008). The plan identifies the importance of ongoing research programs to inform management and conservation of the species. The recovery plan specifically references ocean and tidal energy development noting that monitoring of effects to marine mammals including killer whales will be an important part of early projects to help assess potential impacts. Since completing the Recovery Plan, NMFS has prioritized actions to address the threats with highest potential for mitigation: salmon recovery, oil spill response, and reducing vessel impacts (NMFS 2011b).

Summary
The SR killer whale DPS is at low abundance with a variable but small positive growth rate (0.03%) over the past 28 years. Prey quantity and quality reductions, exposure to toxic chemicals that accumulate in top predators, and vessel and sound disturbances are threats to persistence of SR killer whales. Considering the status and continuing threats, the Southern Resident killer whales remain in danger of extinction and are listed as endangered.

2.2.1.6 Humpback whales

Humpback whales were listed as endangered across their entire range under the Endangered Species Conservation Act (ESCA) in June 1970 (NMFS 1970). The ESA replaced the ESCA in 1973 and continued to list humpback whales as endangered. NMFS issued the final recovery plan for humpback whales in November 1991 (NMFS 1991). This section summarizes information taken largely from the recovery plan as well as new data that became available more recently.

Spatial Structure and Diversity
Humpback whales occur in all major oceans of the world. In the North Pacific, humpback whales feed in coastal waters from California to Russia, including in the Bering Sea. These humpback whales migrate south off Mexico, Central America, Hawaii, southern Japan, and the Philippines (Carretta et al. 2013). Significant levels of nuclear and mtDNA differences exist between the North Pacific humpback whale populations (Baker et al. 1998). Currently there are four separate stocks (defined based on feeding areas) in the North Pacific recognized in the U.S. MMPA Pacific stock assessment reports: the Central North Pacific Stock, the Western North Pacific Stock, the California/Oregon/Washington Stock, and the American Samoa Stock (Carretta et al. 2013). These stocks are defined based on feeding areas because maternally directed fidelity appears stronger in feeding areas than in wintering areas. The California / Oregon / Washington stock winters in coastal waters of Mexico and Central America and migrates to feeding areas ranging from the coast of California to southern British Columbia in summer/fall (Carretta et al. 2013).

Humpback whales forage on a variety of crustaceans, other invertebrates and forage fish (reviewed in NMFS 1991). In their summer foraging areas, humpback whales tend to occupy shallow, coastal waters. In contrast, during their winter migrations humpback whales tend to occupy deeper waters further offshore, and are less likely to occupy shallow, coastal waters. Humpback whales have been infrequently observed in Puget Sound.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Abundance and Productivity
The abundance and population trends of humpback whales are difficult to estimate, but based on the available data, humpback whales appear to be increasing in abundance across much of their range (Carretta et al. 2013). Calambokidis et al. (2008) estimated that the current population of humpback whales in the North Pacific is about 18,000 to 20,000 whales, not counting calves. More recently, the abundance was estimated to be over 21,000 individuals (Barlow et al. 2011). The estimated growth rate for this stock is between 7% and 8%, annually (Calambokidis et al. 2009).

The best estimate of abundance for the California/Oregon/Washington stock is 2,043 (Calambokidis et al. 2009). Within this stock, regional abundance estimates vary among the feeding areas. Average abundance estimates ranged from 200 to 400 individuals for southern British Columbia/northern Washington, and 1,400 to 2,000 individuals for California/Oregon (Calambokidis et al. 2008, Barlow et al. 2011). There is a high degree of site fidelity in these feeding ranges with almost no interchange between these two feeding regions.

Limiting Factors
Several factors identified in the final recovery plan for humpback whales may be limiting recovery. These factors include entanglement in fishing gear, collision with ships, whale watch harassment, scientific harvest (i.e., Japan's scientific whaling) and subsistence hunting, and anthropogenic sound in the ocean that is a habitat concern for low- frequency sound specialists, such as humpback whales (NMFS 1991).

Recovery
The recovery plan for humpback whales was adopted in 1991 (NMFS 1991) and includes actions which focus on identification and protection of essential habitats and monitoring of key population parameters. Other actions include efforts to minimize adverse impacts from human activities such as pollution, scientific harvest, ship collisions, and gear entanglement.

Summary
While the humpback whale population is at relatively low abundance compared to historic levels, they appear to be increasing in abundance across much of their range with annual growth rates of 7 to 8 percent. Continued limiting factors affecting the species include entanglement in fishing gear, vessel collision and harassment, proposed harvest and anthropogenic sound.

2.2.2 Status of Critical Habitat

NMFS review the status of designated critical habitat affected by the proposed action by examining the condition and trends of essential physical and biological features throughout the designated area. These features are essential to the conservation of the listed species because they support one or more of the species' life stages (e.g., sites with conditions that support spawning, rearing, migration and foraging).

For salmon and steelhead, NMFS ranked watersheds within designated critical habitat at the scale of the fifth-field hydrologic unit code (HUC5) as high, medium, or low in terms of the conservation

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

value they provide to each listed species[23]. To determine the conservation value of each watershed to species viability, NMFS' critical habitat analytical review teams (CHARTs; NOAA Fisheries 2005) evaluated the quantity and quality of habitat features (for example, spawning gravels, wood and water condition, side channels), the relationship of the area compared to other areas within the species' range, and the significance to the species of the population occupying that area. Thus, even a location that has poor quality of habitat could be ranked with a high conservation value if it were essential due to factors such as limited availability (e.g., one of a very few spawning areas), a unique contribution of the population it served (e.g., a population at the extreme end of geographic distribution), or the fact that it serves another important role (e.g., obligate area for migration to upstream spawning areas).

2.2.2.1 Marine Fishes

This section will describe critical habitat designated for PS Chinook salmon, HCSR chum and the proposed critical habitat for PS/GB canary and yelloweye rockfish and bocaccio. Critical habitat has been proposed but is not yet final for PS steelhead; the area proposed for designation does not include the action area.

Critical Habitat for PS Chinook salmon and HCSR chum salmon

This section will describe critical habitat designated for PS Chinook salmon and HCSR chum salmon. The analysis is combined because of the similarity of PCEs for each species, and the overlapping critical habitat (CH) areas. Critical habitat is proposed, but not final, for PS steelhead, bocaccio and canary and yelloweye rockfish.

NMFS designated critical habitat for PS Chinook salmon and HCSR chum salmon effective January 2, 2006 (NMFS 2005c). Critical habitat in the action area includes nearshore marine waters to a depth of 30 meters, which includes the cable route although the turbines will be located outside of the designated critical habitat. NMFS identified the following physical or biological features essential to conservation in nearshore marine areas as being free of obstruction with water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels.

The CHART rated all marine areas as having high conservation value for PS Chinook salmon, and those areas from the southern terminus of Hood Canal northeast to Dungeness Bay as high conservation value for HCSR chum salmon. The degradation of multiple PCEs throughout the nearshore indicates that the conservation potential of the critical habitat is not being reached, even in areas where the conservation value of habitat is ranked high. Impacts to the PCEs include loss of or simplification of deltas and delta wetlands; modification of shorelines by armoring, overwater structures and loss of riparian vegetation; contamination of nearshore and marine resources, including degradation of water quality; and alteration of biological populations and communities. The Washington Department of Natural Resources ShoreZone Inventory estimates that 33 percent of

[23] The conservation value of a site depends upon "(1) the importance of the populations associated with a site to the ESUs [or DPSs] conservation, and (2) the contribution of that site to the conservation of the population through demonstrated or potential productivity of the area" (NMFS 2005).

Puget Sound Shorelines have been modified with bulkheads or other modifications that convert intertidal habitat to uplands and alter nearshore processes (PSWQAT 2002). Puget Sound now has 3,500 piers and docks, 29,000 small boat slips, and 700 large ship slips. These shoreline modifications potentially interfere with juvenile salmonid migration and diminish aquatic food supply. Related boat traffic is also a potential source of water pollution.

In summary, critical habitat for PS Chinook and HCSR chum is degraded in the nearshore areas due to loss of or simplification of deltas and delta wetlands; modification of shorelines by armoring, overwater structures and loss of riparian vegetation; contamination of nearshore and marine resources, including degradation of water quality; and alteration of biological populations and communities.

Proposed Critical Habitat for Puget Sound/Georgia Basin Rockfish
In August 2013, NMFS (2013b) proposed critical habitat designations for PS/GB rockfish species. We are including an analysis of the effects of the proposed action on this proposed critical habitat, so that when NMFS issues a final designation, and if no new information alters our conclusions and the designation has not changed significantly from what has been proposed, then this consultation would be valid for PS/GB rockfish critical habitat, and reinitiation of this consultation would not be required.

Proposed critical habitat includes the physical and biological features essential to the conservation of these species: quantity, quality, and availability of prey species to support individual growth, survival, reproduction, and feeding opportunities; water quality and sufficient levels of dissolved oxygen to support growth, survival, reproduction, and feeding opportunities; and structure and rugosity to support feeding opportunities and predator avoidance. NMFS rated all areas proposed as critical habitat for rockfish as having high conservation value. In the action area, loss or degradation of kelp habitats through harvest or shoreline construction; contamination of nearshore and marine resources, including degradation of water quality; occurrence of derelict gear and alteration of biological populations and communities appear to limit the conservation value of the designated area.

2.2.2.2 Marine mammals

Of the three ESA-listed marine mammals, which occur in the action area, critical habitat has been designated only for SR killer whale.

Critical Habitat for SR Killer Whale
NMFS published the final designation of critical habitat for the SR killer whale DPS on November 29, 2006 (NMFS 2006c). Critical habitat consists of three specific areas: (1) the Summer Core Area in Haro Strait and waters around the San Juan Islands; (2) Puget Sound; and (3) the Strait of Juan de Fuca. These areas comprise about 2,560 square miles of marine habitat. Based on the natural history of the Southern Residents and their habitat needs, NMFS identified the following physical or biological features essential to conservation: (1) Water quality to support growth and development; (2) Prey species of sufficient quantity, quality and availability to support individual growth, reproduction and development, as well as overall population growth; and (3) Passage conditions to allow for migration, resting, and foraging. The action area is within the Puget Sound area of the critical habitat designation.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Water Quality. Water quality in Puget Sound, in general, is degraded as described in the Puget Sound Partnership Recommendations and subsequent Action Agenda (Puget Sound Partnership 2006, 2008). For example, toxic chemicals in Puget Sound persist and build up in marine organisms including Southern Residents and their prey resources, despite bans in the 1970s of some harmful substances and cleanup efforts. NMFS's primary concern for direct effects on whales from water quality is oil spills, although oil spills can also have long-lasting impacts on other habitat features. The Environmental Protection Agency and U.S. Coast Guard oversee the Oil Pollution Prevention regulations promulgated under the authority of the Federal Water Pollution Control Act. There is a Northwest Area Contingency Plan, developed by the Northwest Area Committee, which serves as the primary guidance document for oil spill response in Washington and Oregon. In 2007, the WDOE published a new Spill Prevention, Preparedness, and Response Program Annual Report describing recent accomplishments and declining trends in spill incidents per transit (WDOE 2007).

Prey Quantity, Quality, and Availability. Most wild salmon stocks throughout the Northwest are at fractions of their historic levels. Beginning in the early 1990s, NMFS listed 28 ESUs and DPSs of salmon and steelhead in Washington, Oregon, Idaho, and California as threatened or endangered under the ESA. Historically, overfishing, habitat losses, and hatchery practices were major causes of decline. Poor ocean conditions over the past two decades have reduced populations already weakened by the degradation and loss of freshwater and estuary habitat, fishing, hydropower system management, and hatchery practices. While wild salmon stocks have declined in many areas, hatchery production has been generally strong. Total Chinook abundances along the west coast increased significantly from the mid-1990s to the early 2000s, but have declined in the last several years (PFMC 2008).

Contaminants and pollution also affect the quality of SR killer whale prey in Puget Sound. Contaminants enter marine waters and sediment from numerous sources, but are typically concentrated near areas of high human population and industrialization. Once in the environment these substances proceed up the food chain, accumulating in long-lived top predators like SR killer whales. Chemical contamination of prey is a potential threat to SR killer whale critical habitat, despite the enactment of modern pollution controls in recent decades, which were successful in reducing, but not eliminating, the presence of many contaminants in the environment. The size of Chinook salmon is also an important aspect of prey quality (i.e., Southern Residents primarily consume large Chinook), and any reduction in Chinook salmon size can affect the prey feature and the conservation value of their critical habitat. In addition, vessels and sound may reduce the effective zone of echolocation and reduce availability of fish for the whales in their critical habitat (Holt 2008).

Passage. Southern Residents are highly mobile and use a variety of areas for foraging and other activities, as well as for traveling between these areas. Human activities can interfere with movements of the whales and impact their passage. In particular, vessels or acoustic disturbance may present obstacles to whale passage, causing the whales to swim further and change direction more often, which can increase energy expenditure for whales and impact foraging behavior (NMFS 2011b).

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

2.3 Environmental Baseline

The "environmental baseline" includes the past and present impacts of all Federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR 402.02).

The proposed project is located in Admiralty Inlet in the northwestern portion of Puget Sound, between the Olympic Peninsula and Whidbey Island (Island County) (Figure 1, Section 1.3). Puget Sound is the second largest estuary in the United States, where salt water from the Pacific Ocean is mixed with fresh water draining from the surrounding watersheds. Admiralty Inlet is the major connection between Puget Sound and the Strait of Juan de Fuca. The channel is a fairly small passage, about 5 km at its narrowest constriction and is the major connection between Puget Sound and the Strait of Juan de Fuca.

2.3.1 Tidal Currents

Strong currents occur within the site because the relatively narrow and shallow channel (about 5km at the narrowest constriction) at the entrance to Admiralty Inlet reduces the cross-sectional area (from 213,000 square meters south of the inlet to 317,000 square meters to the north) and regulates flow. In the proposed turbine location of Admiralty Inlet, tidal currents are effectively bi-directional and velocities are variable. The mean depth-averaged velocity at the turbine site is 1.2 m/s and the maximum sustained (at least 5 minutes) was 3.4 m/s (Snohomish PUD 2012b).

2.3.2 Benthic Habitat and Invertebrates

The tidal currents in Admiralty Inlet have scoured the sea floor in the vicinity of the project, washing away clays and silts, shifting sands and gravels, and leaving surface areas of cobbles, rocks, and boulders that are too large to be mobilized on the sea bed. The sea floor surface in the area of the turbine installation site is a cobbled pavement interspersed with gravel and shell and small and large boulders (Figure 8). This cobbled pavement is estimated to be between 1 to 2 meters thick and underlain with clay and sand and/or a mixture of sand, gravel, cobble, and boulders (Snohomish PUD 2012b).

The applicant conducted ROV surveys to characterize the site-specific benthic habitat and community in August, late September, and early October 2010 (Snohomish PUD 2012a). The benthic community at the turbine site, especially in areas with boulder and cobble substrate, was dominated with small encrusting organisms such as sponges, bryozoans, and tubeworms. (the smaller-grained substrates, pebbles, and gravel, roll back and forth in the tidal currents and are therefore do not become encrusted with these organisms). In addition, a variety of larger attached organisms such as anemones were observed. The anemones varied in size from 4 to 12 cm (1.6 to 4.7 in) in diameter when closed and three basic types were distinguished by color and pattern. A total of 1,375 anemones were counted. Sessile organisms included chitons, limpets, tunicates, clams, and stemmed and basket sponges. Mobile epifauna included shrimp, hermit crab, crab, sea stars, urchins, and turban snails. The most dominant species were the urchin and common five-legged orange starfish, which composed 90 percent of the individuals observed (Snohomish PUD 2012a).

Figure 8 ROV image of cobble pavement bottom in project area (Source: FERC 2013)

The Applicant conducted an ROV video survey of the revised route for the trunk cable in July 2012, with a particular focus on surveying areas likely to have eelgrass beds, kelp forests, and geoduck clams. Conditions were found to be similar to those observed in the October 2010 survey. That is, no geoduck clams, eelgrass beds, or kelp forests were observed (Snohomish PUD 2012a).

2.3.3 Marine Fishes

The most numerous fish sampled during 50 WDFW trawls in Admiralty Inlet from 1987 to 2008 (trawl depths of 31 to 60 meters, the depth range within which the turbines will be located), were: spotted ratfish (65 percent of the catch by number), Pacific sanddab (5 percent), English sole (4 percent), southern rock sole (4 percent), great sculpin (3 percent), buffalo sculpin, Pacific tomcod, spiny dogfish, and Puget Sound rockfish (all 2 percent). All species of rockfish caught (Puget Sound, copper, greenstripe, quillback, redstripe, and unidentified individuals) comprised 5 percent of the total catch (Snohomish PUD 2012a).

All species of anadromous salmonids originating from the Skagit River, Stilliguamish River, Snohomish River, Lake Washington Basin, Duwamish/Green River, Puyallup River, Nisqually River Deschutes River, Skokomish River, Hamma Hamma River, Dosewallops River, Duckabush River, and Quilcene River, both out-migrating juveniles and returning adults, pass through Admiralty Inlet. These rivers collectively produce in excess of a million adult fish (and over 50 million juvenile fish),

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

of hatchery and wild origin, each year. The spatial and temporal occurrence and habitat use of ESA-listed fishes in the action area is detailed in section 2.3.7 below.

2.3.4 Marine Mammals

Marine mammal species observed in central Puget Sound (includes Admiralty Inlet)include harbor porpoise, Dall's porpoise, killer whale, Minke whale, gray whale, California sea lion, Steller sea lion, harbor seal, and northern elephant seal. Programs to document the presence of marine mammals in Puget Sound include twelve years of vessel surveys conducted by the WDFW. Harbor seals were the most frequently observed species in Admiralty Inlet followed by harbor porpoise, Dall's porpoise, river otter, killer whale, and California sea lion (Snohomish PUD 2012a).

2.3.5 Vessel Activity

Commercial fishing for salmon ended in Admiralty Inlet in the early 1990s due to the potential to overharvest diminished native stocks as they passed through the area. Recreational fishing and boating still occurs in Admiralty Inlet, including at the action area. Tribal fisheries including long-line halibut and other efforts have occurred in the past and could occur in the future within the action area.

All maritime traffic bound for, or departing from, the ports of Seattle, Everett, Tacoma and Olympia uses a major shipping lane that passes through the middle of Admiralty Inlet (NOAA 2012). In addition, the Port Townsend- Keystone ferry runs about 1.5 kilometers from the turbine deployment site. During the summer, ferries make 10 round trips across Admiralty Inlet, operating for up to 12 hours per day. The U.S. Navy's Admiralty Bay Mining Range is in the action area, less than 1km from the turbine site. The restricted area is defined as the surface to 5,000 ft and includes the sea surface and subsurface waters.[24] In addition, many small commercial and recreational craft operate throughout the action area.

2.3.6 Sound

Several factors contribute to ambient noise in Admiralty Inlet, including anthropogenic sound, bedload transport associated with strong tidal currents, rain, and biological vocalizations. Anthropogenic sources of ocean noise include commercial shipping, military activities, geophysical surveys, oil drilling and production, dredging and construction, sonar systems, and oceanographic research. Vessel traffic contributes significantly to the sound profile of Admiralty Inlet as detailed in baseline evaluations of the acoustic environment (Bassett 2010). Source levels associated with the more than 1,300 vessels reported transiting the action area over the 1-year study period ranged from 165 decibel (dB) referenced to (re:) 1 micro-pascal (μPa)[25] to 185 re 1 μPa (Bassett et al 2012). Noise recorded in the proposed turbine location (which is outside of the shipping lane), ranged from a

[24] This area is not used for mining as the name suggests but is for military exercises such as small and unmanned aircraft training other activities.

[25] Researchers studying sound in water and air typically use a different reference pressure. In water, the common reference has been 1 micropascal (1 μPa, or one millionth of a pascal; a pascal is 1 newton per square meter). In air, the common reference is 20 μPa, because that is near the absolute threshold for a normal human listener for a sound frequency of 1,000 Hz. The reference level is analogous to sea level in our specification of the height of some land mass.

minimum of 98 dB re 1µPa to over 130 dB re 1µPa with a mean of about 117 dB re 1µPa (Bassett 2010). Bassett reported that vessel noise can raise the ambient level in the turbine area by 20-30 dB depending on the type of vessel and its distance from the turbine area.

Summary of Environmental Baseline Condition
Admiralty Inlet is where most all waters and marine species must pass when they go between Puget Sound and the Strait of Juan de Fuca. For that reason, it has strong tidal currents, as well as a large number of marine species that pass through it. Heavy commercial shipping and ferry traffic contribute to the moderately high ambient noise in the action area and are a potential source of water pollution. The condition of the action area is degraded although within the action area habitat is in relatively good condition compared to other areas of Puget Sound where much of the shoreline has been modified or armored and structures have been installed including piers docks, small boat and large ship slips.

2.3.7 ESA-listed species occurrence and habitat use in the action area

In the following sections, we describe the status of the ESA-listed marine fishes and marine mammals that occur in the action area and thus would be exposed to effects of the project. In this section, we describe the likelihood of occurrence and habitat use in the action area for each species. NMFS is unable to estimate abundance within the action area for most of the listed species due to a lack of site-specific data.

2.3.7.1 Salmonids

Research on the behavior of juvenile salmonids indicate that juvenile Pacific salmon (Onchorynchus spp) including Chinook, chum and steelhead are typically surface oriented and are most often found in the upper 20 meters of the water column (Emmett et al 2004,Walker et al 2007, Melnychuk et al 2010). A Canada Department of Fisheries and Oceans (CDFO) study also reported that juvenile Pacific salmon typically occupy shallower depths of the water column (as cited in Snohomish PUD 2012a). Figure 9 shows the depth distribution for juveniles of five salmonid species sampled during the CDFO study. About 75 percent of all juvenile Chinook salmon were located in the top 15 meters (49 feet) of the water column. About, 15 percent of the juvenile Chinook salmon were captured at the 16 to 30 meter (52 to 98 feet) and 10 percent in the 31 to 45 meter (101 to 148 feet) depth interval.

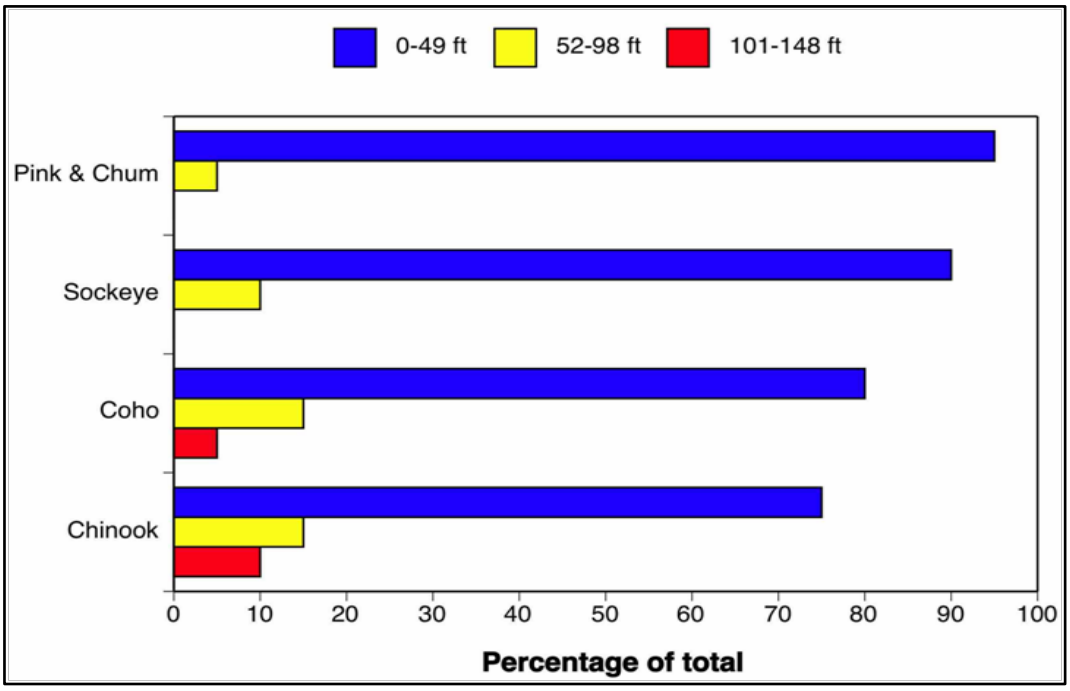

Figure 9. Depth distribution of juvenile salmon captured in the Georgia Strait and Puget Sound (Source: CDFO study as summarized in Snohomish PUD 2012)

Research indicates that juvenile steelhead are also surface oriented during migration. Although diel variation occurs, they are typically within 3 meters of the surface (Beeman and Maule 2006)

Puget Sound Chinook Salmon

Juvenile PS Chinook salmon move through the nearshore waters of Puget Sound upon their emigration from local estuaries. Nearshore habitats provide food such as small fish, aquatic invertebrates, and insects that are essential for juvenile growth. Juveniles stay in the nearshore zone for periods ranging from several days to several weeks, moving to deeper waters as they grow. Although most PS Chinook salmon eventually emigrate to Pacific Ocean coastal waters, some remain in the Puget Sound throughout their life cycle. While in the Puget Sound, the diet of sub-adult Chinook salmon is similar to those reported for Chinook salmon elsewhere. Higgs et al. (1995) documented that in marine waters, Chinook salmon generally eat a mixture of crustaceans, squid, and fish, especially Pacific herring and Pacific sand lance as they grow.

No Chinook salmon-bearing streams enter Puget Sound within the action area. Because the turbine site and cable route are near the entrance of Admiralty Inlet, salmonids (including hatchery stocks) originating in central and south Puget Sound tributaries such as the Cedar, Green, Nisqually, and Snohomish river populations emigrate through Admiralty Inlet. Likewise, Chinook salmon originating in Hood Canal tributaries and hatcheries also must emigrate through Admiralty Inlet. Populations originating from the Nooksack, Dungeness and Elwha rivers are not expected to be affected by the proposed action as these fish are not likely to migrate through Admiralty Inlet. The greatest numbers of adults likely pass through the Inlet from April through September as they return from the ocean to their natal streams and rivers. The five-year average of total (natural and hatchery origin) spawners for the years 2005-2009 was about 37400 (Ford 2011). The turbine footprint and the

turbine-swept area[26] (about 28 square meters) are located in the pass between Admiralty Head and the northeast tip of the Olympic Peninsula (Figure 1). It is therefore likely that some fraction of the adult PS Chinook moving south through the pass would migrate through the action area.

In summary, juvenile Chinook exhibit a strong preference for habitat within 30 meters of the surface, so very few individual juveniles are likely to encounter the turbine structures or their effects. For adults, an unknown fraction are likely to pass through the action area while migrating and encounter the turbine structures or their effects.

Hood Canal Summer-run Chum Salmon

The closest HCSR chum salmon stream to the action area is Chimacum Creek, about five miles south of the Port Townsend ferry terminal, across the Inlet from the project. Summer-run chum juveniles and adults from other Hood Canal tributaries could also migrate through Port Townsend Bay, Individuals from the Strait of Juan de Fuca population are not as likely to pass through the action area as migrating individuals from the Hood Canal population. Juvenile HCSR chum salmon rear and migrate through the nearshore of Puget Sound during their emigration to the Pacific Ocean during the spring and early summer months. Adult HCSR chum salmon migrate back through the Puget Sound and Strait of Juan de Fuca region on their way to natal streams in Hood Canal during late spring and summer months. The five-year average of total (natural and hatchery origin) spawners is about 13,900 (Ford 2011). As described above for PS Chinook salmon, juveniles are surface oriented and thus very few individual juvenile chum are likely to encounter the turbines as they pass through the action area. For adult chum, and some unknown fraction of returning adults are likely to pass through the action area while migrating and encounter the turbine structures or their effects.

PS steelhead

Unlike most other Pacific salmonids, juvenile steelhead move quickly through nearshore marine waters in Puget Sound. The species' lengthy freshwater rearing period is thought to result in large smolts that are prepared to move rapidly through estuaries and nearshore waters to forage on larger prey in offshore marine areas (Melnychuk et al 2007; Welch, 2004). Although data specific to Puget Sound are limited, recent studies of steelhead migratory behavior strongly suggest that juveniles spend little time (a matter of hours in some cases) in estuarine and nearshore areas and do not migrate along shorelines (Moore et al., 2010a, Moore et al., 2010b).

Adult steelhead habitat use in Puget Sound is also relatively unknown. Some adult steelhead probably migrate through Puget Sound year-round, although winter-run steelhead are known to migrate back to natal spawning grounds in late fall through winter months (Hard et al 2007) The closest natal stream to the action area is Chimacum Creek. Other steelhead-bearing Hood Canal rivers and streams near Oak Bay include Thorndyke Creek, and the Big and Little Quilcene rivers. Steelhead from southern Puget Sound and other Hood Canal rivers and streams are also likely to be present in the action area. Adult steelhead occur at any depth down to 200 m at sea, but are found most often above 30 m of depth

[26] The turbine swept area is the estimation of the area, which is comprised by the two turbine blade assemblies (rotors) which spin. The estimated area accounts for the open center of the rotor and is about 28 square meters.

(Ruggerone et al. 1990). The average total number of spawners (natural and hatchery origin) for the period from 2000-2004 was about 13,700 (Hard et al 2007).

In summary, juvenile steelhead are surface oriented and likely to move quickly through Puget Sound to the open ocean, thus very few individual juveniles may encounter the turbine structures or their effects. For adult steelhead, some fraction of returning adults are likely to pass through the action area while migrating and encounter the turbine structures or their effects.

2.3.7.2 Puget Sound/Georgia Basin DPS Bocaccio, Canary Rockfish, and Yelloweye Rockfish

Data on spatial distribution in Admiralty Inlet from Palsson et al. (2009) indicate that adults from these rockfish species typically occur at depths greater than 50 m and that both boccaccio and yelloweye rockfish are rare and canary rockfish is uncommon[27]. The data also indicate that the frequency of occurrence of all rockfishes sampled in Admiralty Inlet, including the listed species, is relatively high when compared to the rest of Puget Sound, but lower than the San Juan Islands (Greene and Godersky 2012). The high abundance of these species in the San Juan Region in comparison to in Puget Sound, could be explained by the prevalence of rocky habitat in the San Juan Region, whereas rocky habitat is not common in Puget Sound (Drake et al 2010). Admiralty Inlet also has rocky habitat and therefore might be more attractive to the three listed rockfish species than other areas of the Puget Sound region.

Rockfish eggs are fertilized within the female and the young are born free swimming. After release, all rockfishes have a pelagic stage, which varies among species in both duration and vertical location in the water column (Love et al. 2002). Larval rockfish occupy open waters of Puget Sound, generally in the upper water column (Waldron 1972; Weis 2004; Greene and Godersky 2012). Juvenile bocaccio, yelloweye, and canary rockfish are likely to be passively distributed with currents into the action area. Pelagic juvenile bocaccio are usually found close to the surface and are often found under drifting kelp mats (Love et al. 2002). Off central California, juvenile bocaccio as small as 2 cm settle in (recruit to) benthic inshore water from February to August, and recruitment was noted in January off La Jolla (southern California) (Love et al. 2002). Juvenile bocaccio most often recruit over rocks covered with various algae, or sandy zones with eelgrass or drift algae (Love et al. 2002). Miller and Geibel (1973) documented bocaccio juveniles in kelp beds from April through November in Monterey Bay, California. After their pelagic phase, juvenile canary rockfish also recruit to nearshore habitats, such as tide pools and kelp beds, starting in April (Love et al. 2002). Juvenile canary rockfish gradually move from shallow habitat to deeper adult habitat toward the end of summer (Love et al. 2002), but Miller and Geibel (1973) reported canary rockfish juveniles remaining in a Monterey Bay kelp bed area until the advent of winter storms. In contrast, there are no published observations of juvenile yelloweye rockfish in intertidal or nearshore waters.

Data from research conducted in Puget Sound by Greene and Godersky (2012) and Paulsson et al (2009) indicate that within a given year, larval rockfish abundance patterns likely reflect a combination of water circulation and residence time, larval movements into nearshore habitats, and spatio-temporal variation in spawning among multiple species. The research by Greene and Godersky

[27] From Greene and Godersky 2012 Appendix 4: Occurrence is categorized as rare (R), uncommon (U), and common (C), or very rare or absent (blank). Rankings based on frequencies of catch (rare: frequency ≤ 10, uncommon: $60 \geq$ frequency ≥ 11, common: frequency > 60).

(2012) supports the hypothesis that larval abundance patterns are influenced by adult abundance patterns in Admiralty Inlet.[28] The researchers report that no bocaccio were identified in the 495 samples collected, indicating their rarity. They further state that the absence of boccacio is a reflection of patterns for canary and yelloweye rockfishes, indicating the rarity of these species as well. Given that juvenile and adult rockfish prefer rocky and high relief habitats, which occur at the depth of the turbines, some juveniles and adults are likely to be present in the action area although ESA-listed canary, yelloweye, and bocaccio are likely to be rare.

Therefore, based on their preferred habitat types and patterns of use, larval, juvenile and adult lifestages of the three ESA-listed rockfish species are likely to occur in Admiralty Inlet. However, based on their rarity, only very small number of adults and juveniles of each species is likely to encounter the turbines or their effects.

2.3.7.3 SR Killer Whales

The Whale Museum manages a long-term database of SR killer whale sightings and geospatial locations in inland waters of Washington State. While these data are predominately opportunistic sightings from a variety of sources (public reports, commercial whale watching, Soundwatch, land-based observations from Lime Kiln State Park, and independent research reports), SR killer whales are highly visible in inland waters, and widely followed by the interested public and research community. The dataset does not account for level of observation effort by season or location; however, it is the most comprehensive long-term dataset available to evaluate broad scale habitat use by SR killer whales in inland waters. For these reasons, these are the best available data for assessing the likelihood of SR killer whale presence in the action area.

The Whale Museum dataset from the years 1990 to 2008 documents 2,532 sightings of SR killer whales in Puget Sound "proper" (i.e., south of Deception Pass and Admiralty Inlet; Whale Museum, 2009), and of those, about 194 occurred within the action area (Table 1).

[28] By extension, the juvenile life-stage, which begins in the pelagic zone but includes settlement to the bottom (Palsson et al 2009), is also influenced by adult abundance patterns.

Table 1 SR killer whale sightings in the project vicinity

Month	SR killer whale sightings in the action area
January	15
February	15
March	8
April	6
May	2
June	1
July	0
August	8
September	17
October	38
November	40
December	44

Source: SR Killer Whale Sighting Compilation 1990-2008 (Osborne, 2008).

The seasonality of the SR killer whale usage of south Puget Sound (including Admiralty Inlet) is likely due to the timing of Chinook and chum salmon runs in Puget Sound (Osborne 1999, NMFS 2008). The Whale Museum notes that all three pods use Puget Sound with J pod the most common, followed by K pod. Observations of transits through Admiralty Inlet indicate SR killer whales most frequently use the western side of the entrance to the Inlet (i.e., within the action area but on the far side of the inlet away from the turbine site), although the eastern portion, nearer the turbine site, is occasionally used as well (Whale Museum 2009, Tollit et al 2010a, 2010b).

Ford et al. (2000) report four behavioral states in killer whales, including foraging, traveling, resting, and socializing. Resident killer whales spend about 50 to 67 percent of time foraging, either actively feeding or searching for food (Ford, 1989). While traveling, killer whales swim in a tight formation, consistently swimming in a specific direction, often surfacing and diving in unison (Ford et al., 2000). During resting behavior, killer whales swim slowly, usually abreast and in a tight formation, and surface and dive in unison (Ford et al., 2000). Socializing includes physical interactions, displays (e.g. breaching, tail slapping, spy hopping), and vocalizations (Ford et al., 2000).

While in the inshore waters of southern British Columbia and Washington, SR killer whales spend 95 to 97 percent of their time between the surface and a depth of 30 meters (Baird et al., 2003, 2005). Baird reported SR killer whale in inshore water of southern British Columbia and Washington averaged about 0.7 to two dives per hour made below 30 meters, with such dives occurring more often during the daytime. These represented 5 percent of all dives and occupied less than 2.5 percent of an animal's total dive time. During the day, dives greater than 150 meters deep were made on average about once every five hours (Baird et al., 2003, 2005). Because dives below 30 meters represented only 2.5 percent of an animal's dive time, it is assumed that dives to 150 meters represent an extremely small portion of a whale's dive time. Although this research is not specific to the action area it represents the best available information on SR killer whale behavior and is assumed to be representative of behavior that would occur in the action area because it was conducted on individuals from the same ESA-listed population (SR killer whale DPS) and both areas (the research location and the action area) are within the inland waters used by the population.

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Snohomish PUD conducted marine mammal field studies in the action area between October 2009 and April 2010. The study area for this effort comprises a five nautical mile radius area from the proposed turbine location which includes (and extends beyond) the action area, defined as a 3 km radius from the proposed turbine location. The visual observation data collected during the study were used to complement results from passive acoustic monitoring (PAM) efforts from two hydrophones already mounted on the seafloor in the project area, as well as a cabled hydrophone located near Port Townsend. SR killer whales were seen in the study area by land based observers on three observer days in October and one "fast response"[29] day in December (i.e., no observations were recorded during November 2009 or January through April 2010). During the study period, an estimated 22 SR killer whale transits[30] were observed. Of the 22 visual observations of SR killer whales transiting the study area, they were detected acoustically 14 times via the hydrophone at the Port Townsend Marine Science Center and/or 10 times by human shore-based observers (Tollit et al., 2010b). Snohomish PUD used opportunistic sighting information and PAM to collect new data on seven of the SR killer whale transits observed through Admiralty Inlet during the study. Opportunistic dive depth information was collected in the vicinity of the proposed installation site using a vertical hydrophone. The depths at which vocalizations were recorded ranged from the surface down to 142 meters; however, 80 percent of the vocalizations were produced at depths of 30 meters or less, with little difference between average depth by behavior category (foraging, travelling, resting, socializing). The study results also indicate significant variability in the amount of vocalization recorded by the hydrophones when Southern Residents were visually observed transiting the study area (0 to 92 percent of recording time) (Tollit et al. 2010b). The depths observed in the study area are consistent with dive depths observed in previous studies (Baird et al 2003, 2005). However, SR killer whales are capable of dives deeper than that of the hydrophones used in the Snohomish PUD study and may not vocalize during all dives or at all times during a particular dive.

On seven occasions, boat-based observers followed SR killer whales through the study area. The whales traveled through the shipping lanes and generally west and southwest of the turbine location but within the outer portions of the 3 km radius action area; simultaneous land-based observations provided similar data. On one occasion SR killer whales spent more than four hours within the action area in the eastern portion of the entrance to Admiralty Inlet, moving north and then circling back to move through the action area again on the same day. Also on this day, boat- and land-based observers saw the whales foraging within 275 meters of the proposed turbine location (Tollit et. al 2010a, 2010b).

In summary, boat- and shore-based observers recorded about 11.5 hours of data during SR transits of the action area. SR killer whales spent most of their time in the study area traveling (74 percent), while the remainder of the time was spent foraging (21 percent) and socializing (5 percent) (Tollit et al., 2010a, 2010b)

[29] A 'fast-response or rapid response' day is an observation and monitoring effort driven by detection or sighting of SR killer whales entering the study area as opposed to a pre-scheduled day of monitoring. Fast response efforts can be land or boat based observations.

[30] A transit of Admiralty Inlet is defined as any crossing (entry or exit) of the line connecting Admiralty Head and Point Wilson.

All of the individuals in the listed DPS (currently 82 SR killer whales) could transit through, and forage, rest or socialize in the action area.[31] SR killer whales appear to spend the majority of their time in the upper 30 meters of water column, above the depth of the turbines. The best available scientific information indicates that dives to depths greater than 30 meters (as studied and reported from observations in the San Juan Islands and other areas of Puget Sound) represent about 2.5 percent of an animal's dive time, which reduces the potential for direct interactions with the turbine structures and cable system.

2.3.7.4 Humpback whales

There is limited information about humpback whale foraging habits and space use in inside waters of Washington, and there is no specific fine-scale information for the project area. In recent years, humpback whales are sighted with increasing frequency in the inside waters of Washington, including Puget Sound (primarily during the fall and spring); however, occurrence is uncommon. On a few occasions, humpback whales have been recorded passing through Admiralty Inlet.

Therefore, individual humpback whales could pass through, or forage in, the action area at some time during the 10-year license duration, although their presence would be considered rare.

2.4 Effects of the Action on Species and Designated Critical Habitat

"Effects of the action" means the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02). Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur.

There is high uncertainty around the environmental effects of tidal energy development (Polagye et al., 2011), especially in the case of the proposed project, because it is the first in the United States to employ this new technology. Marine hydrokinetics, in general, is an emerging field with limited in-situ research on the effect of such deployments to the marine environment.

The proposed action is FERC's issuance of a 10-year Pilot License for the deployment and operation of two 6-meter OpenHydro turbines. FERC developed a modified license for tidal energy projects out of recognition that there is very little information on their environmental effects. The purpose of the limited duration pilot license is to allow for testing and deployment of this new technology, to gather information on the effects of the turbines through monitoring programs, while ensuring the protection of the public and the environment with safeguard plans.

The Snohomish PUD, in cooperation with NMFS and other natural resource agencies and Tribes, developed an adaptive management framework to address the lack of information and uncertainty associated with the effects of deploying and operating the new technology. The proposed pilot license includes the adaptive management framework and the specific monitoring and mitigation plans, which are designed to gather data and determine whether project effects are within the expected range. The framework also includes mitigation measures to avoid or minimize any unacceptable

[31] Because the project would have a 10-year duration, the exact number of individuals may vary from year to year depending on population changes. Regardless of future population numbers, all individuals from the SR killer whale DPS could use habitat in the action area.

levels of impact to marine species or their habitat. In the event that modification of the project or its operations would not avoid or minimize adverse effects, the proposed license specifies that the Applicant would cease project operations and remove all equipment from the action area.

Based on the best available scientific and commercial information, the applicant-prepared BA, the FERC's draft and final EAs, and the Final License Application, NMFS finds that the proposed 10-year pilot license authorizing a limited 5-year deployment and operation of two OpenHydro tidal turbines would result in the following effects for ESA-listed marine fishes and mammals: *anthropogenic sound, electromagnetic field generation (EMF), habitat alteration from the introduction of physical structure, marine debris entanglement, and blade strike.*

We describe the exposure to the effects, biological responses, and risk for listed marine fishes and marine mammals in the following sections. Where an effect is specific to one group or the other (e.g. EMF may affect marine fishes but not marine mammals), potential effects are described only for the relevant species.

2.4.1 Anthropogenic Sound

The potential effects of noise generated by ocean energy projects has been a primary environmental concern in their development (Cada et al. 2007, Scottish Executive 2007, Minerals Management Service MMS 2007, Michel et al. 2007, Department of Energy 2009, Polayge et al 2011). Operations, as well as installation, maintenance, and removal activities would generate underwater noise, which would propagate for some distance from the project depending on ambient conditions and source levels.

Noise effects can be divided into short-term effects associated with installation, maintenance, monitoring, and removal of the turbines, and long-term albeit intermittent effects (i.e., over the 10-year term of the proposed license) associated with the operation of the turbines. No activities that would produce impulse sounds are included in the proposed action thus effects of impulse sounds are not analyzed.

Installation, Maintenance, Monitoring, and Removal Activities

The use of vessels and gear associated with installation and removal of the OpenHydro turbines, as well as vessels used for monitoring, maintenance, and project-related studies, including tug/barge, small vessels, and research ships, would intermittently increase marine traffic in the action area for periods of days to weeks although the increase would be very small given the heavy shipping traffic, ferry transits and recreational boating which occurs in Admiralty Inlet. In general sound sources from installation, maintenance and removal would be continuous and would range between 125 and 175 dB (re 1 µPa @ 1 m). Maximum source levels during HDD, cable laying, turbine installation and removal, routine maintenance, and environmental monitoring ranges from 165 dB to 175 dB, with the frequency content expected to range from 20 Hz to 10 kHz (Richardson et al., 1995).

Vessels would move slowly or idle in the project vicinity and would follow standard navigation and vessel regulations for marine mammal protection at all times. The sound intensity would be lower when the vessels are operating at idle speed. Installation activities would be conducted during WDFW work windows (i.e., July 16 to October 14) to minimize or avoid impacts to salmonids and

other marine species from marine construction activities. [32] In addition, Snohomish PUD would follow project specific protocols for vessel operations around marine mammals during installation and removal (Snohomish PUD 2012b). Specifically, if a listed cetacean occurs within 500 meters of an installation or removal vessel, operations would be halted until the cetacean or pinniped left the vicinity to protect species from vessel strike and reduce exposure to sound sources associated with installation and removal.

The turbines and their support frames would be removed from the water after five years for scheduled maintenance and could be removed at other times during the 10-year license term for unscheduled maintenance. A non-propulsion turbine installation barge, ROV, three supporting tugs, and personnel transfer/safety boats would be required to remove the device from the water. Snohomish PUD expects removal to be completed within one tidal cycle for each turbine.

Boats would be on site periodically for environmental monitoring and maintenance inspections such as those conducted using an ROV. These environmental monitoring and maintenance activities could take place over parts of several days per month during the early stages of operation, but are likely to decrease in frequency over the 10-year deployment period.

Turbine Operations

Sound from turbulent eddies generated by the flow of water around the support structure or in the turbine wake is expected to dissipate quickly and would not significantly contribute to ambient noise levels (Polagye et al. 2012). During the time that the turbines would be deployed, they would create sound only when the blades are rotating, which, based on pre-installation velocity surveys, is expected to occur 70 percent of the time[33] (Snohomish PUD 2012a). Because turbine rotation increases with tidal velocity, sound would be variable, starting at the lowest velocity that causes the turbines to spin (about 0.7 m/s) and increasing with current speed as it approaches maximum velocity (3.6 m/s).

Although data, on noise generated by operating turbines, is very limited, OpenHydro conducted an underwater noise assessment, using drifting hydrophone recordings, for a 6-meter diameter turbine (similar size to the two turbines in the proposed action) deployed at the European Marine Energy Center (EMEC) in Scotland. OpenHydro estimated a broadband source level of 154 dB (re 1µPa at 1 m) for the turbine by integrating over frequencies from 10 Hz to 5 kHz (Snohomish PUD 2012a).[34] Polagye et al. (2012) reanalyzed these data to estimate the potential sound level from operating a 6-meter turbine over the range of flow velocities observed in Admiralty Inlet. Figure 10 shows the expected distribution of broadband sound levels created by operating a 6-m turbine at the proposed site. The noise levels estimated for the turbine deployed in Admiralty Inlet would be higher than the levels recorded for the deployment at EMEC due to the higher current velocities in Admiralty Inlet.

[32] State of Washington and the US Army Corps of Engineers have established work windows for 17 Tidal Reference Areas in the State of Washington's coastal waters to avoid or minimize impacts from marine construction.

[33] Water velocity must exceed 0.7 m/s before the turbines will rotate. Velocities in the turbine location are expected to be less than 0.7 m/s 30 percent of the time.

[34] In this case, a broadband source level of 154 dB (re 1µPa at 1m) is the sum of the estimated acoustic energy produced by the 6-meter turbine over all frequencies, estimated at a distance of 1 meter from the center of the rotor.

The sound level for the 95th operating percentile[35], which corresponds to a current velocity of 2.3 m/s, is 163 dB re 1µPa at 1 m (i.e., at the source) (Figure 10). NMFS uses this as the expected upper level of sound likely to be generated by the project under regular operating conditions in our evaluation of potential effects on listed species. Sound levels from the project could reach a maximum level of 172 dB re 1µPa @ 1m when velocities reach the maximum level recorded in the project area, 3.6 m/s, but this condition is expected to occur only 0.01% of the time (one hundredth of the 99th operating percentile) and to last for periods of less than 5 minutes.

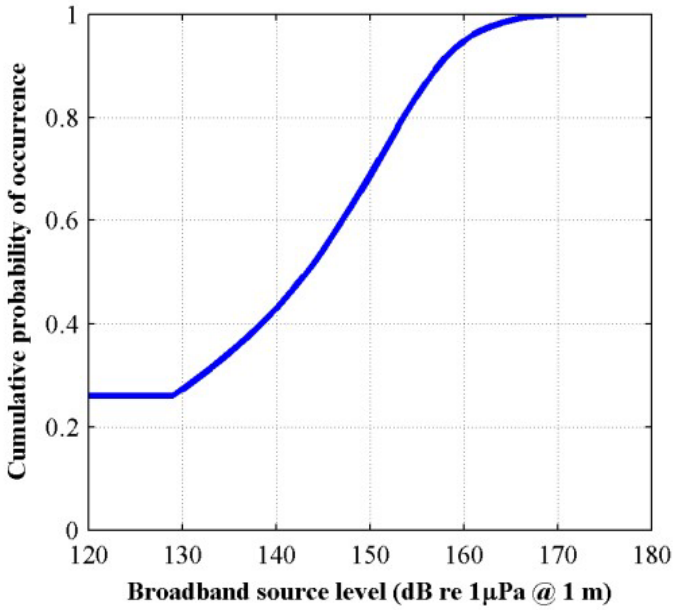

Figure 10. Probability distribution of sound expected to be produced by a 6-meter turbine in Admiralty Inlet at one meter from the source (Source: Snohomish PUD 2012b)

As previously noted, the project turbines would produce sound 70 percent of the time over the 10-year deployment. This sound would be characterized as a continuous source, not an impulse sound, with the level produced varying with current velocity.

Although the project will produce continuous sound, NMFS uses exposure thresholds of sound pressure levels from impulse sounds that have been shown to cause behavioral disturbance (a negative effect) in marine fishes as a conservative measure of harm and harassment. The exposure thresholds are 183 dB (SEL) re: 1 µPa for fishes weighing up to 2 g and 187 dB (SEL) re: 1 µPa for fishes weighing over 2 g and a peak sound level of 206 dB (Peak) re: 1 µPa (Fisheries Hydroacoustic Working Group, FHWG, 2008). For marine mammals, NMFS is currently developing comprehensive guidance on sound levels likely to cause injury and different types of behavioral disruption in the context of the MMPA and the ESA, among other statutes. Although the comprehensive guidance is

[35] The sound produced at the 95th operating percentile would occur 5 % of the time or less, meaning that sound would be below this level 95% of the time during turbine operations.

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not yet available, NMFS uses a conservative threshold for behavioral disturbance in marine mammals exposed to continuous broadband sounds: 120 dBrms re: 1μPa (NMFS 2005d).[36]

2.4.1.1 Effects of sound on ESA-listed Fishes

Based on the information provided in Sections 2.2 and 2.3, the following life-stages and species are likely to be in the action area during installation and operation and therefore would be exposed to the stressor "sound:" juvenile and adult PS Chinook and HCSR chum salmon; PS steelhead; and adult, juvenile, and larval PS/GB yelloweye and canary rockfish, and bocaccio.

The proposed action is likely to produce sound within the hearing range of salmonids and other marine fishes as described in section 2.4.1.

Hastings and Popper (2005) provide an overview of published and gray literature studies that evaluate the effects of sound on fish. They note that there is little research on the effects of underwater anthropogenic noise other than the impulse-type sound generated by pile driving. They report that the majority of Pacific fishes studied are "hearing generalists," (i.e., have no special adaptations to enhance their hearing) that are capable of detecting sounds at intensities between 75 and 150 dB (re: 1 μPa) and frequencies of 30 to 2,000 Hz. However, the data are only relevant to the species studied and not easily extrapolated (Hastings and Popper 2005). In a later paper, Popper and Hastings (2009) show that, in general, fish are not adversely affected by sound levels less than about 160 dB (re: 1 μPa), and at higher levels they exhibit a range of responses: avoidance, stress, temporary and permanent hearing loss, auditory and non-auditory tissue damage, egg damage, reduced growth rates, and mortality based on a number of studies conducted in laboratory settings. The authors conclude that the available literature does not support meaningful noise exposure metrics or reliable noise exposure criteria for fish that could be used in evaluations of exposure to noise from anthropogenic activities in the "natural" environment. Therefore, NMFS evaluates the likely effects of noise associated with the proposed action qualitatively.

High level, short duration, impact sounds, such as the noise from pile driving, also referred to as "impulse" sounds, are known to cause behavioral changes, physical injury and in some instances are lethal depending on the level of sound and distance from the source. In comparison, the response to non-impulse or continuous sound such as vessel traffic or the continuous sound might range from no overt change in fish behavior to a startle response to evidence of just a mild awareness of the sound (Wardle et al. 2001). These types of responses can be small, temporary movements for the duration of the sound to larger and more persistent movements that displace fish from their normal locations (e.g. Slotte et al. 2004). In some cases, sound can change the migration routes of fish (Popper and Hastings 2009).

NMFS does not have fine-scale information about use of the action area by salmonids or rockfish, but it is likely that continuous, non-impact sound emissions from the operation of the OpenHydro turbines would result in behavioral avoidance of the action area. However, there is no information to suggest that the action area is a unique or otherwise important foraging area and there is similar habitat in the surrounding area that could be used by marine fishes. Avoidance of the area due to

[36] Both the project vessels and the turbines will produce continuous (i.e., not impulse) sound.

sound from turbine operations may reduce the likelihood of direct interaction with the turbine structures and thus decrease the risk of blade strike analyzed in section 2.4.5.

Ambient noise in the action area is dominated by sound from vessels traveling through Admiralty Inlet and from the natural movements of shell fragments, small rocks and other benthic debris during high current velocities and averages about 117 dB (re: 1 µPa). Noise generated by the proposed action during operation may be similar to, or masked by the ambient noise. However, uncertainty regarding the actual sound produced by the operation of the turbines and the potential response of marine species remains a concern to NMFS. To address this uncertainty, Snohomish PUD proposes to carry out a post-deployment Acoustic Monitoring and Mitigation Plan that would accomplish two purposes – gather information on sound levels during operation of the two test turbines, and mitigate for any sound levels high enough to adversely affect listed species. The Plan will test two hypotheses: (1) sound levels produced by the tidal turbines across power generation states are within expected values, and (2) changes in sound produced by the tidal turbines over time due to biofouling or component wear are within expected values. Snohomish PUD would report monitoring results to the MARC. If monitoring results indicate that sound levels from the project exceed the expected values, Snohomish PUD would follow the procedures described in the Adaptive Management Framework when conferring with the MARC to consider modification of the project and/or the monitoring plan. This would include potential adjustments to monitoring, project operation, and removal methods. The Acoustic Monitoring and Mitigation Plan include the specific triggers and mitigation actions. Snohomish PUD would develop modifications to the project and/or monitoring plan in consultation with the MARC and would obtain NMFS' approval for any specific mitigation measures. In addition to participating in the MARC's review of the monitoring results and reviewing the mitigation actions, NMFS would evaluate whether sound produced by the project exceeds NMFS criteria for potential harm caused by impulse sounds for marine fishes.

Therefore, as a result of the proposed monitoring and mitigation plan and the use of the adaptive management framework to ensure that sound produced by the project is below NMFS' exposure thresholds for marine fishes, the likelihood that any individuals would be injured or killed by the sound from proposed action is very small. The likely behavioral responses, even considering potential for repeat exposures to sound over the 10-year life of the project, would not reduce the reproductive success or increase the risk of injury or mortality for any individual ESA-listed salmonid or rockfish. Sounds generated by vessels during turbine installation, maintenance, monitoring, and removal and sounds generated by the turbines during both regular operating conditions (163 dB re: 1 µPa) and at maximum tidal velocity (172 dB re: 1 µPa) would be below the threshold for harm or injury but may cause behavioral effects. However, any avoidance of the area due to vessel traffic would be temporary and only affect a very small area compared to their range so would not significantly reduce forage opportunities. Therefore, sound from the proposed action is not likely to affect the numbers, reproduction, or distribution of ESA-listed salmon or rockfish at the population level.

2.4.1.2 Effects of Sound Exposure on ESA-listed Marine Mammals

Based on the information provided in Sections 2.2 and 2.3, the following life-stages and species are likely to be in the action area during project installation, operation, and removal and therefore are likely to be exposed to the stressor "sound": juvenile and adult SR killer whales and humpback whales.

As described above in section 2.4.1, sound generated by vessels involved in installation, monitoring maintenance, and removal activities would be continuous (not impulse) type and in the range of 125 to 175 dB re: 1 µPa. This level of sound would exceed NMFS' 120 dBrms threshold for behavioral disturbance at the source, but would dissipate to below background levels a short distance (about 500 meters) from the vessel. Sound associated with vessels during installation would occur daily for up to two months whereas sound from vessels conducting monitoring or maintenance would occur infrequently over the 10-year duration of the project. Vessels would move slowly or idle in the project vicinity; sound intensity would be lower when the vessels are operating at idle speed. Vessels used to carry out the proposed action would follow standard navigation and vessel regulations for marine mammal protection at all times. In addition, Snohomish PUD would follow project specific protocols for vessel operations around marine mammals during installation and removal. Specifically, if a listed cetacean occurred within 500 meters of an installation or removal vessel, operations would be halted until it left the vicinity to reduce the risk of vessel strike as well as exposure to sound sources associated with these activities (Snohomish PUD 2012b). As a result, NMFS does not expect sound from project vessels to have a negative effect on marine mammal use of habitat in the action area.

As previously described, broadband sound from operation of the turbines would not exceed 172 dB re: 1 µPa; this maximum sound level would occur at 1 m from the rotor only 0.01 percent of the time and be sustained for less than 5 minutes. Under regular operations (95th operating percentile—sound would be below this level 95 percent of the time) the turbines would produce 163 dB re 1 µPa at a distance of 1 m. Using a practical spreading model[37] as detailed in NMFS guidance on determining the area affected by sound (NMFS and NWFSC 2012), NMFS estimates that sound would fall below 120 dB re 1 µPa at a distance of 750 m from the turbines. Figure 5 shows the distance from the center of the combined turbine footprint to the Level B (120 dB) harassment threshold for the full range of operating percentiles. At a distance of 100 m from the turbines, broadband noise would be below the threshold for Level B harassment for marine mammals 75 percent of the time (beyond the 75th operating percentile (Figure 11).

The maximum sound level the turbines would generate (172 dB re: 1 µPa at 1 m), corresponding to a tidal velocity of 3.6 m/s, would occur about 0.01% (one hundredth of the 99th operating percentile) of the time and last for up to 5 minutes.[38] Under this condition, sound could remain above the 120 dB re 1µPa threshold for behavioral disturbance of marine mammals at a distance of up to 3 km from the center of the turbines. However, the extremely low percentage of operating time this would occur and the limited duration (on the order of a few minutes) means the potential risk to individual marine mammals from behavioral disturbance is extremely small.

[37] Using the practical spreading loss model, transmission loss (TL) in dB units can be defined by: TL = 15 log (R2/R1) Where R1 is the distance of a known or measured sound level, and R2 is the estimated distance that is required for sound to attenuate to a prescribed acoustic threshold. In practice, this equation can be rearranged to solve for the distance at which sound attenuates to an acoustic threshold: R2 = R1 * 10^ ((dBat R1– dBacoustic threshold)/15) (NMFS and NWFSC 2012)

[38] That is, the 120 dBrms re: 1 µPa harassment threshold would be exceeded for about 525 minutes over a period of 10 years, divided into periods of less than 5 minutes each.

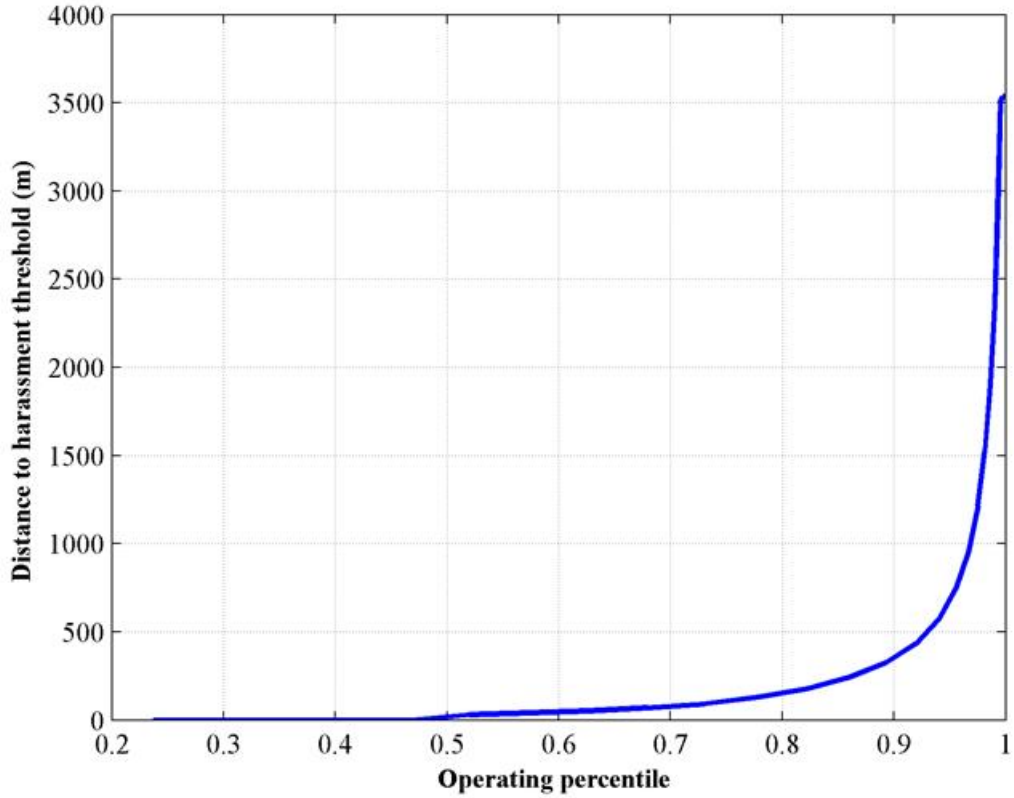

Figure 11. Distance from project center (mid-point between turbines) to Level B harassment threshold for broadband (25 Hz – 25 kHz) sound levels throughout the range of operating percentiles (Source: FERC 2013

To further assess potential risk to marine mammals from sound produced by operation of the turbines, Polagye et al. (2012) evaluated the probability of detecting turbine noise relative to ambient noise (i.e., signal excess) for three hearing classes of marine mammals: mid-frequency cetaceans (represented by killer whales), high-frequency cetaceans (represented by harbor porpoises), and pinnipeds (represented by harbor seals). The researchers did not evaluate noise detection by low-frequency cetaceans in this effort because no audiograms for this class of marine mammals exist (Southall et al., 2007). The results indicate that for mid- and high-frequency cetaceans, detection of turbine sound is unlikely (i.e., probability < 25%) beyond a few hundred meters. Detection does not necessarily imply a negative response. Ambient noise within the action area is produced predominantly by vessel traffic (passenger ferries and cargo vessels) and, at high current velocities, bedload transport (Bassett et al., 2010, 2012, 2013) which may mask sound produced by the turbines, although the extent of this effect is uncertain.

SR killer whale

Behavioral responses of cetaceans with mid-frequency hearing capabilities, such as SR killer whales, to non-impulse sound can include moderate changes in speed of travel, direction, or dive profile; cessation or modification of vocal behavior for moderate to extended periods; avoidance of the sound source, and change in group distribution (Southall et al. 2007). However, these authors caution that there is considerable variability between individuals and groups of individuals in behavioral responses to received levels of sound. Contextual variables (i.e., the novelty of the sound and what

the animals are doing in the area) are potential reasons for the variable responses (Southall et al. 2007).

If exposed to sound that created a behavioral disturbance, Southern Residents would be likely to deflect their movements around the area instead of continuing in the same direction. The distance moved would depend on the sound level at the time of interaction. NMFS uses the conservative and protective distance of 750 meters for a sound level of 163 dB (re 1 µPa at 1 m) to evaluate the potential effects. An individual SR killer whale that deflected its path by up to 750 meters would travel that distance in less than 10 minutes assuming an average swimming speed of 1.6 m/s (i.e., similar to that observed in northern resident killer whales). This minor increased travel time is unlikely to cause a significant increase in an individual's energy budget (Williams and Noren 2009, Noren 2011) and thus would not affect condition. Avoidance of the area due to sound may reduce the likelihood of direct interaction with the turbine structures and thus decrease the risk of blade strike which is analyzed in section 2.4.5. If individuals are displaced from the area affected by sound they could be prevented from foraging in the area. However, alternate foraging sites and routes are available through the entrance to Admiralty Inlet and the additional distance traveled is unlikely to cause a significant increase in an individual's energy budget. Therefore, NMFS assumes that these short-term effects would not affect the numbers, reproduction, or distribution of the SR killer whale population.

Humpback Whale

Humpback whales are considered to have low frequency hearing. As previously stated, the proposed action is expected to produce broadband sound in excess of 120 dB re 1µPa for a distance of up to 750 m from the center of the turbine location. If exposed, an individual humpback whale is likely to deflect around the sound instead of continuing in the same direction. The distance moved is expected to depend on the sound level at the time of interaction. Similar to SR killer whales, exposed humpback whales are likely to be displaced and precluded from foraging in the action area or from using it to move between foraging sites. However, alternate foraging sites and routes are available through the entrance to Admiralty Inlet and the additional distance traveled is unlikely to cause a significant increase in an individual's energy budget. NMFS assumes these short-term effects would not affect the numbers, reproduction, or distribution of the humpback whale population.

Monitoring, Mitigation and Adaptive Management

To confirm the expected acoustic output of the turbines, Snohomish PUD would carry out the acoustic monitoring and mitigation plan to gather information, test two hypotheses, and provide for mitigation if necessary, as detailed in section 1.3.7 and discussed in section 2.4.1.1 above.

Further, Snohomish PUD would carry out the marine mammal monitoring and mitigation plan to evaluate whether marine mammals respond to the turbines, including sound produced by turbine operation. Seals and harbor porpoise are the two animals (although SR killer whales will also be monitored the entire time of the license due to their status described below) used for the study, and the results are representative for the other marine mammals. Snohomish PUD's proposed monitoring uses a combination of shore-based visual observations and passive acoustic monitoring observations (hydrophones and click detectors), depending on the functional group (i.e. mid-frequency cetaceans, high-frequency cetaceans and pinnipeds), and complements existing efforts and expertise as represented by the Orca Network, Beam Reach Marine Science and Sustainability School, NMFS, and the Whale Museum. Detailed methods are provided in the plan. In summary, for pinnipeds, 2 to 3

experienced observers would be positioned on Admiralty Head and visually scan the study area using a theodolite or reticle binoculars, documenting pinnipeds entering the study area (within a 500- to 1000-meter radius, centered on the turbine). Observations would be made during winter (October 1 to March 31) and during summer (April 1 to September 30). Snohomish PUD would analyze these data, combined with data on vessel traffic obtained from the vessel Automatic Identification System (AIS), turbine power generation levels from the supervisory control and data acquisition (SCADA), project generated noise monitored based on results of the Acoustic Monitoring and Mitigation Plan, and the presence of prey monitored based on results of the Near-turbine Monitoring and Mitigation Plan, would be analyzed by Snohomish PUD to determine if pinniped presence/absence is correlated with turbine noise. After the first year of monitoring, the MARC would consider whether changes to the study scope or methods are warranted.

The harbor porpoise was selected to represent mid-frequency cetaceans (such as SR killer whales) in this study because of this species' high frequency of observations in the action area and general sensitivity to acoustic disturbance. Shore-based observers would use focal group techniques[39] and high-definition video to follow harbor porpoises through the study area. Snohomish PUD would evaluate data on point-of-closest-approach (to the turbines) and directionality of movement to determine if turbine sound appears to alter harbor porpoise movements. A pair of C-POD click detectors integrated into the adaptive monitoring package (AMP) on each turbine would record echolocation activity. These data would be compared to pre-installation studies which included deployment of C-POD click detectors in the study area to determine if there were detectable changes.

Because of their cultural importance and endangered status, the behavior of killer whales (both the listed southern resident and non-listed transients) in the action area would be followed by Snohomish PUD for the entire license period through the use of shore-based observers, localizing hydrophones, and passive acoustic monitoring (part of the Near Turbine Monitoring and Mitigation Plan). The objective is to both learn more about interactions with the turbines and to avoid harm through mitigation based on the information. An array of four hydrophones would be attached to each turbine. The hydrophones would be able to resolve frequencies up to 200 kHz in order to detect killer whale vocalizations. Upon detection of killer whale calls on the hydrophones on the turbines, the hydrophone at the Port Townsend Marine Science Center, or sightings reported through the Orca Network, the PUD would dispatch shore-based observers to the observation point on Admiralty Head. Direction of transit, surfacing interval, behavior state, surface-active behavior, click rate, and call rate would be recorded and analyzed for evidence of changes in behavior between pre- and post-installation and between different tidal velocities and therefore turbine outputs and sound levels.

The Marine Mammal Monitoring and Mitigation Plan include a schedule for reporting these monitoring results to the MARC and FERC. It also includes eight specific triggers (listed in section 1.3.7) for modifying the plan or project based on monitoring results or identified adverse effects on SR killer whales.

[39] Focal group techniques are focused observation and tracking of movement and behavior for an individual or group of individuals based on an opportunity to observe due to known presence in a given area rather than a pre-scheduled survey interval. This method allows for gathering detailed data about activity or behaviors, which may not be captured during pre-scheduled sampling surveys (i.e. individuals that appear most likely to be entering the study area).

In summary, NMFS expects that sound from operation of the turbines during the 5-year deployment period would exceed NMFS level B harassment threshold for continuous sound (120 dB re re 1 µPa) up to a distance of 750 meters away from the turbine location up to 95 percent of the time during operations and very rarely (0.01 percent of the time) up to a distance of 3km. However, the co-occurrence of marine mammals in the action area during the short (less than 5 minutes) and rare (occurring 0.01 percent of the time) periods when sound above 120 dB would extend out to 3km is extremely unlikely.

Therefore, NMFS expects marine mammals to temporarily avoid the action area (up to a distance of 750 m from the turbines) when turbine-generated sound exceeds 120 dB re 1 µPa (harassment threshold for continuous sound). This state would occur intermittently over the limited 5-year deployment and NMFS does not expect it to increase the risk of injury or death or reduce the reproductive success of any individual SR killer whale or Humpback whale. Snohomish PUD would carry out the monitoring and mitigation plans, to determine whether the sound levels or their effects are actually in excess of those analyzed in this opinion. If so, then mitigation would be required, which could include modifications to project operations, ceasing project operations, and/or removal of the turbines. These measures ensure that the effects of sound from the project would not be likely to affect the numbers, reproduction, or distribution of the SR killer whale or humpback whale populations.

2.4.2 Habitat Alteration—Electromagnetic Fields

EMF Type and Intensity: Project Operation

Electromagnetic fields (EMF) originate from both natural and man-made sources. Natural sources include the earth's magnetic field and various biochemical, physiological, and neurological processes within organisms. Electromagnetic fields consists of both electric (E) and magnetic (B) field components with a second, weak, induced electrical (iE) component to the latter that is created by the flow of seawater or movement of organisms. The strength of the two main fields (E and B) that would be generated by the proposed project would depend on the magnitude and type of current flowing through the cable and the way the cable is constructed. Overall, the strength of both the E and B fields in seawater, whether man- made or naturally occurring, would diminish with distance from the source (Slater et al. 2010). Cable construction methods can shield and thus reduce or eliminate the E-field, but cannot reduce B-field strength.

The transmission of electrical power (the acceleration or fluctuation of charged particles) generated from the OpenHydro turbines to the onshore electrical grid via the subsea trunk cables would be a source of EMF. To avoid adverse impacts to the sensitive shoreline areas, near-shore habitat, and benthic species, the trunk cable route would be drilled horizontally through the seabed using HDD, from shore to a depth of at least 18 meters. From location of the underwater HDD exit, the trunk cables would be laid on top of the seabed for about 2 km before connecting to the turbines. ESA-listed species could be exposed to EMF along the portion of the cables that lies on the surface of the seabed. The proposed 5 cm-diameter trunk cables would carry 4 to6 kV of 3 phase, 22 amp alternating current (AC), which would produce the three types of fields (E, B, and iE). The transmission line would be shielded to block the E field. Snohomish PUD estimated that the intensity of the B field at the surface of the cable would be 200 Amps per meter (A/m), and that a small B field would be generated up to 45 cm (about 18 inches) from the cable surface but it would drop to 40 A/m, equal to the intensity of the Earth's magnetic field at the latitude of the project, at a

distance of 3.3 cm (1.3 inches) from the cable's surface Figure 12. Everywhere beyond that distance from the surface of the cable, the intensity of the B field (and very small iE field) produced by the proposed action would be below the level of the Earth's natural magnetic field. (Snohomish PUD 2012a).

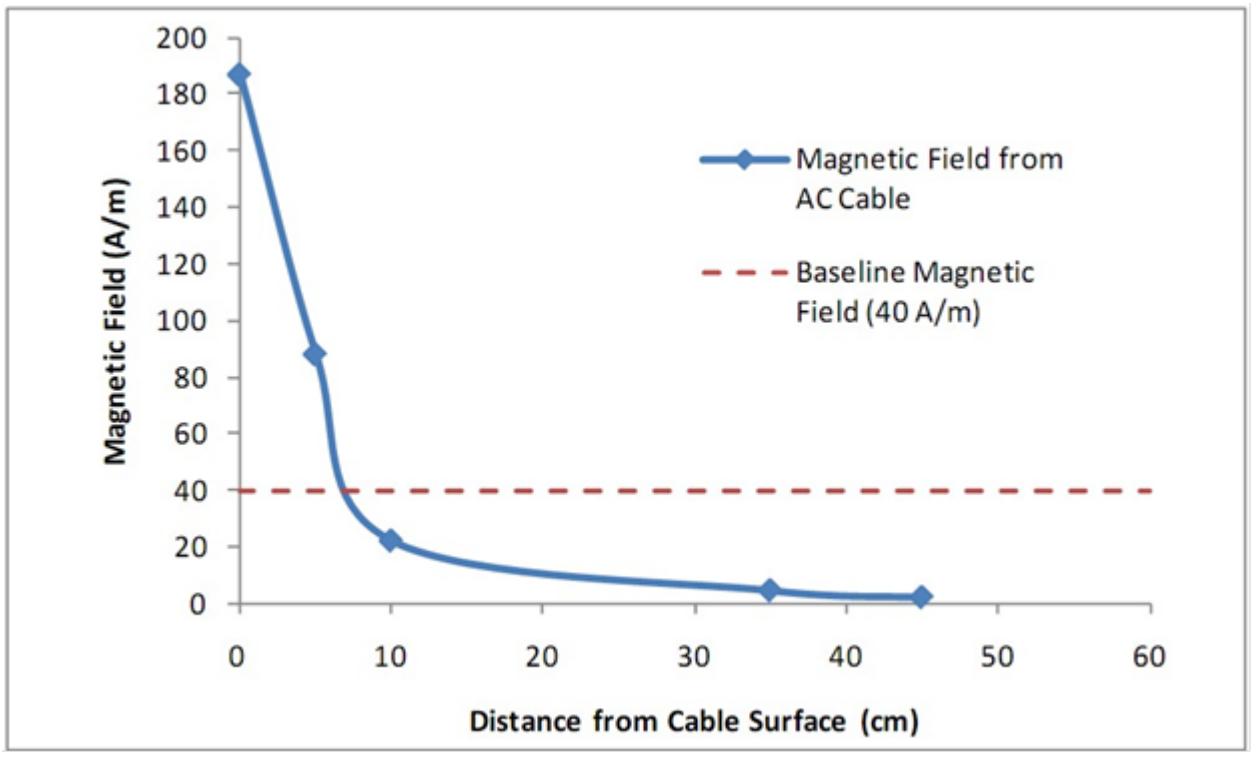

Figure 12 Magnetic field declines with distance from cable surface. (Source: Snohomish PUD 2012a)

The turbines themselves would not create a magnetic field greater than the earth's natural magnetic field in the surrounding environment. OpenHydro has developed a system for insulating the turbine generator such that it would not transmit any electrical current (E or B type) into the water or the benthic environment. In the event of an electrical fault, a protection system would de-energize the system so that no current continued to leak into the surrounding environment (Snohomish PUD 2013a).

2.4.2.1 Effects of EMF on ESA-listed Fishes

Based on the information provided in Sections 2.2 and 2.3, the following life-stages and species are likely to be in the action area during project operation and therefore would be exposed to the stressor "EMF:" juvenile and adult PS Chinook and HCSR chum salmon; PS steelhead and adult juvenile, and larval PS/GB bocaccio, yelloweye, and canary rockfish.

Responses of Marine Fishes to EMF

Data on the potential responses of marine species to anthropogenic EMFs are limited (Gill et al. 2005). Normandeau et al. (2011) note that few studies have examined responses of marine species to EMF from undersea power cables and that short of site-specific studies (of which none are available for the action area), any conclusions about biological effects are speculative.

Marine animals that can detect B fields are likely to do so through either iE field detection or through magnetite based detection.[40] Organisms as diverse as Atlantic salmon, cod, plaice, eels, lampreys, sea trout, yellowfin tuna, lobsters, crabs, shrimp, prawns, snails, bivalves, squids, and sharks and other elasmobranchs, are able to detect B fields (Gill et al., 2005) although the biological effects of these fields are uncertain. Yano et al. (1997) fitted migrating chum salmon (Oncorhynchus keta) with a tag that generated an artificial B field around the head of the fish. Altering the magnetic field produced by the tag did not appear to affect the fish's horizontal or vertical movements. Quinn and Brannon (1982) concluded that although salmon appear to detect B fields, any behavioral response is likely to be governed by multiple stimuli. Similar results were found in studies using Atlantic salmon (Salmo salar). Summarizing research results, Scottish Executive (2007) concluded that the navigation and migration of Atlantic salmon were not likely to be affected by the magnetic field produced by an underwater cable.

There are no data on the potential effect of EMF on any species of rockfish.

Risk of Negative Effects of EMF on Marine Fishes
As described above, there are no data indicating that salmonids or rockfish would respond to B or iE type EMF emitted by the cable either positively or negatively. In addition, individuals would have to pass within 3.3 cm of the cables to experience a field greater than earth's own and within 45 cm (18 inches) to detect any field from the cables, which limits the risk of exposure and any negative biological effects to a very small part of the action area.

The cable extends 2 km along the sea floor and habitat along the pathway is similar to surrounding habitat within the project area. The cable itself and thus any associated EMF do not extend across the entrance to Admiralty Inlet and therefore would not create barrier to migration. The risk that an individual salmonid or rockfish would be injured or killed by exposure to EMF generated by the project is very low and any effect that does occur is not likely to reduce numbers, reproduction, or distribution at the population level.

2.4.2.2 Effects of EMF on ESA-listed Marine Mammals

Based on the information provided in Sections 2.2 and 2.3, the following life-stages and species are likely to be in the action area during project operations and therefore are likely to be exposed to the stressor "EMF": juvenile and adult SR killer whales and humpback whales.

As described above EMF from the project would be less than the earth's magnetic field at a distance of about 3 cm and would dissipate completely within about 45 cm. Marine mammals are not known to be adversely affected by B or iE type fields (which cannot be shielded). Because of the short range (up to 45 cm) of EMF fields generated by the proposed action, the likelihood that individual marine mammals would be injured or killed by EMF caused by the proposed action is extremely low and will not affect the numbers, reproduction, or distribution of SR killer whale or humpback whales on a population level.

[40] In the magnetite-based sensory model, magnetic fields are transduced by small magnetic crystals (magnetite) in special receptors in an animal's head (Normandeau et al. 2011).

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2.4.3 Habitat Alteration - Seafloor Structure

The presence of the turbines in the lower water column (below 40 m) and the turbine bases and subsea cable on the seafloor would create new habitat structures that alter the physical environment in the local area. The base of the turbine structures would displace a small amount of natural seafloor habitat, which is boulder and cobble substrate covered by encrusting organisms such as sponges, bryozoans, and tubeworms. These types of organisms would also attach to the turbines bases and the cables, but not the shroud, rotor and blades, which would be coated with an anti-fouling compound (approved for marine use so there will be no toxic effects) prior to installation. Relative to the area of habitat available, the turbine footprints are very small (about 28 m^2). Habitat would also be altered at the transmission line corridor and horizontal drilling exit point, but these areas are also very small when compared to the amount of surrounding habitat. The introduction of these structures may result in changes in marine community composition (use patterns, attraction, and aversion). Each turbine structure could generate a reef effect, which could have broader effects on the community ecology near the turbines (Polagye et al., 2011). The effects to community ecology over these small areas and for the short 5-year deployment period are uncertain and could be positive, negative, or neutral. Post-installation monitoring will provide information to address this uncertainty and mitigation action would be taken to minimize or avoid any negative effects.

Near field effects to the sea floor from changes in hydraulic flow patterns could occur as a result of the introduction of the turbine structures. The tidal currents in Admiralty Inlet are strong and have scoured the sea floor in the vicinity of the project, washing away clays and silts, shifting sands and gravels, and leaving surface areas of cobbles, rocks, and boulders that are too large to be mobilized on the sea bed (section 2.3). The cobble pavement acts as scour protection for the softer sediments assumed to lie underneath. Changes to the magnitude of tidal flows from the proposed action could affect scour in the immediate vicinity of each of the turbine foundations. However, the potential magnitude of the change in flow is small. Snohomish PUD estimates that the velocity around the turbine foundation is expected to increase to around 2 m/s (Snohomish PUD 2012b). These increases would be high enough to locally mobilize and transport some cobbles but would not be high enough to mobilize and transport boulders (FERC 2013). Smaller diameter particles would be exposed to the tidal currents and could experience scour if the turbine foundation structure penetrates the cobble pavement. While there is some uncertainty regarding if the turbine foundation would sink below the cobble pavement, if the structure does, the lateral extent of the scour would likely be limited to the area where cobble-sized and smaller particles are exposed, and would not be likely to laterally extend beyond where the cobble pavement would be intact.

The footprint of the foundation for each turbine is 10 m^2, thus the potential effect to seafloor habitat through scour or deposition of existing materials is small. ROV monitoring as proposed in the Project Safeguard Plans (Snohomish PUD 2012b), would be conducted in the near-turbine areas three times in the first three months after deployment of the turbines. This will allow for identifying and monitoring of any scour that would occur. If scour causes differential settling or otherwise impacts turbine operations Snohomish PUD would install scour protection (such as scour skirts or scour resistant materials) to minimize or correct the problem. Monitoring of the effects of the turbines on hydrodynamics and sediment transport processes will be conducted over the 5-year deployment allowing for evaluation of any changes.

2.4.3.1 Effects on ESA-listed Fishes

Based on the information provided in Sections 2.2 and 2.3, the following life-stages and species are likely to be in the action area during project operation and therefore would be exposed to the stressor "Habitat Alteration - Structures:" juvenile and adult PS Chinook HCSR chum salmon; PS steelhead; and adult, juvenile, and larval PS/GB bocaccio, yelloweye, and canary rockfish.

The turbine structures, which would rise 13 m above the seabed, would add high-relief features to an area of natural low relief, dominated by cobbles. The high-relief structure created by the installation of the turbines could be used by fish for refuge from predators (Scharf et al 2006). Fish and invertebrates are known to colonize artificial reefs quickly, though the community structure may take years to develop into a pattern similar to that of nearby, longstanding reefs (Bohnsack and Sutherland, 1985; Sherman et al 2002). In many reefs, larger fish would be the first colonizers and use the structure as cover, while obtaining most of their food in the surrounding environment (Buckley and Hueckel, 1985; Bohnsack and Sutherland, 1985; WDFW 2011 Hueckel and Buckley 1987, Hueckel et al 1989). Increased presence or colonization by marine life that otherwise would not occur in a particular area may attract predators (Ogden 2005) and increase predation on ESA-listed fish, specifically rockfish. However, artificial habitats may not serve as well as natural habitats because of the potential for overcrowded conditions and the need to search elsewhere for food (Matthews 1990; Palsson et al. 2009).

Juvenile salmonids (Chinook, chum, and steelhead) all exhibit a strong preference for habitats near the surface within 30 meters of depth (section 2.3) and pass through the action area as they move to the open ocean. Thus, juvenile salmonids are unlikely to be attracted to the project structure as they do not provide the nearshore habitat functions such as are found at shallower depths (availability of prey such as insects). If the small amount of structure provided by the turbines aggregates prey species preferred by adult salmonids (e.g. sand lance, surf smelt) it is possible that they may be attracted to the turbines as a forage opportunity. Any aggregation of fishes would be small because of the small amount of structure provided by the turbines is very limited and because aggregations are likely to occur intermittently, when the turbines are not spinning (only 30 percent of the time).

Rockfishes (which have pelagic larvae) have a general affinity for high relief benthic habitat as juveniles and adults, are likely to occur at the depth of, and be attracted to the turbines. In a case where WDFW created an artificial reef at a 30-m depth in Puget Sound, rockfish segregated by size of hiding spaces, with juveniles occupying only places where they could enter a small hole when startled (West et al., 1994). If juvenile rockfish in the project area behaved the same way, they would only occupy the turbine structure when the blades are not rotating (about 30 percent of the time). While the extent of the attraction is uncertain, attraction to the structures could increase the likelihood of exposure of individual rockfish to sound and blade strike. The effects of exposure to these stressors are discussed in sections 2.4.1 (sound) and section 2.4.5 (blade strike). Although there is uncertainty regarding the potential effect to the marine community, because of the limited duration of the deployment and the small size of the turbine footprint and structure relative to the surrounding waters (0.05 percent of the cross-sectional area of the entrance to Admiralty Inlet) NMFS expects the potential changes to marine community composition to be small.

To address the uncertainty about how rockfish and the other listed marine fish species would respond to the presence of the structure introduced by the two tidal turbines, Snohomish PUD would carry out the Benthic Habitat Monitoring and Mitigation Plan to describe the benthic habitat created

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

by the installation and presence of the project. In combination with the other monitoring and mitigation plans, these plans will provide information about whether species are attracted to project structures. Specifically, the Near-Turbine Monitoring Plan provide information on the effects of the structures on marine species by investigating the following hypotheses: 1) Strobe illumination may result in a species-specific startle response, avoidance response, or attraction; 2) The turbines may attract marine animals due to the area of refuge offered by the low-velocity wake; 3) Marine animals are unlikely to pass through the rotor or open center during turbine operation. Investigation of this hypothesis will test the assumption that although listed and other aquatic species may be shown near the turbine rotor, these aquatic species will not be struck by a moving turbine rotor; 4) The turbines may attract marine animals due to an artificial reef effect; and 5) Fish may avoid the turbine due to its pressure field or sound (particle velocity or acoustic pressure). To investigate these hypotheses video cameras mounted on the turbines as part of the Near-Turbine Monitoring Plan would monitor part of each turbine face for biofouling and viewing of species that approach the turbine. The benthic habitat monitoring plan would monitor the benthic habitat in the vicinity of the two turbines, cable route, and at six selected sampling locations[41]. The study would provide observations of fish abundance and size. Provide habitat descriptions associated with observations of fish use in these areas, and review data relative to pre-installation data sets. This study will complement Snohomish PUD's post- installation monitoring using ROV to transmit video. Snohomish PUD would consult with the MARC to evaluate the effectiveness of monitoring methods described above, the collected data, and whether adjustments to monitoring methods are necessary. Further, the information gained from monitoring will be used to trigger actions (safeguards) to mitigate for negative effects, including modifications to project operations, modification to study objectives, modification of the turbine structures, shutdown of the turbines or removal of the turbines.

Therefore, given the small amount of structure provided by the two tidal turbines as a proportion of available habitat in the action area and the implementation of monitoring and mitigation plans to identify and take action to avoid or minimize and negative effects, the likelihood that more than a few individual ESA-listed marine fish would be injured or killed by the benthic habitat alteration resulting from proposed action is very small. The likely behavioral responses (avoidance or attraction), even considering the potential for exposure to the structures and their biological effects over the 10-year term of the pilot license, would not reduce the reproductive success or significantly increase the risk of injury or mortality for any individual ESA-listed salmonid, or rockfish. Therefore, benthic habitat alteration resulting from the introduction of structures by the proposed action would not affect the numbers, reproduction, or distribution of ESA-listed salmonids or rockfish at the population level .

[41] There are no paired reference sites for the near-turbine study. For the issue of blade strike, the concept of a reference site is not applicable in an observational study. For the issues of behavior and reef effects, development of a reference site would be difficult, if not impossible, because the effect of the monitoring equipment itself on the fish behavior would be difficult to eliminate. The baseline information that has been collected by Snohomish PUD would serve to reference the monitoring results for the near-turbine study. For effects of the operating turbine, observations when water velocities are too slow to turn the turbine blades would serve for comparison.

2.4.4 Marine debris entanglement

Based on the information provided in Sections 2.2 and 2.3, the following life-stages and species are likely to be in the action area during project operation and therefore would be exposed to the stressor "Marine debris entanglement:" juvenile and adult PS Chinook and HCSR chum salmon; PS steelhead; adult, juvenile, and larval PS/GB bocaccio, yelloweye, and canary rockfish; juvenile and adult SR killer whales; and humpback whales.

In dynamic tidal sites such as this one, any freely floating debris is likely to be carried within the water column or along the bottom by the tidal flow. As a result, debris could contact and become entangled on the turbine or its foundation. Derelict fishing gear would be especially hazardous if it snagged on the turbine structures because it is designed to entangle aquatic species, including ESA-listed fishes and marine mammals.

The Northwest Straits Foundation (NWSF) independently estimated that as many as 4,000 derelict fishing nets/gear are present on the seafloor in Puget Sound and the Northwest Straits (Straits of Juan de Fuca, Haro Straits) south of the U.S.-Canada border (Northwest Straits Foundation 2007). Good et al. (2009) reported that for the 902 derelict fishing nets recovered since 2002 from the United States portions of the Juan de Fuca Strait and Puget Sound, most were gillnets recovered from depths less than 22 meters (maximum recovery depth of 42.7 meters; Good et al., 2009). [42]

Derelict gear recovery efforts by the NWSF have significantly reduced the presence of derelict gear in Puget Sound, including Admiralty Inlet. As of September 30, 2013, 4,527 derelict fishing nets, 3,081crab pots, and 47 shrimp pots have been removed from Puget Sound and fewer than 1,000 derelict fishing nets remain in shallow sub-tidal areas of Puget Sound (NWSF 2013). Because of these efforts, the risk of derelict fishing gear snagging on the turbine or its base has decreased substantially over the past 10 years. The NWSF recently received funding to expand their removal efforts into deeper waters (NWSF 2013) which would reduce the amount of derelict gear in Puget Sound which could collect on the turbine structures.

The probability that derelict gear would become snagged on the turbines or their bases is reduced by the absence of mooring or anchoring lines that could snag floating debris and the hydrodynamic movement of water around and through the open center of the turbine. In addition, the tide reverses every six hours, which in some circumstances would allow material that attached to the structures to break loose. No gillnet fishing currently occurs in Admiralty Inlet, further reducing the risk of derelict gear of this type attaching to the turbines and their bases.

The proposed action includes a Derelict Gear Monitoring Plan that would allow for the detection and removal of derelict fishing gear. An ROV would be used to inspect project structures for accumulated derelict gear, with findings recorded by video camera. During the first year, following project installation, the ROV would be deployed a minimum of once every three months. For the duration of the Pilot License, an ROV would be deployed at least twice a year as long as the project structures are in the water. Snohomish PUD would review video data collected during each deployment for evidence of derelict gear, and would notify the MARC as to the result of its review of video data

[42] Due to safety concerns for divers, efforts through mid-2013 have focused on nets and derelict gear in areas less than 105 feet in depth.

within seven days following the deployment. Snohomish PUD would also monitor, in real time, a portion of each turbine using the stereo cameras implemented as part of the Near-Turbine Monitoring Plan.

If Snohomish PUD observed derelict fishing gear snagged on the project works, it would remove the gear as soon as possible. This would be undertaken with a ROV equipped with a video camera, manipulator skid, grabber arm, and rotary disc cutter or other cutting device for gear removal. The specific removal action taken would depend on the size, position, and weight of the derelict object and the prevailing weather conditions.

Therefore, based on the project's design and the ongoing monitoring and recovery efforts required by the derelict gear monitoring plan, the risk of a listed species becoming entangled in derelict gear snagged on the project structures is low because the chance of derelict gear coming in contact with the turbines is low, and if it does happen, the gear will be removed. The plan also includes mitigation triggers and specific mitigation actions such as assessing the risk to marine life from the derelict gear, reporting of injured or stranded marine animals to the appropriate agency, and gear recovery efforts, which would be completed by the Snohomish PUD. Therefore, it is unlikely that more than a few ESA-listed marine fishes or that *any* marine mammals would be injured or killed by derelict gear collecting on the turbines. Entanglement in derelict gear associated with the proposed action is not likely to affect the numbers, reproduction, or distribution of ESA-listed fishes or marine mammals at the population level.

2.4.5 Blade Strike

Each 6-m diameter OpenHydro turbine[43] would be deployed in water about 58 meters deep and would sit on a foundation such that the top of the turbine is 13 meters above the seabed. The turbine rotors would be located at depths of about 45 to 51 meters. The turbines would reach a rotational speed of about 29 rpm at maximum tidal velocities, which occur 0.01 percent of the time and are sustained for only a few minutes at a time. The turbine will operate at 6 to 20 rpm under most tidal conditions (95^{th} operating percentile). Although the turbine rotors have open centers and the tips of the blades are covered (i.e., not exposed), there is a chance that individual marine animals could come into contact with the blades when they are spinning, which is up to 70 percent of the time. The operation of the turbines therefore creates a risk of injury or mortality from blade strike.

Turbine operations could also create pressure differentials and a water velocity gradient across the turbine rotor. If individual fishes were to pass through the turbine blades, they could be exposed to this pressure differential. OpenHydro used a computational fluid dynamics (CFD) model to derive a potential pressure change of less than 4.5 kPa, is comparable to the hydrostatic pressure change an organism would experience with a small change in depth (5 kPa over about 0.5 meters).[44] We do not consider this biologically significant because most aquatic organisms regularly experience pressure changes of this size or greater with random or self-propelled movements in the water column.

[43] Actual rotor diameter is 4.7 meters.

[44] Reported thresholds for injury of juvenile salmonids are pressure changes of 30-90 kPa (Abernethy et al 2003).

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

2.4.5.1 Effects on ESA-listed Fishes

Based on the information provided in Sections 2.2 and 2.3, the following life-stages and species are likely to be in the action area during project operation and therefore would be exposed to the stressor "Blade Strike:" juvenile and adult PS Chinook and HCSR chum salmon; PS steelhead; and adult, juvenile, and larval PS/GB bocaccio, yelloweye and canary rockfish.

The likelihood of blade strike for ESA-listed fishes depends on an individual's habitat use in the action area; its size and mass, angle and speed of approach, and detection and avoidance abilities, and the speed of turbine rotation.

Adult and juvenile salmonids and rockfish in the action area could encounter the turbines and therefore be at risk for blade strike. However, these fishes are adapted to the high-energy environment of Puget Sound and the open ocean and have well developed swimming capabilities, reducing the likelihood that they would be swept into the path of the turbine blades and unable to swim away from them. Additionally, the OpenHydro turbines have a 2.2m diameter hole through the center of the rotor through which fish could pass, providing an additional route for strike avoidance.

Although no data exist for in-situ interactions of ESA-listed species with tidal turbine technologies similar to the OpenHydro turbines, fish avoided contact with the turbine blades in recent laboratory experiments and flume tests (Electric Power Research Institute (EPRI) 2011). Alden Research Laboratories, Inc. demonstrated this type of avoidance behavior using rainbow trout with body lengths of about 15 cm and 25 cm (5.9 and 9.8 in). In four trials (100 fish per trial), they released the fish 7.5 m upstream of the device (EPRI 2011) and about 90 percent of the test fish entirely avoided Lucent Energy Technology's horizontal axis, spherical turbine. Similarly, in tests at the U.S. Geological Survey's Conte Anadromous Fish Research Laboratory, Atlantic salmon smolts appeared to avoid a straight-bladed, cross-flow turbine (EPRI 2011).

In the event fish were not able to avoid traveling through the turbine blades, early testing indicates that hydrokinetic turbines have higher survival rates for fish passing through them than those of conventional hydropower projects. EPRI (2011) carried out an *in situ* entrainment test of a small, ducted, hydrokinetic turbine in the Mississippi River at Hastings, Minnesota using balloon-tagged fish. Researchers found that 99 percent of the fish that passed through the blades survived. Alden Research Labs, Inc., in another element of the flume study mentioned above, released rainbow trout and smallmouth bass at a point about 28 cm in front one horizontal cross-flow (spherical) and one horizontal axis turbine (EPRI 2011). Survival rates were between 98 and 100 percent, not significantly different from those of fish exposed to the control treatment (EPRI 2011). While conditions in the laboratory and other locations are different than what might occur with the turbines deployed as a part of the proposed action this information suggests that avoidance is likely and that survival rates are high. Uncertainty regarding the avoidance of or encounters with the turbines would be investigated and address by Snohomish PUD through the near-turbine monitoring and mitigation plan and adaptive management.

At OpenHydro's turbine deployments at EMEC, fish aggregated near the turbine in slack water when the turbine blades were not spinning, but dispersed and were not observed near the turbines while they were operating. It is uncertain whether this was an effect of increasing tidal velocities or the spinning of the turbine blades (Snohomish PUD 2010b).

Salmonids

Juvenile salmonids (Chinook, chum, and steelhead) all exhibit a strong preference for habitats near the surface within 30 meters of depth. Research on the behavior of juvenile salmonids indicate that juvenile Pacific salmon (Onchorynchus spp) including Chinook, chum and steelhead are typically surface oriented and are most often found in the upper 20 meters of the water column (as discussed in section 2.3.7.1). The top of the turbines would be at 47 meters of depth. Therefore, their risk of exposure to direct blade strike is extremely low.

Adult PS Chinook, HCSR chum, and PS steelhead are likely to pass through Admiralty Inlet as they return to their natal streams and rivers to spawn. Migratory pathways are poorly defined and vary based on a number of physical and biological factors. Therefore, it is uncertain how many fish of each species would pass through the action area and occur at depths where they would encounter the turbine blades. However, as the turbines occupy a very small portion of Admiralty Inlet (0.05% of the cross sectional area), NMFS expects the number of adults who would be exposed to the turbines to be small.

Although returning adult salmonids are likely to pass through the area and could move with tidal currents and other flows to conserve energy, they have evolved the ability to maneuver around obstacles and avoid predators, which would indicate they have the ability to avoid the turbines. Fish are known to be able to detect, avoid, or use structure from visual cues but perhaps more importantly, their lateral line system for detecting changes in pressure and velocity, including changes associated with detecting obstacles (Bouffanais et al. 2011, Liao 2007, Coutant and Whitney 2000), and their inner ear for detecting changes in acceleration (Coutant and Whitney 2000). The region of relatively elevated pressure upstream extends about 10 meters upstream of the turbine during the modeled operating condition (Snohomish PUD 2012a). Unlike traditional hydropower, fish cannot be entrained into an intake where they have no other route for escape; laboratory studies as discussed above indicate that if fish can move around a hydrokinetic turbine, they will (EPRI 2011, Amaral et al. 2010, Gorlov 2010, Normadeau 2009). These studies also indicate high survival rates for fish that pass through the turbines (98-100 percent survival). Further, the turbines create noise and pressure when the blades rotate, although the level of noise and pressure is not expected to harm fishes (pressure differentials are equivalent to a change in depth of about 0.5 meters), it would likely be detectable and would increase the likelihood of avoidance.

Adult, Larval, and Juvenile Rockfish

Adult PS/GB canary and yelloweye rockfish and bocaccio are considered rare throughout Puget Sound and are primarily found in the San Juan region to the north of Admiralty Inlet. There are no data available to calculate the number of adults or juveniles likely to be present in the action area and thus exposed to the risk of blade strike. Uncertainty regarding the potential interaction of ESA-listed juvenile and adult rockfish with the turbines and the resulting effect would be addressed through the Near-Turbine Monitoring and Mitigation Plan. Results of the monitoring would be used to adaptively manage the project to limit the effect on these species through modification to project operations or configuration or the shut down and removal of the turbines.

Larval rockfish are likely to be exposed to the turbine blades if they move through the action area with tidal flow at the depth of the turbines. Given their small size and weak swimming ability at the larval stage, it is uncertain if they would be able to avoid the blades by swimming around or through the hole in the center of the rotor. No data are available to estimate potential survival rates if they were to pass through the blades, but the space is quite large (about 55cm) compared to the size of a larval rockfish (3 to 15 mm). Juvenile rockfish that have settled to the bottom could be attracted to the relief created by the turbine structures and could attempt to occupy spaces between the blades when the rotor is at rest (30 percent of the time during the 5-year deployment), but juveniles prefer nearshore habitats such as eelgrass areas and kelp beds which are not present in the turbine area. Further any juveniles in the near-turbine area are expected to move out of these spaces as increasing tidal velocities cause the turbines to begin spinning.

Snohomish PUD estimated the number of listed larval rockfish likely to be exposed to the turbines based on densities of larval rockfish published in Chamberlain et al. (2004) and the volume of water passing through the pair of turbines per unit time (Snohomish PUD 2011). Snohomish PUD estimated that 8,000 to 290,000 larvae from all rockfish species in Puget Sound, including the three relatively rare listed species, would pass through the turbine swept area (28 m^2) during each year of operation.[45] NMFS has further refined this estimate based on the proportion of yelloweye and canary rockfish and bocaccio recently caught in recreational fisheries (Palsson et al 2009, NMFS 2010d). For the purposes of this analysis, we assume that the proportion of ESA-listed rockfish caught by anglers roughly represents the proportion of larval rockfish. This approach is supported by recent research showing that numbers of larval rockfish are proportional to those of adults of the same species (Greene and Godersky 2012).

Adult yelloweye rockfish were 0.008% of total numbers caught by recreational anglers from 2004 to 2008 (Palsson et al 2009, NMFS 2010d). Canary rockfish were 0.012% of the catch and bocaccio were 0.00026%. By multiplying each end of the density range by the corresponding percentage of recreational catch for each species, we derive estimated densities of yelloweye and canary rockfish and bocaccio larvae likely to be exposed to the turbine swept area annually. This calculation results in estimated densities of zero to 24 yelloweye rockfish larvae, zero to 35 canary rockfish larvae, and zero to one bocaccio larvae exposed to the turbine swept area each year over the ten years of operation under the pilot license.

In comparison, a female yelloweye rockfish produces between 1,200,000 and 2,700,000 larvae, a canary rockfish produces 260,000 to 1,900,000 larvae, and a bocaccio produces between 20,000 and 2,298,000 eggs per year (Love et al., 2002). To conservatively estimate the potential effect of annual exposure, we compare the upper end of the range of larvae that could be exposed to the lower end of the range of annual production. This result in an estimate of less than 0.002% of larvae produced per female yelloweye rockfish, 0.0135% of larvae produced per female canary rockfish, and 0.005% of larvae produced per female bocaccio, that would be exposed and potentially killed, annually. Although there are no density estimates available for juveniles, NMFS expects that an even smaller

[45] The analysis assumed the turbine swept area was about 28 m^2 based on the rotor diameter, which is about 0.05% of the total cross-section of the entrance to Admiralty Inlet.

number of juveniles would be exposed to the risk of blade strike because of the high natural mortality from predation between the larval and juvenile settling life stages. These very low levels of annual mortality are unlikely to impair the productivity of individual PS/GB rockfishes or to reduce abundance, reproduction, or distribution at the population level.

Near-turbine Monitoring and Mitigation Plan

Because of the uncertainty regarding interactions of marine fishes and mammals and the tidal turbines in Admiralty Inlet, Snohomish PUD, in cooperation with project stakeholders, has developed Near-Turbine Monitoring and Mitigation Plan (near-turbine plan) to monitor and then minimize any observed interactions of mobile marine organisms with the turbines. Snohomish PUD proposes to achieve three study objectives in the first year of project operations:

1. Evaluate conditions, including current velocity and direction, time of day, and season for which species presence or absence is likely. Determine the effectiveness of the AMP[46] camera system mounted on the turbines to identify species under different environmental conditions.
2. An artificial lighting study to develop guidelines for strobe frequency, duration, and interval that would allow observation of interactions with the turbine rotor (aggregation, strike, passage) without altering marine animal behavior. This study would use an acoustic camera with a field of detection similar to that of the optical camera, which is part of the AMP mounted on the turbines.
3. A turbine interaction study to evaluate the frequency and type of near-turbine interactions between marine animals and the turbine rotor.

After the first year, Snohomish PUD will present the results of these first three studies to the MARC. If the MARC concludes that direct interaction between marine animals is not sufficiently understood with the information from the initial studies, two additional study objectives would be pursued (in sequence):

4. An artificial reef effect study to evaluate whether marine mammals are attracted to prey species, which have aggregated around the turbine structures.
5. A fish avoidance study to determine if fish are avoiding the turbines at a relatively close range due to the turbine's pressure field or sound.

Snohomish PUD proposes to use a stereo-optical camera as a part of the AMP mounted to each of the turbines, which would capture still images out to a distance of about 3 to 7 m. The stereo-optical camera would be assisted by a strobe light and would support 3-dimensional imagery. The stereo-optical images would be complemented by data from an acoustic camera, which would take footage before and after the optical camera's shots. Most of the monitoring system would be recoverable (using an ROV or divers) to allow for maintenance and reconfiguration of the camera systems without removing the turbines. If the MARC determined that active sonar was needed to meet the objectives of the monitoring program, Snohomish PUD would add this capability during a later study phase. Snohomish PUD bases this proposed study design on its evaluation of previous efforts to monitor environmental effects of tidal energy elsewhere in the United States and the world.

[46] The adaptive monitoring package (AMP) is a component package, which would be mounted on each turbine. The package includes a high definition camera, a strobe light, including

Snohomish PUD proposes to repeat each of the first three Near-turbine Monitoring Plan studies four times (once per season) during the first year of turbine deployment. Snohomish PUD would carry out each of the three studies in the consecutive order shown above. If needed, Snohomish PUD would design the methods and timing of the remaining two studies in the Near-turbine Monitoring Plan based on the findings of the first three studies and consultation with the MARC.

Snohomish PUD includes adaptive management triggers in its proposed Near-turbine Monitoring and Mitigation Plan: (1) shutting the project down if harm to an ESA-listed species is suggested by monitoring; (2) consultation with the MARC if monitoring shows aquatic species passing through the turbine rotor; (3) consultation with the MARC if monitoring shows diving marine mammals in the field of view; (4) consultation with the MARC if monitoring shows diving sea birds in the field of view; (5) a contextually appropriate response[47] to a monitoring system outage, including temporary shut-down of the turbine, if needed.

Based on the analysis above, very few individual juvenile salmonids or adult rockfish are likely to encounter the turbines and be exposed to a direct blade strike. Larval and juvenile rockfish are likely to encounter the turbines and be exposed to direct blade strike. However, even with a very conservative assumption that all encounters would be fatal, the very low levels of mortality that would result would not be likely to reduce the abundance or productivity of any of the three listed species of PS/GB rockfishes at the population level.

Adult salmonids are more likely than juveniles to occur at the depths of the turbines, but given their ability to detect and avoid objects and predators it is unlikely that more than a few individuals would pass through the turbines. Although laboratory studies indicate high survival for fish encountering turbines (98-100 percent survival) there is uncertainty regarding blade strike for marine species. Snohomish PUD would therefore carry out the Near-turbine Monitoring and Mitigation Plan to investigate interactions of marine species with the turbines. If negative effects are identified or are in excess of those analyzed in this opinion, then mitigation would be required. Mitigation actions would include modifications to project operations, ceasing project operations, or removal of the turbines. This would ensure that the effects of blade strike on salmonids and rockfish would be mitigated and thus, would not be expected to reduce the abundance, reproduction, or distribution of salmonids or rockfish at the population level.

2.4.5.2 Effects on marine mammals

Based on the information provided in Sections 2.2 and 2.3, the following species of marine mammals are likely to be in the action area during project operation and therefore would be exposed to the stressor “Blade Strike:” SR killer whales and humpback whales.

[47] In the event of a monitoring system outage, the significance and immediacy of repair would depend on when the outage occurs within the life of the project and the information about environmental interactions that has been gathered to that time. The significance of an outage at an early stage of the project would also depend on whether endangered species, such as Southern Resident killer whales, were likely to be present in the project area during the outage.

The likelihood of exposure to blade strike for ESA-listed marine mammals is influenced by overlap in both the spatial and temporal distribution of these species with the turbines. Additionally, many variables would influence the outcome of a direct interaction including, but not limited to the size and mass of the individual, its angle and speed of approach, the speed of the turbines, and the individual's detection and avoidance abilities and potential curiosity.

SR killer whale

SR killer whales are likely to be present in the action area as detailed in section 2.3.7. Although there is limited data on specific behavior in the action area the same population of SR killer whales has been studied extensively in the San Juan region of Puget Sound, northwest of the action area. Diving depths and transit and foraging behaviors most frequently observed in the San Juan region, indicate that SR killer whales spend more than 95% of their time within the top 30 meters of the water column. Similar behavior expressed in the action area would reduce the likelihood and frequency of encounter, as the turbines are at depths greater than 45 meters. The turbines are expected to produce sound at audible levels at a distance of 750 m from the turbines (section 2.4.1 above), which could alert SR killer whales to the presence of the turbines, allowing SR killer whales to avoid encounters (coming close enough to see and react to the turbine). However, there is some uncertainty regarding their use of depths greater than 30 meters (section 2.3.7, above) and also the likely responses of individuals to the presence of a new structure in their environment. It is possible that a SR killer whale would approach the turbine out of curiosity or for other reasons (an encounter). If the individual did not avoid the turbine, they could be struck by a moving blade or hit the outside of the structure. In order to receive a blade strike some portion of the individual's body would need to contact the turbine blades. Regardless of the reason for the encounter, the outcome poses a potential risk to the individual involved. Therefore, NMFS further evaluates the risk to an individual in the case of the most severe injury (maximum turbine blade revolutions per minute (rpm) and direct strike on the head) that could result from an encounter.

Because there were no data readily available to inform the potential outcome of a direct encounter with a tidal turbine, the Department of Energy contracted with Pacific Northwest National Laboratory (PNNL) and Sandia National Laboratory (SNL) to investigate the consequences of such an interaction for SR killer whales. A turbine encounter could represent a range of risk to the SR killer whale, based on the speed of the turbine, which varies with the speed of the tidal currents. PNNL and SNL developed a worst-case exposure scenario for strike of a SR killer whale. An adult SR killer whale was selected for modeling because an adult has a large body mass where more of the energy in a blade strike would be absorbed by the whale's tissue, maximizing the risk of injury to a SR killer whale (Carlson et al 2012). The researchers noted that although a juvenile SR killer whale might intuitively be considered to be at greater risk of injury, because of its much smaller mass (~500 kg) more of the energy in the blade strike would go into momentum transfer, pushing the juvenile SR killer whale out of the path of the turbine's blades so that much less of its body mass would be subject to tissue damage. Sandia National Laboratory calculated the force of blade impact on the head of an adult male SR killer whale weighing about 4000 kg assuming a blunt edge turbine blade based on proprietary design data from OpenHydro. Their conclusions were summarized in the report dated October 2012:

> "…an adult male SR killer whale weighing about 4,000 kg is not likely to experience significant tissue injury from impact by an OpenHydro tidal turbine blade in the configuration used in this analysis. Based on a number of assumptions, SR killer

> whale skin and the underlying soft tissue should absorb the force of the strike without external damage to the skin or fracturing of the mandibular bone. However, key information required to fully understand the biomechanical properties of marine mammal tissues is lacking, limiting the results of the analyses. To address the lack of data, conservative estimates were made, and the worst-case scenario was used for the modeling studies (Carlson et al 2012)."

Following the release of the 2012 report, researchers obtained additional biomechanical data from SR killer whale tissue samples to refine their analyses. The revised analyses support the previous conclusions that skin and blubber are resistant to significant injury, as was modeled in the worst-case scenario evaluations. Researchers again concluded that the potential injury to an adult SR killer whale from a turbine blade strike on the rostrum would not be catastrophic. The refined analysis confirms the initial outcome that a temporary injury similar to a bruise would occur in the worst-case scenario. Researchers further note that such an injury would be unlikely to break or split the skin but there is the possibility of a persistent skin deformation such as a wrinkle or stretch mark (PNNL 2013

To receive a strike equivalent to the worst-case scenario modeled by PNNL and SNL, the head of a SR killer whale (or some other portion of the body) would need to be inserted into the 55cm space between the blades when they are spinning at the maximum 29 rpm which occurs less than 0.1 percent of the time during operations. To put this in perspective, a 55 cm (about 22 inches) space is roughly the same as the height of standard carry-on luggage. An adult male SR killer whales' head is roughly 30 to 90 cm. The maximum 29 rpm rotation is roughly one quarter of the speed of a typical ceiling fan spins (150-250 rpm). So the whale could conceivably stick its snout in a short distance, but would need to try hard to do that. Then, if the whale did put its snout in the blades when they are turning, the blades would not be turning fast enough to do significant damage. NMFS conservatively assumes that regardless of the reason for direct interaction, contact between an individual SR killer whale and the spinning turbine blades would result in a temporary bruise-like injury as detailed in the research and modeling conducted by PNNL and SNL (Carlson et al 2012, PNNL 2013).

To address the uncertainty regarding SR killer whale (and other marine mammal) interactions with the turbines and their effects Snohomish PUD and project stakeholders developed a monitoring and mitigation plans (as detailed in the proposed action 1.3.7.1). The monitoring and mitigation plans specifically related to blade strike are discussed below.

Humpback whales

There has been no research on the outcome of a blade strike event for humpback whales. Only a few individuals have been documented in Puget Sound and their occurrence is rare. However, given their size, it is highly unlikely that any portion of an individual would be able to be inserted in to the narrow space between the turbine blades, an action necessary to result in a blade strike. Humpback whales are vulnerable to vessel strikes but the turbines are stationary and located on the seafloor. The turbines also would create noise at level, which would be detected by humpback whales for up to 750 km from the turbines, which the whales could use to avoid the area. However, although the likelihood of encounter is very low, there is uncertainty regarding the effect of a direct encounter with the turbines. Therefore, Snohomish PUD would carry out the monitoring and mitigation plans that address this uncertainty as part of the proposed action as described below.

Marine Mammal Monitoring and Mitigation Plan

Pacific Northwest National Laboratory conducted research to identify the worst-case result of a direct blade strike on SR killer whales; however, uncertainty remains regarding the risk associated with any direct marine mammal interaction with the tidal turbines. To monitor and characterize the occurrence and nature of interactions that could put ESA-listed marine mammals at risk of blade strike from tidal turbines in Admiralty Inlet, the Snohomish PUD, in cooperation with project stakeholders, has developed monitoring and mitigation plans and adaptive management and mitigation triggers (described in section 1.3.7.1). The goal of the Marine Mammal Monitoring and Mitigation Plan is to detect and observe marine mammals in the action area during turbine installation, operations and removal to investigate behavioral changes: avoidance, attraction or changes in activity. This information will be used to inform mitigation actions to avoid or minimize negative effects.

To reduce uncertainty and characterize the interaction of marine mammals with the tidal turbines as well as identifying any potential adverse interactions, Snohomish PUD will investigate three hypotheses: 1) Pinnipeds may respond to the acoustic stressors from turbine operations or prey aggregations through attraction or avoidance; 2) Harbor porpoise may respond to the acoustic stressors or prey aggregations through attraction or avoidance. Their high rate of occurrence in the action area provides an opportunity to conduct studies with greater statistical power than for other marine mammals; and 3) SR killer whales may respond to the acoustic stressors or prey aggregations in the vicinity of the turbine through attraction, avoidance, or change in activity state. The monitoring program includes a passive acoustic hydrophone array coupled with onshore observer monitoring to document SR killer whale behavior in the action area during the 5-year turbine deployment. The results of this monitoring would be considered along with results from the near-turbine monitoring, acoustic monitoring, and any other new information that would contribute to evaluations of marine mammal interactions with the turbines. The monitoring results would then guide adaptive management of the project. The Marine Mammal Monitoring and Mitigation Plan is summarized in section 1.3.7.1 and include 6 triggers for mitigation action. Key triggers related to blade strike include shutdown of the turbines if a killer whale has been found to be injured (lacerations or discoloration to extremities) in the Salish Sea within a week of a known transit through Admiralty Inlet and the injury is determined to be related to the turbines. Operations will not resume until NMFS approves the resumption of operations. Snohomish PUD would carry out protective measures to protect killer whales. Additionally, if behavioral responses to the presence of the turbine by mid-frequency cetaceans (Southern Resident killer whales) within the survey area are reported, Snohomish PUD will convene a meeting of the MARC to evaluate whether modifications to the monitoring and mitigation plan or project operations are necessary. Snohomish PUD would obtain NMFS' approval for any specific mitigation measures.

If a determination is made to shut down the turbines as is required by Marine Mammal Adaptive Management and Mitigation Trigger 5 (or for any other reason such as sound levels above established thresholds - Marine Mammal Adaptive Management and Mitigation Trigger 2) Snohomish PUD would carry out procedures to engage the mechanical brake. The mechanical break would have to be applied at slack tide, which could fall as much as five or six hours after a decision to shut down the turbines is made. The ROV will also need time to be brought to the site and deployed. Snohomish PUD estimates that 97% of the time, the brake would be engaged within 72 hours of a decision to

stop the blades (Snohomish PUD 2013a). Although due to the sea conditions required to deploy the ROV and engage the manual brake, it could take up to four days to complete the shutdown.[48]

Because of this delay, SR killer whales may be at risk of encounter for up to four days after a decision to shut down the turbines is made. Therefore, individuals that encounter the turbines in the time, which elapses before the brake is engaged, may be at risk of such blade strike. NMFS expects that the worst case outcome of a blade strike would be a temporary bruise-like injury and that no increased risk would result from the delay between the decision to shut down the turbines and engaging the brake.

Therefore, although there is uncertainty regarding the likelihood of interaction, a blade strike on a SR killer whale is expected to cause a temporary, bruise-like injury to the head. This temporary injury would not be expected to significantly reduce individual fitness or reproductive success of an individual SR killer whale. For humpback whales, the likelihood of occurrence in the action area is rare and the risk of encounter with the turbine blades is extremely low. Monitoring carried out to evaluate marine mammal behavior and activity in the action area and identify negative interactions of marine mammals, including SR killer whales and humpback whales, with the turbines would be evaluated by the MARC and Snohomish PUD. The latter would take action to mitigate any negative effects through modifications to project operations, ceasing project operations, or removal of the turbines. Any mitigation actions would be reviewed and approved by NMFS before submittal to FERC. Blade strike therefore would not be expected to affect numbers, reproduction, or distribution of the SR killer whale or humpback whale at the population level.

2.4.6 Effects of the proposed action on Critical Habitat

As detailed in section 2.2.2 above, critical habitat has been designated or proposed within the action area for PS Chinook salmon, all three species of PS/GB rockfishes, and SR killer whale.

2.4.6.1 PS Chinook Salmon critical habitat

Critical habitat for Puget Sound Chinook salmon occurs in the action area. As discussed above, critical habitat was designated in nearshore marine areas of Puget Sound "contiguous with the shoreline from the line of extreme high water out to a depth no greater than 30 meters relative to mean lower low water" (MLLW) (70 FR 52684). The PCEs (important components of habitat) for nearshore marine areas that could be affected by the proposed action are (1) sufficient forage, including aquatic invertebrates and fishes that support growth and maturation and (2) free of obstruction. The only project structure located within the 30-meter deep designation is the portion of the seafloor cable that runs southeast from the underwater HDD exit (at about 19-m) to the 30-m depth contour along the northwest shoreline of Admiralty Bay (Figure 6 – Transmission Cable Route).

1. **Sufficient forage**. Food resources for salmonids are unlikely to be altered within 30 meters of depth, as the only project feature in this area is the cable corridor along the seafloor. Juvenile

[48] Based on tidal current measurements and sea state conditions between August 2011 and May 2012, Snohomish PUD estimates that the probabilities that the mechanical brake for both turbines would be engaged within 24, 48, 72, and 96 hours of the decision to engage the brake are 90%, 97%, 99%, and 99.7%, respectively (Snohomish PUD 2013a).

salmonids in Puget Sound feed primarily on zooplankton and as they mature, their diet transitions to forage fish. Returning adults, which feed infrequently on their return to natal streams, primarily consume forage fishes. The presence of the cable on the seafloor is unlikely to have an effect on any of these prey resources. Thus, the proposed action would not have a negative effect on the functioning of sufficient forage in designated critical habitat.

2. **Free from obstruction**. As detailed in the analysis of effects, the project may emit a small B and iE EMF from power transmission along the cable. However, the cable is shielded and the power transmitted is relatively low. Modeling predicts that beyond 3.3 cm from the cable any magnetic field would dissipate to levels at or below the earth's own magnetic field and completely dissipate at a distance of 45 cm. Further, the seafloor cable extends from the nearshore on the northeast side of Admiralty Bay to the turbine location and does not cross the entrance to Admiralty Inlet. Therefore, it would not obstruct fish passage into or through the inlet. As detailed in section 2.4.1, there is uncertainty regarding the sound that would be produced by turbine operation and the potential responses of marine fishes including Chinook salmon. The best available scientific information indicates that sound is expected to cause behavioral avoidance of the turbine location, but would not create a barrier to passage.

Snohomish PUD would carry out the monitoring and mitigation plans, which address uncertainties regarding effects of sound, project structures, and other aspects of the project on the functioning of PCEs in critical habitat. If an adverse effect were identified, mitigation such as modification to project operations or structures, ceasing operations, or removal of the project would occur, further reducing the likelihood that the proposed action would appreciably reduce the conservation value of critical habitat designated for PS Chinook salmon.

2.4.6.2 PS/GB rockfish proposed critical habitat

NMFS has proposed critical habitat for adult yelloweye and canary rockfish and adult bocaccio within the action area—benthic habitats or sites deeper than 30 m (98 ft) that possess or are adjacent to areas of complex bathymetry consisting of rock and or highly rugose habitat. Proposed critical habitat for juvenile canary rockfish and boccacio in the action area includes juvenile settlement habitats located in the nearshore with substrates such as sand, rock and/or cobble compositions that also support kelp. The physical and biological features that might be affected by the proposed action are (1) quantity, quality, and availability of prey species to support individual growth, survival, reproduction, and feeding opportunities and (2) structure and rugosity[49] to support feeding opportunities and predator avoidance.

1. **Quantity, quality, and availability of prey species.** Food resources for rockfish could be altered within the cable corridor and the turbine area throughout the 10-year pilot license. The presence of the cable on the seafloor and the structure introduced by the turbines could alter the local benthic community composition; however, the magnitude of this alteration would be small due to the small footprint of the features. Further, there is uncertainty regarding whether the potential changes would result in a decrease or negative change in prey (primarily small

[49] Rugosity is small-scale variations or amplitude in the height of a surface and is an indicator of the amount of available habitat available for colonization by benthic organisms (those attached to the seafloor), and shelter and foraging area for mobile organisms.

crustaceans) quantity, quality or availability. Rockfish species beyond the larval stage are highly mobile, able to access a variety of available habitats and foraging areas in Admiralty Inlet and Puget Sound. Because any effects on the forage base would be highly localized, the potential for net decrease in the quantity, quality or availability of prey is likely to be insignificant compared to the total food resources available to rockfish at the entrance to Admiralty Inlet.

2. **Structure and rugosity to support feeding opportunities and predator avoidance.** The project features would introduce relief by the placement of the turbines on the seafloor. It is likely that the presence of the turbines would result in a reef effect and attract species to the area, particularly when the turbines' rotors are not spinning (30 percent of the time). There is uncertainty regarding the magnitude of a reef effect and its impact on the benthic community (the addition of structure could increase or decrease feeding opportunities and refuge from predators or could have no effect), but these factors would be investigated through the Benthic and Near-field Monitoring and Mitigation plans for the project. If the results of the monitoring indicate potential problem, and a trigger has been met or if they identify a negative effect not previously considered, the PUD would take mitigation actions to minimize or avoid harm to critical habitat. Therefore, the proposed action would not have a negative effect on the conservation value of structure and rugosity to support feeding opportunities and predator avoidance in proposed critical habitat.

In summary, the proposed action is likely to have small effects on two of the essential functions of proposed critical habitat for PS/GB rockfishes, but only over a very small area. If these were observed through the proposed benthic and near-field monitoring, they would be minimized by mitigation such as modification to project operations or structures, ceasing operations, or removal of the project. Therefore, the proposed action would not reduce the conservation value of proposed critical habitat for PS/GB rockfish.

2.4.6.3 SR killer whale critical habitat

Of the two ESA-listed species of marine mammals that could be affected by the project, critical habitat has been designated only for SR killer whale. Critical habitat for SR killer whale occurs within the action area and includes "waters relative to a contiguous shoreline delimited by the line at a depth of 6.1 meters relative to extreme high water" (71 FR 69054). The PCEs "passage conditions to allow for migration, resting, and foraging and prey quality and quantity," are likely to be affected by the proposed action.

The turbine structures themselves would not create a barrier to passage, as they are located on the seafloor at a depth of 55meters and only occupy a very small portion (0.05%) of the passage through Admiralty Inlet. However, as detailed in the analysis of effects above, this PCE could be affected by sound from the operating turbines. SR killer whales are documented to transit through the entrance to Admiralty Inlet and use the area despite relatively high ambient noise conditions of 117 dB re 1 µPa (Bassett 2010), heavy commercial shipping and other boat traffic and fishing activities. As discussed in section 2.4.1, additional effects would be small; sound would exceed NMFS Level B harassment threshold of 120 dB re 1 µPa only at a distance of up to 750 m from the center of the turbine location, which would only extend 15 percent of the distance across the narrowest constriction of Admiralty Inlet. Thus, project sound would not prevent SR killer whales from passing through the entrance to the inlet for migration, rest, or foraging.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

The proposed action could indirectly affect the conservation value of SR killer whale critical habitat by reducing numbers of their primary prey, PS Chinook salmon. However, as analyzed in sections 2.4.1 - 2.4.5, the proposed action is expected to result in only a very small reduction in numbers of adult Chinook salmon, an insignificant reduction in prey resources for SR killer whales.

Therefore, the effects of the proposed action are not likely to reduce the conservation value of critical habitat designated for SR killer whales.

2.5 Cumulative Effects

"Cumulative effects" are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

Within the action area, some state, tribal, and local government actions contribute to negative cumulative effects. Those that are currently ongoing or occurred frequently in the recent past can also be considered reasonably certain to occur in the future, especially if authorizations or permits have not yet expired. Although these factors are ongoing and likely to continue in the future, past occurrence is not a guarantee that they will continue at the same level of activity. The negative effects depend on whether there are economic, administrative, and legal impediments. Therefore, the cumulative effects of these activities will be commensurate to those of similar past activities analyzed in the baseline.

2.6 Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we will add the effects of the action (Section 2.4) to the environmental baseline (Section 2.3) and the cumulative effects (Section 2.5) to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) reduce the value of designated or proposed critical habitat for the conservation of the species. These assessments are made in full consideration of the status of the species and critical habitat (Section 2.2).

The proposed action is the granting of a 10-year pilot license to Snohomish PUD for the 5-year deployment and operation of two OpenHydro tidal turbines and the associated installation, monitoring, mitigation and maintenance activities described in section 1.3. Any future development of tidal energy projects, including any activities beyond the proposed action and the 10-year duration of the pilot license would be subject to separate review and would need a FERC license and any other applicable local, state or Federal authorizations. Therefore, NMFS does not consider the effects of any deployment of tidal turbines or other equipment beyond the 10-year term of the proposed action in this opinion.

2.6.1 Salmonids

Juvenile and adult PS Chinook and HCSR chum salmon and PS steelhead would be likely to pass through the action area, and some of these individuals would be exposed to effects of the proposed

project including sound, EMF, benthic habitat alteration and blade strike effects. However, as described in the effects section, the best available scientific and commercial information indicates that very few ESA-listed Chinook, chum or steelhead are likely to be injured or killed by the effects of the two turbines and cable. Effects common to the three salmonid species and then specific to each species, are summarized below in the context of rangewide status, the environmental baseline, and cumulative effects.

Individuals from the PS Chinook and HCSR chum ESUs and PS steelhead DPS are affected by the same manmade and natural factors including widespread loss and degradation of freshwater and estuarine habitat by land use activities including urbanization, forestry, and agriculture and past hatchery and harvest practices (Rangewide Status of the Species - Section 2.2.1). Juveniles and returning adults are exposed to high levels of ambient noise from anthropogenic and natural sources in the action area. Adults are taken in recreational and Tribal fisheries. Baseline environmental conditions are generally degraded throughout Puget Sound and in the action area (Environmental Baseline – Section 2.3). Although future effects of climate change are uncertain, conditions adverse to salmon and steelhead such as an altered seasonal hydrograph and higher temperatures in freshwater systems and increasing ocean temperatures, changes in upwelling intensity, and ocean acidification, which could affect food webs appear likely under a warming climate (Section 2.3). Recovery efforts for both PS Chinook and HCSR chum focus primarily on freshwater systems and associated deltas although some protection efforts target marine areas such as protection of eelgrass habitats and restoration or protection of shoreline habitat. Many of the habitat and hatchery actions identified in the Puget Sound Chinook and Hood Canal Summer Chum recovery plans would take years or decades to be implemented and to produce significant improvements in natural population attributes.

Effects of the proposed action (including the installation, operation, maintenance, monitoring, and removal of the Open Hydro tidal turbines and associated structures in the action area) that would be likely to adversely affect salmonids include sound, electromagnetic field generation, habitat alterations, risk of entanglement, and blade strike.

- Sound from the proposed action would not exceed NMFS exposure criteria for harm or injury for juvenile and adult fishes. It is uncertain whether the level of sound would cause avoidance of any part of the action area. If so, it would be likely to reduce foraging opportunity or temporarily change migration routes in a small area immediately surrounding the turbines, about 28 m^2 but there is similar habitat available for these activities in the surrounding area (section 2.4.1).
- EMF produced by the proposed action would be limited to a low intensity B field, which would dissipate entirely within 45 cm (18 inches) of the cable surfaces. If an individual detected the EMF from the proposed action, they may avoid the area within 45 cm of the cables. If so, it would be likely to reduce foraging opportunity or temporarily change migration routes within 45cm of the cables, a very small area but there is similar habitat available for these activities in the surrounding area (section 2.4.2).
- The presence of the turbines and cables on the seafloor would alter the benthic habitat in the action area. Although there is uncertainty regarding the potential effects to salmonids and marine resources on which they depend, NMFS expects any changes to community composition to be small because the turbine footprint and structures represent a very small

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

portion of the area at the entrance to Admiralty Inlet (0.05% of the cross sectional area) (section 2.4.3).

- The risk that salmonids would become entangled in derelict gear that became snagged on project structures is low because of the project's design (absence of mooring or anchoring lines and the hydrodynamic movement of water around and through the open center of the turbine) and the ongoing monitoring and recovery efforts required by the derelict gear monitoring and mitigation plan. The chance of derelict gear coming in contact with the turbines is low because of the small size of the two turbines relative to the size of Admiralty Inlet, and if it did happen, the gear would be removed (section 2.4.4).
- The operation of the turbines would introduce the risk of blade strike in the turbine swept portion (28 m^2) of the action area. Juvenile salmonids are surface oriented (i.e., primarily found within the upper 30 meters, above the depth of the turbines) and would be very unlikely to encounter the turbine blades. NMFS expects adult salmonids to occur at the depth of the turbines, but they are not likely to pass between the rotor blades when they are spinning because the space between the blades is small (55cm or less) and sound from the turbines could alert individuals to their presence. Further, salmonids are strong swimmers evolved to maneuver in high energy currents and are documented to exhibit avoidance behavior in laboratory studies. In the event that adult or juveniles did pass through the blades, the likelihood of survival is high based on current research (section 2.4.5).

Uncertainties about the responses of juvenile and adult salmonids to effects of the project would be resolved through the proposed monitoring and mitigation plans. These plans would allow Snohomish PUD to characterize effects of the deployed project. The plans also include specific mitigation triggers and actions that would be taken by Snohomish PUD to address adverse effects. Mitigation measures include short- and long-term changes in project design, operations (including temporary suspension), structures, maintenance or other management activities, and monitoring or studies; new monitoring or studies; and the removal of one or more structures from the site. All mitigation and management actions likely to affect ESA-listed marine species or their habitats would be subject to NMFS' review and approval before submittal to FERC.

Based on the best available scientific and commercial information, the degree of exposure and response to these effects by salmonids are likely to be very small and not likely to affect abundance, reproduction, or distribution at the population level for any of the three species of ESA-listed salmonids.

Nearshore and marine conditions that affect the growth and survival of salmonids in the action area for this consultation are influenced by processes (weather, tidal currents, climate change) and stressors (shoreline development, agriculture, hatcheries) that would not be significantly affected by the proposed action due to the small size of the turbines relative to the action area, and limited duration of their deployment. The proposed action would not diminish the ability to implement

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

actions recommended by the recovery plans for PS Chinook and HCSR chum salmon[50] such as improvements to freshwater and delta systems, protection of marine shorelines and riparian areas, eelgrass habitat, and improvements to water quality.

2.6.1.1 Puget Sound Chinook Salmon

The PS Chinook salmon ESU is stable (although some populations are declining in abundance) and is at moderate risk of extinction. Limiting factors are loss and degradation of habitat due to land use activities including urbanization, forestry, and agriculture (Rangewide Status of the Species; section 2.2.1). Conditions are degraded under the environmental baseline (section 2.3) and future cumulative effects are likely to be commensurate with those of past non-Federal activities, as considered in the baseline (section 2.5).

Based on the best available scientific and commercial information, no more than a few individual juvenile or adult PS Chinook salmon would be exposed to negative effects of the proposed action (section 2.4). Populations originating from the Nooksack, Dungeness and Elwha rivers are not likely to be affected as these fish do not migrate through Admiralty Inlet to reach their natal streams. Eighteen populations originating in central and south Puget Sound do move through Admiralty Inlet as they migrate to or from the ocean and therefore would be exposed to effects of the proposed action. There is no evidence that individuals from any of these populations would be affected more than others or that natural-origin fish would be more susceptible to risk than those from a hatchery stock. The very small degree of impact on a few individuals from these populations is not likely to affect abundance, reproduction, or distribution at the ESU level.

2.6.1.2 Hood Canal summer-run chum salmon

The ESU has shown increased abundance since listing in 1999, although abundance and productivity have been down slightly over the past five years. The ESU is at moderate risk of extinction. Limiting factors include climate change impacts and the widespread loss and degradation of freshwater habitat (Rangewide Status of the Species; section 2.2.1). Conditions are degraded under the environmental baseline (section 2.3) and future cumulative effects are likely to be commensurate with those of past non-Federal activities, as considered in the baseline (section 2.5).

Based on the best available scientific and commercial information, no more than a few individual juvenile or adult HCSR chum salmon would be exposed to negative effects of the proposed action (section 2.4). Populations originating from the Strait of Juan de Fuca summer chum population would not be affected as these fish do not migrate through Admiralty Inlet. Individuals from the Hood Canal population do move through Admiralty Inlet as they migrate to or from the ocean and therefore would be exposed to effects of the proposed action. There is no evidence that natural-origin fish would be more susceptible to risk than those from a hatchery stock. The very small degree of impact on a few individuals from the Hood Canal population is therefore not likely to affect abundance, reproduction, or distribution at the ESU level.

[50] Although NMFS has not adopted a recovery plan for PS steelhead, nearshore and marine actions designed to improve conditions for other salmonids would also be likely to benefit steelhead

2.6.1.3 Puget Sound Steelhead

The Puget Sound steelhead DPS is at low abundance compared to historical levels and recent data indicate continued downward trends. The DPS is at moderate risk of extinction. Limiting factors include climate change impacts, widespread habitat loss and degradation, freshwater passage barriers, and changes to stream hydrology (Rangewide Status of the Species; section 2.2.1). Conditions are degraded under the environmental baseline (section 2.3) and future cumulative effects are likely to be commensurate with those of past non-Federal activities, as considered in the baseline (section 2.5).

Based on the best available scientific and commercial information, no more than a few individual juvenile or adult PS steelhead would be exposed to negative effects of the proposed action (section 2.4. Although NMFS has proposed population delineations for the DPS, the designations are not yet final. However, most of the individuals from this DPS are likely to move through Admiralty Inlet as they migrate to or return from the open ocean and therefore would be exposed to effects of the proposed action. There is no information to indicate that individuals from any of these populations would be affected more than others or that natural-origin fish would be more susceptible to risk than those from a hatchery stock. The very small degree of impact on a few individuals from these populations is therefore not likely to affect abundance, reproduction, or distribution at the DPS level.

2.6.2 Rockfish

Larval, juvenile, and adult PS/GB canary rockfish, PS/GB yelloweye rockfish, and bocaccio DPSs are likely to occur in the action area and some individuals of each species would be exposed to effects of the proposed project. Larval and juvenile rockfish would be exposed to sound, EMF, benthic habitat alteration, and the risk of blade strike; adult PS/GB canary rockfish are considered uncommon and yelloweye rockfish and bocaccio are considered rare in the action area, reducing the likelihood of adverse effects on this life stage. As described in Effects of the Action (section 2.4), the best available scientific and commercial information indicates that very few ESA-listed larval, juvenile, or adult rockfish are likely to be injured or killed by the effects of the two turbines and cable.. Effects common to the three rockfish species and then specific to each species are summarized below in the context of rangewide status, the environmental baseline, and cumulative effects.

Puget Sound/Georgia Basin canary rockfish, yelloweye rockfish, and bocaccio are affected by the same manmade and natural factors including overfishing and bycatch mortality in recreational fisheries and urbanization which caused the loss of nearshore habitat and degradation of water quality (Rangewide Status of the Species Section 2.2.1). Rockfish in the action area are exposed to high levels of ambient noise from anthropogenic and natural sources. Baseline environmental conditions are generally degraded throughout Puget Sound and in the action area (Environmental Baseline – Section 2.3). Although future effects of climate change are uncertain, conditions adverse to rockfish such as warmer ocean temperatures, hypoxic conditions and changes to primary productivity are likely to negatively influence their growth, productivity, and survival (Section 2.2.3). NMFS has not yet adopted a recovery plan for ESA-listed PS/GB rockfish species.

Effects of the proposed action relevant to rockfish (including the installation, operation, maintenance, monitoring, and removal of the OpenHydro tidal turbines and associated structures in the action area) are generally the same as those that affect salmonids described above. These effects are sound,

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

electromagnetic field generation, and risk of entanglement. However, because of differences in their habitat use and resident life history, the effects of the habitat alteration and the risk of blade strike from the proposed action are different for rockfishes as they use benthic habitat more than salmonids:

- The presence of the turbines and cables on the seafloor would alter the benthic habitat in the action area. Rockfish exhibit a strong preference for high-relief structures and thus could be attracted to the turbines. Although there is uncertainty regarding the potential effects on rockfishes and the marine resources on which they depend, NMFS expects the potential changes to marine community composition to be very small because the turbine footprint and structures represent a very small portion of the area at the entrance to Admiralty Inlet (0.05% of the cross sectional area).
- Juvenile rockfish settling to the bottom could be attracted to the turbine structures (reef effect), increasing the risk of blade strike for this life stage. Additionally, larval and juvenile rockfish are passively dispersed by or travel with currents and if entrained in local flow, would be unlikely to avoid passing through the turbine blades. Adult canary or yelloweye rockfish or bocaccio presence is uncommon in the action area and they are likely to swim away from the rotors. Survival estimates for any adults or juveniles that pass through the blades are likely to be high (98-100%) based on current research. Larval rockfish are fragile and unlikely to survive at such high rates as juveniles or adults. NMFS estimates that zero to 24 yelloweye rockfish larvae, zero to 35 canary rockfish larvae, and between zero and one bocaccio larvae would be killed by blade strike each year during the five-year deployment. (section 2.4.5).

Uncertainties about the responses of PS/GB rockfish to effects of the proposed action would be resolved through the proposed monitoring and mitigation plans. These plans would allow Snohomish PUD to characterize effects of the deployed project. The plans also include specific mitigation triggers and actions that would be taken by Snohomish PUD to address adverse effects. Specific mitigation actions include short- and long-term changes in project design, operations (including temporary suspension), structures, maintenance or other management activities, and monitoring or studies; new monitoring or studies; and the removal of one or more structures from the site. All mitigation and management actions likely to affect ESA-listed marine species or their habitats are subject to NMFS' review and approval before submittal to FERC.

Nearshore and marine conditions in Puget Sound that affect the growth and survival of rockfish in the action area for this consultation are influenced by processes (weather, tidal currents, climate change) and stressors (shoreline development, harvest) that would not be significantly affected by the proposed action. NMFS has not yet adopted a recovery plan for PS/GB canary or yelloweye rockfish or bocaccio.

2.6.2.1 PS/GB Canary Rockfish

The PS/GB canary rockfish DPS is at low abundance compared to historical levels and is at moderate risk of extinction. Limiting factors are detailed under Rangewide Status of the Species (climate change impacts, bycatch mortality, loss of nearshore habitat and water quality degradation; section 2.2.1). Conditions are degraded under the environmental baseline (section 2.3) and future cumulative effects are likely to be commensurate with those of past non-Federal activities, as considered in the baseline (section 2.5).

Based on the best available scientific and commercial information, NMFS estimates that no more than 35 canary rockfish larvae, very few juveniles and no adults would be killed annually as a result of blade strike or other aspects of the proposed action. NMFS chose this number of larvae based on the density of larval canary rockfish likely to occur within the turbine swept area and be exposed the effects of the project (section 2.4.5). Although it cannot be calculated, the number is even smaller for juveniles because of the expected high rate of mortality between the larval and juvenile life stages and zero for adults because adult canary rockfish are uncommon in Admiralty Inlet (section 2.4.5). This is equivalent to 0.0135% of the larvae produced per female canary rockfish. This very low level of annual mortality is unlikely to impair the productivity of individual PS/GB Canary rockfish or to reduce abundance, reproduction, or distribution at the DPS level.

2.6.2.2 PS/GB Yelloweye Rockfish

The PS/GB yelloweye rockfish DPS is at low abundance compared to historical levels and is at moderate risk of extinction. Numbers have been reduced in Hood Canal and South Puget Sound (Rangewide Status of the Species – Section 2.2.1). Conditions are degraded under the environmental baseline (section 2.3) and future cumulative effects are likely to be commensurate with those of past non-Federal activities, as considered in the baseline (section 2.5).

Based on the best available scientific and commercial information, NMFS estimates that no more than 24 yelloweye rockfish larvae, very few juveniles and no adults would be killed annually as a result of blade strike or other aspects of the proposed action. NMFS chose this number of larvae based on the density of larval yelloweye rockfish likely to occur within the turbine swept area (section 2.4.5). Although it cannot be calculated, the number is smaller for juveniles because of the expected high rate of mortality between the larval and juvenile life stages and zero for adults because adult yelloweye rockfish are uncommon in Admiralty Inlet (section 2.4.5). This is equivalent to 0.002% of larvae produced per female yelloweye rockfish. This very low level of annual mortality is unlikely to impair the productivity of individual PS/GB yelloweye rockfishes or to reduce abundance, reproduction, or distribution at the DPS level.

2.6.2.3 PS/GB Bocaccio

The PS/GB bocaccio DPS is at very low abundance compared to historical levels and is at high risk of extinction (Rangewide Status of the Species (section 2.2.1). Bocaccio, which were once most abundant in the Central and South Puget Sound, are now rarely observed in these areas. Conditions are degraded under the environmental baseline (section 2.3) and future cumulative effects are likely to be commensurate with those of past non-Federal activities, as considered in the baseline (section 2.5).

Based on the best available scientific and commercial information, NMFS estimates that no more than one bocaccio larvae and no juveniles or adults would be killed annually as a result of blade strike or other aspects of the proposed action. NMFS chose this number of bocaccio larvae based on the density of larval bocaccio likely to occur within the turbine swept area (section 2.4.5). Although it cannot be calculated, the number is smaller for juveniles because of the expected high rate of mortality between the larval and juvenile life stages, and zero for adults because adults are rare in Admiralty Inlet (section 2.4.5). This is equivalent to 0.005% of larvae produced per female bocaccio annually. This very low level of annual mortality is unlikely to impair the productivity of individual PS/GB bocaccio or to reduce abundance, reproduction, or distribution at the DPS level.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

2.6.3 Puget Sound Chinook Salmon Critical Habitat

Effects of the proposed action on the functioning of the PCE of critical habitat for PS Chinook salmon (sufficient forage, including aquatic invertebrates and fishes that support growth and maturation; areas free of obstruction) would be relatively short in duration (5 years). Any adverse effects would occur over a very small portion (about 0.05 percent) of the available habitat at the entrance to Admiralty Inlet and would be minimized by the implementation of the proposed monitoring and mitigation plans and of resulting mitigation actions (through adaptive management). The proposed action would not appreciably diminish the value of designated critical habitat for the species' conservation.

2.6.4 PS/GB Rockfish Proposed Critical Habitat

Effects of the proposed action on the functioning of the primary constituent elements PCE of critical habitat (quantity, quality, and availability of prey species to support individual growth, survival, reproduction and feeding opportunities; structure and rugosity to support feeding opportunities; predator avoidance) would be relatively short in duration (5 years) and the area affected is very small. Any adverse effects would be minimized by the implementation of the proposed monitoring and mitigation plans and resulting mitigation actions (through adaptive management). The proposed action would not appreciably diminish the value of designated critical habitat for the species' conservation.

2.6.5 Marine Mammals (SR Killer Whales and Humpback whales)

Over the last 28 years, the growth of the SR killer whale population has been variable, with an average annual population growth rate of 0.3 percent and standard deviation of ± 3.2 percent (Rangewide Status of the Species - Section 2.2.1). NMFS determined that there were 81 whales in the SR killer whale population in its most recent census (Center for Whale Research 2013). In addition to demographic factors, habitat conditions, which could include reduced quantity and quality of prey (particularly their primary prey, Chinook salmon), exposure to toxic chemicals through the food web, and disturbances from sound and vessels appear to be limiting recovery. Chemical contamination from oil spills is also a risk factor (Section 2.2.1).

Numbers of humpback whales have been increasing globally; the recent annual growth rate of North Pacific populations was estimated at 7-8% (Calambokidis et al. 2009). Humpback whales face a variety of threats including entrapment and entanglement in fishing gear, collisions with ships, acoustic disturbance, habitat degradation, and scientific harvest (Rangewide Status of the Species - Section 2.2.1).

Sound produced by the proposed action would not exceed NMFS Level A criteria for harm of marine mammals. Thus, no individual whale of either species is likely to be injured or harmed by sound. However, NMFS expects that sound from the proposed action will exceed 120 dB re 1µPa, NMFS Level B harassment threshold for marine mammals, within a 750-meter radius of the turbines when they are operating (section 2.4.1). If individual whales are exposed to sounds above the 120 dB harassment threshold, they are expected to deflect around the ensonified area instead of continuing in the same direction. The additional distance traveled is very small (up to 750m) so is unlikely to cause a significant increase in an individual’s energy budget and effects would be short-term. Deflection around the ensonified area would not significantly reduce access to important habitat for foraging, socializing, resting, or transiting in Admiralty Inlet. Therefore, NMFS does not anticipate that the

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

likely behavioral responses, even considering potential for repeat exposures of individuals over the five-year turbine operation period, would reduce the reproductive success or increase the risk of injury or mortality for any affected individuals of either of the two ESA-listed marine mammal species in the action area.

Individual SR killer whales could be exposed to the risk of blade strike if they dove to the depth of the turbines (45 meters) and made direct contact with rotating blades. Data from the San Juan Islands indicate that dives to greater than 30 meters constitute about 2.5% of the dive profile (section 2.3). While it is likely individuals would avoid rotating turbines due to sound levels, sound would likely alert an individual to the presence of the turbines. . An individual SR killer whale could approach the turbines out of curiosity or for other reasons. If an individual approached the turbines and was unable to avoid them, it could deflect off the structure. In order to receive a blade strike equivalent to the worst case scenario modeled by PNNL and SNL (Carlson et al 2012) the head of a SR killer whale would need to be inserted into the space between the blades (a maximum at the outer edge of about 55 cm) when they are spinning at the maximum speed of 29 rpm (turbines spin at this speed about 0.01 percent of the time). Based on the results of this study, NMFS expects that this degree of impact to the head of a SR killer whale would result in an injury equivalent to a bruise. This type of injury would be temporary and would not be likely to significantly reduce an individual's lifetime fitness or reproductive success.

Because humpback whales are rare in the action area, the likelihood that an individual would be exposed to blade strike is very small (even less than for SR killer whales). There has been no research on the outcome of a blade strike event for humpback whales, but given their size, it is highly unlikely that any portion of an individual would be inserted between the turbine blades, an action necessary to result in a blade strike. If a humpback whale were to contact the turbines it would likely deflect off of the outer structure of the turbines. Therefore, while NMFS cannot completely rule out the possibility of a blade strike for humpback whales, we do not expect it to occur. If a blade strike did occur, NMFS expects that the type of injury (bruising) would be less significant than for SR killer whales because humpbacks are larger and have thicker bone structure and skin.

Snohomish PUD would carry out the monitoring and mitigation plans which would employ a number of methods (passive acoustics- hydrophones, boat and shore observations, near-turbine cameras) to identify negative interactions and effects such as a blade strike event. If behavior indicating a negative interaction were identified, Snohomish PUD would consult with the MARC and take action to avoid or minimize the effect through mitigation including modifications to project operations, ceasing project operations, or removal of the turbines. In the event that a blade strike injury to a SR killer whale occurred, the Snohomish PUD would shutdown the turbines by engaging a manual turbine brake. This pre-determined mitigation action (Marine Mammal Adaptive Management and Mitigation Trigger 5) would ensure that the effects of any observed or suspected blade strike would not occur repeatedly over the 5-year operation of the turbines.

Thus, each factor needed to result in a blade strike is very unlikely to occur. First, it is unlikely that the SR killer whales would be close to the turbines because they do not typically dive to the depth of the turbines, and the whales would likely avoid the turbines when spinning due to the noise. If the whales are close to the turbines, the amount of time the blades are spinning fast is small, and inserting their nose into the spinning blades would be an intentional act. Then if all those unlikely

things happened, the worst injury the whale could sustain is a bruise that would have no long-lasting effect on the whale's health. Therefore, the risk of blade strike from the proposed action, remote in itself, would not appreciably reduce the likelihood of survival and recovery of the SR killer whale DPS.

As noted above, Snohomish PUD would carry out the monitoring and mitigation plans, which would identify negative effects such as a blade strike event. In the case where an event occurred or was suspected due to evidence of an injury on a whale in or near the action area, mitigation would be required including modifications to project operations, ceasing project operations, or removal of the turbines. This would ensure that the effects of any observed or suspected blade strike would not appreciably reduce the abundance, reproduction, or distribution of either the SR killer whale or humpback whale DPS.

2.6.6 SR Killer Whale Critical Habitat

The following PCEs for SR killer whales critical habitat could be affected by the proposed action: passage conditions to allow for migration, resting, and foraging; prey quality and quantity. As detailed in the analysis of effects above, the project could affect these PCEs through the production of sound from turbine operations. However, the effect on passage would be very small and intermittent. Sound from turbine operation would exceed NMFS Level B harassment threshold of 120 dB re 1 μPa up to 750 m from the center of the turbine location, which would only extend 15 percent of the distance across the entrance to Admiralty Inlet. Thus, project sound would not prevent SR killer whales from passing through the entrance to the inlet for migration, rest, or foraging.

NMFS does not expect that the proposed action will affect water quality or SR killer whale prey quality; however, the project could affect the quantity of prey available to Southern Residents. Because the salmon densities in the action area are expected to be low, and the effects of the proposed action would result in only very small reduction in numbers of salmon, any reduction in prey available to SR killer whales would also be very small. Therefore, NMFS anticipates that any reduction in Chinook salmon prey resources for SR killer whales within the action area would be insignificant and would not reduce the functioning of PCEs in designated critical habitat.

2.7 Conclusion

Puget Sound Chinook salmon ESU

After reviewing the current status of the listed species (threatened and moderate risk), the environmental baseline within the action area (degraded), the effects of the proposed action (minimal from sound, EMF, habitat alteration, derelict gear and blade strike), and cumulative effects (minimal), it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of the Puget Sound Chinook salmon ESU, or to destroy or adversely modify designated critical habitat for PS Chinook salmon.

Hood Canal summer-run chum salmon ESU

After reviewing the current status of the listed species (threatened and moderate risk), the environmental baseline within the action area (degraded), the effects of the proposed action (minimal from sound, EMF, habitat alteration, derelict gear and blade strike), and cumulative effects (minimal), it is NMFS' biological opinion that the proposed action is not likely to jeopardize the

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

continued existence of the Hood Canal summer-run chum salmon ESU, or to destroy or adversely modify designated critical habitat for Hood Canal summer-run chum salmon.

Puget Sound steelhead DPS
After reviewing the current status of the listed species(threatened and moderate risk), the environmental baseline within the action area (degraded), the effects of the proposed action (minimal from sound, EMF, habitat alteration, derelict gear and blade strike), and cumulative effects (minimal), it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of the Puget Sound steelhead DPS, or to destroy or adversely modify proposed critical habitat for Puget Sound steelhead.

Puget Sound/Georgia Basin canary rockfish DPS
After reviewing the current status of the listed species(threatened with declining abundance), the environmental baseline within the action area (degraded), the effects of the proposed action (minimal from sound, EMF, habitat alteration, derelict gear and blade strike), and cumulative effects (minimal), it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of the Puget Sound/Georgia Basin canary rockfish DPS, or to destroy or adversely modify proposed critical habitat for Puget Sound/Georgia Basin canary rockfish.

Puget Sound/Georgia Basin yelloweye rockfish DPS
After reviewing the current status of the listed species(threatened with declining abundance), the environmental baseline within the action area (degraded), the effects of the proposed action (minimal from sound, EMF, habitat alteration, derelict gear and blade strike), and cumulative effects (minimal), it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of the Puget Sound/Georgia Basin yelloweye rockfish DPS, or to destroy or adversely modify proposed critical habitat for Puget Sound/Georgia Basin yelloweye rockfish.

Puget Sound/Georgia Basin bocaccio DPS
After reviewing the current status of the listed species(threatened with declining abundance), the environmental baseline within the action area (degraded), the effects of the proposed action (minimal from sound, EMF, habitat alteration, derelict gear and blade strike), and cumulative effects (minimal), it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of the Puget Sound/Georgia Basin bocaccio DPS, or to destroy or adversely modify proposed critical habitat for Puget Sound/Georgia Basin bocaccio.

Puget Sound/Georgia Basin Rockfish Proposed Critical Habitat
FERC may ask NMFS to adopt the conference opinion as a biological opinion when critical habitat for PS/GB Rockfish is designated. The request must be in writing. If we review the proposed action and find there have been no significant changes to the action that would alter the contents of the opinion and no significant new information has been developed (including during the rulemaking process), we may adopt the conference opinion as the biological opinion on the proposed action and no further consultation will be necessary.

Southern Resident killer whale
After reviewing the current status of the listed species (endangered with declining abundance), the environmental baseline within the action area (degraded), the effects of the proposed action (minimal from EMF, habitat alteration and derelict gear and small from sound and blade strike), and

cumulative effects (minimal), it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of the Southern Resident killer whale, or to destroy or adversely modify designated critical habitat for Southern Resident killer whale.

Humpback whales
After reviewing the current status of the listed species (endangered with increasing abundance), the environmental baseline within the action area (degraded), the effects of the proposed action (minimal from EMF, habitat alteration, derelict gear and blade strike and small from sound), and cumulative effects (minimal), it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of the humpback whales. No critical habitat has been designated or proposed for this species; therefore, none will be affected.

2.8 Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by regulation to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. For this consultation, we interpret "harass" to mean an intentional or negligent action that has the potential to injure an animal or disrupt its normal behaviors to a point where such behaviors are abandoned or significantly altered.[51] Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this incidental take statement.

2.8.1 Amount or Extent of Take

2.8.1.1 Marine Mammals

NMFS is not including an incidental take authorization for Southern resident killer whales or humpback whales at this time because the incidental take of marine mammals has not been authorized under section 101(a)(5) of the Marine Mammal Protection Act and/or its 1994 Amendments. Following issuance of such regulations or authorizations for marine mammals, NMFS may amend this Opinion to include an incidental take statement for marine mammals.

[51] NMFS has not adopted a regulatory definition of harassment under the ESA. The World English Dictionary defines harass as "to trouble, torment, or confuse by continual persistent attacks, questions, etc." The U.S. Fish and Wildlife Service defines "harass" in its regulations as "an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering (50 CFR 17.3). The interpretation we adopt in this consultation is consistent with our understanding of the dictionary definition of harass and is consistent with the Service's interpretation of the term.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

2.8.1.2 Marine Fishes

The proposed action will affect ESA-listed adult and juvenile PS Chinook salmon, PS steelhead, HCSR chum salmon and larval, juvenile and adult PS/GB yelloweye rockfish, canary rockfish, and bocaccio as analyzed in the opinion. The action area is potential foraging and migration habitat for all these marine fishes. Potential causes of incidental take are the following:

- Exposure to blade strike from operation of two OpenHydro turbines is likely to injure or kill some individual fish, as NMFS estimated in the opinion, that pass through the turbines each year over the 5-year deployment period.
- Exposure to sound pressure from operation of the turbines may result in behavioral avoidance of the action area.
- Alteration of benthic habitat may result changes in seafloor habitat or the biologic community in the near-turbine area which may have an effect on forage opportunities.
- Exposure to EMF along the cable route from the production and transmission of power could result in behavioral avoidance of the area.

Therefore, incidental take of these species in the form of harm and harassment is likely to occur. The very small amount of take likely to be caused by sound pressure, benthic habitat alteration, and EMF from the operation of the two tidal turbines cannot be accurately quantified as a number of fish because there is no practical way to predict the distribution and abundance of listed fishes, with the exception of larval rockfish, in the action area.

Blade Strike

The best available indicator for the number of fish that would be injured or killed by blade strike is the number of fish that pass through the turbine rotors. The number of fish passing through the turbines will be monitored using near-turbine equipment, specifically the high-definition cameras[52]. The number of fish crossing the plane of the turbines when the blades are spinning is a conservative indicator for the likely to be struck by the blades when they are spinning (blade strike). This number is an overestimate and therefore protective of the species because some individuals may cross the plane of the turbines through the open center and thus would not be exposed to blade strike. Further, mortality rates will be less than 100% for any group of fish that pass through the turbine blades; current research indicates that the survival rates for fish passing through hydrokinetic turbine blades are about 98-100% (as detailed in section 2.4.5).

Snohomish PUD will carry out near field monitoring as detailed in the proposed action, which includes the use of underwater cameras that will capture imagery of marine species in the near field of the turbines. This approach will allow for monitoring the number of fish that pass through the plane of the turbines. The cameras are capable of capturing images with sufficient resolution to allow for species level identification and enumeration of adult salmonids and rockfishes, crossing the plane of the turbine within about 5 meters of the camera. The ability to identify fish to the species level

[52] Two cameras locations are included in the monitoring package, one on each turbine. Their placement will capture images of fish travelling into one turbine from the upstream side and other fish exiting the other turbine on the downstream side. The camera on one turbine will be watching the behavior of fish on the “upstream” side of the rotor during one half of the tidal cycle and on the “downstream” side when the tide turns.

beyond 5 meters will vary seasonally with water and environmental conditions. The cameras could capture evidence of injury or mortality as a result of direct contact with the turbine blades but if signs of injury may not be readily apparent.

Given that low numbers of individuals from each of the PS Chinook, HCSR chum, PS steelhead, and adult PS/GB yelloweye rockfish, PS/GB canary rockfish, and PS/GB Bocaccio ESUs/DPSs are likely to be exposed to the risk of blade strike as analyzed in the opinion (section 2.4.5), and that this adverse effect does not jeopardize the continued existence of the species or contribute to the destruction or adverse modification of any designated critical habitat, NMFS authorizes incidental take for blade strike, using the number of fish likely to pass through the plane of the turbine rotors while the blades are spinning as the measure, on an annual basis as follows:

- A combined total of up to 10 adult salmon from the PS Chinook ESU, HCSR chum salmon ESU, or PS steelhead DPS
- 1 adult PS/GB yelloweye rockfish
- 1 adult PS/GB canary rockfish
- 1 adult PS/GB Bocaccio

In Section 2.4.5, NMFS conservatively assumed that the project will injure or kill small numbers of juvenile or larval rockfish each year (0-35 PS/GB Canary rockfish larvae, 0-24 PS/GB yelloweye rockfish larvae and 0-1 PS/GB bocaccio larvae). However, their small size (less than 10-15 cm) will limit the ability to identify and count the numbers of larval and juvenile rockfish passing through the turbines using the imaging system described above for adult fishes. NMFS therefore uses a surrogate for take that is more practical to monitor: the amount of time the blades are spinning. This surrogate is used because the analysis of effects in the opinion is based on operation of the turbines up to 70 percent of the time during the 5-year deployment. If the actual amount of time the turbines blades spin is higher, the risk of injury or mortality from blade strike will increase. Therefore, if the blades are spinning more than 70% of the time during the 5-year deployment, the reinitiation provisions of this opinion will be triggered.

NMFS does not expect is not allocating any incidental take for juvenile salmonids as they are very unlikely to be exposed to the risk of blade strike as analyzed in section 2.4.5. NMFS does not expect that any juvenile salmonids will occur at the depth of the turbines.

Sound pressure

The best available indicator for the extent of incidental take associated with sound pressure is the broadband sound pressure levels produced by operation of the turbines. Broadband sound from the project (measured at a distance of 1m from the center of the turbine location) is not expected to exceed 172 dB re 1 upa. Sound levels from the project would be monitored as detailed in the Acoustic Monitoring and Mitigation Plan. Although formal guidance is not yet available, NMFS uses conservative exposure thresholds of sound pressure levels from impulse sounds that have been shown to cause behavioral disturbance (a negative effect) in marine fishes; 183 dB (SEL) re: 1 µPa for fishes weighing up to 2 g and 187 dB (SEL) re: 1 µPa for fishes weighing over 2g and a peak sound level of 206 dB (Peak) re: 1 µPa (FHWG 2008). If the monitoring results indicate that broadband sound from the operation of the turbines exceeds these levels, the reinitiation provision of this opinion would be triggered.

Seafloor habitat alteration

The installation of the two tidal turbines would alter habitat in the action area by creating structure and hard surfaces in the water column and on the bottom. These factors would alter hydraulics around the turbines, potentially changing the distribution of sediment grain sizes due to scour/erosion and/or deposition which could result in a change in prey availability and forage opportunities. These changes would occur over the 5-year deployment of the turbines.

The best available indicator for the extent of incidental take associated with loss of forage opportunities due to changes to benthic habitat is a change in seafloor grain size and distribution over an area 10 m (in any direction) from the turbine footprint. Changes in seafloor grain size would be caused by changes in currents and scouring that would be directly related to the presence of the turbines on the sea floor. This is because the flow along the bottom would no longer be smooth, but interrupted by the presence of the turbines and could cause eddies or slow the flow down. Changes in flow along the bottom would mean that different sized particles would be swept along with the current. The grain size distribution of these particles will be monitored using ROV equipment. Changes to the grain size distribution will indicate changes in other aspects of the benthic habitat because specific types of marine life are associated with specific bottom types and currents, making it a good indicator for potential changes in the forage opportunities for listed species. More specifically, NMFS defines the extent of take for benthic habitat modification by the change in substrate type (grain size distribution) from baseline conditions (cobble pavement; Snohomish PUD 2012b) to another state (e.g., from to dominated by pebbles or silt; Table 2) up to a distance of 10 meters from the turbine footprint (in any direction), as determined by ROV monitoring (section 1.3.4 and 2.4.3). Exceeding this threshold (i.e., a change in grain size distribution that extends beyond 10 meters from the turbine footprint) will trigger the reinitiation provisions of this opinion.

Table 2.Standard grain size classification scheme, the Wentworth scale (Wentworth 1922)

Median Diameter	Wentworth Grade	Phi (Φ) Scale
>256 mm	Boulder	−8
>64 mm	Cobble	−6
>4 mm	Pebble	−2
>2 mm	Granule	−1
>1 mm	Very coarse sand	0
> 500 μm	Coarse sand	1
>250 μm	Medium sand	2
>125 μm	Fine sand	3
>62.5 μm	Very fine sand	4
>31.3 μm	Coarse silt	5
>15.6 μm	Medium silt	6
>7.8 μm	Fine silt	7
>3.9 μm	Very fine silt	8
<3.9 μm	Clay	>8

EMF

Electromagnetic fields will be produced by the transmission of power through cables reaching from the turbine location to the onshore connection. “E” fields will be blocked by the cable shielding, but

a small “B” and smaller associated “iE” field will propagate up to 18 inches from the cable surface. The very low level and small propagation of EMF produced by the project (section 2.4.2) is correlated to the expected power transmission of 4 to 6 kV (section 1.3 and 2.4.2). Because individual fish are expect to avoid the area of EMF emitted from the cables, the best available indicator for the extent of incidental take associated with EMF is the level of power produced and transmitted from the turbines to the onshore control building through the seafloor cables. That is, an increase in power transmission would result in an increase in EMF along the. Snohomish PUD will assess the power levels generated by the turbines and transmitted through the cables. If results indicate that power transmitted from the turbines to the shore is more than 20% percent higher than the expected level of 6kV, then the reinitiation provisions of this opinion will be triggered.

2.8.2 Effect of the Take

In Section 2.7, NMFS determined that the level of anticipated take, coupled with other effects of the proposed action, is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

2.8.3 Reasonable and Prudent Measures

“Reasonable and prudent measures” are nondiscretionary measures to minimize the amount or extent of incidental take (50 CFR 402.02).

FERC will ensure that the licensee fully complies with the license. Specifically the licensee will address uncertainties surrounding the effects of the proposed action through the monitoring and mitigation plans and take action to minimize and mitigate for the effects of the proposed action by conducting appropriate and effective mitigation through an adaptive management.

The following reasonable and prudent measures will ensure that incidental take from the proposed action is minimized:

1. FERC will ensure that the licensee will monitor sound produced by the turbines to collect necessary data to evaluate 1) the broadband sound levels at the source (1 meter from the center of the turbine location) over the full range of flow conditions occurring during project operations; and 2) the distance from the center of the turbines where broadband sound levels from operating turbines exceed 120 dB re: 1 µPa, including an evaluation of levels out to distance of up to 3km from the center of the turbine location. The licensee will mitigate for adverse effects of sound according to the Acoustics Monitoring and Mitigation Plan.

2. FERC will ensure that the licensee will monitor and collect data necessary to evaluate the risk of blade strike from turbine operations by determining the number of individuals that pass through the turbine plane and reporting any observed injury or direct strike observed. The Licensee will mitigate for any effects of blade strike according to the Near-turbine Monitoring and Mitigation Plan.

3. FERC will ensure that the licensee will complete a monitoring and reporting program to confirm that the incidental take exemption for the proposed action is not exceeded, and that the terms and conditions in the ITS are effective in minimizing incidental take.

2.8.4 Terms and Conditions

The terms and conditions described below are non-discretionary, and the FERC and licensee must comply with them in order to implement the reasonable and prudent measures (50 CFR 402.14). The FERC or any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this ITS (50 CFR 402.14). If the following terms and conditions are not complied with, the protective coverage of section 7(o)(2) will likely lapse.

To implement the reasonable and prudent measures described above, the FERC will ensure that the licensee implements the following terms and conditions:

4. To implement RPM 1, the licensee monitors and measures sound levels at the turbine location to determine source levels. If sound from the turbine operation 1) exceeds 180 dB re: 1 µPa at any distance from the turbines; or 2) is propagated at a level of 120 dB re: 1 µPa at a distance beyond 750m when operating at the 95th percentile; the licensee will engage the turbine brake until modifications to turbine operations or configuration to reduce the sound below this level are complete. NMFS approval must be obtained prior to resuming operations.

5. To implement RPM 1, the licensee will provide the preliminary results of monitoring for sound source levels and propagation distances within 120 days.

6. To implement RPM 2, use methods to collect data on the number of individuals passing through the plane of the turbine that are sufficient to identify the number and species category (salmon, steelhead, rockfish) of the individual adults passing within 5 meters of the turbines at least 50 percent of the time during turbine operations.

7. To implement RPM 2, the licensee will provide the preliminary results of the monitoring within 14 days if individual salmon, steelhead or rockfishes are visibly injured or killed or are recorded crossing through the turbine blades and not through the open center of the rotor.

8. To implement RPM 2, and 3, the licensee will contact NMFS within 48 hours, (and before the limit is exceeded) if it is reasonably foreseeable that the number of individuals crossing the plane of the turbines will exceed the level authorized in this opinion.

9. To implement RPM 1, 2, and 3,the licensee will obtain documented approval from NMFS for all changes to the Adaptive Management Framework (Appendix A) and Monitoring and Mitigation plans (Appendices B-F) that affect ESA-listed species or NMFS authorities; and for approval of implementation of mitigation measures, based on adaptive management. The licensee will file all changes with FERC after approval by NMFS.

2.9 Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information (50 CFR 402.02).

In conjunction with the required removal of the turbines at the end of five years, Snohomish PUD will consult with NMFS and other interested agencies that would assist in determining the benefit or consequence of removal of the undersea trunk cables over the 2 km route. The PUD will also consult with NMFS on whether to remove the cable.

2.10 Reinitiation of Consultation

As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion, (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

2.11 "Not Likely to Adversely Affect" Determinations

2.11.1 Southern DPS North American green sturgeon

The Southern DPS North American green sturgeon spawn only in California's Sacramento River. Although individual adults and subadults have been documented in Puget Sound, they are uncommon, (Adams et al 2002, Lindley et al 2011). Puget Sound has a long history of commercial and recreational fishing and fishery-independent monitoring of species that use habitats similar to those of green sturgeon and have reported few green sturgeons. In addition, Puget Sound does not appear to be part of the coastal migratory corridor that Southern DPS fish use to reach wintering grounds north of Vancouver Island (Adams et al 2002), supporting the assumption that Southern DPS North American green sturgeon rarely occur in Puget Sound (NMFS 2009). Therefore, NMFS finds that southern DPS green sturgeon eulachon would not co-occur in space and time with the effects of the action, thus the effects are discountable.

2.11.2 Southern DPS Pacific eulachon

Historical information dating back to 1858 documents the presence of eualchon in Puget Sound although it is believed that the reports are largely of longfin or surf smelt, both of which occur through Puget Sound (Gustafson et al., 2010). A 2007 WDFW technical report entitled (Pentilla, 2007) presents detailed data on the biology, status, and trends of surf smelt and longfin smelt in Puget Sound states that "there is virtually no life history information within the Puget Sound Basin" available for eulachon. Similarly, detailed notes provided by WDFW and Oregon Department of Fish and Wildlife as part of the ESA status review (Gustafson et al 2010) provide no evidence of spawning stocks of eulachon in Puget Sound rivers. Therefore, NMFS finds that southern DPS eulachon would not co-occur in space and time with the effects of the action thus, the effects are discountable.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

3. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT CONSULTATION

The consultation requirement of section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. The MSA (section 3) defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Adverse effects occur when EFH quality or quantity is reduced by a direct or indirect physical, chemical, or biological alteration of the waters or substrate, or by the loss of (or injury to) benthic organisms, prey species and their habitat, or other ecosystem components. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH.

This analysis is based, in part, on the EFH assessment provided by the FERC and descriptions of EFH for Pacific coast groundfish (PFMC 2005), coastal pelagic species (PFMC 1998), and Pacific coast salmon (PFMC 1999) contained in the fishery management plans developed by the Pacific Fishery Management Council (PFMC) and approved by the Secretary of Commerce.

3.1 Essential Fish Habitat Affected by the Project

The project action area includes EFH for Pacific coast groundfish, coastal pelagic species and Pacific salmon. The action area also includes rocky reef habitat and areas of interest[53] (PFMC 2005), which have been designated as habitat areas of particular concern (HAPC) for groundfish. HAPCs are specific habitat areas, a subset of the much larger area identified as EFH, that play an important ecological role in the fish life cycle or that are especially sensitive, rare, or vulnerable.

3.2 Adverse Effects on Essential Fish Habitat

The opinion above provides an analysis of the potential adverse effects of the proposed action on ESA-listed species and their habitats. Because of the overlap in species and habitat conditions, the analysis for ESA-listed marine fishes is applicable to the analysis of effects for EFH. The ESA analysis identified the following effects:

1. **Food resources.** The presence of the turbines and transmission cables on the seafloor would alter benthic habitat and subsequently food resources within the action area over the 5-year deployment of the turbine. The exposure, response, and risks to forage fish species and groundfish are likely to be similar to those described for ESA-listed species and their habitats as analyzed in the opinion. Because these effects on the forage base would be restricted to an extremely small portion of the entrance to Admiralty Inlet and a narrow cable route along the northwest margin of Admiralty Bay, the potential for a decrease in quality or quantity of forage would be extremely small. Therefore, there will be no adverse effects to the prey component of EFH.

[53] Marine waters in the state of Washington have been identified as 'areas of interest' and are considered a HAPC for groundfish.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

2. **Safe Passage.** Safe passage for species with designated EFH would be minimally affected by anthropogenic noise generated by the project and the presence of the turbine structures and the transmission cable on the seafloor.

    a. The project would emit a small B and iE EMF from power transmission along the cable. However, E field produced by the cable is shielded. Modeling of potential B and iE EMFs from the cable predicts that any magnetic field it would produce would dissipate to background levels (at or below that of the earth's magnetic field) at a distance of 3.3 cm (Snohomish PUD 2012a). Further, the seafloor cable extends from the turbine location near Admiralty Head on the east side of the entrance to the inlet, along the northwest shoreline of Admiralty Bay and does not block passage into Admiralty Inlet. Therefore, the passage component of EFH would not be adversely affected by EMF or the cable.

    b. As detailed in section 2.4.1, there is uncertainty regarding the sound levels that will be produced by the operation of the turbines and the potential responses of marine fishes. Sound from the project, could cause either behavioral avoidance of the turbine location or attraction to the structures. In the worst-case scenario, the proposed action would cause avoidance of an extremely small portion of the entrance to Admiralty Inlet (about 0.05 percent of the cross-sectional area of the entrance). Therefore, NMFS expects that sound will cause an adverse effect on the safe passage component of EFH.

Based on information in the analysis of effects presented in the ESA portion of this document (section 2.4), and summarized here, the proposed action would not adversely affect EFH.

3.3 Essential Fish Habitat Conservation Recommendations

The environmental measures that Snohomish PUD would carry out under the proposed FERC license would minimize the effect of the project on EFH. Because there would be no adverse effect, NMFS does not have any conservation recommendations.

3.4 Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, FERC must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation. However, NMFS has not included any additional conservation recommendations therefore no response is required.

3.5 Supplemental Consultation

The FERC must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH conservation recommendations (50 CFR 600.920(l)).

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

The DQA specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the opinion addresses these DQA components, documents compliance with the DQA, and certifies that this opinion has undergone pre-dissemination review.

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion are the Federal Energy Regulatory Commission. Other interested users could include Snohomish Public Utility District, Sovereign Tribal governments, citizens and users of areas Admiralty Inlet, and those individuals or groups interested in the conservation of the affected ESUs and DPSs. Individual copies of this opinion were provided to FERC. This opinion will be posted on the NMFS West Coast Region web site (http://www.nwr.noaa.gov). The format and naming adheres to conventional standards for style.

4.2 Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

4.3 Objectivity

Information Product Category: Natural Resource Plan

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA regulations, 50 CFR 402.01, et seq., and the MSA implementing regulations regarding EFH, 50 CFR 600.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this opinion/EFH consultation contain more background on information sources and quality.

Referencing: All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.

Review Process: This consultation was drafted by NMFS staff with training in ESA and MSA implementation, and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

5. REFERENCES

Abernethy C.S., B.G. Amidan, G.F. Cada. 2003. Fish passage through a simulated horizontal bulb turbine pressure regime: A supplement to Laboratory studies of the effects of pressure and dissolved gas supersaturation on turbine-passed fish. U.S. Department of Energy. PNNL-13470-B.

Adams, P. B., C. B. Grimes, S. T. Lindley, and M. L. Moser. 2002. Status review for North American green sturgeon, Acipenser medirostris. NOAA, National Marine Fisheries Service, Southwest Fisheries Science Center, Santa Cruz, CA. 50 p.

Amaral S., N. Perkins, G. Hecker, D. Dixon, P. Jacobson. 2010. Development of theoretical models for estimating hydrokinetic turbine strike probability and survival. Symposium on Hydrokinetic Electricity Generation and Fish: Asking the Right Questions, Getting Useful Answers. Pittsburgh (PA): Annual Meeting of the American Fisheries Society.

Baird, R.W., M.B. Hanson, E.A. Ashe, M.R. Heithaus, and G.J. Marshall. 2003. Studies of foraging in "southern resident" killer whales during July 2002: dive depths, bursts in speed, and the use of a "Crittercam" system for examining subsurface behavior. National Marine Fisheries Service, National Marine Mammal Laboratory, Seattle, Washington. Cited in NMFS 2008c.

Baird, R.W., M.B. Hanson, and L.M. Dill. 2005. Factors influencing the diving behaviour of fish-eating killer whales: sex differences and diel and inter-annual variation in diving rates. Canadian Journal of Zoology 83:257-267. Cited in NMFS 2008c.

Baker C. S., L. Medrano-Gonzalez, J. Calambokidis, A. Perry, F. Pichler, H. Rosenbaum, J. M. Straley, J. Urban-Ramirez, M. Yamaguchi, and O. Von Ziegesar. 1998. Population structure of nuclear and mitochondrial DNA variation among humpback whales in the North Pacific. Molecular Ecology 7:695-707.

Barlow, J., J. Calambokidis, E. A. Falcone, C. S. Baker, A. M. Burdin, P. J. Clapham, J. K. B. Ford, C. M. Gabriele, R. LeDuc, D. K. Mattila, T. J. Quinn II, L. Rojas-Bracho, J. M. Straley, B. L. Taylor, J. Urbán R., P. Wade, D. Weller, B. H. Witteveen, and M. Yamaguchi. 2011. Humpback whale abundance in the North Pacific estimated by photographic capture-recapture with bias correction from simulation studies. Marine Mammal Science. 27:793-818.

Bassett, C. 2010. Underwater Ambient Noise at a Proposed Tidal Energy Site in Puget Sound. University of Washington.

Bassett, C.; J. Thomson, B. Polagye. 2010. Characteristics of Underwater Ambient Noise at a Proposed Tidal Energy Site in Puget Sound. Paper presented at the Oceans 2010, Seattle, WA.

Bassett, C.S., B. Polagye, M. Holt, and J.M. Thomson. 2012. A vessel noise budget for Admiralty Inlet, Puget Sound, Washington (USA). J Acoust Soc Am. 2012 Dec; 132(6):3706-19.

Bassett, C.S., J.M Thomson, and B. Polagye. 2013. Sediment-generated noise and bed stress in a tidal channel. Journal of geophysical research: oceans. VOL. 118, 1–17.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Battin, J., M.W. Wiley, M.H. Ruckelshaus, R.N. Palmer, E. Korb, K.K. Bartz, and H. Imaki. 2007. Projected impacts of climate change on salmon habitat restoration. Proceedings of the National Academy of Sciences, USA 104(16): 6720-6725.

Beeman, J., and A. G. Maule. 2006. Migration depths of juvenile Chinook salmon and steelhead relative to total dissolved gas supersaturation in a Columbia River Reservoir. Transactions of the American Fisheries Society 135:584-594.

Berkeley, S.A., C. Chapman, and S.M. Sogard. 2004. Maternal age as a determinant of larval growth and survival in a marine fish, Sebastes melanops. Ecology 85: 1258-1264.

Bobko, S.J., and S.A. Berkeley. 2004. Maturity, ovarian cycle, fecundity, and age-specific parturition of black rockfish, (Sebastes melanops). Fishery Bulletin 102: 418-429.

Boehlert, G.W., W.H. Barss, and P.B. Lamberson. 1982. Fecundity of the widow rockfish, Sebastes entomelas, off the coast of Oregon. Fishery Bulletin 80: 881-884.

Bohnsack, J.A. and D.L. Sutherland. 1985. Artificial reef research: A review with recommendations for future priorities. Bulletin of Marine Science, 37(11): 11-39.

Bouffanais R., G.D. Weymouth, and D.K.P. Yue. 2011. Hydrodynamic object recognition using pressure sensing. Proceedings of the Royal Society (A) 467:19-38.

Brewer, S., J. Watson, D. Christensen, and R. Brocksmith. 2005. Hood Canal & eastern Strait of Juan de Fuca summer chum salmon recovery plan. Hood Canal Coordinating Council.

Buckley, R. M. and G.J. Hueckel. 1985. Biological Processes and Ecological Development on an Artificial Reef in Puget Sound, Washington. Bulletin of Marine Science, Volume 37, Number 1, July 1985, pp. 50-69(20).

Busby, P. J., T. C. Wainwright, G. J. Bryant, L. Leirheimer, R. S. Waples, F. W. Waknitz, and I.V. Lagomarsino. 1996. Status review of West Coast steelhead from Washington, Idaho, Oregon, and California. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS-NWFSC-27.

Cada, G.; J. Ahlgrimm, M. Bahleda, T. Bigford, S. Stavrakas, D. Hall, R. Moursund, and M. Sale. (2007). Potential Impacts Of Hydrokinetic And Wave Energy Conversion Technologies On Aquatic Environments. Fisheries, 32(4), 174-181.

Calambokidis, J. E.A. Falcone, T.J. Quinn, A.M. Burdin, P.J. Clapham, J.K.B. Ford, C.M.Gabriele, R. LeDuc, D. Mattila, L. Rojas-Bracho, J.M. Straley, B.L. Taylor, J. Urbán R., D. Weller, B.H. Witteveen, M. Yamaguchi, A. Bendlin, D. Camacho, K. Flynn, A. Havron, J. Huggins, and N. Maloney. 2008. SPLASH: Structure of Populations, Levels of Abundance and Status of Humpback Whales in the North Pacific. Final report for Contract AB133F- 03-RP- 00078 U.S. Dept of Commerce Western Administrative Center, Seattle, Washington.

Calambokidis, J., E. Falcone, A. Douglas, L. Schlender, and J. Huggins. 2009. Photographic identification of humpback and blue whales off the U.S. West Coast: results and updated abundance estimates from 2008 field season. Final Report for Contract AB133F08SE2786 from Southwest Fisheries Science Center. 18pp.

Carlson, T., J. Elster, M. Jones, B. Watson, A. Copping, M. Watkins, R. Jepsen, and K. Metzinger. 2012. Assessment of Strike of Adult Killer Whales by an OpenHydro Tidal Turbine Blade, Pacific Northwest National Laboratory technical report, PNNL-21177 (prepared for U.S. Department of Energy), February, 2012.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Carretta, J.V.; E. Oleson, D.W. Weller, A.R. Lang, K.A. Forney, J. Baker, B. Hanson, K. Martien, M. M. Muto, M.S. Lowry, J. Barlow, D. Lynch, L. Carswell, R.L. Brownell Jr., D.K. Mattila, and M.C. Hill. 2013. U.S. Pacific Marine Mammal Stock Assessments: 2012. NMFS/NOAA Technical Memorandum. NOAA-TM-NMFS-SWFSC-504.

Center for Whale Research. 2013. Southern Resident Killer Whale Research - September 2013 population census summary. November 5, 2013.

Chamberlin, J. T. Goodsell, and P. Lingwood. 2004. Systematics and distribution of pelagic larval rockfish (Sebastes maliger and Sebastes caurinus) in the San Juan Archipelago. Friday Harbor Laboratories Research Report.

Cope, B. and M. Roberts. 2013. Review and Synthesis of Available Information to Estimate Human Impacts to Dissolved Oxygen in Hood Canal. Washington Department of Ecology study 11-045.

Coutant C.C. and R.R. Whitney. 2000. Fish behavior in relation to passage through hydropower turbines: A review. Trans. Am. Fish. Soc. 129:351-380.

Crawford, B. 1979. The origin and history of the trout brood stocks of the Washington Department of Game. Fishery Research Report. Washington State Game Department, Olympia.

Department of Energy. 2009. Report to Congress on the Potential Environmental Effects of Marine and Hydrokinetic Energy Technologies. December 2009.

Drake J.S., E.A. Berntson, J.M. Cope, R.G. Gustafson, E.E. Holmes, P.S. Levin, N. Tolimieri, R.S. Waples, S.M. Sogard, and G.D. Williams. 2010. NOAA Technical Memorandum NMFS-NWFSC-108. Status of five species of rockfish in Puget Sound, Washington: Bocaccio (Sebastes paucispinis), Canary Rockfish (Sebastes pinniger), Yelloweye Rockfish (Sebastes ruberrimus), Greenstriped Rockfish (Sebastes elongatus) and Redstripe Rockfish (Sebastes proriger). U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-108, 234 p.

Emmett, R., R. Brodeur, and P. Orton. 2004. The vertical distribution of juvenile salmon (Oncorhynchus spp.) and associated fishes in the Columbia River plume.

Electric Power Research Institute (EPRI). 2011. Evaluation of fish injury and mortality associated with hydrokinetic turbines. EPRI Technical Report 1024569, Palo Alto, CA.

FERC. 2010. Transcript of the Admiralty Inlet Tidal Pilot Project P-12690-003 scoping meeting and technical conference held April 12, 2010.

FERC. 2012. Request for Formal Consultation as Required by Section 7 of the Endangered Species Act and the Magnuson-Stevens Fishery Conservation and Management Act. Letter from J. Hill (FERC) to K. Kirkendall (NMFS) dated April 23, 2012.

FERC. 2013. Final Environmental Assessment for Hydropower License. Admiralty Inlet Pilot Tidal Project—FERC Project No. 12690-005 (DOE/EA-1949).

FHWG (Fisheries Hydroacoustic Working Group). 2008. Agreement in principle for interim criteria for injury to fish from pile driving activities. Memorandum of agreement between NOAA Fisheries Northwest and Southwest Regions, USFWS Regions 1 and 8, California/Washington/Oregon Departments of Transportation, California Department of Fish and Game, and U.S. Federal Highway Administration. June 12, 2008.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Fisher, R., S.M. Sogard, and S.A. Berkeley. 2007. Trade-offs between size and energy reserves reflect alternative strategies for optimizing larval survival potential in rockfish. Marine Ecology Progress Series 344: 257-270.

Ford, J.K.B. 1989. Acoustic behavior of resident killer whales (Orcinus orca) off Vancouver Island, British Columbia. Canadian Journal of Zoology 67:727-745.

Ford, M.J. (ed.). 2011. Status review update for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-113, 281 p.

Ford, J.K.B., G.M. Ellis, and K.C. Balcomb. 2000. Killer whales: The natural history and genealogy of Orcinus orca in British Columbia and Washington State. Second edition UBC Press, Vancouver, British Columbia.

Ford, M.J., M.B. Hanson, J.A. Hempelmann, K.L. Ayres, C.K. Emmons, G.S. Schorr, R.W. Baird, K.C. Balcomb, S.K. Wasser, K.M. Parsons, and K. Balcomb-Bartok. 2011. Inferred paternity and male reproductive success in a killer whale (Orcinus orca) population. Journal of Heredity. 102(5):537-553.

Gill, A.B., I. Gloyne-Phillips, K.J. Neal, and J.A. Kimber. 2005. The potential effects of electromagnetic fields generated by sub-sea power cables associated with offshore wind farm developments on electrically and magnetically sensitive marine organisms - a review. Institute of Water & Environment, Cranfield University, Silsoe, and Centre for Marine and Coastal Studies, Ltd. Cammell Lairds Waterfront Park, Campbeltown Road, Birkenhead, Merseyside for COWRIE.

Good, T.P., R.S. Waples, and P. Adams (editors). 2005. Updated status of federally listed ESUs of West Coast salmon and steelhead. U.S. Dept. Commer., NOAA Tech. Memo., NMFS-NWFSC-66, 598 p.

Good, T.P., J.A. June, M.A. Etnier, and G. Broadhurst. 2009. Derelict fishing nets in Puget Sound and the Northwest Straits: Patterns and threats to marine fauna. Marine Pollution Bulletin 60 (2010) 39–50.

Gorlov A. 2010. Helical turbine and fish safety.

Greene C. and A. Godersky. 2012. Larval Rockfish in Puget Sound surface waters. Northwest Fisheries Science Center December 27, 2012.

Groot, C. and L. Margolis. 1991. Pacific Salmon Life Histories. University of British Columbia Press, Vancouver, British Columbia.

Gustafson, R.G., M.J. Ford, D. Teel, and J.S. Drake. 2010. Status review of eulachon (Thaleichthys pacificus) in Washington, Oregon, and California. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-105, 360 p.

Hard, J.J., J.M. Myers, M.J. Ford, R.G. Kope, G.R. Pess, R.S. Waples, G.A. Winans, B.A. Berejikian, F.W. Waknitz, P.B. Adams, P.A. Bisson, D.E. Campton, and R. Reisenbichler. 2007. Status review of Puget Sound steelhead (Oncorhynchus mykiss. U.S. Dept. Commer., NOAA Tech. Memo., NMFS-NWFSC-81, 117 p.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Hastings, M.C. and A.N. Popper. 2005. Effects of Sound on Fish. (Subconsultants) Submitted by Jones & Stokes to California Dept. of Transportation Contract No. 43A0139. Task Order 1.

Higgs, D. A., J. S. MacDonald, C. D. Levings, and B. S. Dosanjih. 1995. Nutrition and feeding habits in relation to life history stage. Pages 159–315 in C. Groot, L. Margolis, and W. C. Clarke, editors. Physiological ecology of Pacific salmon. University of British Columbia Press, Vancouver.

Holt, M.M. 2008. Sound exposure and Southern Resident killer whales (Orcinus orca): A review of current knowledge and data gaps. NOAA Technical Memorandum NMFS-NWFSC- 89, U.S. Department of Commerce, Seattle, Washington.

Hueckel, G. and R. Buckley. 1987.The influence of prey communities on fish species assemblages on artificial reefs in Puget Sound, Washington Environmental Biology of Fishes Volume 19, Issue 3, pp 195-214.

Hueckel, G.J., R.M. Buckley and B.L. Benson. 1989. Mitigating rocky habitat loss using artificial reefs. Bulletin of Marin Science 44(2): 913-922, 1989.

ISAB (Independent Scientific Advisory Board). 2007. Climate change impacts on Columbia River basin fish and wildlife. Northwest Power and Conservation Council, Portland, Oregon.

Krahn, M.M., M.J. Ford, W.F. Perrin, P.R. Wade, R.B. Angliss, M.B. Hanson, B.L. Taylor, G.M. Ylitalo, M.E. Dahlheim, J.E. Stein, and R.S. Waples. 2004. 2004 status review of Southern Resident killer whales (Orincus orca) under the Endangered Species Act, U.S. Dept. of Commerce, NOAA Tech. Memo., NMFS-NWFSC-62, 73p.

Landahl, J., L. Johnson, J. Stein, T. Collier, U Varanasi. 1997. Approaches for Determining Effects of Pollution on Fish Populations of Puget Sound. Transactions of the American Fisheries Society Vol. 126, Iss. 3, 1997.

Liao J.C. 2007. A review of fish swimming mechanics and behaviour in altered flows. Philosophical Transactions of the Royal Society (B) 362:1973-1993.

Lindley, S.T., D.L. Erickson, M.L. Moser, G. Williams, O.P. Langness, B.W. McCovey, M. Belchik, D. Vogel, W. Pinnix, J.T. Kelly, J.C. Heublein, and A.P. Klimley. 2011. Electronic tagging of green sturgeon reveals population structure and movement among estuaries. Transactions of the American Fisheries Society 140:108-122.

Love, M.S., M.M. Yoklavich, and L. Thorsteinson. 2002. The rockfishes of the Northeast Pacific. University of California Press, Berkeley, California. Cited in 74 FR 18516.

Mantua, N., I. Tohver, and A.F. Hamlet. 2009. Impacts of climate change on key aspects of freshwater salmon habitat in Washington State. In: Washington Climate Change Impacts Assessment: Evaluating Washington's future in a changing climate. Climate Impacts Group, University of Washington, Seattle, Washington.

Matthews, K.R. 1990. An experimental study of the habitat preferences and movement patterns of copper, quillback, and brown rockfishes (Sebastes spp.). Environmental Biology of Fishes 29: 161-178. Cited in NMFS letter to the District dated July 23, 2009.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

McElhany, P., M.H. Ruckelshaus, M.J. Ford, T.C. Wainwright, and E.P. Bjorkstedt. 2000. Viable salmonid populations and the recovery of evolutionarily significant units. U.S. Dept. of Commerce, NOAA Tech. Memo., NMFS-NWFSC-42, 156p.

Melnychuk MC, Welch DW, Walters CJ, Christensen V (2007) Riverine and early ocean migration and mortality patterns of juvenile steelhead trout (Oncorhynchus mykiss) from the Cheakamus River, British Columbia. Hydrobiologia 582: 55–65.

Melnychuk MC, Welch DW, Walters CJ (2010) Spatio-Temporal Migration Patterns of Pacific Salmon Smolts in Rivers and Coastal Marine Waters. PLoS ONE 5(9): e12916. doi:10.1371/journal.pone.0012916.

Michel, J., H. Dunagan, C. Boring, E. Healy, W. Evans, J. Dean, A. McGillis and J. Hain. 2007. Worldwide Synthesis and Analysis of Existing Information Regarding Environmental Effects of Alternative Energy Uses on the Outer Continental Shelf. OCS Report MMS 2007-038. Minerals Management Service, U.S. Department of the Interior, Washington, DC.

Miller, D.J. and J.J. Geibel. 1973. Summary of blue rockfish and lingcod life histories; a reef ecology study; and giant kelp, Macrocystis pyrifera, experiments in Monterey Bay, California. Fish Bulletin: 137.

Minerals Management Service (MMS). 2007. Draft Programmatic EIS for alternative energy development and production and alternative use of facilities on the Outer Continental Shelf. U.S. Department of the Interior. March 2007.

Moore ME, Berejikian BA, Tezak EP. 2010a. Early marine survival and behavior of steelhead smolts through Hood Canal and the Strait of Juan de Fuca. T Am Fish Soc 139: 49–61.

Moore ME, Goetz FA, Van Doornik DM, Tezak EP, Quinn TP, et al. . 2010b. Early marine migration patterns of wild coastal cutthroat trout (Oncorhynchus clarki clarki), steelhead trout (Onchorhynchus mykiss), and their hybrids. PLoS ONE 5: e12881. doi: 10.1371/journal.pone.0012881.

Mote, P.W. and E.P. Salathé. 2009. Future climate in the Pacific Northwest. In: Washington Climate Change Impacts Assessment: Evaluating Washington's future in a changing climate. Climate Impacts Group, University of Washington, Seattle, Washington.

Myers, J.M., R.G. Kope, G.J. Bryant, D. Teel, L.J. Lierheimer, T.C. Wainwright, W.S. Grand, F.W. Waknitz, K. Neely, S.T. Lindley, and R.S. Waples. 1998. Status Review of Chinook Salmon from Washington, Idaho, Oregon, and California. U.S. Department of Commerce, National Marine Fisheries Service, Northwest Fisheries Science Center, NOAA Technical Memo. NMFS-NWFSC-35, Seattle, Washington (February 1998). 443 p.

Nichol, D.G., and E.K. Pikitch. 1994. Reproduction of dark blotched rockfish off the Oregon coast. Transactions of the American Fisheries Society 123: 469-481.

NMFS. 1970. Title 50—Wildlife and Fisheries, Chapter I—Bureau of Sport Fisheries and Wildlife, Fish and Wildlife Service, Department of the Interior, Part 17—Conservation of endangered species and other fish and wildlife; list of endangered foreign fish and wildlife. Federal Register 35:233(2 December 1970):18319-18322.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

NMFS. 1991. Recovery Plan for the Humpback Whale (Megaptera novaeanglia). Prepared by the Humpback Whale Recovery Team for the National Marine Fisheries Service, Silver Spring, MD. 105 pgs.

NMFS. 1999. Endangered and Threatened Species; threatened status for three Chinook salmon Evolutionarily Significant Units (ESUs) in Washington and Oregon, and endangered status for one Chinook Salmon ESU in Washington. Final rule. Federal Register 64:14308-14328.

NMFS. 2003. Endangered and threatened species: regulations governing the taking and importing of marine mammals; Eastern North Pacific Southern Resident Killer Whales. Final rule. Federal Register 68:103 (29 May 2003): 31980-31983.

NMFS. 2005a. Memorandum from William T. Hogarth to Regional Administrators, Office of Protected Resources, NMFS (Application of the "Destruction or Adverse Modification" Standard Under Section 7(a)(2) of the Endangered Species Act) November 7, 2005.

NMFS. 2005b. Endangered and threatened wildlife and plants: endangered status for Southern Resident killer whales. Final rule. Federal Register 70:222(18 November 2005):69903-69912.

NMFS. 2005c. Endangered and threatened species; designation of critical habitat for 12 evolutionarily significant units of West Coast salmon and steelhead in Washington, Oregon, and California. Final rule. Federal Register 70:170(2 September 2005):52630-52858.

NMFS. 2005d. Endangered Fish and Wildlife; Notice of intent to prepare an environmental impact statement. 70:7 (11 January 2005):1871-1975.

NMFS. 2006a. Final supplement to the Shared Strategy's Puget Sound Salmon Recovery Plan. National Marine Fisheries Service, Northwest Region. November 15. 43 pp.

NMFS. 2006b. Endangered and threatened species: final listing determinations for 10 distinct population segments of West Coast steelhead. Final rule. Federal Register 71:3(5 January 2006):834-862.

NMFS. 2006c. Endangered and threatened species; designation of critical habitat for Southern Resident killer whale. Final rule. Federal Register 71:229(29 November 2006): 69054-69070.

National Marine Fisheries Service (NMFS). 2008. Recovery Plan for Southern Resident Killer Whales (Orcinus orca). National Marine Fisheries Service, Northwest Region, Seattle, Washington.

NMFS. 2009. Endangered and threatened wildlife and plants: final rulemaking to designate critical habitat for the threatened Southern Distinct Population Segment of North American green sturgeon. Final rule. Federal Register 74:195(9 October 2009):52300-52351.

NMFS. 2010a. National Marine Fisheries Service Comments and Notice of lntervention for Snohomish Public Utility District No. 1 (PUD) Application for Preliminary Permit, Admiralty Inlet Tidal Energy Project (FERC No. 12690-004). Letter from K. Kirkendall (NMFS) to Secretary Bose (FERC). Dated April 6, 2010.

NMFS. 2010b. NMFS comments on the Snohomish PUD Draft License Application for FERC P-12690 Admiralty Inlet Tidal Pilot Porject. Letter from B. Thom (NMFS) to Secretary Bose (FERC) Dated February 26, 2010.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

NMFS. 2010c. Endangered and Threatened Wildlife and Plants: Threatened Status for the Puget Sound/Georgia Basin Distinct Population Segments of Yelloweye and Canary Rockfish and Endangered Status for the Puget Sound/Georgia Basin Distinct Population Segment of Bocaccio Rockfish. Federal Register 75:22276-22290.

NMFS. 2010d. Endangered Species Act Section 7 Formal Consultation for the Continued Use of Puget Sound Dredged Disposal Analysis Program Dredged Material Disposal Sites, Puget Sound, Washington (HUCs, 171100200306 Lower Dungeness River, 171100200403 Ennis/Tumwater Creek, 171100020204 Anacortes, 171100020104 Lower Whatcom Creek, 171100110202 Lower Snohomish River, 171100130399 Lower Green River, 171100140599 Lower Puyallup River, 171100190503 Anderson Island). NMFS Consultation Number: 2010/04249.

NMFS. 2011a. Endangered and Threatened Species; 5-Year Reviews for 17 Evolutionarily Significant Units and Distinct Population Segments of Pacific salmon and steelhead. Federal Register 76:76386.

NMFS. 2011b. Southern Resident Killer Whales (Orcinus orca) 5-year Status Review: Summary and Evaluation. National Marine Fisheries Service, Northwest Region, Seattle, Washington.

NMFS. 2012. Letter from K. Kirkendall to Secretary Bose (FERC) NMFS Terms and Conditions and 10 (j) recommendations for the Snohomish PUD FERC P-12690 Admiralty Inlet Tidal Pilot License.

NMFS. 2013a. Endangered and Threatened Species; Delisting of the Eastern Distinct Population Segment of Steller Sea Lion Under the Endangered Species Act; Amendment to Special Protection Measures for Endangered Marine Mammals; Final Rule November 4, 2013. FR78:66140-66199.

NMFS 2013b. Endangered and Threatened Species; Designation of Critical Habitat for Yelloweye Rockfish, Canary Rockfish and Bocaccio of the Puget Sound/ Georgia Basin. FR 78:47635-47669.

NMFS and NWFSC. 2012. Memorandum re:Guidance Document: Sound Propagation Modeling to Characterize Pile Driving Sounds Relevant to Marine Mammals. Dated January 31, 2012.

NOAA. 2012. Coast Pilot 7- Forty-fourth Edition. Office of Coast Survey, National Ocean Service, Silver Springs, MD.

NOAA Fisheries. 2005. Critical habitat analytical review teams for 12 evolutionarily significant units of west coast salmon and steelhead. Protected Resources Division, Portland, Oregon. August. 27 p.

Noren, Dawn P., 2011. Estimated field metabolic rates and prey requirements of resident killer whales. Publications, Agencies and Staff of the U.S. Department of Commerce.Paper 296.

Normandeau. 2009. An estimation of survival and injury of fish passed through the Hydro Green Energy hydrokinetic system, and a characterization of fish entrainment potential at the Mississippi Lock and Dam No. 2 hydroelectric project (FERC No. 4306), Hastings, MN, Final Report. Prepared for Hydro Green Energy, LLC. December 2009.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Normandeau Associates, Exponent Inc, T. Tricas and A. Gill. 2011. Effects of EMFs from undersea power cables on elasmobranchs and other marine species. Final Report prepared for U.S. Department of the Interior Bureau of Ocean Energy Management, Regulation and Enforcement Pacific OCS Region. OCS Study BOEMRE 2011-09.

Northwest Straits Foundation (NWSF). 2007. Derelict fishing gear priority ranking project. Mt. Vernon, WA: NWSF. 40 pp.

NWSF. 2013. Press release: Funding approved for continuation and expansion of derelict gear removal efforts in Puget Sound. Printed to file November 2013.

Ogden, J.C. 2005. Hydrokinetic and wave energy technologies and offshore marine resources. White paper delivered at the Hydrokinetic and wave energy technologies technical and environmental issues workshop. Held at Resolve, Washington, D.C. October 26 to 28, 2005.

Olesiuk, P.F., M.A. Bigg, and G.M. Ellis.1990. Life history and population dynamics of resident killer whales (Orcinus orca) in the coastal waters of British Columbia and Washington State. Report of the International Whaling Community (special issue).

Osborne, R. 1999. A historical ecology of Salish Sea resident killer whales (Orcinus orca) with implications for management. University of Victoria.

Osborne, R.W. 2008. Southern Resident Killer Whale Sighting Compilation 1990-2003. Final Report: AB133F-03-SE-1133 (Req. No. NFFP7000-3-00070).

Palsson, W.A., T.-S. Tsou, G.G. Barbman, R.M. Buckley, J.E. West, M.L. Mills, Y.W. Cheng, and R.E. Pacunski. 2009. The biology and assessment of rockfishes in Puget Sound. Washington Department of Fish and Wildlife, Olympia WA.

Pentilla, D. 2007. Marine forage fishes in Puget Sound. Puget Sound Nearshore Partnership Report No. 2007-03. Published by Seattle District, Army Corps of Engineers, Seattle, WA.

PFMC. 1998. Description and identification of essential fish habitat for the Coastal Pelagic Species Fishery Management Plan. Appendix D to Amendment 8 to the Coastal Pelagic Species Fishery Management Plan. Pacific Fishery Management Council, Portland, Oregon. December.

PFMC. 1999. Description and identification of essential fish habitat, adverse impacts and recommended conservation measures for salmon. Appendix A to Amendment 14 to the Pacific Coast Salmon Plan. Pacific Fishery Management Council, Portland, Oregon. March.

PFMC. 2005. Amendment 18 (bycatch mitigation program), Amendment 19 (essential fish habitat) to the Pacific Coast Groundfish Fishery Management Plan for the California, Oregon, and Washington groundfish fishery. Pacific Fishery Management Council, Portland, Oregon. November.

Pacific Fishery Management Council (PFMC). 2008. Pacific Coast groundfish fishery management plan for the California, Oregon, and Washington groundfish fishery as amended through Amendment 19. July 2008.

PNNL. 2013. Additional Analysis of Potential Strike of Southern Resident Killer Whales by Tidal Turbine Blade. Memorandum from Copping, A. to Battey, H. (USDOE). Dated July 8, 2013.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Polagye, B., C. Bassett, J. Wood, and S. Barr. 2012. Detection of tidal turbine noise: A pre-installation case study for Admiralty Inlet, Puget Sound, Washington (USA).

Polagye, B., B. Van Cleve, A. Copping, K. Kirkendall. 2011. Environmental effects of tidal energy development. Proceedings of a scientific workshop March 22-25, 2010. NOAA technical memorandum NMFS F/SPO-116.

Polagye, B., C. Bassett, J. Wood, and S. Barr. 2012. Detection of tidal turbine noise: A pre-installation case study for Admiralty Inlet, Puget Sound, Washington (USA).

Popper, A.N. and M.C. Hastings. 2009. The effects of anthropogenic sources of sound on fishes. Jour. Fish. Biol. 75, pp. 455-489.

PSWQAT (Puget Sound Water Quality Action Team). 2002. Puget Sound Update: Eighth Report of the Puget Sound Ambient Monitoring Program. Puget Sound Water Quality Action Team, Olympia, Washington.

Puget Sound Partnership. 2008. Puget Sound Action Agenda: Protecting and Restoring the Puget Sound Ecosystem by 2020. Updated May 27, 2009.

Puget Sound Partnership. 2006. Puget Sound Agenda: Protecting and Restoring the Puget Sound Ecosystem by 2020.

Quinn, T.P., E. Brannon. 1982. The use of celestial and magnetic cues by orienting sockeye salmon smolts. Journal of Comparative Physiology A: Neuroethology, Sensory, Neural, and Behavioral Physiology. Vol. 147, Number 4. Pp 547-552. December 1982.

Richardson, W.J., C.R. Greene, Jr., C.I. Malme, and D.H. Thomson. 1995. Marine Mammals and Noise. Academic Press, London.

Ruckelshaus, M.H., K.P. Currens, W.H. Graeber, R.R. Fuerstenberg, K. Rawson, N.J. Sands, and J.B. Scott. 2006. Independent populations of Chinook salmon in Puget Sound. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-78, 125p.

Ruggerone, G.T., T.P. Quinn, I. McGregor and T.D. Wilkinson. 1990. Horizontal and vertical movements of maturing steelhead trout, Oncorhynchus mykiss, in Dean and Fisher channels, British Columbia. Canadian Journal of Fisheries and Aquatic Sciences 47:1963-1969.

Scharf, F., J. Manderson and M. Fabrizi. 2006. The effects of seafloor habitat complexity on survival of juvenile fishes: Species-specific interactions with structural refuge. Journal of Experimental Marine Biology and Ecology 335 (2006) 167–176.

Scottish Executive. 2007. Scottish Marine Strategic Environmental Assessment. March 2007.

Sherman, R. L., Gilliam, D. S., and Spieler, R. E. 2002. Artificial reef design: void space, complexity, and attractants. – ICES Journal of Marine Science, 59: S196–S200.

Slater, M., A. Schultz, R. Jones, and C. Fisher. 2010. Electromagnetic Field Study. Prepared for Oregon Wave Energy Trust.

Slotte, A., K. Hansen, J. Dalen, and E. Ona. 2004. Acoustic mapping of pelagic fish distribution and abundance in relation to a seismic shooting area off the Norwegian west coast Fisheries Research 67 (2004) 143–150.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Snohomish PUD. 2011. Admiralty Inlet Pilot Tidal Project Project No. P-12690 Response to Additional Information Request. Letter from J. Kallstrom (PUD) to Secretary Bose (FERC) Date April 19, 2013.

Snohomish Public Utility Department (PUD). 2012a. Admiralty Inlet Pilot Tidal Project P-12690. Draft Biological Assessment. February 29, 2012 - revised April 16, 2012.

Snohomish Public Utility Department. 2012b. Admiralty Inlet Pilot Tidal Project P-12690. Final License Application.

Snohomish PUD. 2013a. Supplemental information regarding the proposed mechanism for ceasing turbine rotation for the Admirlaty Inlet Pilot Tidal Project P-12690. Letter from K. Moore (Snohomish PUD) to Secretary Bose (FERC).

Snohomish PUD. 2013b. Comments of the Public Utility District No. 1 of Snohomish County Washington on the Environmental Assessment for the Admiralty Inlet Tidal Project. February 14, 2013.

Sogard, S.M., S.A. Berkeley, and R. Fisher. 2008. Maternal effects in rockfishes Sebastes spp.:a comparison among species. Marine Ecology Progress Series 360: 227-236.

Southall Brandon L., A. Bowles, W. Ellison, J. Finneran, R. Gentry, C. Greene Jr., D. Kastak, D.Ketten, J. Miller, P. Nachtigall, J. Richardson, J. Thomas, and P. Tyack. 2007. Marine mammal noise exposure criteria: initial scientific recommendations.

SSPS. 2007. Puget Sound salmon recovery plan. Plan Adopted by NMFS on January 19, 2007.

Tolimieri, N., and P.S. Levin. 2005. The roles of fishing and climate in the population dynamics of bocaccio rockfish. Ecological Applications 15: 458-468.

Tollit, D.J., J.D. Wood, S. Veirs, S. Berta, and H. Garret. 2010a. Admiralty Inlet Pilot Project Marine Mammal Pre-installation Field Studies - Final Report June 15, 2010.

Tollit, D.J., E. Philpott, R. Joy, B. Polagye, and J. Thomson. 2010b. Admiralty Inlet Hydrophone Monitoring Study: 2009/2010 Deployments - Final Report June 15 2010. Prepared for Snohomish PUD June 18, 2010.

U.S. Department of Commerce and Department of Interior. 1997. Secretarial Order: American Indian Tribal Rights, Federal-Tribal Trust Responsibilities, and the Endangered Species Act (June 5, 1997).

Waldron, K.D. 1972. Fish larvae collected from the northeastern Pacific Ocean and Puget Sound during April and May 1967. NOAA Tech. Rep. NMFS SSRF-663. 16 p.

Walker, R.J., V.V. Sviridov, S. Urawa, and T. Azumaya. 2007. Spatio-temporal variation in vertical distributions of Pacific salmon in the ocean. N. Pac. Anadr. Fish Comm. Bull. 4: 193–201.

Ward, E.J., E.E. Holmes, K.C. Balcomb. 2009. Quantifying the effects of prey abundance on killer whale reproduction. Journal of Applied Ecology 46: 632-640.

Wardle, C.S., T.J. Carter, G.G. Urquhart, A.D.F. Johnstone, A.M. Ziolkowski, G. Hampson, D. Mackie. 2001. Effects of seismic air guns on marine fish. Continental Shelf Research 21 (2001) 1005–1027.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Washington, P. M., R. Gowan, and D. H. Ito. 1978. A biological report on eight species of rockfish (Sebastes spp.) from Puget Sound, Washington. Northwest and Alaska Fisheries Center Processed Report, National Marine Fisheries Service, Seattle.

WDFW. 2011. Final Environmental Impact Statement for the Puget Sound Rockfish Conservation Plan. WDFW, March, 2011. Olympia, WA.

WDFW (Washington Department of Fish and Wildlife) and PNPTT (Point No Point Treaty Tribes). 2000. Summer chum salmon conservation initiative: An implementation plan to recover summer chum in the Hood Canal and Strait of Juan de Fuca Region. Report for WDFW and Point No Point Treaty Tribes.

WDOE (Washington State Department of Ecology). 2007. Spill scene spill prevention, preparedness, and response program 2006 Annual Report Program. Volume 10, Number 1. February 2007. WDOE Publication: 07-08-002.

Weis, L.J. 2004. The effects of San Juan County, Washington, marine protected areas on larval rockfish production. A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science, University of Washington.

Welch, D.W., B.R. Ward, and S.D. Batten. 2004. Early ocean survival and marine movements of hatchery and wild steelhead trout (Oncorhynchus mykiss) determined by an acoustic array: Queen Charlotte Strait, British Columbia. Deep-Sea Research, Part II 51, pp 897-909.

Wentworth, C.K. 1922. A scale of grade and class terms for clastic sediments. The Journal of Geology 30(5): 377-392.

West, J.E., R,M, Buckley, and D.C. Doty. 1994. Ecology and Habitat Use of Juvenile Rockfishes (Sebastes spp.) Associated with Artificial Reefs in Puget Sound, Washington Bulletin of Marine Science, Volume 55, Numbers 2-3, September 1994, pp. 344-350(7).

Whale Museum. 2009. Review of historical information and site-specific synthesis. The Whale Museum, SMRU Ltd., Orca Network. October 2009.

Williams, R. and D. Noren. (2009) Swimming speed, respiration rate and estimated cost of transport in killer whales. Marine Mammal Science 25:327-350.

Yano, A., M. Ogura, A. Sato, Y. Shimizu, N. Baba, K. Nagasawa. 1997. Effect of modified magnetic field on the ocean migration of maturing chum salmon, Oncorhynchus keta. Marine Biology Vol. 129, No. 3. September 1997.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

6. APPENDICES

Appendix A Adaptive Management Framework
Appendix B Acoustic Monitoring and Mitigation Plan
Appendix C Marine Mammal Monitoring and Mitigation Plan,
Appendix D Near-Field Monitoring and Mitigation Plan
Appendix E Benthic Habitat Monitoring and Mitigation Plan
Appendix F Derelict Gear Monitoring and Mitigation Plan

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Appendix H

Adaptive Management Framework

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

ADMIRALTY INLET PILOT TIDAL PROJECT
FERC PROJECT NO. 12690

ADAPTIVE MANAGEMENT FRAMEWORK

(submitted with the Final Application for a New Pilot Project License)

Submitted by:
Public Utility District No. 1 of Snohomish County

February 29, 2012

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

TABLE OF CONTENTS

1.0 MARINE AQUATIC RESOURCE COMMITTEE 1

2.0 COMMITTEE MEMBERSHIP AND MEETING PARTICIPATION 1

3.0 MEETING PROVISIONS 2

4.0 COMMITTEE DELIBERATIONS 3

5.0 DISPUTE RESOLUTION PROCEDURES 3

5.1 Dispute Resolution Procedures 4

5.2 Remedies 5

6.0 NOTICE 5

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

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ADAPTIVE MANAGEMENT FRAMEWORK
for the Admiralty Inlet Pilot Tidal Project

1.0 MARINE AQUATIC RESOURCE COMMITTEE

The purpose of the Marine Aquatic Resource Committee ("MARC" or Committee) is to advise the District on aquatic resource issues related to construction, monitoring, and operation of the Admiralty Inlet Pilot Tidal Project (Federal Energy Regulatory Commission Project No. 12690). As a component of this purpose, the Committee will advise the District on implementation of the following monitoring plans: (1) the Marine Mammal Monitoring Plan; (2) the Near-Field Monitoring Plan; (3) the Derelict Gear Monitoring and Removal Plan; (4) the Benthic Habitat Plan; and (5) the Acoustic Monitoring Plan.

Key functions of the Committee are to:

1.1 Review the results of studies, including pre-installation and monitoring, (e.g., interim, quarterly, annual, or final reports), and determine whether results are properly characterized;

1.2 Use study results or other sources of new information to determine whether a change to project monitoring (e.g., study design, methods, or duration) is warranted or if existing monitoring approaches continue to be appropriate;

1.3 Evaluate, propose an alternative, and/or approve, any changes in plans made by the District in response to studies; and

1.4 In the event that effects are identified that require modification to project operation or monitoring, provide the District with recommended measures to avoid, minimize, or mitigate for the effects.

1.5 In the event that adverse effects are identified that require immediate response, provide the District with actions to address these effects.

2.0 COMMITTEE MEMBERSHIP AND MEETING PARTICIPATION

2.1 The Committee shall be comprised of the following entities: the District, National Marine Fisheries Service, U.S. Fish and Wildlife Service, Washington Department of Fish and Wildlife, Washington Department of Ecology, Washington Department of Natural Resources, the Tulalip Tribes, Suquamish Tribe, Swinomish Indian Tribal Community, and Sauk-Suiattle Tribe (hereafter referred to as "Members"). The Committee, by unanimous agreement, may grant any other entity membership status on the Committee.

2.2 Each Member should designate a primary representative to the Committee within 30 days after issuance of the Project License, and may change their representative at any time thereafter. Designation shall be by notice to the Members in accordance with section 6. Each Member may name alternate representatives to the Committee to act on the representatives' behalf. Failure to designate a representative shall not prevent the Committee from convening or conducting its

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

functions in accordance with the time schedules set forth in specific License Articles in the Project License.

2.3 Each Member should select a representative who has relevant training or experience with natural resource management. Parties may also send staff with particular expertise or experience in addition to a designated Member to attend and participate in meetings to advise the Member.

2.4 Committee participation by state or federal agencies does not affect their statutory responsibilities and authorities. Issues involving the exercise of agencies' specific authorities can be discussed, but decisions are not delegated to the Committee. Consensus advice from the Committee is not binding on any state or federal agency.

2.5 An entity may withdraw as a Member from the Committee at any time, for any reason, by providing prior written notice to the other Members. An entity that has withdrawn as a Member of the Committee may continue to be involved in Committee matters in an informal advisory capacity but will not have voting rights for purposes of Section 4.1 of the plan. Such withdrawal may be temporary, and the entity that has withdrawn may rejoin the Committee as a Member at any time by providing prior written notice to the other Members.

3.0 MEETING PROVISIONS

3.1 The District shall arrange, administer, and chair all meetings, unless otherwise agreed. The Committee shall establish protocols for Committee meetings such as agenda development, subcommittee involvement, and timely distribution of materials, location and scheduling.

3.2 Scheduling of meetings should be informed by milestone events contained within specific License Articles (e.g., following development of study reports summarizing monitoring results), and as the need arises based on new information and monitoring results. The Committee will meet quarterly for the term of the Project License or as needed to meet the consultation requirements of the License Articles.

3.3 The District shall make the Committee meeting schedule and meeting agenda available on its web site.

3.4 The District shall bear all costs associated with conducting meetings. Each Member shall bear its own cost of attendance. A Member's ongoing participation on the Committee is subject to that Member's budget and resource constraints.

3.5 Committee Members shall first use the dispute resolution process described in section 5 herein to resolve disputes arising from Committee deliberations (e.g., disputes over characterization of study or monitoring results or the need to alter Project monitoring or operation), prior to seeking remedies in any other forums.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

4.0 COMMITTEE DELIBERATIONS

4.1 The Committee shall seek to reach consensus. Consensus is achieved when all Committee Members cast a supportive or neutral vote, or have abstained from the decision. When any vote is taken at a meeting, the District will provide the results to and seek the vote of non-present members within three (3) working days. Members not present must inform the District of their vote within ten (10) working days after the meeting or they will be deemed to have abstained from the decision. Alternatively, a vote may be cast by proxy.

4.2 Agencies do not waive or relinquish in any respect any approval authority under the Federal Power Act or other applicable law through their participation in the Committee consensus process and any subsequent dispute resolution process.

4.3 The District shall implement any action where consensus by the Committee has been reached, subject to the requirements of the Project License (such as filing for Commission approval) and any necessary regulatory approval. In the absence of consensus, the District may proceed to file plans or make any required filings necessary to meet a License deadline. Unless otherwise noted, the District shall file with the Commission any plans or other required actions within seven (7) days of Committee approval or of an agency decision in case of dispute resolution. Where appropriate, prior to implementing a plan or other required action, the District shall obtain Commission and agency approval.

4.4 Unless otherwise noted in a specific License Article in the Project License, the District shall allow a minimum of thirty (30) days for Committee Member comments and recommendations, and subsequent document revision, before submitting the document to the Commission or the state or federal agencies for approval. When filing the document with the Commission, the District shall include documentation of consultation, copies of comments and recommendations, and specific descriptions of how comments and recommendations from Committee Members are accommodated by the District's plan. If the District does not adopt a recommendation, the filing shall include the District's reasons based on Project-specific information.

4.5 The District may seek review from the Committee participants individually on matters in which they have expertise prior to seeking consensus of the Committee.

5.0 DISPUTE RESOLUTION PROCEDURES

Committee Members shall first use the dispute resolution process described herein to resolve disputes arising from Committee deliberations or otherwise related to the Committee, prior to seeking other remedies, unless otherwise precluded by statute or regulation.

The Member initiating dispute resolution under this section 5 shall notify the Commission when ADR proceedings are initiated.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

The Members agree to devote such time and attention to dispute resolution as necessary and reasonable to attempt to resolve the dispute at the earliest time possible; and each Member will cooperate in good faith promptly to schedule, attend, and participate in dispute resolution. Each Member will promptly implement all final agreements reached, consistent with its applicable statutory and regulatory responsibilities.

5.1 Dispute Resolution Procedures

5.1.1 Dispute Initiation Notice

A Member initiating a dispute resolution procedure shall provide timely notice to the other Members, describing the matter(s) in dispute and any proposed relief or resolution. Each Member that wishes to participate in dispute resolution shall provide written Notice to the other Members within twenty (20) days of receiving the dispute initiation Notice.

5.1.2 Informal Meetings

The Members involved in attempting to resolve the dispute (the "Disputing Members") shall hold at least two (2) informal meetings to resolve the dispute, unless agreed otherwise, commencing within thirty (30) days after the dispute initiation Notice and concluding within sixty (60) days. If the Members are unable to resolve the dispute, at least one (1) meeting will be held at the management level to seek resolution. The 60-day period may be extended upon mutual agreement of the Disputing Members. If these meetings fail to resolve the dispute, the Disputing Members may, by unanimous consent, agree to mediation. The Member initiating the dispute shall be responsible for coordinating all meetings under this section and shall make good faith efforts to coordinate a meeting time and location satisfactory to all Disputing Members.

5.1.3 Mediation

The Disputing Members shall choose a mediator within thirty (30) days of the conclusion of the informal meetings. Mediation shall not occur if the Disputing Members cannot unanimously agree on the allocation of costs or choice of mediator. The mediation process shall be concluded not later than sixty (60) days after the mediator is selected. The above time periods may be shortened or lengthened upon mutual agreement of the Disputing Members.

5.1.4 Dispute Resolution Notice

The Member initiating the dispute shall provide Notice to all Members of the result of the ADR process.

5.1.5 Commission Filings After Dispute Resolution

If the District is required to make a Commission filing relating to an issue that was not successfully resolved through ADR, such filing will include the District's reasons, based on Project-specific information, for not adopting a Member's recommendation or for seeking the Commission's approval without obtaining agency approval. Any other Member may oppose or seek modification of the District's filing.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

5.1.6 Effect of ADR on Other Proceedings

The ADR process in this section 5 does not preclude any Member from timely filing and pursuing an action for administrative or judicial relief of any Commission order, compliance matter, or other regulatory action related to the Project License; provided that any such Member shall initiate ADR pursuant to this section 5 as soon as practicable thereafter or concurrently therewith.

5.2 Remedies

Following conclusion of dispute resolution, the Members may exercise any appropriate remedy, including filing comments with the Commission, and seeking a License amendment or other appropriate relief from the Commission.

6.0 NOTICE

Any Notice required to be given to other Committee Members shall be written. If practicable, Notice shall be provided by e-mail or facsimile to all Members. Notice shall also be sent to all Members by first-class mail or comparable method of distribution, and as applicable shall be filed with the Commission. Unless otherwise specified, a Notice, including Notice via e-mail or facsimile, shall be effective upon receipt, but if provided only by U.S. Mail, seven (7) days after the date on which it is mailed. When Notice is required in fewer than seven (7) days, Notice shall be provided by facsimile or e-mail and shall be effective when provided.

For the purpose of Notice, the list of authorized representatives of the Members as of the Effective Date is attached as Appendix 1. The Members shall provide Notice of any change in the authorized representatives designated in Appendix 1, and the District shall maintain the current distribution list of such representatives. The Members acknowledge their responsibility to keep the other Members informed of their current address, telephone, facsimile and e-mail information. Notice obligations under this section are in addition to any notice provisions required by applicable law.

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ADMIRALTY INLET PILOT TIDAL PROJECT
FERC PROJECT NO. 12690

ACOUSTIC MONITORING AND MITIGATION PLAN

Submitted by:
Public Utility District No. 1 of Snohomish County

~~November 16, 2012~~

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February 14, 2013

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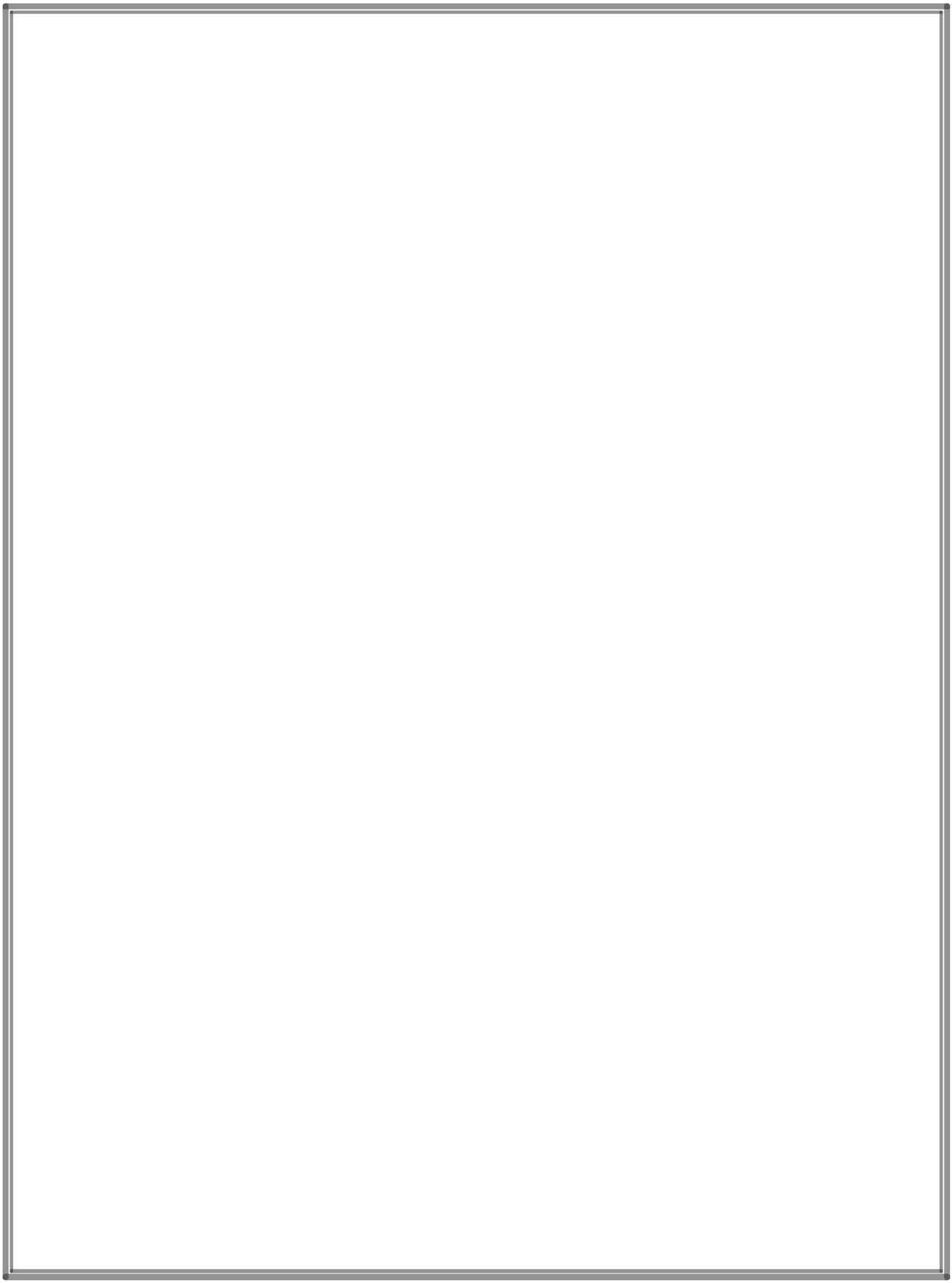

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

TABLE OF CONTENTS

1.0 INTRODUCTION 1

2.0 PROJECT DESCRIPTION 1

3.0 BACKGROUND INFORMATION 4

3.1 Overview 4

3.2 Present Knowledge of Ambient Noise in Admiralty Inlet 5

3.3 Pre-Installation Acoustic Effects Estimate 6

4.0 PLAN OBJECTIVES AND GOALS 9

5.0 POST-INSTALLATION MONITORING AND MITIGATION PLAN 9

5.1 Relation between Turbine Noise and Power Generation 9

5.1.1 Objective 9

5.1.2 Data Collection 9

5.1.3 Data Analysis ~~12~~11

5.1.4 Reporting and Adaptive Management 13

5.2 Long-term Variation in Turbine Noise 13

5.2.1 Objective 13

5.2.2 Data Collection 13

5.2.3 Data Analysis 14

5.2.4 Reporting and Adaptive Management 14

6.0 APPROACH TO ADAPTIVE MANAGEMENT AND MITIGATION ~~15~~**14**

7.0 REFERENCES **16**

Attachment 1 – ~~Accepted draft "A Vessel Noise Budget for Admiralty Inlet, Puget Sound, WA (USA)"~~**~~Attachment 2 – November 15, 2012, draft~~**Submitted version of "A framework for detection of tidal turbine sound: A pre-installation case study for Admiralty Inlet, Puget Sound, Washington (USA)"

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

LIST OF FIGURES

Figure 1 -- Conceptual instrumentation layout (fixed and recoverable). Instrumentation shown on a 4th Generation turbine (higher rotor solidity than 7th Generation turbine). The general dimensions of the subsea based and support structure are approximately ~~const ant~~constant between technology generations for the same rotor size. 2

Figure 2 -- Turbine deployment location in northern Admiralty Inlet. Blue triangles denote turbines, each of which is connected back to shore via a separate power cable. Dashed red polygon to the east of Keystone Harbor is a marine protected area. 3

Figure 3 -- One-third octave source levels from measurements of an OpenHydro turbine at EMEC, red line indicates the mean of the 8 measurements (acoustic harassment device removed by linear interpolation). (excerpted from Polagye et al., ~~*in prep*~~*submitted*) 4

Figure 4 -- Percentile TOLs for ambient noise (25 – 1000 Hz) (excerpted from Polagye et al., *in prep*) 5

Figure 5 -- Median TOLs for ambient noise as a function of velocity (1000 – 25 000 Hz) 6

Figure 6 -- Horizontal slices of broadband turbine sound field at different inflow velocity conditions, based on analysis from Polagye et al. (~~*in prep*~~*submitted*). The sound patterns associated with the pair of sources are only distinct at close range (i.e., within 100 m). 7

Figure 7 -- Probability distribution of turbine source levels. (left) Broadband (25 – 25 000 Hz). (right) One-third octave source levels for select percentiles. Turbine operation begins at the 27th percentile currents. (excerpted from Polagye et al., ~~*in prep*~~*submitted*) 8

Figure 8 -- ~~Percentage~~Fraction of one-third octave bands ~~detected~~likely to be identified relative to ambient noise (at least 75% probability, 25 – 25 000 Hz) at four inflow velocities (~~30~~5 m depth relative to surface). (excerpted from Polagye et al., ~~*in prep*~~*submitted*) 8

LIST OF TABLES

Table 1 -- Low-frequency hearing limits for functional groups established by NMFS (2012) 13

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

ACOUSTIC MONITORING AND MITIGATION PLAN
for the Admiralty Inlet Pilot Tidal Project

1.0 INTRODUCTION

The acoustic stressor from tidal turbine operation is not well-understood (Polagye et al., 2011). This uncertainty is a barrier to understanding acoustic effects of turbine noise on marine animals and, in doing so, to ensure proper resource protection.

This plan will investigate two hypotheses: (1) that the sound from tidal turbines will vary will power generation state and (2) that the sound from tidal turbines may change over time due to biofouling or component wear. Data to address these hypotheses will be collected by drifting hydrophones on the surface and cabled hydrophones on the turbine foundation, respectively. This information is essential to estimate the exposure of marine animals to turbine noise.

Through adaptive management, this information will provide for proper resource protection and suitability of marine mammal monitoring (Marine Mammal Monitoring and Mitigation Plan). Additional details regarding instrumentation on the turbines are presented in the Monitoring Plan Summary.

2.0 PROJECT DESCRIPTION

The demonstration project proposed by Snohomish County Public Utility District consists of two turbines manufactured by OpenHydro, an Irish turbine developer. Each of these turbines has a 6 m diameter outer shroud, as shown in Figure 1. These will be deployed on a gravity tri-frame, with tubular cans contacting the seabed at the vertices. Turbine hub height will be 10 m above the seabed. The OpenHydro turbines are fixed-pitch, high-solidity rotors with an open center. The rotor cassette is the single moving part and is supported by water-lubricated bearings. A permanent magnet generator is contained in the shroud surrounding the blades. Anti-fouling coatings are applied to the interior surface of the shroud, hub, and rotor blades, but the gravity frame (steel, ballasted by concrete and aggregate) is left bare. The turbine shown in Figure 1 represents the 6 m version of 4th Generation technology. The turbines deployed in Puget Sound will be 6 m variants of 7th Generation technology – the principle differences being fewer blades and more streamlined central hub.

The turbines will be deployed in northern Admiralty Inlet, Puget Sound, Washington. Admiralty Inlet is a constricted sill separating the deep Main Basin of Puget Sound from the Straits of Juan de Fuca and Straits of Georgia. At the narrowest point, between Admiralty Head and Point Wilson, the channel is approximately 5 km wide and 70 m deep. Excepting a small exchange through Deception Pass, the entire tidal prism of Puget Sound passes through this constriction, giving rise to tidal currents that routinely exceed 3 m/s (6 knots) at mid-water. The project site is approximately 1 km SE of Admiralty Head in 55 m of water (Figure 2). The project location was chosen on the basis of strong tidal currents (intensified by the proximity to the headland), negligible seabed slope (necessary to deploy the gravity foundation), separation from high vessel traffic areas (federal navigation lanes, ferry route), and ease of cable routing back to shore.

Each turbine will be connected to shore by a separate power cable. These cables will also provide power for monitoring instrumentation and fiber optic communication with the turbine and monitoring instrumentation. Turbine monitoring systems are grouped into two categories –

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

instruments that will be deployed for the duration of the demonstration project (fixed) and instruments that will be periodically recovered for maintenance (recoverable). This will be enabled by an Adaptable Monitoring Package (AMP) consisting of a self-aligning frame with instrumentation and a wet-mate power and fiber connector.

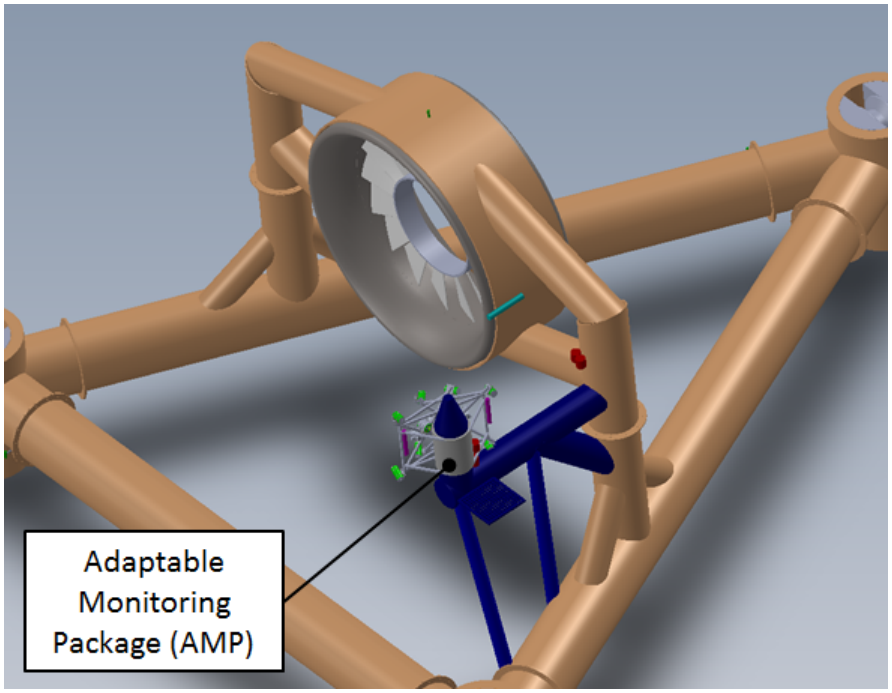

Figure 1 -- Conceptual instrumentation layout (fixed and recoverable). Instrumentation shown on a 4th Generation turbine (higher rotor solidity than 7th Generation turbine). The general dimensions of the subsea based and support structure are approximately ~~const ant~~constant between technology generations for the same rotor size.

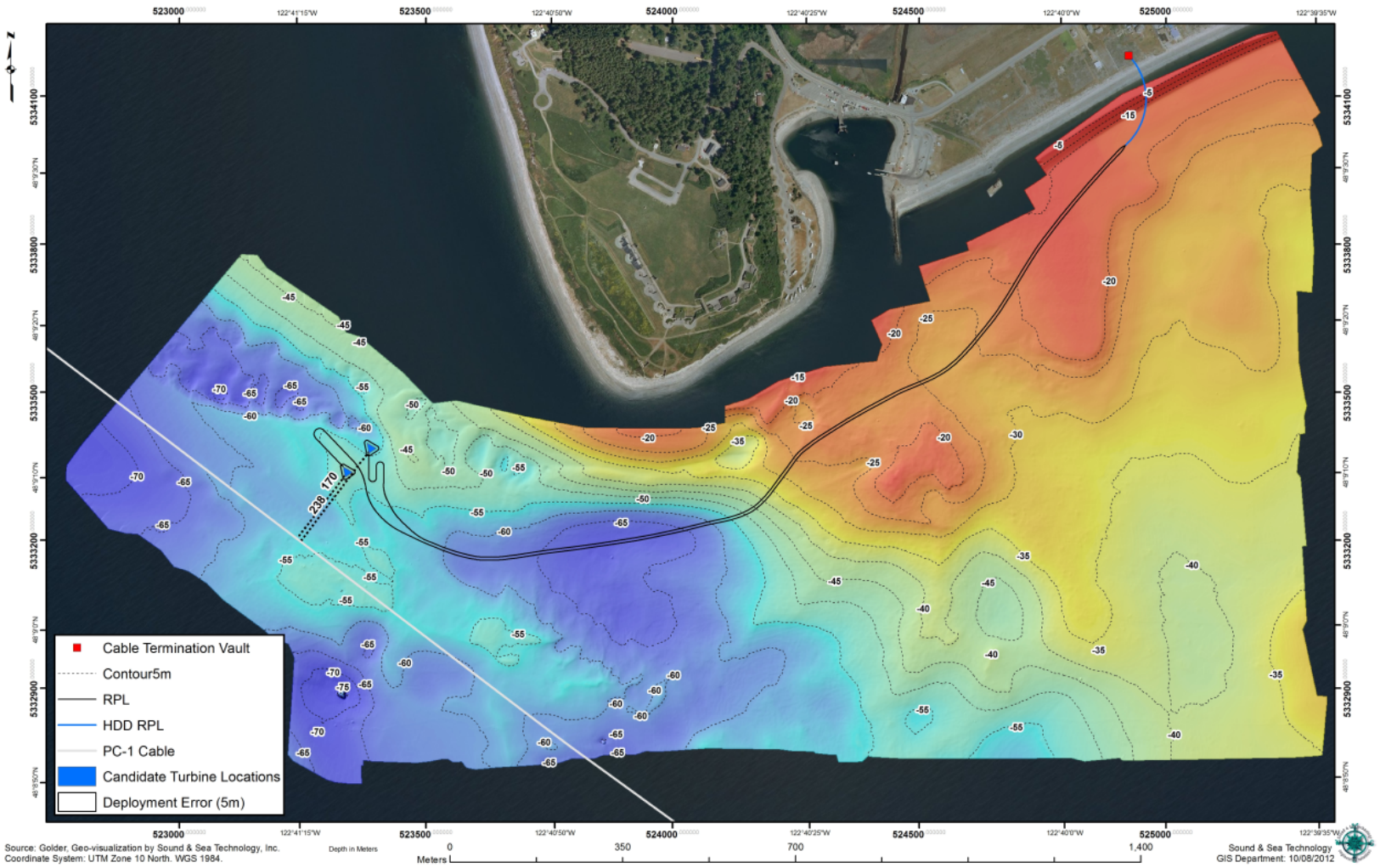

Figure 2 -- Turbine deployment location in northern Admiralty Inlet. Blue triangles denote turbines, each of which is connected back to shore via a separate power cable. Dashed red polygon to the east of Keystone Harbor is a marine protected area.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

3.0 BACKGROUND INFORMATION

A brief summary of information about turbine sound, site-specific ambient noise, and the likely sound generated by turbines in the context of ambient for the proposed project is presented in this section. Further details are presented in Polagye et al. (~~*in prep*~~*submitted*), ~~a draft of~~ which is appended to this plan.

3.1 Overview

There is limited information in the public domain about the sound produced by tidal turbines. Figure 3 shows one-third octave source levels estimates from measurement of a 6 m OpenHydro turbine undergoing testing at the European Marine Energy Centre (EMEC). Each blue-shaded spectrum corresponds to consecutive 8 second windows and the red spectrum is the mean of all eight measurements. The sound profile of the turbine shows considerable variability over these time scales, but tonal clusters are apparent around 40, 160, 500, and 1600 Hz. Measurements were obtained from a free-drifting surface package with a hydrophone suspended to a depth of 5 m.

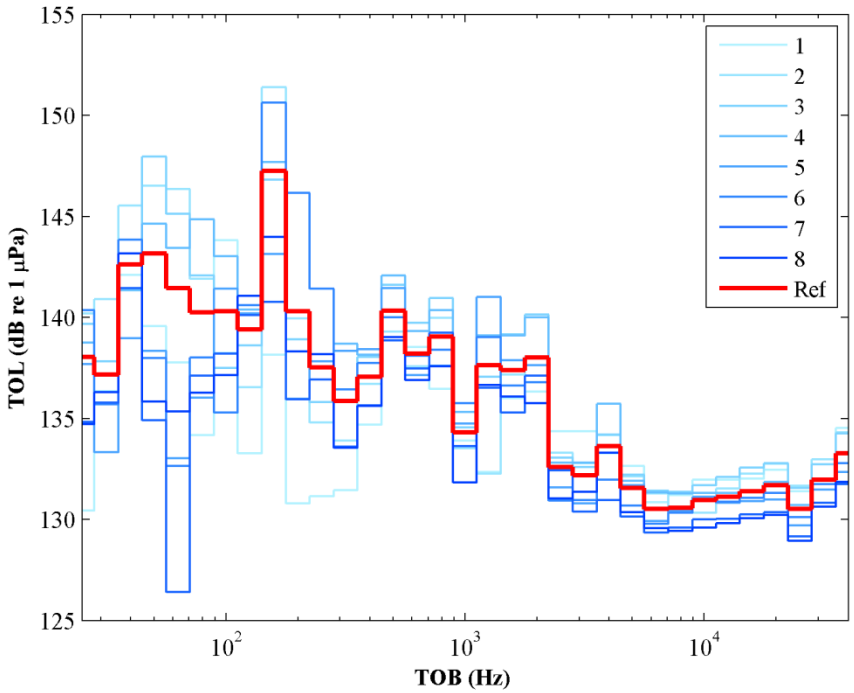

Figure 3 -- One-third octave source levels from measurements of an OpenHydro turbine at EMEC, red line indicates the mean of the 8 measurements (acoustic harassment device removed by linear interpolation). (excerpted from Polagye et al., ~~*in prep*~~*submitted*)

The measurements shown in Figure 3 correspond to a single operating state (inflow current velocity of 1.8 m/s). To date, no measurement campaigns have been undertaken to characterize how turbine would be expected to vary with operating state (combination of current velocity and turbine generator load).

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

3.2 Present Knowledge of Ambient Noise in Admiralty Inlet

Several factors contribute to ambient noise in Admiralty Inlet, including anthropogenic sound from vessel traffic, bedload transport associated with strong tidal currents, rain, biological vocalizations. At frequencies below 1 kHz, ambient noise levels are dominated by anthropogenic sound associated with commercial vessel traffic (Bassett et al., ~~*in press*~~2012). Consequently, the temporal patterns in ambient noise levels at those frequencies mirror those in commercial vessel traffic. Percentile ambient noise levels in the 25 Hz – 1000 Hz frequency range are shown in Figure 4. These data are derived from measurements of ambient noise in Admiralty Inlet described in Bassett et al. (~~*in press*~~2012) using autonomous recording hydrophones on seabed moorings. This accepted copy of the manuscript is appended to this plan.

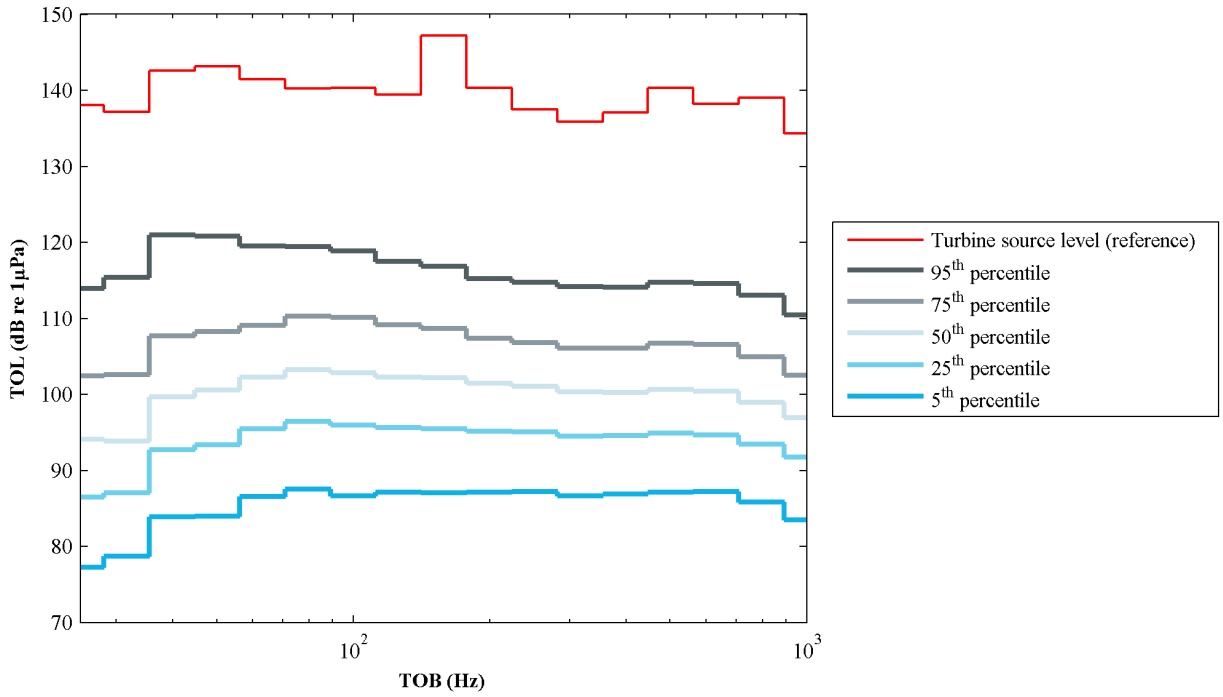

Figure 4 -- Percentile TOLs for ambient noise (25 – 1000 Hz) (excerpted from Polagye et al., *in prep*)

At frequencies above 1 kHz, bedload transport (mobilization of gravel and shell hash) is a significant sound source during periods of strong currents (Bassett et al., ~~*submitted*~~*in revision*). Consequently, the temporal patterns in ambient noise at those frequencies are correlated with current magnitude. Figure 5 shows median one-third octave levels (TOLs) as a function of tidal current magnitude.

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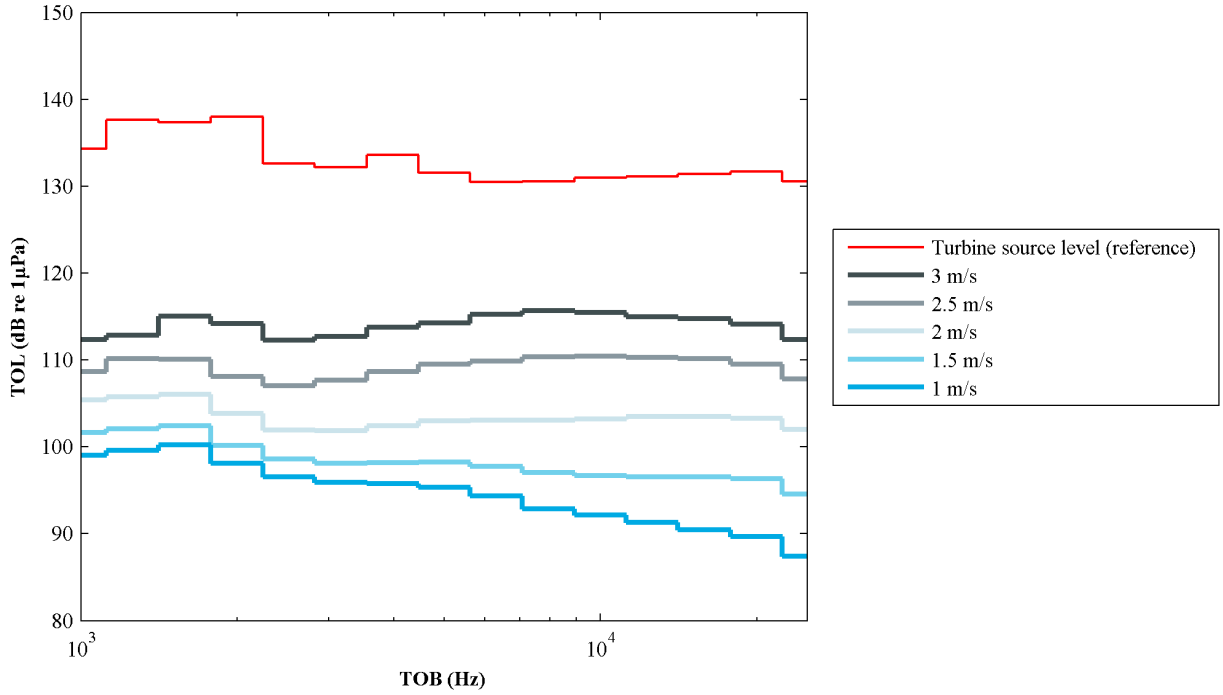

Figure 5 -- Median TOLs for ambient noise as a function of velocity (1000 – 25 000 Hz)

While rain and biological activity also are sound sources, they do not significantly influence overall sound budgets.

3.3 Pre-Installation Acoustic Effects Estimate

Polagye et al. (~~*in prep*~~*submitted*) describes a framework for estimating the acoustic effects of tidal turbines in the context of ambient noise. This framework is largely structured around the concept of "signal excess" which is defined as the excess of a sound source relative to ambient noise levels in a particular frequency band (in this case, one-third octave bands). This model, described in NRC (2003), is modified to account for hearing thresholds of particularly functional hearing groups (e.g., mid-frequency cetaceans). The analysis presumes a correlation between sound intensity and the power generated by a tidal turbine, an analogue to the correlation between sound intensity and power input for underwater mechanical processes described by Hazelwood and Connelly (2005). Estimates for turbine source levels are combined with a simple, frequency-dependent propagation model to predict received levels as a function of distance to the turbines, as shown in Figure 6.

Maximum turbine source levels (radiated noise levels) are estimated to be 172 dB re 1 µPa at 1 m, corresponding to an extreme inflow condition of 3.6 m/s. The expected temporal variability in turbine sound levels is shown in Figure 7, based upon the measured distributions of current velocity at the project site (Polagye and Thomson, *in press*).

Figure 8 shows the fraction of one-third octave bands of turbine sound that are likely to be detected relative to ambient noise, given the variations in turbine sound and ambient noise for four different inflow velocity conditions. This is for a hydrophone with an assumed uniform

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sensitivity over all frequencies of interest (marine animal detection of turbine sound will have a frequency dependence due to auditory thresholds). Deep reds denote conditions under which the majority of sound from a turbine would likely be identified during a characterization study. Cool colors denote conditions under which only a few one-third octave bands might be distinguishable from ambient noise. For example, at an inflow velocity of 1.5 m/s, the full spectrum of turbine sound would not likely be identifiable at any range from the turbine, whereas, at 2.5 m/s, turbine sound would likely be identifiable in a majority of one-third octave bands to a range up to a few hundred meters. This information serves to structure the approach for post-installation characterization of turbine sound described in this plan.

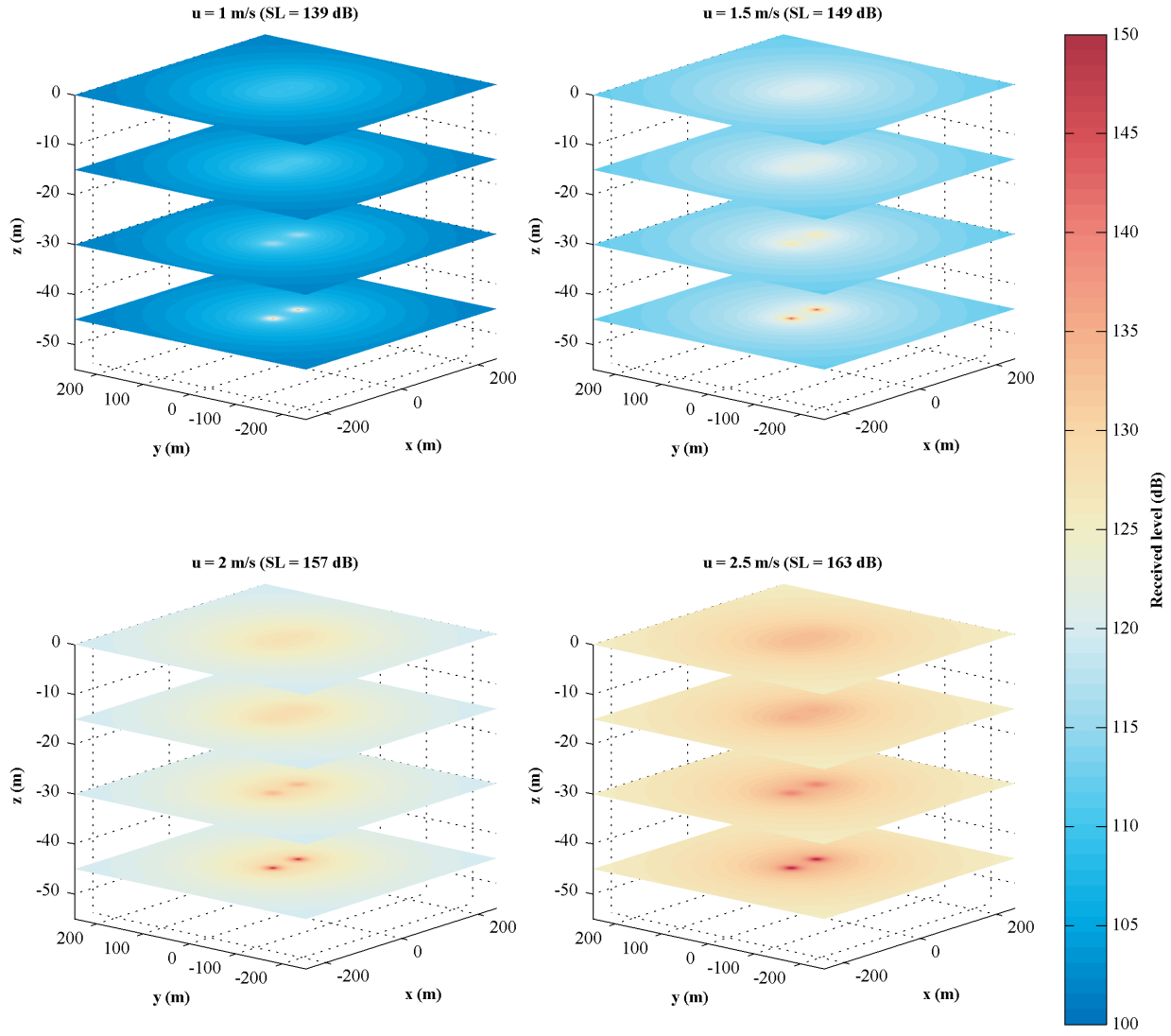

Figure 6 -- Horizontal slices of broadband turbine sound field at different inflow velocity conditions, based on analysis from Polagye et al. (*~~in prep~~submitted*). The sound patterns associated with the pair of sources are only distinct at close range (i.e., within 100 m).

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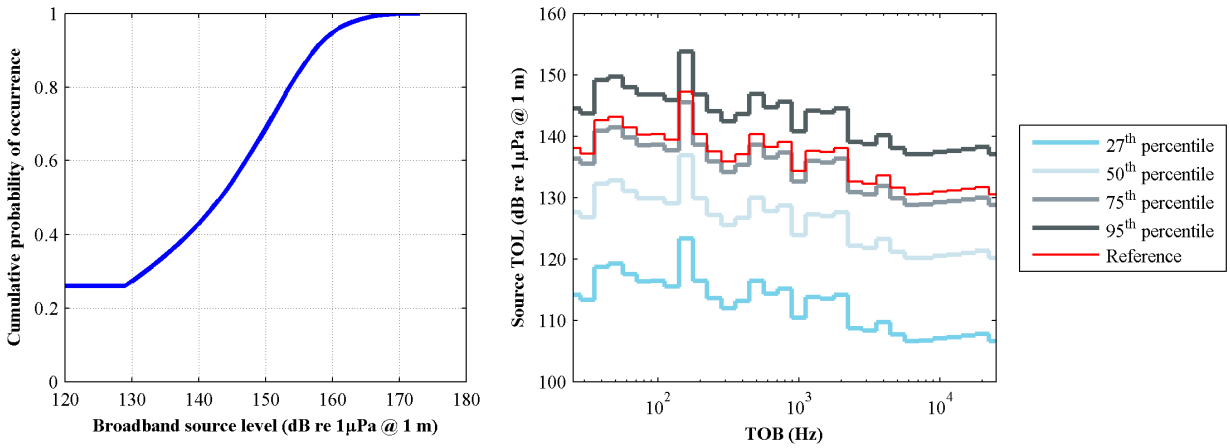

Figure 7 -- Probability distribution of turbine source levels. (left) Broadband (25 – 25 000 Hz). (right) One-third octave source levels for select percentiles. Turbine operation begins at the 27th percentile currents. (excerpted from Polagye et al., ~~*in prep*~~*submitted*)

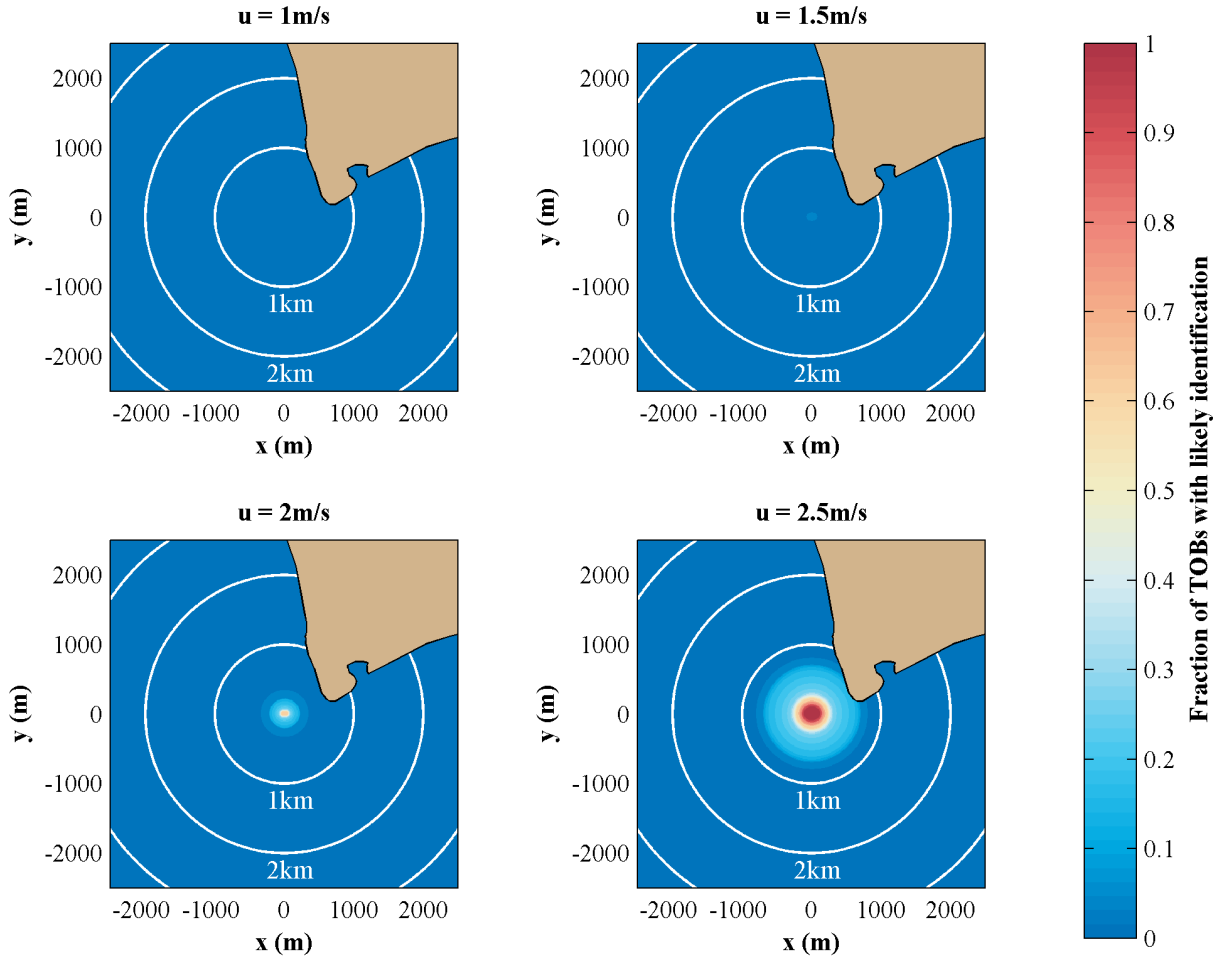

Figure 8 -- Fraction of one-third octave bands likely to be identified relative to ambient noise (at least 75% probability, 25 – 25 000 Hz) at four inflow velocities (5 m depth relative to surface). (excerpted from Polagye et al., ~~*in prep*~~*submitted*)

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4.0 PLAN OBJECTIVES AND GOALS

As a means to assure that the License provides proper resource protection, the goal of this Acoustic Monitoring and Mitigation Plan is to measure and describe the sound profile of the Project and to modify the Project or monitoring plan, or both, based on results of monitoring. To accomplish this, the District will evaluate two hypotheses:

- *Hypothesis 1:* Turbine sound will vary with power generation state
- *Hypothesis 2:* Turbine sound may demonstrate a long-term variation due to wear on bearings or biofouling of the rotor and shroud.

The District will confer with the Marine Aquatic Resource Committee (MARC) to consider modification of the Project and/or this Plan in response to the results of acoustic monitoring efforts. NMFS will use the results of the Acoustic Monitoring and Mitigation Plan to evaluate the assumptions contained in the analyses under the Marine Mammal Protection Act and the Endangered Species Act; and based on the results FERC may need to reinitiate consultation.

5.0 POST-INSTALLATION MONITORING AND MITIGATION PLAN

5.1 Relation between Turbine Noise and Power Generation

5.1.1 Objective

Turbine sound is likely to vary with power generation state (i.e., higher intensity sound will be produced when the turbines are closer to their rated capacity than around cut-in speed). However, no studies to date have rigorously assessed this relation. Pre-installation estimates (Sec. 3.3) indicate that if sound from turbines does vary with power generation state, the extent of marine mammal detection of this sound will also be a strong function of power generation state. Understanding time-varying nature of turbine sound is central to evaluating the acoustic effects for large arrays and informing engineering design decisions that could enable quieter turbines.

5.1.2 Data Collection

Equipment Description

Acoustic data will be collected using surface drifters – specifically, the SWIFT (Surface Wave Instrumentation Float with Tracking) float described in Thomson (2012). This is a buoyant spar buoy equipped, for this application, with a radio frequency transmitter, GPS logger, and hydrophone. The hydrophone will be a Loggerhead DSG (www.loggerheadinstruments.com). This is an autonomous recorder connected to a Hi-Tech hydrophone (HTI-96-MIN). The hydrophone, when accounting for the internal preamplifier, had an effective sensitivity of -165.9 dB µPa V^{-1}. The frequency response of the hydrophone and data acquisition system is linear (±3 dB) from 20 Hz to 80 kHz. The Loggerhead hydrophones will be configured to sample continuously at 80 kHz (pre-installation measurements suggest the noise floor will be around 30 kHz). The hydrophone response will be compared to a calibration standard before and after testing to ensure accurate comparisons between multiple drifters, as discussed later in this plan.

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When attached to the SWIFT, the hydrophone will be 1 m below surface. Received levels will vary with depth, particularly at relatively close range to the turbines (i.e., with 100 m). Depending on consultation with the MARC, following initial surveys, further surveys with cabled hydrophones may help to characterize this depth variation. However, the autonomous drifters at a fixed depth will be most effective to resolve the relation between turbine noise and power generation state.

The sound velocity profile will be measured periodically during surveys using a "time of flight" profiler. Water quality information collected during pre-installation studies indicate that the water column is generally well-mixed over the Admiralty sill on account of the vigorous tidal exchange, but a complete description of the acoustic medium is a best practice for studies of underwater noise.

An Automatic Identification System (AIS) receiver deployed on Admiralty Head in cooperation with Washington State Parks will be used to monitor vessel traffic and confirm that noise from commercial vessels is not masking turbine sound.

Doppler profilers mounted to the turbine foundations will monitor tidal currents throughout the acoustic survey in post-installation surveys. These will collect velocity data at a sampling rate of 1 Hz. The turbine Supervisory Control and Data Acquisition (SCADA) will monitor the power output from the turbine, also at a sampling rate of at least 1 Hz. In combination, acoustic, velocity, and power data will be used to understand if short-term fluctuations in turbine sound are correlated to short-term fluctuations in power generated. In pre-installation surveys, current velocity will be monitored by a vessel-mounted Doppler profiler.

Survey Procedure

Surveys will be conducted for nominal inflow velocity conditions of 1.0, 1.5, 2.0, and 2.5 m/s. The pre-installation sound estimates described in Polagye et al. (~~*in prep*~~*submitted*) indicate that turbine sound will not likely be detected for inflow velocity of 1.0 m/s, only be detectable at close range (i.e., < 100 m distance) for inflow velocity of 1.5 m/s, detectable over a few hundred meters at 2.0 m/s, and detectable of several hundred meters at 2.5 m/s.

These surveys will be conducted during ebb or flood tides, as there is no known mechanism for a different turbine sound profile between ebb and flood at equivalent inflow velocities. Survey timing will be based on a prediction of sustained current magnitude (i.e., 10 minute average) greater than 2.5 m/s at hub height during the peak of the particular tidal cycle. Surveys at the inflow conditions listed above will be initiated based on real-time information from the Doppler profiler on Turbine 1 for post-installation measurements (velocities are likely to be similar between the two turbines) and a vessel-mounted Doppler profiler for pre-installation measurements.

During surveys, vessel traffic will be monitored using the AIS receiver on Admiralty Head and surveys will not be initiated if vessel noise is likely to mask turbine sound. Masking is likely to occur if large commercial vessels are within 10 km of the study area. Pre-installation studies of ambient noise (Bassett et al., 2012) show a "lull" in vessel traffic from 0200 – 0500 local time. Surveys will be conducted within this window to improve the probability of vessels not being

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present during the study, which will maximize the signal to noise ratio for measurements of turbine sound.

For each survey (i.e., measurement at a particular current velocity), 5 hydrophone-equipped SWIFT buoys will be deployed from a surface vessel. Prior to buoy deployment, a sound velocity profile will be collected to within 5 m of the seabed. Buoy position will be referenced to the "acoustic center" of the turbine array – the mid-point of a line connecting the center of mass of the two turbines.

At the start of each survey, buoys will be deployed upstream of the turbines on the principal current axis at distances of:

- **Buoy 1**: 125% of expected acoustic extent from pre-installation studies at survey inflow velocity (verify extent of turbine noise)
- **Buoy 2**: 800 m from acoustic center (evaluate received levels)
- **Buoy 3**: 400 m from acoustic center (evaluate received levels)
- **Buoy 4**: 200 m from acoustic center (evaluate received levels)
- **Buoy 5**: 100 m from acoustic center (evaluate received levels)

~~Over the course of a single survey sequence (described below), these buoys will drift considerably, such that the buoy that begins 800 m out may be closest to the turbines when the last measurement in the survey sequence is conducted.~~

~~Data will be collected while the turbines brakes are applied and released in sequence. Data collection by the hydrophones will be continuous, but we are targeting four distinct operating states for subsequent analysis. The survey sequence will be:~~

- ~~**Measurement 1**: Both turbines operating (30 seconds)~~
- ~~Apply Turbine 2 brake, bring Turbine 2 to braked condition (30 seconds)~~
- ~~**Measurement 2**: Turbine 1 operating, Turbine 2 braked (30 seconds)~~
- ~~Apply Turbine 1 brake, bring Turbine 1 to braked condition (30 seconds)~~
- ~~**Measurement 3**: Turbine 1 braked, Turbine 2 braked (30 seconds)~~
- ~~Release Turbine 2 brake, bring Turbine 2 to normal operating state (30 seconds)~~
- ~~**Measurement 4**: Turbine 2 operating, Turbine 1 braked (30 seconds)~~
- ~~Release Turbine 1 brake, bring Turbine 1 to normal operating state (30 seconds)~~
- ~~**Measurement 5**: Both turbines operating (30 seconds)~~

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Buoys will drift and record sound until the buoy initially deployed furthest from the turbine deployment site passes its closest point of approach to the turbine deployment site.

Surveys will be conducted prior to turbine installation, following the installation of the first turbine, and following the installation of the second turbine. Each condition (e.g., ambient baseline, single turbine, two turbines) will be measured over three tidal cycles meeting the criteria for maximum sustained current velocity at the turbine deployment site (2.5 m/s).

The total data set will consist of these ~~five~~drifting measurements, from five buoys, during ~~six~~sixty-four surveys (~~three~~four velocity states measured on the rising and falling tide nine times in total). This corresponds to ~~150~~320 time series, each ~~30 seconds~~several minutes in duration, that will be post-processed.~~During surveys, vessel traffic will be monitored using the AIS receiver on Admiralty Head and surveys will not be initiated if vessel noise is likely to mask turbine sound. Masking is likely to occur if large commercial vessels are within 10 km of the study area. Pre-installation studies of ambient noise (Bassett et al., *submitted*) show a "lull" in vessel traffic from 0200 – 0500 local time. Surveys will be conducted within this window to improve the probability of vessels not being present during the study~~.

Doppler profilers on the turbines will monitor hub-height current velocity throughout the acoustic survey for post-installation measurements. The turbine SCADA will monitor power generation state during the acoustic survey. Hub-height current velocity will be monitored by a vessel-based Doppler profiler for pre-installation measurements.

In summary, the time series that will be analyzed will include: acoustic pressure (measured by the hydrophone), hydrophone position (measured by the GPS logger), commercial vessel position (measured by the AIS), turbine inflow velocity (measured by ~~the~~a Doppler profiler), and turbine power generation (measured by the SCADA, for post-installation monitoring).

5.1.3 Data Analysis

Analysis of acoustic data will utilized the same Fourier transform method as Polagye et al. (~~*in prep*~~*submitted*), with *post hoc* selection of analysis windows that provide the best interpretation of acoustic data. Analysis of sound intensity will be by one-third octave bands from 15 Hz to 25 kHz (i.e., one-third octave levels, TOLs). It is desirable to understand how the turbine "source level" varies with power generation state. For sound sources as large as a tidal turbine where sound will be produced at many points around the rotor and foundation, "source levels" at a range of 1 m are an abstraction. For this reason, it has been proposed to describe such extrapolations as "radiated noise levels" at a 1 m reference (discussion at BOEM workshop on underwater noise, March, 2012). Here, we use "source level" synonymously with "radiated noise levels".

Turbine acoustic signature: Using data from a single buoy, ambient noise ~~(measurement 3~~spectra (pre-installation measurements) will be compared to ~~recordings of sound produced by~~spectra recorded during the operation of a single turbine (~~measurement 2 and 4)~~first round of post-installation measurements) under equivalent tidal current and vessel traffic conditions. One-third octave bands with statistically higher sound intensities will correspond to turbine sound (i.e., distinguish turbine sound from ambient noise).

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Relation to between received levels and power generation state: Using data from a single buoy, received levels associated with turbine sound will be compared for equivalent distances and inflow velocities (i.e., 1.0, 1.5, 2.0 and 2.5 m/s). Trends in received levels will be quantified for one-third octave bands.

Increase in noise for multiple turbines: Using data from a single buoy, the sound from single-turbine operation (first round of post-installation measurements) will be compared to two-turbine operation (second round of post-installation measurements) at equivalent distances ~~and~~, power generation states ~~(i.e., measurement 1 and 2 compared to measurement 4 and 5)~~, and vessel traffic conditions. The expectation is that turbines will act as incoherent sound sources, with broadband sound pressure levels increasing by no more than 3 dB with two turbines operating in comparison to one turbine operating.

Source level: Using data from all buoys during a single survey with only one turbine in operation, the source level will be estimated by fitting a transmission loss coefficient to each one-third octave band (i.e., *N*log). This analysis will be repeated for all surveys. In combination with results of other analyses, this information will be used to quantify the trend in source level with power generation state. In addition to one-third octave levels, source levels will also be estimated for root mean square (rms) sound pressure levels corresponding to four functional hearing groups established by NMFS (2012). The low frequency limit for each group is shown in Table 1. The high-frequency limit will be determined, in consultation with the MARC, based on the maximum frequency of sound produced by operating turbines, as determined by this study. Note that these limits correspond to a "box car" filter and, therefore, do not roll off in the same manner as the M-weightings described in Southall et al. (2007).

Table 1 -- Low-frequency hearing limits for functional groups established by NMFS (2012)

Functional Group	Low Frequency Limit
Low-frequency cetaceans	7 Hz
Mid-frequency cetaceans	150 Hz
High-frequency cetaceans	200 Hz
Pinnipeds	75 Hz

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

5.1.4 Reporting and Adaptive Management

An oral report will be made to the MARC within 60 days of survey completion describing the survey and presenting preliminary results. Final written and oral reports will be made to the MARC within 120 days of survey completion.

Based on the final results, the MARC may recommend additional surveys be undertaken to further decrease uncertainty and ensure resource protection.

5.2 Long-term Variation in Turbine Noise

5.2.1 Objective

If, over the time, the bearings on the turbine experience wear or the rotor and shroud are fouled (in spite of anti-fouling coatings), the sound profile of the turbine may vary. Information about long-term trends in noise is needed to evaluate acoustic effects over the operating life for a commercial project (nominally 25 years). While this pilot project will be substantially shorter in duration at five years, this time frame does correspond to expected maintenance intervals and information about trends in the acoustic signature of a device will be instructive.

5.2.2 Data Collection

Equipment Description

Acoustic data will be collected by a hydrophone with a flow shield that is integrated into the adaptable monitoring package (AMP). A flow shield is necessary because the frequencies of turbine sound overlap with the frequencies of turbulence-induced pseudo-noise for an unshielded hydrophone. The hydrophone will be cabled to shore and recovered/serviced/redeployed every 3-6 months in order to maintain the flow shield. The low-frequency version of the icListen "smart" hydrophone (www.instrumentconcepts.com) is compatible with the overall post-installation monitoring system and is one possible option for long-term monitoring. Each turbine will be equipped with a cabled hydrophone of this type.

Collection Procedure

The AMP will be located within the acoustic near-field of the turbine. This precludes direct monitoring of source levels (i.e., radiated noise levels at 1 m), but will be suitable to compare relative changes in the acoustic signature of the turbine over time. Acoustic data will be streamed to shore via the instrumentation cable and archived on a 5% duty cycle spread out evenly over the quarter with each sample being 10 seconds in duration. Sample duration is in alignment with recent guidance on ambient noise characterization (NMFS, 2012). This duty cycle and sample duration will produce approximately 40,000 samples per quarter and is sufficient to achieve robust statistics without an unnecessary burden on the archiving and analysis of data.

Vessel traffic patterns will be monitored continuously using the AIS receiver on Admiralty Head.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Doppler profilers mounted to the turbine foundations will monitor tidal currents at a sampling rate of 1 Hz. The turbine Supervisory Control and Data Acquisition (SCADA) will monitor the power output from the turbine, also at a sampling rate of at least 1 Hz.

In summary, the time series that will be analyzed will include: acoustic pressure (measured by the cabled hydrophone), commercial vessel position (measured by the AIS), turbine inflow velocity (measured by the Doppler profiler), and turbine power generation (measured by the SCADA).

5.2.3 Data Analysis

Observations will be stratified by inflow velocity and retained for conditions corresponding to the characterization survey (i.e., 1.5, 2.0, and 2.5 ± 0.2 m/s). Periods in which vessel traffic is within 10 km of the turbine will be excluded.

On a quarterly basis, time series analysis will follow the same procedure applied to the turbine sound characterization study. One-third octave levels (TOLs) and broadband sound pressure levels for these three power generation states will be evaluated. In addition, root mean square (rms) sound pressure levels will be calculated for the four functional hearing groups described in § 5.1.3.

5.2.4 Reporting and Adaptive Management

If the mean, broadband sound pressure level increases by more than 5 dB relative to the mean broadband sound pressure level during the first quarter of operation and there are no obvious contributions from local anthropogenic sources (i.e., construction activities), the increase in noise will be ascribed to a change in the acoustic properties of the turbine and the MARC will be convened. Biofouling/colonization information from the Benthic Habitat Monitoring and Mitigation Plan will inform discussions with the MARC.

Cumulative probability distributions by one-third octave band, broadband sound pressure level, and the four functional hearing groups will be made available to the MARC within 30 days of the end of each quarter.

If post-installation noise characterization (§ 5.1) suggests that turbine sound is not dependent on power generation state or a weak function of power generation state, the MARC will determine if the stratification of results by velocity is unnecessary.

6.0 APPROACH TO ADAPTIVE MANAGEMENT AND MITIGATION

In implementing this Acoustic Monitoring and Mitigation Plan, the District will confer with the MARC as appropriate on the technical issues described above and data interpretation associated with the monitoring. This will include consideration of results from monitoring efforts and subsequent adjustments to monitoring, project operation, and removal methods.

The District will follow the procedures described in the Adaptive Management Framework when conferring with the MARC on implementation of the Acoustic Monitoring and Mitigation Plan and considering how to address the results of the monitoring.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Adaptive Management and Mitigation Trigger 1: If acoustic monitoring (drifting surveys or long-term monitoring) indicate received levels at any distance from the operating turbines has the potential to injure marine mammals, the District will modify Project operations to ensure that received levels are below this threshold. The District will develop modifications in consultation with the MARC, and will obtain NMFS' approval for any specific mitigation measures. Until the modifications are implemented, the District will ~~keep~~engage the brake ~~engaged~~ on the turbines or take other ~~take~~ actions to reduce received levels to below the thresholds cited above. The District may also need to modify its monitoring plan if the information shows this is necessary for proper resource protection purposes.

Adaptive Management and Mitigation Trigger 2: If post-installation characterization surveys identify a larger area than the pre-installation estimate within which received levels exceed thresholds for Level B Harassment (MMPA Level B harassment is currently considered to occur for all exposures above 120 dB_{rms} SPL), the District will coordinate with the MARC to determine if modifications to Project operations are necessary to reduce the ensonified area to be consistent with the MMPA Authorization. The District will develop modifications to the Project and/or monitoring plan in consultation with the MARC, will obtain NMFS' approval for any specific mitigation measures.

Adaptive Management and Mitigation Trigger 3: Within 120 days of completion of the surveys to characterize the turbines' sound profile, a final report will be presented to the MARC by the District. The MARC will review this information and determine whether acoustic information is sufficient for decision making purposes or whether additional data collection is required to ensure proper resource protection. If the MARC determines that additional data is needed, the District will collect the additional information.

Adaptive Management and Mitigation Trigger 4: Following the first quarter of turbine operation, turbine sound statistics will be reviewed by the MARC to establish triggers for further adaptive management (i.e., determine the level of increase recorded by long-term monitoring that triggers further analysis for shifts in the underlying ambient noise).

Adaptive Management and Mitigation Trigger 5: Based on the results of the turbine noise characterization described in § 5.1, the MARC will establish a high-frequency limit for reporting rms sound pressure levels for the four functional groups of marine mammals.

By June 30 of each year of the license, the District will develop and file with the Commission an annual report fully describing its implementation of the Acoustic Monitoring and Mitigation Plan during the previous calendar year, the results of the monitoring, and a list of the proposed activities during the current calendar year. The District will develop the report in consultation with the MARC. The Annual report will provide the following:

- A summary of actions implementing the Plan, including any modifications to the Project, and the results of monitoring pursuant to this Plan.

- A summary of any issues or concerns identified by the District or other members of the MARC during the year regarding implementation of the Acoustic Monitoring and Mitigation Plan and results of the monitoring.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

- A list of any changes to the Acoustic Monitoring and Mitigation Plan proposed by the MARC and how the District will address those proposed changes.

- A list of Acoustic Monitoring and Mitigation Plan activities planned for the current and next year.

As provided in the Adaptive Management Framework, the MARC will have at least 30 days to review and comment on a draft of the report prior to the District filing with the Commission. Modifications to the Acoustic Monitoring and Mitigation Plan will be implemented upon the Commission's approval. The District will provide copies of the final annual report to the members of the MARC. The District will also file MARC comments with the report itself.

7.0 REFERENCES

Basset, C., B. Polagye, M. Holt, and J. Thomson (~~*in press*~~i2012) A vessel noise budget for Admiralty Inlet, Puget Sound, WA (USA), *J. Acous. Soc. Am.*, 132(6), 3706-3719.

Basset, C., J. Thomson, and B. Polagye (~~*submitted*) Contribution of bedload transport to ambient noise in a high-energy environment, Submitted to~~*in revision*) Sediment-generated noise and bed stress in a tidal channel, *J. Geo. Res.*, *in revision.*

Hazelwood, R. and Connelly, J. (2005) Estimation of underwater noise – a simplified method. *International J. Soc. Underwater Technology*, 26:51-57.

National Research Council of the U.S. National Academies (NRC) (2003) *Ocean Noise and Marine Mammals*, National Academy Press, Washington, DC.

National Marine Fisheries Service (NMFS) (2012) Guidance Document: Data Collection Methods to Characterize Underwater Background Sound Relevant to Marine Mammals in Coastal Nearshore Waters and Rivers of Washington and Oregon, NMFS Northwest Region and Northwest Fisheries Science Center, January 31, 2012.

Polagye, B., B. Van Cleve, A. Copping, and K. Kirkendall (eds.) (2011) Environmental effects of tidal energy development: Proceedings of a scientific workshop, March 22-25, 2010. *NOAA Technical Memorandum* NMFS F/SPO-116.

Polagye, B. and J. Thomson (*in press*) Tidal energy resource characterization: methodology and field study in Admiralty Inlet, Puget Sound, US, *Proc. IMechE: Part A, J. Power and Energy*.

Polagye, B., C. Bassett, M. Holt, J. Wood, and S. Barr (~~*in preparation*~~*submitted*) Detection of tidal turbine noise: A pre-installation case study for Admiralty Inlet, Puget Sound, Washington (USA)~~.~~, Submitted to *J. Ocean. Eng.*

Thomson, J (2012) Wave Breaking Dissipation Observed with `SWIFT' Drifters, ~~Accepted for publication in~~ *J. Oceanic Atmos. Technology*~~.~~, 29(12), 1866-188

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

ADMIRALTY INLET PILOT TIDAL PROJECT
FERC PROJECT NO. 12690

MARINE MAMMAL MONITORING AND MITIGATION PLAN

Submitted by:
Public Utility District No. 1 of Snohomish County

November 16, 2012

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

TABLE OF CONTENTS

1.0 INTRODUCTION 1
2.0 PROJECT DESCRIPTION 1
3.0 BACKGROUND INFORMATION 4
3.1 Marine Mammal Presence in Admiralty Inlet 4
3.2 Harbor Porpoise Echolocation Activity 5
3.3 Pre-Installation Acoustic Effects Estimate 7
3.3.1 Marine Current Turbines SeaGen Demonstration 8
3.3.2 European Marine Energy Center 8
3.4 Pre-Installation Noise Detection Estimate 8
4.0 PLAN OBJECTIVES AND GOALS 14
5.0 POST-INSTALLATION MONITORING AND MITIGATION PLAN 15
5.1 Pinniped Response to Turbine Presence 17
5.1.1 Objective 17
5.1.2 Data Collection 17
5.1.3 Data Analysis 19
5.1.4 Reporting and Adaptive Management 20
5.2 Harbor Porpoise Response to Turbine Presence 20
5.2.1 Objective 20
5.2.2 Data Collection 21
5.2.3 Data Analysis 21
5.2.4 Reporting and Adaptive Management 22
5.3 Killer Whale Response to Turbine Presence 23
5.3.1 Objective 23
5.3.2 Data Collection 23
5.3.3 Data Analysis 25
5.3.4 Reporting and Adaptive Management 26
6.0 APPROACH TO ADAPTIVE MANAGEMENT AND MITIGATION 26
7.0 REFERENCES 29

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Attachment 1 – Carlson, T.J., J.L. Elster, M.E. Jones, B.E. Watson, A.E. Copping, M. Watkins, R. Jepsen, and K. Metzinger (2012) Assessment of strike of adult killer whales by an OpenHydro tidal turbine blade, Pacific Northwest National Laboratory technical report, PNNL-21177

Attachment 2 – November 15, 2012, draft "A framework for detection of tidal turbine sound: A pre-installation case study for Admiralty Inlet, Puget Sound, Washington (USA)"

Attachment 3 – Power Analysis for Ability to Detect Changes related to Southern Resident Killer Whales

LIST OF FIGURES

Figure 1 – Conceptual instrumentation layout (fixed and recoverable). Instrumentation shown on a 4th Generation turbine (higher rotor solidity than 7th Generation turbine). The general dimensions of the subsea based and support structure are approximately constant between technology generations for the same rotor size. 2

Figure 2 – Turbine deployment location in northern Admiralty Inlet. Blue triangles denote turbines, each of which is connected back to shore via a separate power cable. Dashed red polygon to the east of Keystone Harbor is a marine protected area. 3

Figure 3 – Typical landmark sequence 6

Figure 4 – Porpoise detection positive minutes per day, as classified by different instrument/software combinations (Collar et al., 2012). Notably, DPM statistics depend significantly on the type of instrument (T-POD vs. C-POD) and version of software used for the analysis. This complicates comparison of data between projects where different versions of the software are employed. 7

Figure 5 – Probability of mid-frequency cetacean (killer whale) detecting turbine noise (30 m depth relative to surface). 11

Figure 6 – Probability of high-frequency cetacean (harbor porpoise) detecting turbine noise (30 m depth relative to surface). 12

Figure 7 – Probability of pinniped (harbor seal) detecting turbine noise (30 m depth relative to surface). 13

Figure 8 – Admiralty Inlet showing possible study area boundaries (500 m or 1000 m) and probable observer location. 16

Figure 9 – Scan procedure for pinniped monitoring 19

Figure 10 – Passive acoustic array on OpenHydro turbine. Hydrophone configuration is preliminary. 24

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

MARINE MAMMAL MONITORING AND MITIGATION PLAN
for the Admiralty Inlet Pilot Tidal Project

1.0 INTRODUCTION

Interactions between marine mammals and tidal turbines are an area of high uncertainty (Polagye et al., 2011) and pilot projects in Europe, Canada, and the United States have devoted considerable resources to characterizing how installation and operation of tidal energy projects affects marine mammals. While marine mammals may respond to any number of cues associated with project operation, sound is, in many cases, likely to be first cue detected. Based on pre-installation estimates, sound from project operation is not expected to rise to a level that constitutes injury, but will periodically rise to a level that may cause behavioral changes over small spatial scales. Marine mammal behavioral responsiveness to noise is a well-known, but not well-understood in terms of relating a particular noise to a specific response (e.g., as discussed in Southall et al., 2007).

The Marine Mammal Monitoring and Mitigation Plan provides studies to evaluate behavioral changes in marine mammals associated with project operation. These are partitioned by functional group (i.e., pinnipeds, mid-frequency cetaceans, high-frequency cetaceans). In all cases, the hypothesis being tested is similar – marine mammals may respond to the sound from project operation or prey aggregations through attraction, avoidance, or change in behavioral state. However, the specific approach, duration of observations, and analyses to be undertaken, vary by functional group based on the statistical power to detect change, need to ensure proper resource protection, and suitable monitoring technologies.

Through adaptive management, this information will provide for proper resource protection of marine mammals. Additional details regarding instrumentation on the turbines are presented in the Monitoring Plan Summary.

2.0 PROJECT DESCRIPTION

The demonstration project proposed by Snohomish County Public Utility District consists of two turbines manufactured by OpenHydro, an Irish turbine developer. Each of these turbines has a 6 m diameter outer shroud, as shown in Figure 1. These will be deployed on a gravity tri-frame, with tubular cans contacting the seabed at the vertices. Turbine hub height will be 10 m above the seabed. The OpenHydro turbines are fixed-pitch, high-solidity rotors with an open center. The rotor cassette is the single moving part and is supported by water-lubricated bearings. A permanent magnet generator is contained in the shroud surrounding the blades. Anti-fouling coatings are applied to the interior surface of the shroud, hub, and rotor blades, but the gravity frame (steel, ballasted by concrete and aggregate) is left bare. The turbine shown in Figure 1 represents the 6 m version of 4th Generation technology. The turbines deployed in Puget Sound will be 6 m variants of 7th Generation technology – the principle differences being fewer blades and more streamlined central hub.

The turbines will be deployed in northern Admiralty Inlet, Puget Sound, Washington. Admiralty Inlet is a constricted sill separating the deep Main Basin of Puget Sound from the Straits of Juan de Fuca and Straits of Georgia. At the narrowest point, between Admiralty Head and Point Wilson, the channel is approximately 5 km wide and 70 m deep. Excepting a small exchange through Deception Pass, the entire tidal prism of Puget Sound passes through this constriction,

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

giving rise to tidal currents that routinely exceed 3 m/s (6 knots) at mid-water. The project site is approximately 1 km SE of Admiralty Head in 55 m of water (Figure 2). The project location was chosen on the basis of strong tidal currents (intensified by the proximity to the headland), negligible seabed slope (necessary to deploy the gravity foundation), separation from high vessel traffic areas (federal navigation lanes, ferry route), and ease of cable routing back to shore.

Each turbine will be connected to shore by a separate power cable. These cables will also provide power for monitoring instrumentation and fiber optic communication with the turbine and monitoring instrumentation. Turbine monitoring systems are grouped into two categories – instruments that will be deployed for the duration of the demonstration project (fixed) and instruments that will be periodically recovered for maintenance (recoverable). This will be enabled by an Adaptable Monitoring Package (AMP) consisting of a self-aligning frame with instrumentation and a wet-mate power and fiber connector.

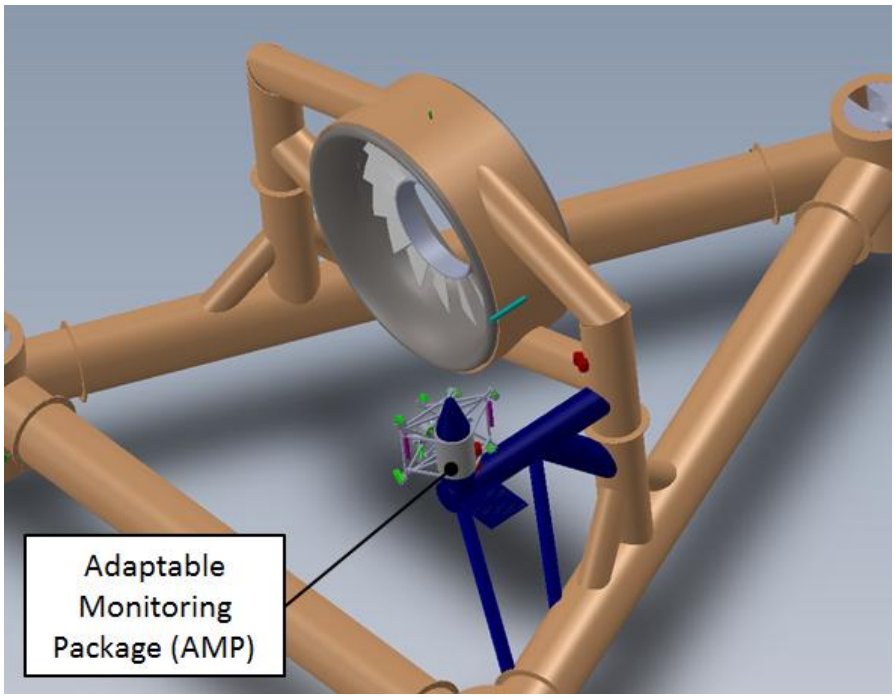

Figure 1 – Conceptual instrumentation layout (fixed and recoverable). Instrumentation shown on a 4th Generation turbine (higher rotor solidity than 7th Generation turbine). The general dimensions of the subsea based and support structure are approximately constant between technology generations for the same rotor size.

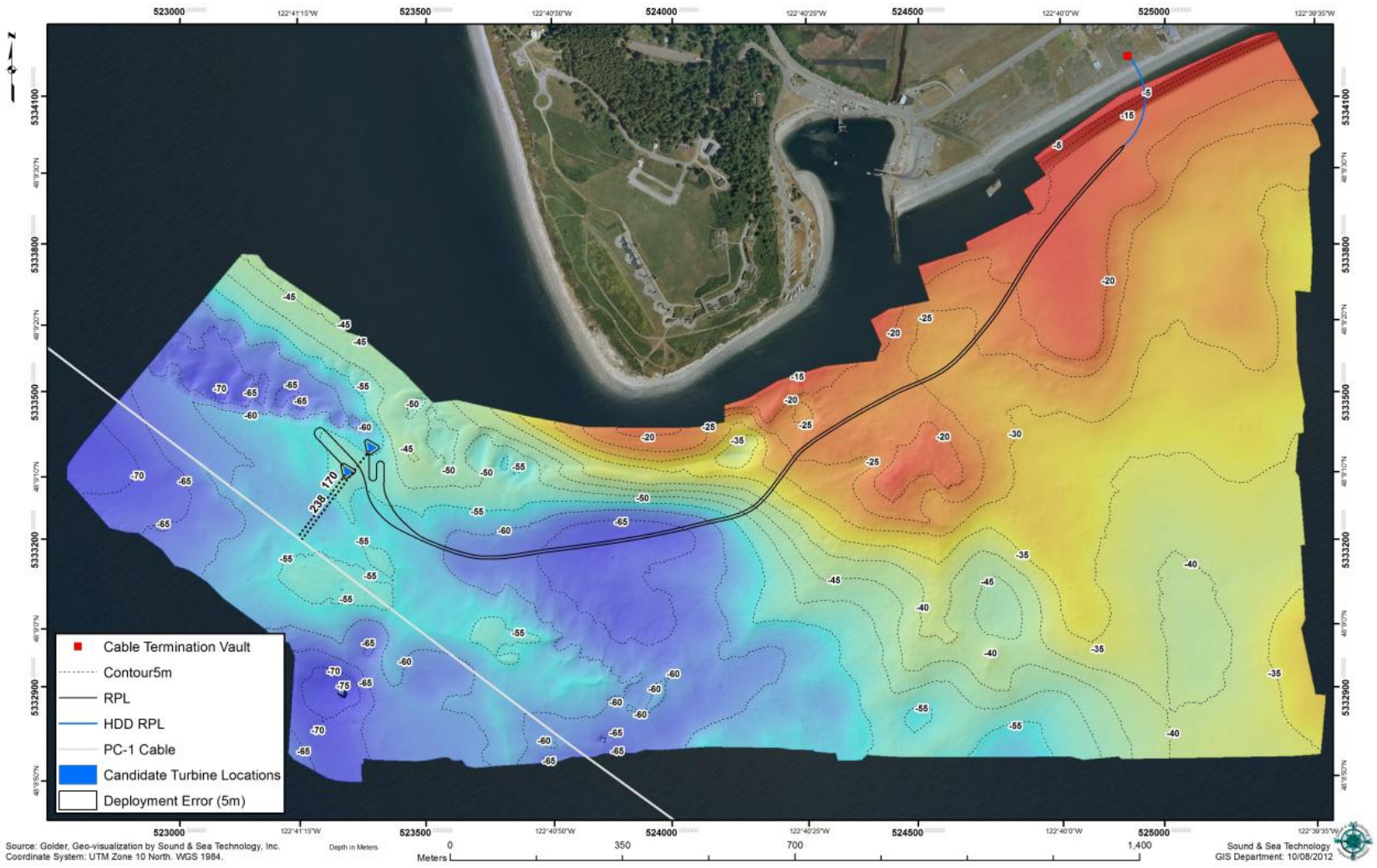

Figure 2 – Turbine deployment location in northern Admiralty Inlet. Blue triangles denote turbines, each of which is connected back to shore via a separate power cable. Dashed red polygon to the east of Keystone Harbor is a marine protected area.

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3.0 BACKGROUND INFORMATION

3.1 Marine Mammal Presence in Admiralty Inlet

As described in the District's Final License Application (Snohomish PUD, 2012), marine mammal species reported to occur in central Puget Sound include: Southern Resident Killer Whale (SRKW) (*Orcinus orca*), humpback whale (*Megaptera novaeangliae*), Steller sea lion (*Eumetopias jubatus*), harbor porpoise (*Phocoena phocoena*), Dall's porpoise (*Phocoenoides dalli*), Minke whale (*Balaenoptera acutorostrata*), gray whale (*Eschrichtius robustus*), California sea lion (*Zalophus californianus*), harbor seal (*Phoca vitulina*), and northern elephant seal (*Mirounga angustirostris*).

Programs to document presence of marine mammals in Puget Sound include twelve years of vessel surveys conducted by the Washington Department of Fish and Wildlife (WDFW). These surveys were conducted basin-wide, and WDFW has compiled the results in a spatially rectified database. Harbor seals accounted for 687 sightings in Admiralty Inlet followed by harbor porpoise (67 sightings), Dall's porpoise (16 sightings), river otter (12 sightings), killer whale (10 sightings), and California sea lion (8 sightings) (WDFW, 2006). There are also several known pinniped haulout locations in the vicinity of Admiralty Inlet, the nearest being to the southeast for the proposed location for the demonstration project.

Harbor seals are the most common, widely distributed pinnipeds found in Washington waters and represented 86 percent of the marine mammals observed by WDFW between 1992 and 2004 (WDFW 2006). Jeffries et al. (2000) identified 13 harbor seal haulout locations in Admiralty Inlet. Harbor porpoise, the second most commonly observed marine mammal in Puget Sound, are relatively common and can be observed in the region year-round (Calambokidis and Baird, 1994; further discussion in §3.2). Seasonal changes in abundance along the west coast have been noted; however, movement patterns are not fully understood. In recent years, the population of harbor porpoise in Puget Sound has increased significantly relative to the 1970's. The factors underlying this increase are not entirely understood.

The Southern Resident killer whale (SRKW) is one of four distinct population segments of resident killer whales in the northeastern Pacific, whose range extends from Alaska to California (Krahn et al., 2002; Krahn et al., 2004). This distinct population segment consists of three pods (one or more matriline groups traveling together), designated J, K, and L pods, that reside for part of the year in the inland waterways of Washington State and British Columbia (Strait of Georgia, Strait of Juan de Fuca, and Puget Sound), principally during the late spring, summer, and fall (Bigg, 1982; Ford et al., 2000; Krahn et al., 2002). Pods can be found in Puget Sound year-round, but during fall, winter and spring, SRKW are more prone to excursions out of Puget Sound and can be seen as far south as California. Winter and early spring movements and distribution are largely unknown for the population (NMFS, 2008). The majority of sightings occur at locations off San Juan Island where there have been 750 to 1,550 sightings from 1993 to 2005. At locations in Admiralty Inlet, in the vicinity of the Project, between 6 and 25 sightings of SRKW were recorded annually from 1990 to 2005 (NMFS, 2009). From January 1990 through December 2008, the Orca Master database recorded 2,532 sightings of SRKW in Puget Sound "proper" (south of Deception Pass and Admiralty Inlet), and of those, 196 occurred within 5 nautical miles (9 km) of the proposed Project (Whale Museum, 2009).

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Between October 2009 and April 2010 land- and boat-based observations of marine mammals were made in the study area (a 5 nautical mile (9 km) radius around the proposed Project deployment site). Overall, 2,145 sighting locations were recorded of seven marine mammal species. Harbor seals were observed most often, occurring on 95 percent of survey days and accounted for 49 percent of all sightings, with a total of 1,041 sightings recorded on 110 separate days (Tollit et al., 2010).

Members of all three SRKW pods were identified during boat-based observations. In summary, a total of 11.5 hours of focal sampling were conducted. During this time, SRKW spent most of their time in the study area traveling (74 percent), while the remainder of the time was spent foraging (21 percent) and socializing (5 percent) (Tollit et al., 2010). Dive depth information was collected using a vertical hydrophone array deployed from a boat. During seven SRKW transits, a total of 655 calls and clicks were localized at depths from the surface down to 142 meters; however, 80 percent of the vocalizations were produced at depths of 30 meters or less, with little difference in average depth by behavior category. During the closest approach to the proposed Project site (October 21, 2009), while the focal group was categorized as foraging, depths from 23 to 58 meters were recorded from eight calls and clicks. The focal studies indicated that there is great variability in SRKW vocalization rates when transiting through the study area (0 to 92 percent of recording time). Periods with little or no vocal activity were witnessed, most notably on October 10, 2009, when the pods were described as undertaking slow (thought to be restful) travel (Tollit et al. 2010).

3.2 Harbor Porpoise Echolocation Activity

Pre-installation studies intended to characterize the physical and biological variability in northern Admiralty Inlet have included cetacean click detectors (C-PODs, Chelonia, Ltd.). These specialized hydrophones detect clicks, which may be of cetacean origin, and log characteristic information. In post-processing, a classifier is used to detect trains that are of cetacean origin (as distinct from clicks caused by sediment transport, boat sonars, etc.). Seasonal variability in harbor porpoise activity is shown in Figure 4, in terms of detection positive minutes per day (i.e., the number of minutes each day in which porpoise are detected). In absolute terms, porpoise presence can be quite high, approaching 800 DPM/day (more than 50% of all minutes). Significant seasonal variability is observed, as well as a pronounced diel inequality (presence much more likely during the night than during the day). These strong patterns of activity and high relative abundance offer potentially greater ability to detect behavioral changes associated with the operation of tidal turbines at this location.

Additionally, "landmark" activity recorded by C-PODs provides a mechanism to directly evaluate harbor porpoise awareness of the turbines. A "landmark" is defined as a sequence of echolocation click trains with linearly decreasing inter-click intervals (ICI). This pattern indicates cetaceans approaching the instrument and actively echolocating at the C-POD, its mooring, or other nearby object (Chelonia user guide). The name for the behavior is derived from the use of such "landmarks" by harbor porpoises for the purpose of navigation. Landmark sequences are identified by cpod.exe software and must be analyzed manually for validity. A typical sequence indicative of landmark behavior recorded during the deployment is depicted in Figure 3. These sequences can be used to roughly estimate the distance at which porpoises becomes aware of their echolocation target (Chelonia user guide).

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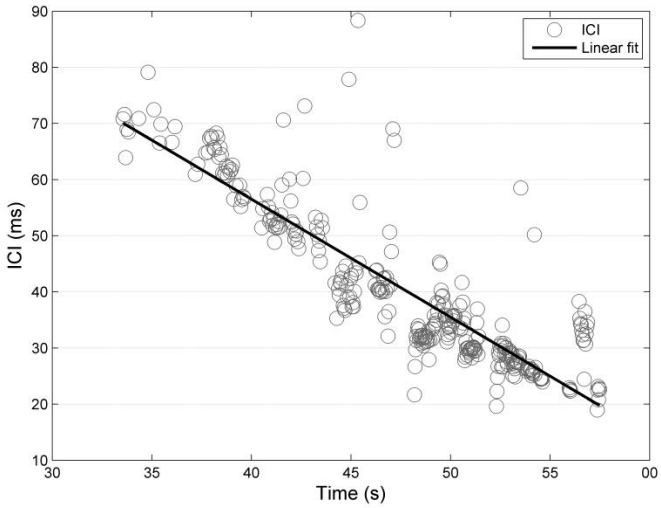

Figure 3 – Typical landmark sequence

A total of six highly likely landmark sequences were identified in the year of data from May 2010 – May 2011 from a single C-POD (Unit #718). As given by the equation above, the average initial distance from the instrumentation package at the start of a landmark sequence was approximately 60 m. The sequences also indicate approaches to within 20 m of the instrumentation, on average. The farthest distance at which a landmark sequence begins is estimated to be approximately 90 m.

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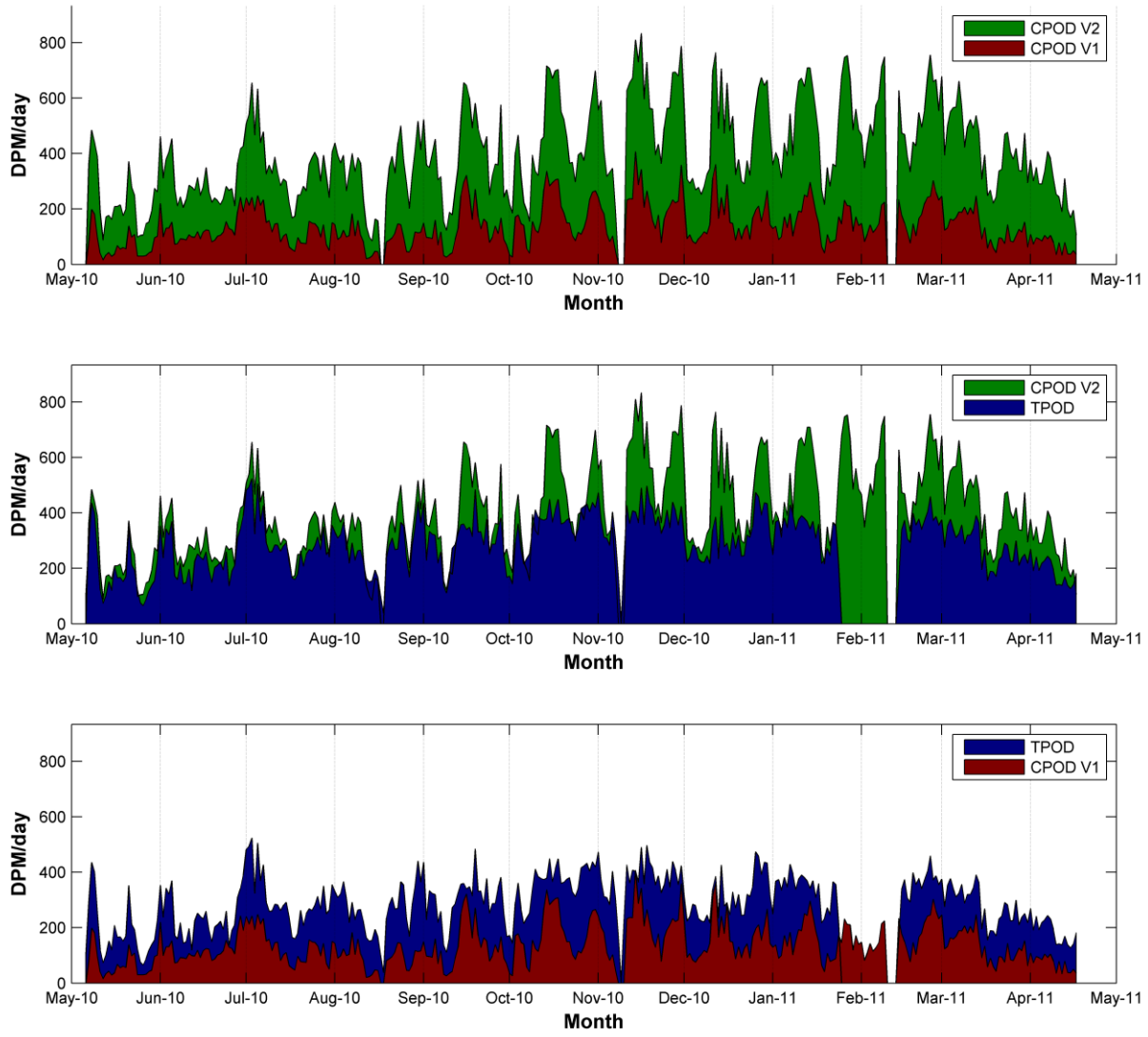

Figure 4 – Porpoise detection positive minutes per day, as classified by different instrument/software combinations (Collar et al., 2012). Notably, DPM statistics depend significantly on the type of instrument (T-POD vs. C-POD) and version of software used for the analysis. This complicates comparison of data between projects where different versions of the software are employed.

3.3 Pre-Installation Acoustic Effects Estimate

There has been limited, though high profile, monitoring of marine mammals at other tidal energy projects, principally for the Marine Current Turbines (MCT) SeaGen demonstration in Strangford Lough, Northern Ireland and the European Marine Energy Center in the Orkney Islands, Scotland. Other projects that have undertaken pre-installation baseline surveys of marine mammal population and presence, similar to those described in § 3.1.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

3.3.1 Marine Current Turbines SeaGen Demonstration

For the Marine Current Turbines SeaGen demonstration in Strangford Lough, Northern Ireland, the two principal marine mammal concerns were, arguably, that (1) the sound produced by the turbine might create a barrier to harbor porpoise moving between the inner and outer Lough through Strangford Narrows and (2) that the rotating turbine might injure or kill harbor seals.

The potential for an acoustic barrier for harbor porpoise was assessed using T-PODs (the older, analog version of the C-POD click detectors used for this project). Monitoring of harbor porpoise echolocation activity took place before installation, during construction (which involved bedrock drilling to secure the jacketed pile foundation), and during operation. Harbor porpoise echolocation activity declined during construction activities, but returned to pre-installation levels thereafter, with no statistically significant differences between presence in the inner and outer Lough before construction and after operation began (Keenan, 2011). Additionally, marine mammal observers on shore and pile have confirmed transits of seals and harbor porpoise occur past the turbine while it is in operation, indicating the absence of a significant barrier effect.

To mitigate against potential mortality or injury to a protected population of harbor seals, the local regulator and MCT agreed to shut down the turbine when harbor seals are within a specified distance (currently, less than 100 m), as detected initially by a shoreline observer and currently by monitoring of active sonar. No seal mortality has occurred, but, because no monitoring of seal-turbine interactions has been possible, the actual risk to harbor seals remains unknown.

Carlson et al. (2012, appended) includes the results of recent research, modeling the consequences of collisions between killer whales and OpenHydro turbines in Admiralty Inlet. The results of this analysis suggest that should collision/strike occur, the consequences would not be severe. An analysis of this type was not undertaken for the SeaGen project and is a crucial difference between the emphasis on *mitigation* undertaken for that projects and the emphasis on *monitoring* proposed for this project.

3.3.2 European Marine Energy Centre

The European Marine Energy Centre (EMEC) is the leading worldwide test facility for tidal turbines. There are presently, multiple turbines under tests at the Fall of Warness, including a 6 m OpenHydro turbine mounted to a pile foundation (rather than a gravity base). Several species of marine mammals, including killer whales, are present in the Fall of Warness, but shoreline observers have not monitored them approaching the turbines (personal communication, Sue Barr, OpenHydro, Ltd.). Within the past year, EMEC has begun a more comprehensive marine mammal monitoring program, but the results are not yet available.

3.4 Pre-Installation Noise Detection Estimate

Marine mammal monitoring undertaken for both the SeaGen project and at the European Marine Energy Center have involved shoreline counts of marine mammals, stratifying these by spatial position (e.g., grid density) to evaluate potential behavioral changes as a consequence of turbine

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

operation. For these studies, observations have been further stratified by turbine operating state – either "on" or "off".

The most likely mechanism for marine mammal behavioral changes over a significant area is the potential for disturbance by turbine sound. As discussed in Southall et al. (2007), marine mammal behavioral responses to sound depend upon multiple factors, including the intensity and frequency of the received sound, behavioral state at the time sound is detected, and prior exposure to similar sounds. In areas of with variable ambient noise levels, such as Admiralty Inlet, the distance from a source that a sound would be detected is variable in time. Further, experience from the wind industry suggests that the sound produced by tidal turbines will vary as a function of power generated. Clearly, stratification of marine mammal counts by whether a turbine is "on" or "off" neglects most of these factors and is likely insufficient to detect what, at the pilot scale, may be subtle behavioral changes.

A key consideration in the development of marine mammal monitoring plans is the spatial extent of the area to be monitored. On one hand, surveying as broad an area as possible is desirable, in order to maximize the number of marine mammals observed. On the other, surveying as small an area as possible maximizes the spatial resolution of the information collected. This is a classic range-resolution trade-off and suggests that surveys be designed to collect information at high resolution within the area that behavioral changes are likely to be observed.

Polagye et al. (*in prep*) proposes a framework for evaluating the detection of turbine sound by marine mammals, with a specific application to the District's proposed demonstration project in northern Admiralty Inlet. It establishes an upper limit on the zone of behavioral responsiveness by estimating the zone of audibility (or, zone of detection) for turbine sound. Turbine sound is said to be audible if received levels (*RL*) exceed noise levels (*NL*), resulting in a positive signal excess (*SE*), as

$$SE = RL - NL \ .$$

Received levels are related to the source level (*SL*) of the sound as

$$RL = SL - TL + AG$$

where *TL* is the transmission loss and *AG* is the auditory gain of the receiver. Further, a sound will only be detected, regardless of the signal excess, if the received level exceeds species-specific hearing thresholds.

Even with a number of simplifying assumptions, there are a number of inter-related variables involved:

- *Noise level*: varies by frequency and in time. Low frequency ambient noise (i.e., < 1 kHz) is independent of tidal current velocity. However, high frequency ambient noise, which includes sound produced by mobilization of coarse sediments, does depend on tidal current velocity.
- *Source level*: varies by frequency and in time, in proportion to power generation, which is, in turn, dependent on tidal current velocity.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

- *Transmission loss*: varies by frequency and with position in three-dimensional space relative to the source.
- *Hearing threshold*: varies by frequency and by species.

Polagye et al. (*in prep*) proposes a framework to evaluate the probability of a particular class of marine mammal (e.g., mid-frequency cetacean) detecting turbine sound in a particular one-third octave band at a particular location in space over all possible ambient noise levels and received levels as:

$$p(d_{x,y,z,f}) = \sum_i \left(\sum_j d(NL_j, RL_i, HT)\, p(NL_j | RL_i) \right) p(RL_i)$$

The terms correspond to the following:

- $p(d_{x,y,z,f})$: the probability of sound in a particular one-third octave band (f) being detected at a particular position in space (x,y,z).
- $d(NL_j, RL_i, HT)$: detection of sound (1 = detection, 0 = no detection) for a particular combination of noise level (*NL*), received level (*RL*), and species/frequency-specific hearing threshold (*HT*) for a particular frequency and position in space.
- $p(NL_j | RL_i)$: the probability of a particular noise level occurring as a particular frequency, given a received level (for frequencies greater than 1 kHz, these are related via current velocity).
- $p(RL_i)$: the probability of a particular received level occurring for a particular frequency and position in space.

The summation results in an overall probability of detecting turbine sound at a given frequency and position in space. The following series of figures visualize the results by marine mammal functional group for the area in the vicinity of the two proposed OpenHydro turbines. For each functional group, six one-third octave bands are visualized. For the first four frequencies (50 Hz, 160 Hz, 500 Hz, and 2000 Hz), these represent relative peaks in the turbine sound spectrum. For the last two (8 kHz and 25 kHz), these represent important frequencies for marine mammal communications.

These results are, by necessity, subject to a number of assumptions (e.g., the variation of turbine sound intensity with tidal currents, uncertainty in hearing thresholds). Evaluating the validity of the sound production assumptions is a key aspect of the Acoustic Monitoring and Mitigation Plan. The results shown here represent updated hearing threshold information from that presented in the appended, draft version of Polagye et al., which was supplied by Marla Holt at the Northwest Fisheries Science Center. This information will be incorporated into a revised version of the manuscript in the near future.

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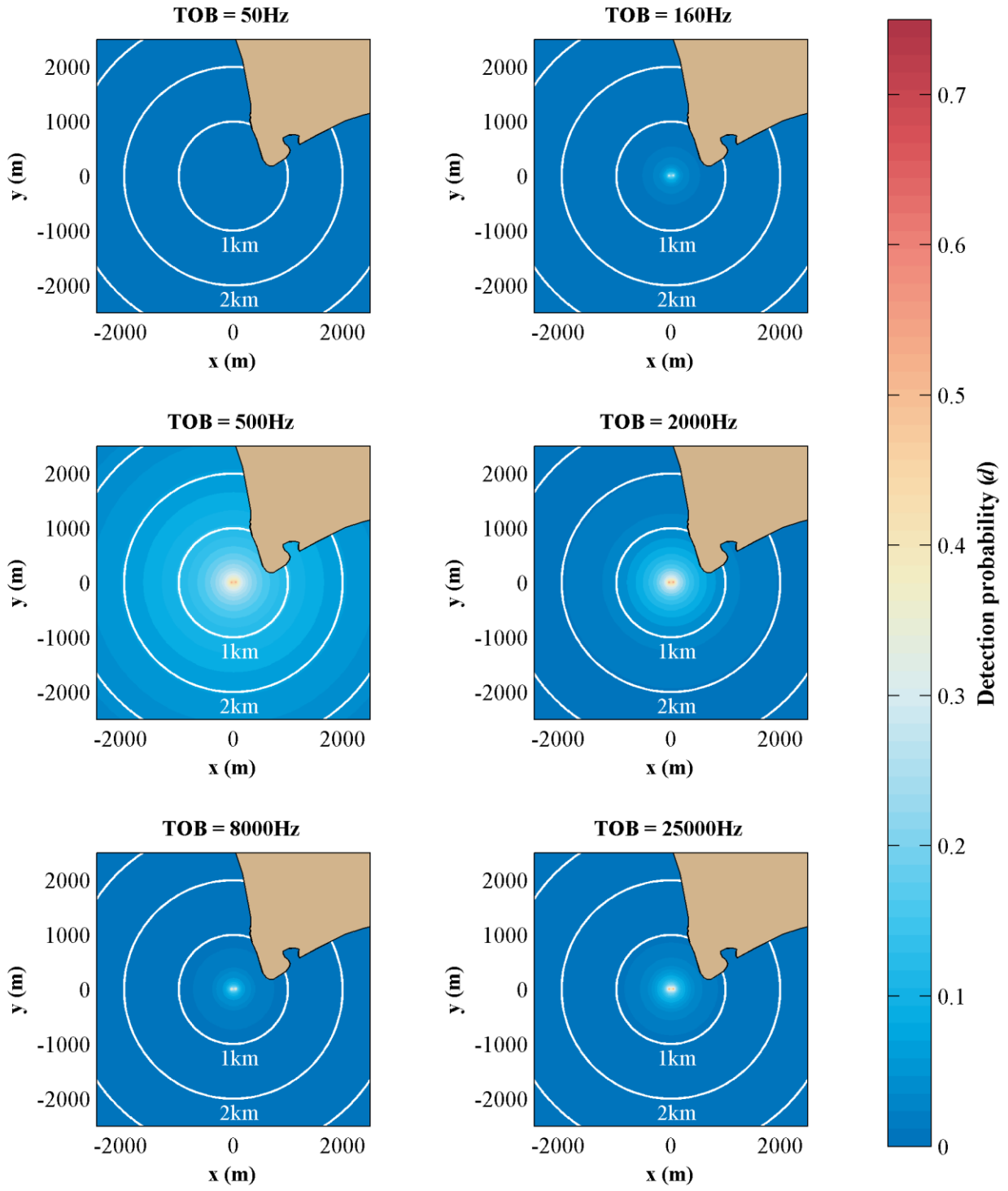

Figure 5 – Probability of mid-frequency cetacean (killer whale) detecting turbine noise (30 m depth relative to surface) (Polagye et al., *in prep*).

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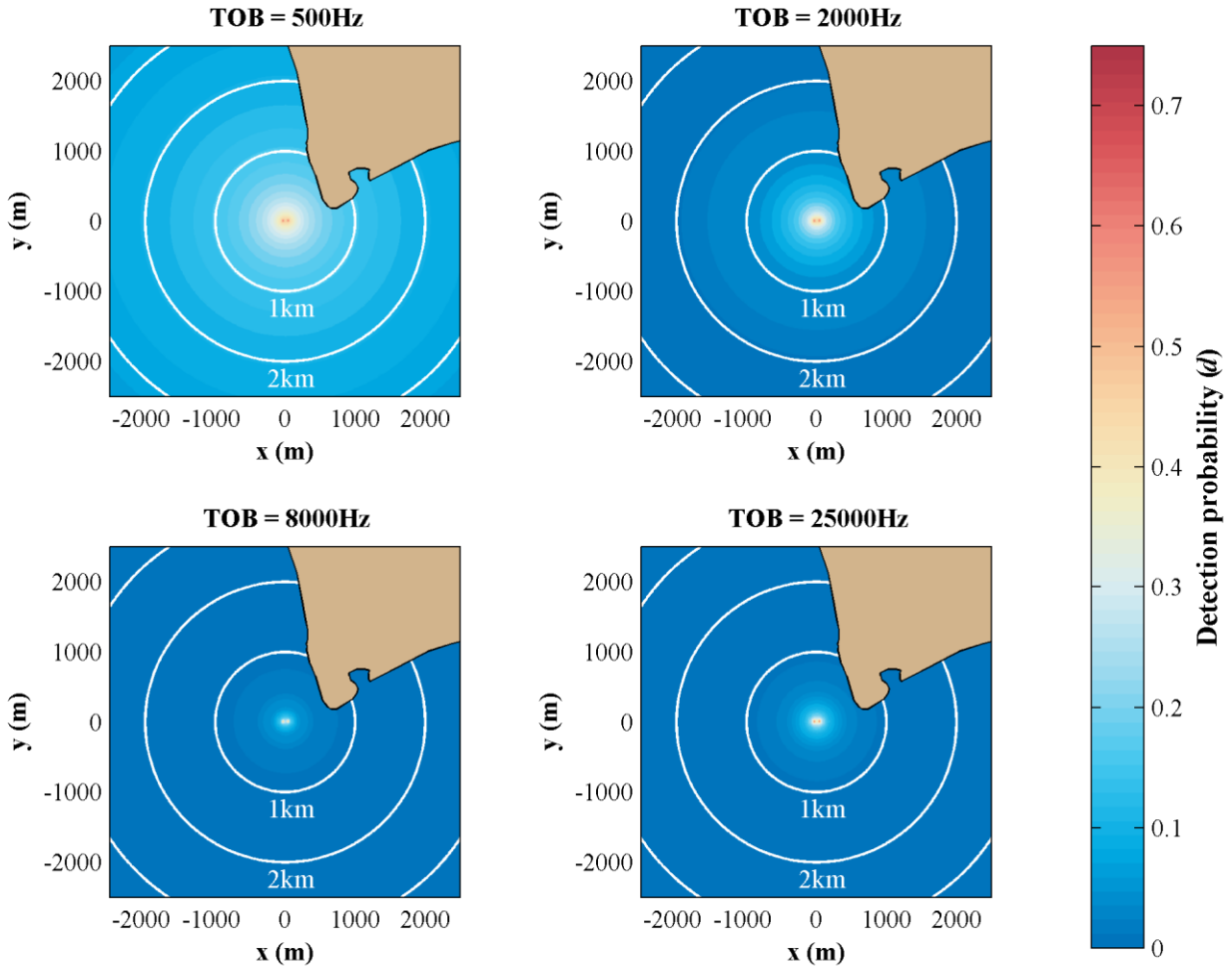

Figure 6 – Probability of high-frequency cetacean (harbor porpoise) detecting turbine noise (30 m depth relative to surface) (Polagye et al., *in prep*). Note: due to harbor porpoise hearing sensitivity, no turbine sound at 50 Hz or 160 Hz is likely to be detected at any range and under any operating condition.

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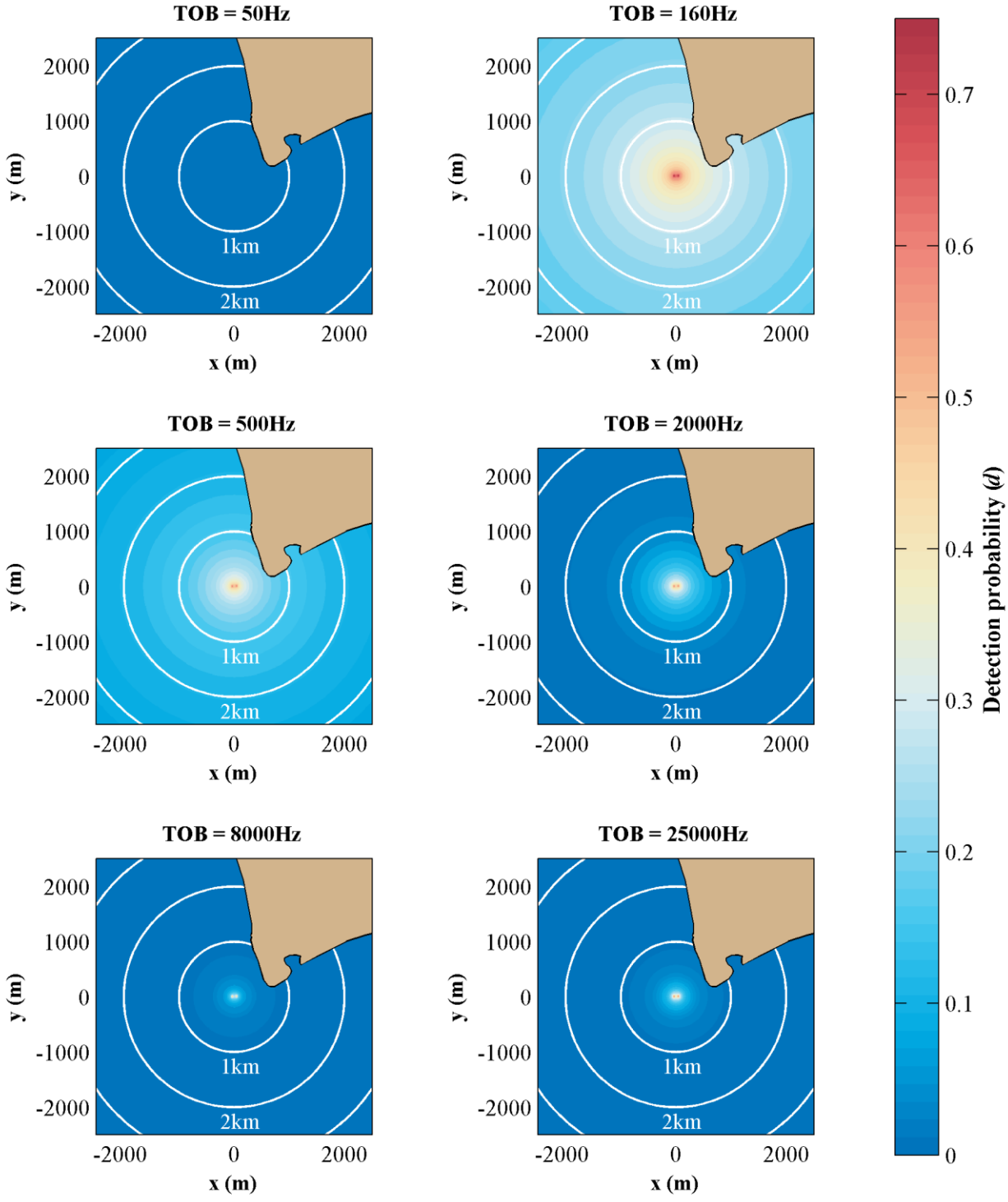

Figure 7 – Probability of pinniped (harbor seal) detecting turbine noise (30 m depth relative to surface).

Detection of turbine sound by three marine mammal classes is presented in Figure 5-Figure 7. A single species has been chosen as having representative hearing thresholds for each class:

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

- Mid-frequency cetacean: killer whale
- High-frequency cetacean: harbor porpoise
- Pinniped: harbor seal

Low-frequency cetaceans are not included in this assessment because audiograms do not exist for this class of marine mammal (Southall et al., 2007).

For mid- and high-frequency cetaceans, sound detection is most probable for the one-third octave band centered at 500 Hz. The probability of sound detection falls to less than 20% within 1 km of the turbines. For pinnipeds, sound detection is most probable for the one-third octave band centered at 160 Hz and is reasonably probable to a range of several kilometers.

Since detection of sound is a necessary, but not sufficient, condition for a behavioral response (particularly for pinnipeds), these results suggest that the area of study for the marine mammal plan should be on the order of 1 km in radius, centered on the turbines.

4.0 PLAN OBJECTIVES AND GOALS

The goal of the Marine Mammal Monitoring and Mitigation Plan is to detect and observe marine mammals in the Project area, during turbine installation, operations, and removal in order to provide information about potential avoidance of the turbines, attraction to the turbines, or changes to activity state caused by the turbine. Another goal is to then use this information to modify the project if needed to provide mitigation and resource protection.

The plan seeks to test three hypotheses, and, in doing so, reduce the existing uncertainty around the interactions between marine mammals and tidal turbines. These are arranged around three functional groups: pinnipeds (specifically harbor seals and Steller sea lions), harbor porpoise, and killer whales (Southern Resident and transient). These species represent those groups that are present in the Project area at levels sufficient to undertake robust analyses (Tollit et al., 2010).

- *Hypothesis 1*: Pinnipeds may respond to the acoustic stressors from turbine operations or prey aggregations through attraction or avoidance.
- *Hypothesis 2*: Harbor porpoise may respond to the acoustic stressors or prey aggregations through attraction or avoidance. Their high rate of occurrence in the Project area provides an opportunity to conduct studies with greater statistical power than for other marine mammals.
- *Hypothesis 3*: Killer whales may respond to the acoustic stressors or prey aggregations in the vicinity of the turbine through attraction, avoidance, or change in activity state. Their endangered and iconic status warrants special consideration.

To accomplish these goals, the District will conduct the Monitoring and Mitigation Plans laid out in this document and consult with the Admiralty Inlet Marine Aquatic Resource Committee (MARC) to consider modification to this Plan and the project in response to the results of marine mammal monitoring efforts or acoustic monitoring efforts.

Land and acoustic-based observations of marine mammals in the Project vicinity will compliment efforts and expertise already in place, as represented by the Orca Network, Beam

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Reach Marine Science and Sustainability School, National Oceanic and Atmospheric Administration (NOAA) and the Whale Museum.

Additionally, during project installation and removal the District will follow NOAA guidelines for vessel operations around marine mammals. Specifically, if a listed cetacean occurs within 500 meters, or listed pinniped occurs within 100 meters of an installation or removal vessel, installation or removal operations will be halted. Once the listed cetacean or pinniped leaves the vicinity, installation or removal operations will resume.

5.0 POST-INSTALLATION MONITORING AND MITIGATION PLAN

Marine mammal behavioral responsiveness to noise is a well-known, but not well-understood in terms of relating a particular sound to a specific response (e.g., as discussed in Southall et al., 2007). The acoustic stressor from project operation is, however, likely to be the first cue associated with the project that is detected by marine mammals. The zone of audibility establishes an upper bound on the zone of responsiveness. As described in Polagye et al. (*in prep*), given assumptions regarding the time variation of turbine noise and pre-installation measurements of ambient noise, the zone of audibility likely extends no further than a few hundred meters around the turbines for mid-frequency cetaceans, high-frequency cetacean, and pinnipeds. The zone of audibility for low-frequency cetaceans is likely to be somewhat greater, but cannot be estimated with certainty due to a lack of audiogram information for this class of marine mammal. This also precludes quantitative studies of this functional group. A clear difference between these proposed studies and past marine mammal studies for tidal energy projects is that observations will be stratified by stressor (e.g., signal excess of turbine sound) rather than simply observation of the proximity of a marine mammal to the turbines. A combination of scan sampling (pinnipeds) and continuous focal individual/group sampling (killer whales and harbor porpoise) will be used by land-based observers.

All observations are restricted to a circular study area with radius referenced to the "acoustic center" of the project (i.e., a point midway between the two turbines). The study area radius will be between 500 m and 1000 m (Figure 8) The study area extent needs to balance between identifying targets before they enter the zone of audibility (larger study area preferred) and well-resolved observations of marine mammals in time and space (smaller study area preferred) . The study area will be finalized in consultation with the MARC following a demonstration of marine mammal monitoring techniques in the fall of 2012. This will consist of a day of monitoring in which trained observers will follow the protocols outlined in the following plans using either reticle binoculars (lower accuracy, easier to use) or theodolite (higher accuracy, hard to use). High definition video capture will also be obtained to evaluate utility for tracking groups referenced to theodolite/reticule observations.

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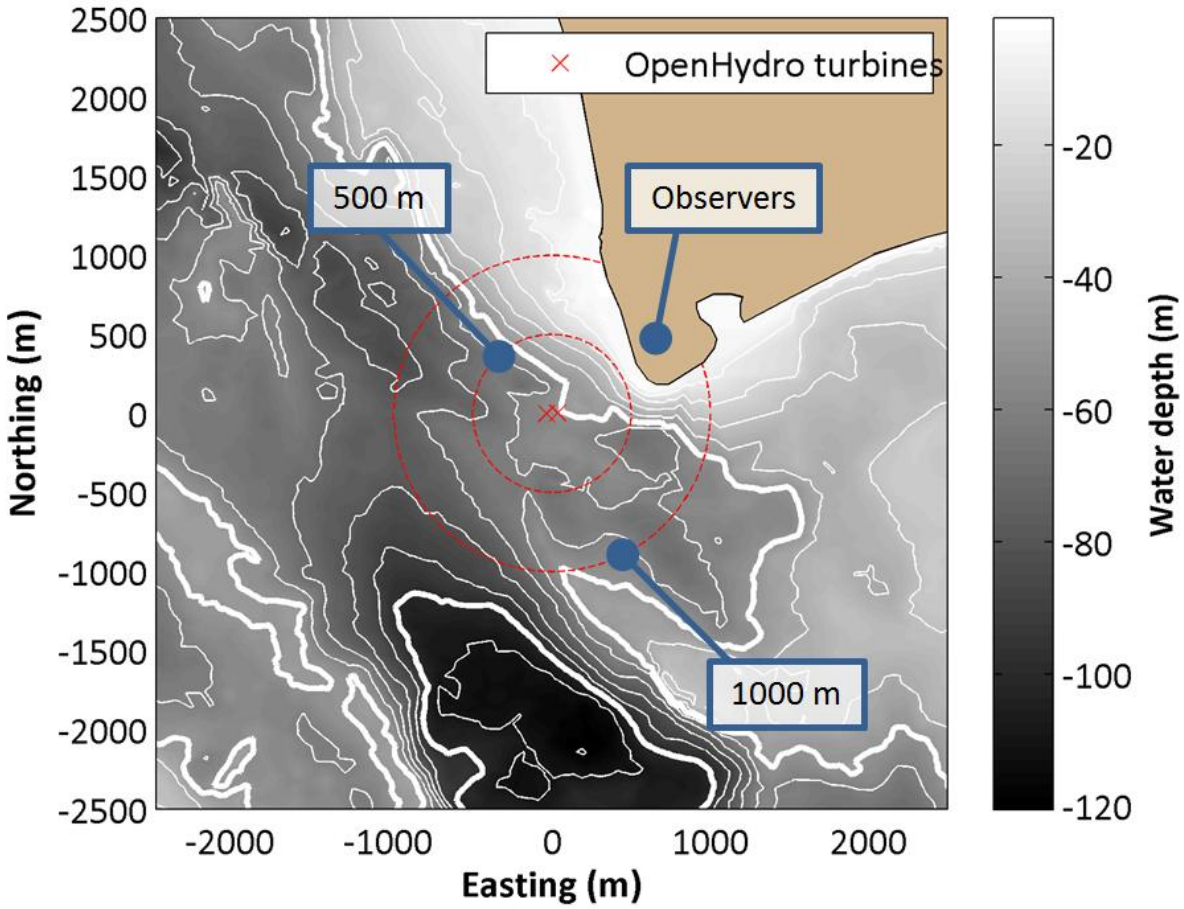

Figure 8 – Admiralty Inlet showing possible study area boundaries (500 m or 1000 m) and probable observer location.

All observations are stratified by the zone of audibility for each functional group (pinnipeds, harbor porpoise, and killer whales). This reduces variations in ambient noise and tidal currents to a single variable, simplifying presentation and interpretation of results. Information about the location of vessels and turbine power generation state will be used to develop time series estimates for turbine sound and ambient noise in one-third octave bands. These will be combined with knowledge of marine mammal hearing thresholds to establish the zone of audibility. Specifically, turbine sound will be estimated using the information from the Acoustic Monitoring and Mitigation Plan that relates source levels (radiated noise levels at 1 m) to power generation state. Ambient noise (frequencies < 1 kHz) will be estimated from vessel presence recorded by an Automatic Identification System receiver using a frequency-dependent model based on the broadband model described in Bassett et al. (*in press*). Higher frequency sound (i.e., > 1 kHz) is dependent on current velocity (Bassett et al., *submitted*), but the zone of audibility is likely to be greatest below 1 kHz (Polagye et al., *in prep*), meaning that this dependence can be neglected. Shoreline marine mammal observers will not have foreknowledge of the zone of audibility, meaning that this will be a blind observation, reducing potential for bias.

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5.1 Pinniped Response to Turbine Presence

5.1.1 Objective

Pinniped responsiveness to turbine noise will firstly be evaluated by 2-3 experienced shoreline marine mammal observers positioned on Admiralty Head (lower gun emplacements on the bluffs at Fort Casey, 48 09.286N, -122 40.686). Observations will focus on identifying attraction or avoidance within the zone of detection for turbine noise. All pinnipeds (e.g., harbor seals, Steller sea lions) will be categorized within this function group to increase sample size and, therefore, statistical power to detect changes. The objective is to detect and observe pinnipeds in the project area during turbine installation, operation, and removal in order to provide information about potential attraction to the turbines, avoidance of the turbines, or changes to activity state within the zone of detection for turbine noise. This information will then be used to modify the Plan or project operations, if needed, to provide mitigation and resource protection.

5.1.2 Data Collection

Equipment Description

The locations of pinnipeds identified during scans will be determined using either a tripod mounted theodolite (±2 m accuracy at a range of 2 km) or reticle binoculars. The decision of whether to use a theodolite (higher accuracy, more difficult to use) or reticle binoculars (lower accuracy, easier to use) will be determined, in consultation with the MARC, following a field test in the fall of 2012. Unlike studies of Southern Resident killer whales and harbor porpoise, video information will not be collected during pinnipeds scans since prior experience (pers. comm., D. Tollit, SMRU, Ltd.) suggests that observations at this distance are unlikely to be able to reliably determine behavioral state for pinnipeds in water.

Survey Procedure

The specific locations of pinnipeds within study area will be determined by theodolite or reticle binoculars using a scan sampling technique. Scan sampling is best done with a sample interval as short as possible (Mann, 1999). Given the small area under observation, seven minute scan blocks will be undertaken (five minutes scanning, followed by two minutes rest). Each scan will consist of observations from left to right across the study area in a systematic manner, recording the locations of all pinnipeds present. *Ad libitum* information on behavior (e.g., feeding events) and group structure (if applicable) will be recorded when possible in the event that an odd behavioral event is observed. Prevailing metocean conditions will also be noted for each scan (Laake et al., 1998).

For each observation, location, species, and group size will be recorded. Only one location per individual or group will be recorded per scan period (e.g., a seal siting on the surface is recorded once during a five minute scan period).

Observations will be undertaken during daylight hours, at most light precipitation, fog less than Category II, and Beaufort Sea State less than 4. Scan effectiveness is likely to be lower when wind, rain, or currents are roughening the sea surface. There will be 400 hours of total observation effort over one calendar year. This is similar to marine mammal observations

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

undertaken by Marine Current Turbines for the SeaGren process in Strangford Lough, Northern Ireland (200 hours total observations) and pre-installation observations to establish species presence/absence in Admiralty Inlet. Observations are likely to be more difficult during the winter than in the summer, given regional weather patterns. Consequently, observers will attempt 250 hours of observations during winter (Oct. 1 – Mar. 31) and 150 hours of observations during summer (Apr. 1 – Sep. 30). During winter months, the percentage of attempted hours with good observations is likely to be lower than the summer (i.e., the total number of "good" observations should be the same between winter and summer, even though more observer effort is scheduled for winter months).

The observation period will be 6 hours per day, as limited by available daylight during the winter months. Observations in the winter and summer will be distributed among months (i.e., approximately 7 days each month during the winter, 4 days each month during summer). The timing of these observations will be selected in order to obtain data over a range of tidal conditions (equal stratification is not possible, given that lower tidal currents are more probable than high tidal currents), with preference given to obtaining data during strong currents when the sound produced by the turbine is likely to be greatest.

Scans will be discontinued to undertake (short) periods of focal animal follows if killer whales or harbor porpoise are detected within the study area (see flow chart in Figure 9).

During scans, vessel traffic will be monitored by an Automatic Identification System (AIS) on Admiralty Head. Turbine power generation state will be monitored using the turbine Supervisory Control and Data Acquisition (SCADA) system. This information will be used to estimate ambient noise and sound produced by the turbines during a scan.

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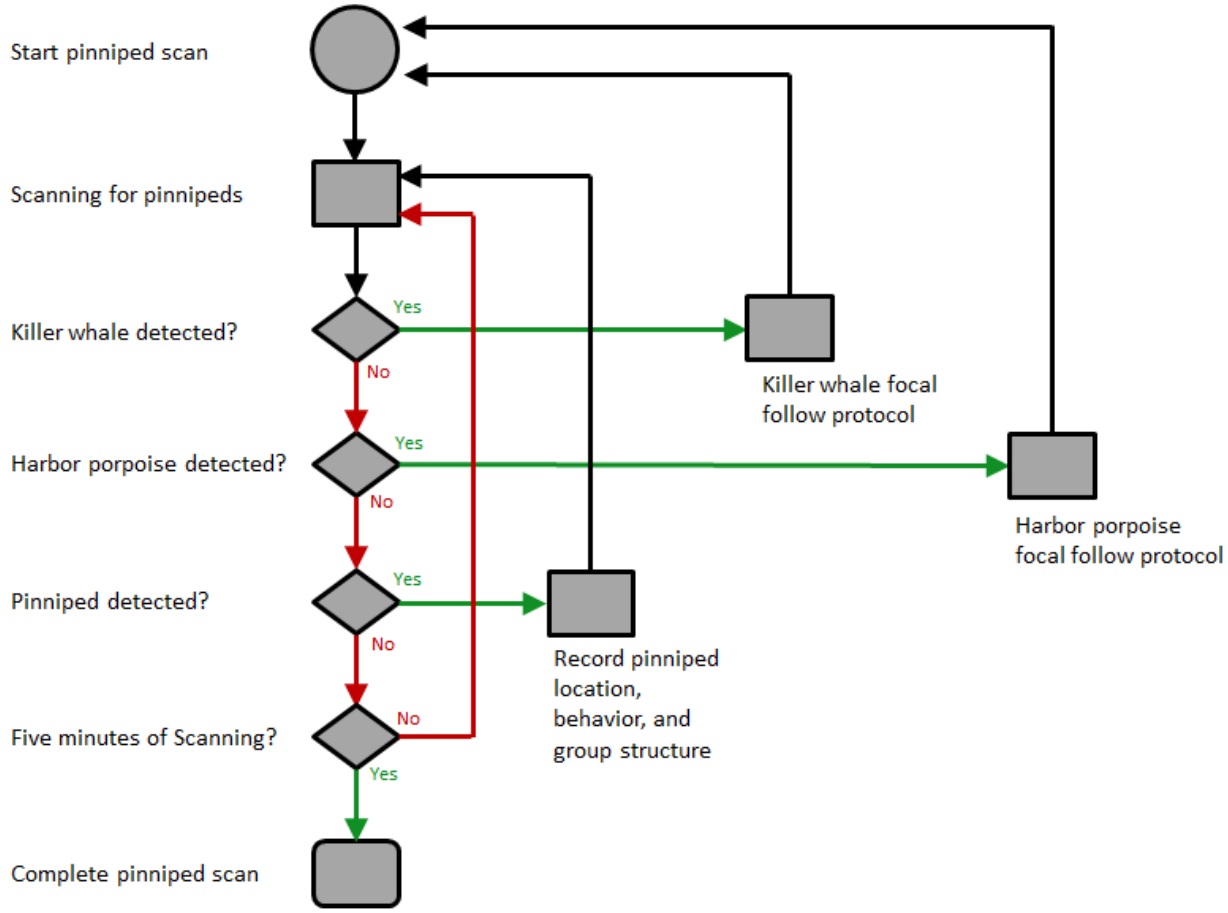

Figure 9 – Scan procedure for pinniped monitoring

5.1.3 Data Analysis

A time series of pinniped locations will be developed from theodolite/reticle binocular data. These locations will be mapped to grid cells around the turbines to quantify presence/absence. Initially, the grid spacing will be 100 m square (approximately 80 grid cells in the study area), but this may be refined during analysis based on consultation with the MARC. By retaining the raw time series data, it will be possible to remap observations to different grid resolutions, as needed.

Observations will be stratified by month, time of day, and presence of prey species in the vicinity of the turbines (as informed by the Near-turbine Monitoring and Mitigation Plan). The objective of the analysis will be to evaluate whether pinniped presence/absence is related to the signal excess of sound produced by the turbine. The relation between presence/absence and model variables (e.g., month, time of day, signal excess) is likely to be non-linear. Given the limited temporal and spatial separation between data points, the collected data is likely to violate assumptions of independence for many statistical tests. This correlation between data points will therefore need to be taken into account during statistical analysis and de-correlation time scales will be evaluated. Generalized Additive Models (GAM) have been used successfully on non-linear marine mammal data with final standard errors and *p*-values adjusted with Generalized

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Estimating Equations (GEE) to deal with the auto-correlation of data points (Keenan et al. 2011). A similar approach will likely be required here.

5.1.4 Reporting and Adaptive Management

Prior to the start of pinniped observations, the MARC will be consulted to establish the extent of the study area, based on the final results of the sound detection analysis in Polagye et al. (*in prep*) and results of observation trials in the fall of 2012.

Pinniped surveys will commence once the project is operational, with a preliminary, oral report made to the MARC within 60 days of turbine installation. On a quarterly basis, a report will be provided to the MARC describing number and species of pinnipeds observed within the survey area and the device operating state during these observations. Final written and oral reports will be made to the MARC within 120 days of survey completion (one calendar year of operation) describing the observations, statistical modeling approach, and results.

If the results of the Acoustic Monitoring and Mitigation Plan indicate that the extent of detectable turbine noise is greater or less than indicated by pre-installation estimates (i.e., Polagye et al., *in prep*), then the survey area may be expanded or contracted with the concurrence of the MARC.

Pinnipeds are food motivated. If the Near-turbine Monitoring and Mitigation Plan indicates that prey is aggregating around the turbines after the first calendar year of pinniped observations is complete (and such aggregations did not occur during the first calendar year), a short-term pinniped study (e.g., 2+ weeks observations) will be conducted to evaluate whether prey aggregations are affecting behavior in the vicinity of the Project. The specific study scope will be developed in consultation with the MARC. In conjunction with the MARC and with NMFS approval, as provided in section 6.0, this information will be used to inform project modifications, where necessary, to provide mitigation and resource protection.

5.2 Harbor Porpoise Response to Turbine Presence

5.2.1 Objective

Pre-installation acoustic monitoring indicates a high level of porpoise activity at this location (Tollit et al., 2010; Cavagnaro et al., *in prep*) and porpoise are known to be more adverse to acoustic disturbance than other marine mammals (though, at this site, there may be habituation to sound from shipping traffic – Polagye et al., *in prep*). Focal animal sampling (the type of sampling being conducted for this Plan), has greater statistical power to detect change than scan sampling and is more feasible for cetaceans than pinnipeds. Consequently, observations of harbor porpoise may have greater statistical power to detect behavioral change than observations of other marine mammals. Additionally, harbor porpoise echolocation can be used to provide additional information about activity state and awareness of the turbines. Therefore, the objective of this study is to both gather information and to use that information to determine if project modifications are necessary to provide mitigation and resource protection.

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5.2.2 Data Collection

Equipment Description

As for pinniped monitoring, harbor porpoise observations will be conducted with either a tripod mounted theodolite or reticle binoculars. Simultaneous high-definition video will be obtained of groups, after the techniques described by DeNardo et al. (2001).

The Adaptable Monitoring Package (AMP) on each turbine will be equipped with a pair of C-POD (www.chelonia.co.uk) click detectors. These will be recovered and redeployed every 3-6 months as part of the standard maintenance cycle. Redundancy is indicated from pre-installation experience with these instruments. If a cabled C-POD (provisionally, the "F-POD") becomes available of the lifetime of the project, it could be integrated into a spare port on the AMP to enable real-time click detections.

Collection Procedure

Continuous focal animal or focal group sampling will be conducted using the theodolite-video methodology (described in DeNardo et al., 2001) or a modified recticle binocular-video methodology. In either case, an animal, or group of animals, is tracked through the study area. Initial detection of harbor porpoise will be through the methodical scans undertaken for pinniped monitoring (§5.1). Observational data will, initially, be collected during pinniped surveys using the observational sampling procedure shown in Figure 9 by a single survey team. If significant survey overlap is found to exist (i.e., both pinnipeds and harbor porpoise are commonly within the study area and breaking off for harbor porpoise focal follows leads to a low number of complete pinniped scans), then, with the concurrence of the MARC, the pinniped and harbor porpoise observations will be handled by separate survey teams.

Focal follows of harbor porpoise will be discontinued if killer whales are detected (analogous to breaking off pinniped scans if harbor porpoise detected).

C-PODs on the turbines will be configured to limit detections of bedload transport (i.e., high pass filter set to 40 kHz). Pre- and post-deployment calibrations of C-POD sensitivity will be undertaken.

5.2.3 Data Analysis

Porpoise visual data: Using the theodolite/reticle binocular location data, the point of closest approach (POCA) and directionality (i.e., approach towards the turbines outside of zone of audibility and movement while inside zone of audibility) can be tested against the signal excess for turbine sound. Focal follows that are determined to begin inside the zone of audibility will not be included in analyses. Given that harbor porpoise were observed in 63% of the observation days during the pre-installation study, sufficient sample sizes to achieve useful statistical power should be achievable. If theodolite/reticule binocular accuracy for harbor porpoise observations is lower than expected, it may be necessary to convert locations to grid cells and analyze with GAM/GEE, as per the pinniped analyses.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

C-POD Detection Range: After Kyhn et al. (2012) porpoise visual data will be compared against click train information in order to assess C-POD detection range and develop empirical calibrations to predict absolute abundance on the basis of detections.

Changes to Porpoise Echolocation Activity: Comparisons will be made to pre-installation information (3+ years), in order to determine if statistically significant differences in echolocation activity, or trends in echolocation activity (such as night/day or seasonal variations, as determined by a Generalized Linear Model) have changed significantly as a consequence of turbine operation.

Instances of Landmark Activity: Using Chelonia, Ltd. software, the number and frequency of "landmark" click sequences (suggestive of harbor porpoise echolocating at the turbines and, therefore, awareness of their presence) will be determined and compared to number and frequency of pre-installation "landmark" click sequences associated with Sea Spider instrumentation packages. If a sufficient number of landmark events are observed, these will be stratified by turbine source level.

5.2.4 Reporting and Adaptive Management

A preliminary, oral report will be made to the MARC within 60 days of turbine installation and quarterly thereafter describing number of harbor porpoises observed within the study area by shoreline observers and the device operating state during these observations. A final written and oral report will be made to the MARC within 120 days of survey completion (one calendar year of operation) describing the observations, statistical modeling approach, and results.

If the results of the Acoustic Monitoring and Mitigation Plan indicate that the extent of detectable turbine noise is greater or less than indicated by pre-installation estimates (i.e., Polagye et al., *in prep*), then the survey area may be expanded or contracted with the concurrence of the MARC.

If a statistically significant effect on echolocation activity is observed due to turbine operation, the MARC will determine whether a gradient study could be used to determine the spatial extent of this change. If the C-POD information suggests that harbor porpoise echolocation is unchanged by the presence/operation of the turbines, then data collection with C-PODs will continue over the lifetime of the project, but without analysis.

If harbor porpoise and pinniped scans overlap to the point that harbor porpoise focal follows are significantly reducing the effectiveness of pinniped observations, then, with the consent of the MARC, a separate observational team will be tasked for pinniped and harbor porpoise observations. In conjunction with the MARC and with NMFS approval, as provided in section 6.0, this information will be used to inform project modifications, where necessary, to provide mitigation and resource protection.

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5.3 Killer Whale Response to Turbine Presence

5.3.1 Objective

Killer whales are an iconic species in Puget Sound. The National Marine Fisheries Services designates Southern Resident killer whales as endangered and the State of Washington extends this designation to all killer whales (Southern Residents and transients). In recognition of this, the Marine Mammal Monitoring and Mitigation Plan allocates a higher intensity of effort to observing their behavioral response to the turbines than other marine mammals. Information about how killer whales interact with tidal turbines must be established before larger-scale or longer-term tidal energy installations could be considered in Admiralty Inlet. Unlike pinniped and harbor porpoise monitoring, monitoring of killer whales will continue throughout the project lifetime and utilize shore-line observers, localizing hydrophones, and the near-turbine monitoring system. These tools will be utilized in a rapid-response mode when killer whales (Southern Resident or transient) are transiting through Admiralty Inlet. The objectives of gathering this information are both to learn more about orca interaction with the turbines and to prevent harm to orcas through mitigation based on this information.

5.3.2 Data Collection

Equipment Description

Observations will utilize the same equipment and procedure as described for harbor porpoise (§5.2). Reticule binoculars are more likely to be used in concert with high definition video than theodolites because of the logistical challenges of mobilizing an observer trained in the use of a theodolite in a rapid-response mode. Observations obtained during pinniped/harbor porpoise monitoring may be more likely to utilize a theodolite.

Shoreline observations will be complimented by two monitoring systems located on the turbine foundation: a passive acoustic array and the near-turbine monitoring system (described in the Near-turbine Monitoring and Mitigation Plan). The passive acoustic array is intended to localize marine mammal vocalizations and will consist of four hydrophones installed on *one* of the turbine foundations, as shown conceptually in Figure 10. The hydrophones will have a functional frequency range up to at least 200 kHz in order to detect killer whale vocalizations. Unlike the hydrophone described in the Acoustic Monitoring and Mitigation Plan, these hydrophones will not be shielded from flow noise, as the frequencies associated with killer whale vocalizations do not overlap with frequencies associated with flow noise. The localizing array is not part of the Adaptable Monitoring Package (AMP) and, consequently, cannot be serviced over the lifetime of the project. Should the array fail, its function could be replicated by a vertical line array deployed from a drifting vessel in a rapid response mode.

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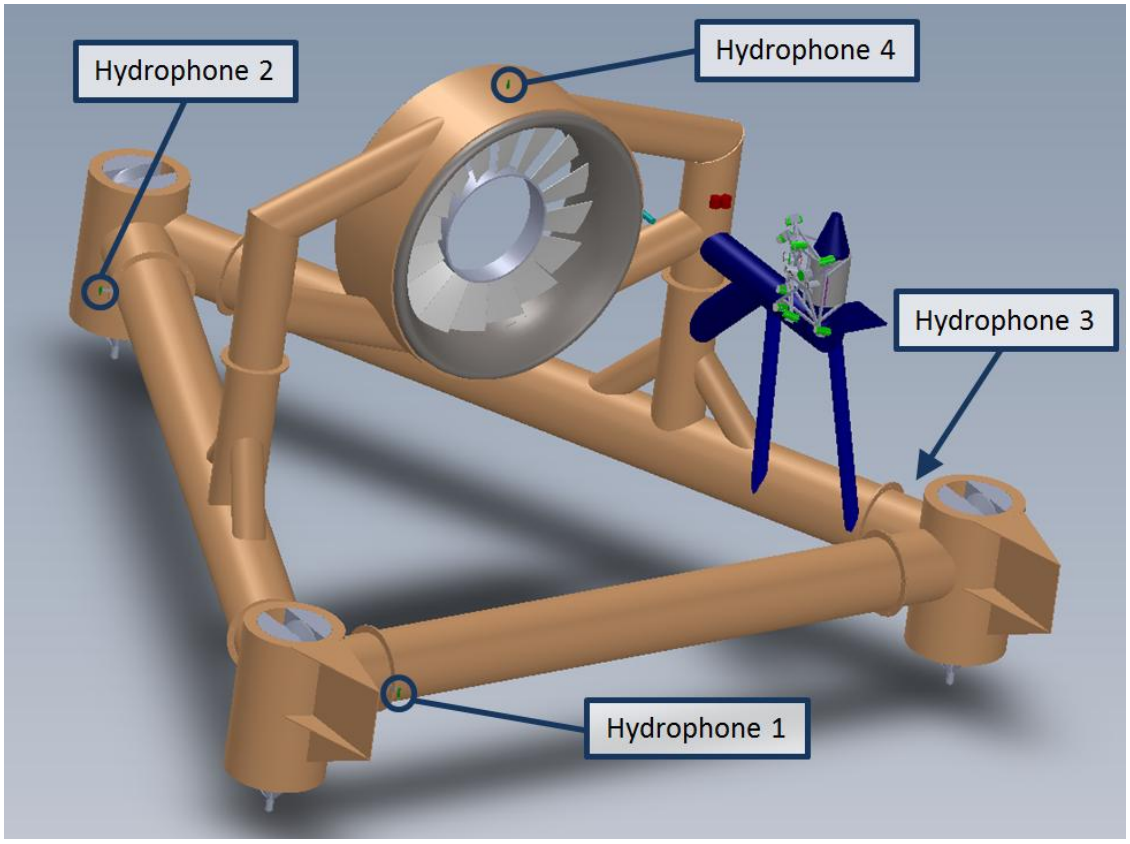

Figure 10 – Passive acoustic array on OpenHydro turbine. Hydrophone configuration is preliminary.

Killer whale monitoring will also include an update to the hydrophone at the Port Townsend Marine Science Center, in order to increase the likelihood of effective rapid response and to support observer networks in Puget Sound.

Collection Procedure

Upon auto-detection of killer whale calls on the hydrophones on the turbine, the hydrophone at the Port Townsend Marine Science Center, or a sightings report via the enhanced Orca Network sightings network , a land based observing team will respond to Admiralty Head and commence data collection. Of the 14 daytime transits of Southern Resident killer whales through Admiralty Inlet during the 7 month pre-installation study, the land response team was able to collect data on 10 transits (71%).

Shoreline observers will select the most appropriate focal group of killer whales (the ones that appear most likely to approach study area). If several groups are present, observers will focus on the group likely to pass closest to the turbines and maintain the focal follow even if, during the transit, another group passes closer to the turbines. Using the reticle binoculars/theodolite and video, the location, time of surfacing, behavior state, and surface active behaviors (SAB) of the focal group will be recorded. Depending upon initial results, observers may wish to prioritize males for focal follows, due to ease of identification and tracking. Any such changes to the observational protocol will be made with the agreement of the MARC.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Rapid response will be initiated for any killer whale siting, either Southern Residents or transients.

Data from the hydrophone array will be streamed back to shore and archived for subsequent analysis of killer whale location, call rate, and echolocation click rate. Analysis will be conducted for all transits, even those for which a rapid response team is unable to mobilize to Admiralty Head to conduct shoreline observations. Transient killer whales vocalize infrequently, since their vocalizations are audible to their prey.

The near-turbine monitoring system can be used to evaluate close-range interactions. The system is capable of operating at high frame rate (i.e., 10 frames per second) for extended periods of time. In consultation with the MARC, a sampling strategy for the camera system will be developed that minimizes the risk of confounding impacts (startle response, attraction, or avoidance) as a consequence of operating the system.

During all observations, vessel traffic will be monitored using the AIS on Admiralty Head, current velocity will be monitored using the Doppler profilers on the turbines, and turbine power generation state will be monitored by the SCADA.

5.3.3 Data Analysis

Unlike harbor porpoise or pinnipeds, the number of killer transits will not be large enough to employ a grid-based GAM/GEE analytical approach, as power to detect change will be too low. In order to test the hypotheses of attraction/avoidance or behavioral change, the following metrics will be used:

- Directionality of transit
- Surfacing interval
- Behavior state
- Surface active behavior (SAB)
- Click rate
- Call rate.

These metrics will be stratified by signal excess of turbine sound within the zone of audibility. Focal follows that are determined to begin inside the zone of audibility will not be included in analyses.

Given the small number of transient killer whale transits through Admiralty Inlet each year, statistical power to detect effects on transients will be too low to treat them as a distinct functional group. Consequently, two functional groups will be established for analysis and reporting. The first will be a mid-frequency cetacean group consisting of Southern Resident and transient killer whales. Analyses for this group will involve only non-vocal metrics (i.e., exclude click rate and call rate) due to differential vocalization between the two species. The second functional group will be Southern Resident killer whales. Analyses for this group will include all metrics described above.

All tests will use repeated measures general linear model designs (Neter et al., 1996; Deecke, 2006) to control for other known sources of variance and to increase the power of the tests.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Although the point of closest approach (POCA) could be used as a dependent variable, preliminary power analyses for POCA which would involve a control of turbine non-operating period (and therefore not a repeated measures design), indicate a sample size of ~29 transits for the coarsest possible grouping (turbine operational, non-operational) would be needed to detect a 30% effect size. In other words, each transit yields one observation of POCA, but multiple observations of the behavioral parameters outlined above. Sample size requirements would further increase if, as expected, observations need to be stratified by power generation (and, by extension, extent/intensity of acoustic stressor). Therefore, POCA is not considered a worthwhile test metric for detecting turbine acoustic impact for killer whales.

For all other metrics, initial power analyses indicate the need for a sample size of ~16 transits to detect a 30% change (Appendix 3). This is more achievable, but will ultimately depend on the number of daytime transits of killer whales during the turbine deployment.

The results of near-turbine monitoring will be used to evaluate whether prey was likely aggregated near the turbine during transit (attractive effect). Analysis of vocalizations detected by the hydrophone array will provide probable location (*x*,*y*,*z*) and activity state for individuals (implied from call and click rates).

5.3.4 Reporting and Adaptive Management

A preliminary, oral report will be made to the MARC within 7 days of each transit describing number of killer whales observed within they study area, the device operating state during these observations, and any notable behavioral changes. A final written and oral report will be presented to the MARC with 120 days of the end of each calendar year of operation.

If survey approach described here does not provide useful information about killer whale interactions with turbine, the MARC may modify the survey methodology.

If the results of the Acoustic Monitoring and Mitigation Plan indicate that the extent of detectable turbine noise is greater or less than indicated by pre-installation estimates (i.e., Polagye et al., *in prep*), then the survey area may be expanded or contracted with the concurrence of the MARC. In conjunction with the MARC and with NMFS approval, as provided in section 6.0, this information will be used to inform project modifications, where necessary, to provide mitigation and resource protection.

6.0 APPROACH TO ADAPTIVE MANAGEMENT AND MITIGATION

In implementing this Plan, the District will consult with the MARC as appropriate on the technical issues described above and data interpretation associated with the monitoring. Such consultation will include consideration of results from monitoring efforts and subsequent adjustments to monitoring methods. All decisions will be based on analyses with a significance level of 0.05. In particular, the District will adopt the triggers and subsequent actions described below.

The District will follow the procedures described in the Adaptive Management Framework when conferring with the MARC on implementation of the Acoustic Monitoring and Mitigation Plan and considering how to address the results of the monitoring.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Adaptive Management and Mitigation Trigger 1: Based on the field test of observational protocols (e.g., scan sampling) in the fall of 2012, an optimized survey area (likely a circle with a radius of 500-1000 m centered on the turbines) and scan pattern will be submitted to the MARC for review and approval. The study area extent will balance the need for observations to be obtained both outside and inside the zone of audibility and the need for well-resolved observations of marine mammals in time and space. Similar changes to the monitoring protocols may be required for the seasonal sampling allocation (i.e., higher effort in the winter versus summer) and selection of focal groups for killer whale transits. If the results of these studies indicate any harm to marine mammals, the District will develop modifications to the project and/or this Plan in consultation with the MARC, will obtain NMFS' approval for any specific mitigation measures.

Adaptive Management and Mitigation Trigger 2: If the results of the Acoustic Monitoring and Mitigation Plan indicate that the zone of audibility for turbine sound is greater than indicated by pre-installation estimates, the size of the study area may be increased to ensure that observations of marine mammal functional groups are obtained both outside and inside of the zone of audibility. If the results of these studies indicate any harm to marine mammals, the District will develop modifications to the project and/or this Plan in consultation with the MARC, will obtain NMFS' approval for any specific mitigation measures.

Adaptive Management and Mitigation Trigger 3: If porpoise presence or echolocation activity (defined by median detection positive minutes per day – DPM/day) shows a statistically significant change during the first calendar year of operation relative to annual median DPM/day from baseline observations at the 5% significance level, the District will consult with the MARC and determine if the change is biologically significant and if modification of the Project or Monitoring and Mitigation Plan is necessary. Upon approval of revisions to the Plan by the MARC, the District shall file the revised Plan with the Commission. Upon Commission approval, the District shall implement the revised Plan. If the results of these studies indicate any harm to marine mammals, the District will develop modifications to the project in consultation with the MARC, will obtain NMFS' approval for any specific mitigation measures.

Adaptive Management and Mitigation Trigger 4: If shoreline observers note a strong avoidance response (defined as consistent and rapid movement away from the study area) for any marine mammal functional group, the District will consult with the MARC and determine if modification of the Project or Monitoring and Mitigation Plan is necessary. Upon approval of revisions to the Plan by the MARC the District shall implement the revised Plan.

Adaptive Management and Mitigation Trigger 5: If a killer whale has been found to be injured (lacerations or discoloration to extremities) in the Salish Sea within a week of a known transit through Admiralty Inlet, the District will consult with the MARC to discuss whether the injury could have been caused by the Project. An independent experienced veterinarian will be part of the MARC for these discussions. If the MARC determines that the injury was caused by the Project, the District will immediately cease operation of the Project and will not resume operations until NMFS approves the resumption of operations. The MARC will evaluate whether additional protective measures, if any, can be implemented to protect killer whales. Upon the request of the MARC, the District will revise this Plan to implement additional measures to ensure effective protection of killer whales within the vicinity of a rotating hydrokinetic turbine.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Upon approval of revisions to the Plan by the MARC and NMFS, the District shall implement the revised Plan.

Adaptive Management and Mitigation Trigger 6: If behavioral responses to the presence of the turbine by mid-frequency cetaceans (Southern Resident and transient killer whales) within the survey area are reported, the District will convene a meeting of the MARC to evaluate whether modifications to the Plan or Project operations are necessary. Upon approval of revisions to the Plan by NMFS, the District shall implement the revised Plan. If the results of these studies indicate any harm to marine mammals, the District will develop modifications to the project in consultation with the MARC, will obtain NMFS' approval for any specific mitigation measures.

Adaptive Management and Mitigation Trigger 7: Pinnipeds are food motivated. If the Near-turbine Monitoring and Mitigation Plan indicates that prey is aggregating around the turbines after the first calendar year of pinniped observations is complete (and such aggregations did not occur during the first calendar year), a short-term pinniped study (e.g., 2+ weeks observations) will be conducted to evaluate whether prey aggregations are affecting behavior in the vicinity of the Project. The specific study scope will be developed in consultation with the MARC. If the results of these studies indicate any harm to marine mammals, the District will develop modifications to the project in consultation with the MARC, will obtain NMFS' approval for any specific mitigation measures.

Adaptive Management and Mitigation Trigger 8: If harbor porpoise and pinniped scans overlap to the point that harbor porpoise focal follows are significantly reducing the effectiveness of pinniped observations, then, with the consent of the MARC, a separate observational team will be tasked for pinniped and harbor porpoise observations.

By June 30 of each year, the District will develop and file an annual report to FERC fully describing its implementation of the Plan during the previous calendar year and a list of the proposed activities during the current calendar year. The MARC will have at least 30 days to review and comment on a draft report prior to the District finalizing and filing the report with FERC. The annual report will provide the following:

- A summary of the monitoring results;
- A summary of any issues or concerns identified by members of the MARC during the year regarding implementation of the Plan;
- A list of any changes to the Plan and/or project operations proposed by consensus of the MARC during the year; and
- A list of Plan activities planned for the current year.

As described in the monitoring plan details, the MARC will also receive specific reports on each plan on the following schedule:

- *Pinniped monitoring* (§5.1): Preliminary, oral report on sightings within first 60 days of turbine operation and quarterly, thereafter. Final report on pinniped response to turbine operation within 120 days of the end of the first calendar year of operation.

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- *Harbor porpoise monitoring* (§5.2): Preliminary, oral report on sightings within first 60 days of turbine operation and quarterly, thereafter. Final report on harbor porpoise response to turbine operation within 120 days of the end of the first calendar year of operation.
- *Killer whale monitoring* (§5.3): Preliminary, oral report to the MARC within 7 days of each transit. Final report on killer whale activity and response to turbine operation within 120 days of each calendar year of operation.

7.0 REFERENCES

Basset, C., B. Polagye, M. Holt, and J. Thomson (*in press*) A vessel noise budget for Admiralty Inlet, Puget Sound, WA (USA), *J. Acous. Soc. Am.*

Basset, C., J. Thomson, and B. Polagye (*submitted*) Contribution of bedload transport to ambient noise in a high-energy environment, Submitted to *J. Geo. Res.*

Bigg, M. (1982) An assessment of killer whale (*Orcinus orca*) stocks off Vancouver Island, British Columbia. Report of the International Whaling Commission 32:655-666.

Carlson, T.J., J.L. Elster, M.E. Jones, B.E. Watson, A.E. Copping, M. Watkins, R. Jepsen, and K. Metzinger (2012) Assessment of strike of adult killer whales by an OpenHydro tidal turbine blade, Pacific Northwest National Laboratory technical report, PNNL-21177

Calambokidis, J. and Baird, R. (1994) Status of marine mammals in the Strait of Georgia, Puget Sound and the Juan de Fucca Strait and Potential human impacts. Symposium on the Marine Environment. January 13 and 14, 1994.

Collar, C., J. Spahr, B. Polagye, J. Thomson, C. Bassett, J. Graber, R. Cavagnaro, J. Talbert, A. deKlerk, A. Reay-Ellers, D. Tollit, J. Wood, A. Copping, T. Carlson, and M. Halvorsen (2012) Study of the acoustic effects of hydrokinetic tidal turbines in Admiralty Inlet, Puget Sound, Final report to the US Department of Energy under DOE Award DE-EE0002654.

Deecke, V. B. (2006). Studying Marine Mammal Cognition in the Wild: A Review of Four Decades of Playback Experiments. *Aquatic Mammals*, *32*(4), 461-482.

DeNardo, C., M. Dougherty, G. Hastie, R. Leaper, B. Wilson, and P.M. Thompson (2001) A new technique to measure spatial relationships within groups of free-ranging coastal cetaceans, J. Appl. Eco., 38: 888-895.

Ford, J.K.B., Ellis, G.M., and Balcomb, K.C. (2000) Killer whales: the natural history and genealogy of *Orcinus orca* in British Columbia and Washington State. Second Edition. UBC Press, Vancouver, British Columbia.

Jeffries, S.J., Gearin, P., Huber, H.R., Saul, D.L., and Pruett, D.A. (2000) Atlas of Seal and Sea Lion Haulout Sites in Washington. February 2000.

Krahn, M.M., Wade, P.R., Kalinowski. S.T., Angliss, R.P., Hanson, M.B., Taylor, B.L., Ylitalo, G.M., Dahlheim, M.E., Stein, J.E., and Waples, R.S. (2002) Status review of southern

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

resident killer whales (*Orcinus orca*) under the Endangered Species Act. NOAA Technical Memorandum NMFS-NWFSC-54, U.S. Department of Commerce, Seattle, Washington.

Krahn, M.M., Ford, M.J., Perrin, W.F., Wade, P.R., Angliss, R.P., Hanson, M.B., Taylor, B.L., Ylitalo, G.M., Dahlheim, M.E., Stein, J.E., and Waples, R.S. (2004) 2004 status review of southern resident killer whales (*Orcinus orca*) under the Endangered Species Act. NOAA Technical Memorandum NMFS-NWFSC-62, U.S. Department of Commerce, Seattle, Washington.

Keenan, G., Sparling, C., Williams, H. & Fortune, F. (2011) SeaGen Environmental Monitoring Programme. Final Report to Marine Current Turbines. Royal Haskoning.

Kyhn, L., J. Tougaard, L. Thomas, L.R. Duve, J. Stenback, M. Amundin, G. Desportes (2012) From echolocation clicks to animal density—Acoustic sampling of harbor porpoises with static dataloggers, *J. Acoust. Soc. Am.*, 131(1), 550-560.

Laake, J., D. Rugh, and L. Baraff (1998) Observations of harbor porpoise in the vicinity of acoustic alarms on a set gill net. NOAA Tech. Memo. NMFS-AFSC-84, 40 p.

Mann, J. (1999) Behavioral sampling methods for cetaceans: a review and critique, *Marine Mammal Sci.*, 15(1):102-122.

National Marine Fisheries Service (NMFS) (2008) Recovery Plan for Southern Resident Killer Whales (*Orcinus orca*). National Marine Fisheries Service, Northwest Region, Seattle, Washington.

National Marine Fisheries Service (NMFS) (2009) Draft Environmental Assessment New Regulations to Protect Killer Whales from Vessel Effects in Inland Waters of Washington. National Marine Fisheries Service Northwest Region. January 2009.

Neter, J., Kutner, M.H., Nachtsheim, C.J. & Wasserman, W. 1996 Applied Linear Statistical Models. Fourth Edition. WCB McGraw-Hill.

Polagye, B., B. Van Cleve, A. Copping, and K. Kirkendall (eds.) (2011) Environmental effects of tidal energy development: Proceedings of a scientific workshop, March 22-25, 2010. *NOAA Technical Memorandum* NMFS F/SPO-116.

Polagye, B., C. Bassett, M. Holt, J. Wood, and S. Barr (*in preparation*) Detection of tidal turbine noise: A pre-installation case study for Admiralty Inlet, Puget Sound, Washington (USA).

Snohomish PUD (2012) Final pilot license application for the Admiralty Inlet pilot tidal project, FERC Project No. 12690-000.

Southall, B., Bowles, A., Ellison, W., Finneran, J., Gentry, R., Greene, C., Kastak, D., Ketten, D., Miller, J., Nachtigall, P., Richardson, W., Thomas, J., Tyack, P. (2007) Marine mammal noise exposure criteria: initial scientific recommendations. *Aquatic Mammals*, 33 (4).

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Tollit D.J., Wood J.D. , Veirs S., Berta S., and Garrett H., Veirs, V., Joy, R., Quick, N., Hastie, G. (2010) Admiralty Inlet Pilot Project Marine Mammal Pre-Installation Field Studies – Final Report to Snohomish Public Utility District, June 15 2010. SMRU Ltd.

Washington Department of Fish and Wildlife (WDFW) (2006) Fish and wildlife geographic information system digital data documentation. Olympia, Washington.

Whale Museum. (2009) Review of historical information and site-specific synthesis. The Whale Museum, SMRU Ltd., Orca Network. October 2009.

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Attachment 1

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Assessment of Strike of Adult Killer Whales by an OpenHydro Tidal Turbine Blade

Revision 1

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September 2012

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Summary

Snohomish Public Utility District #1 (SnoPUD) proposes to deploy two OpenHydro tidal turbines in Admiralty Inlet, Puget Sound. The fisheries service of the National Oceanic and Atmospheric Administration (NOAA Fisheries) has expressed concerns that the turbines may cause a risk for the highly endangered Southern Resident Killer Whale (SRKW) population if a whale is struck by an operating turbine. NOAA Fisheries is responsible for protecting the (fewer than 90) SRKWs under the Endangered Species Act and the Marine Mammal Protection Act. Because the SRKW numbers are so small, significant injury of a single animal could place the population in jeopardy.

The potential risk to a SRKW can be parsed into the probability that a whale would encounter a turbine, the probability that the encounter would injure the whale, and the severity of any injury. During a meeting with representatives of SnoPUD, OpenHydro, the Department of Energy, and NOAA Fisheries, participants agreed that the probability of a SRKW encountering a turbine by chance is negligibly small as the whales spent greater than 97 percent of their time in Admiralty Inlet in the top 30 meters of water, while the turbines are located at 55 meters of depth, and the SRKW have highly evolved acoustic sensory capabilities that would help them detect the presence of a turbine. NOAA Fisheries expressed concerns over the potential severity of a strike on a SRKW should it occur. A proposed solution was to conduct an estimate of the level of injury that might occur from an encounter between a turbine blade and a SRKW, which would allow NOAA Fisheries to determine the permitting requirements for the tidal project.

Pacific Northwest National Laboratory (PNNL) and Sandia National Laboratories (SNL) were tasked by the Department of Energy to carry out an analysis of the mechanics and biological consequences of strike of a SRKW by an OpenHydro turbine blade. The approach taken by the two laboratories was to: 1) develop a scenario for the most severe strike of a SRKW; 2) determine the morphological and biomechanical properties of SRKW tissues that might be affected by a strike; 3) model the forces of a strike; and 4) estimate the potential effects on SRKW tissue and bone of a strike.

PNNL and SNL developed a worst-case exposure scenario for strike of a SRKW. SNL modeled a turbine blade (based on proprietary design data obtained from OpenHydro), and calculated the force of blade impact on the head of an adult male SRKW, weighing approximately 4000 kilograms. The adult SRKW was selected for the model because an adult has a large body mass where more of the energy in a blade strike will be absorbed by the whale's tissue rather than going into momentum transfer that would push the whale out of the path of the turbine blade. This scenario would maximize the risk of injury to the SRKW. Although a juvenile SRKW might intuitively be considered to be at greater risk of injury, because of much smaller mass (~500 kg) more of the energy in the blade strike would go into momentum transfer pushing the juvenile SRKW out of the path of the turbine's blades leaving much less available to damage tissue.

SNL built models of the turbine blades and their motion using specifications and data supplied by OpenHydro (Figure ES-1), and of an adult male SRKW using data available in the literature (Figure ES2).

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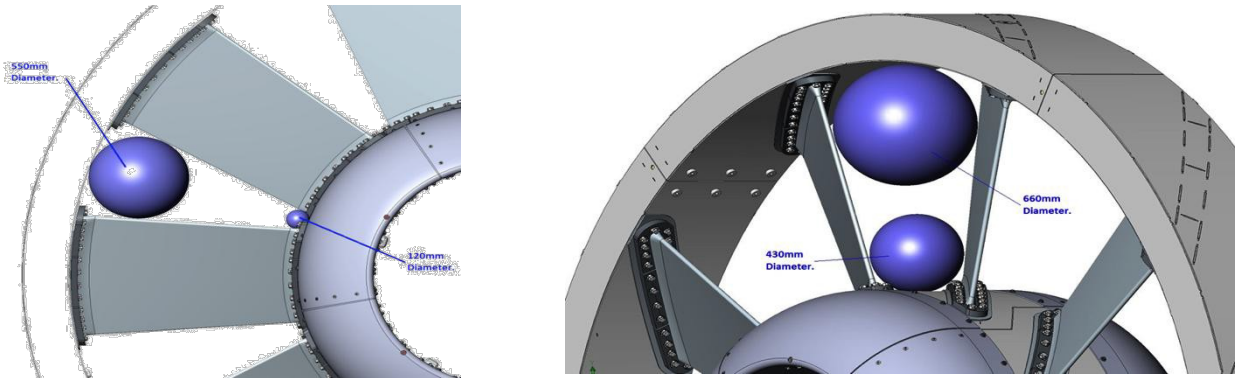

Figure ES-1. Drawings of the OpenHydro turbine blade assembly, as specified by OpenHydro, showing spacing of blade edges (left) and the spacing between blades (right). Also shown is the length of the blades (approximately 1.25m) after accounting for the open hub of the blade assembly that has a diameter of 4.8m.

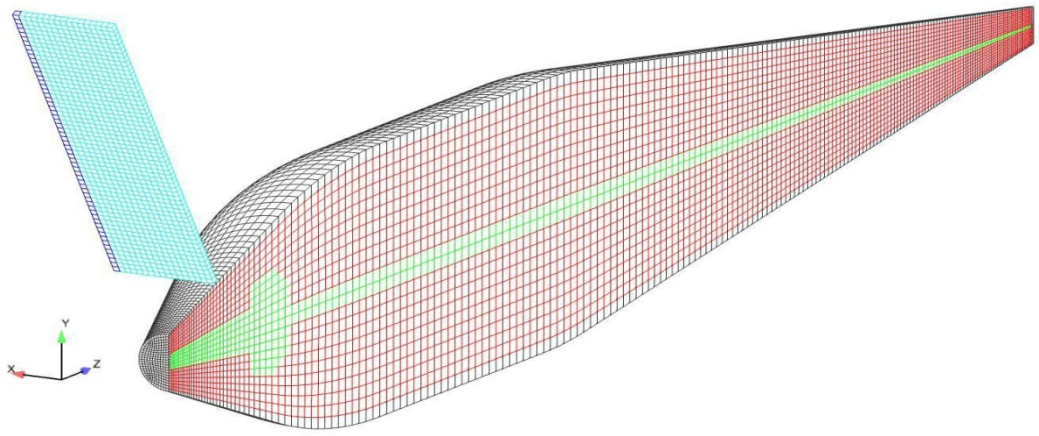

Figure ES2. The finite element mesh created for the model of the SRKW and the tidal turbine blade. The turbine is represented by a single blade. Due to the ducted turbine design, which encloses the tips of the turbine blades, and the spacing between blades, strike could only conceivably occur on the rostrum of a SRKW.

Recent NOAA publications provided appropriate SRKW swimming speeds of 1m/sec to 3m/sec for the type of encounter envisioned in this scenario. The modeling results showed maximum stresses (pressure) for turbine blade strike of the head of an adult male SRKW to range between 2350 to 2365 kPa, with strains (tissue elongation) of 73-93 percent for the most probable rotation speed of the turbine.

PNNL obtained data for the morphology and anatomy from computed tomography (CT) scans of the head of an adult SRKW that died in 2002 (Figure ES-3). Information on the biomechanical properties of whale tissues was found in the scientific literature.

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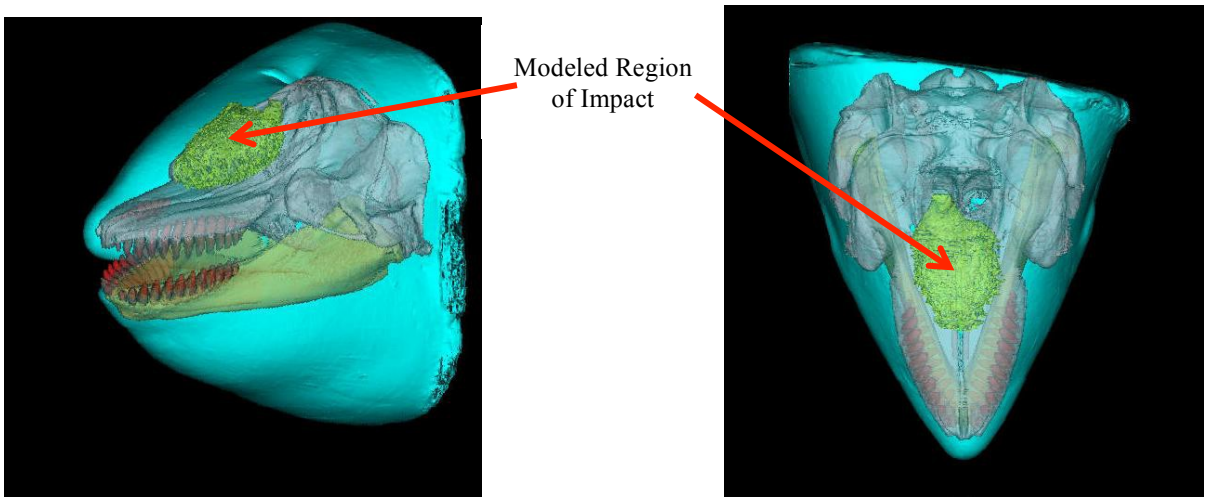

Figure ES-3. CT scan based images of the head of an adult female SRKW from the side (left), and from top view (right). The teeth are shown in red, bone in light color, and the various soft tissues in other colors. The region of impact used for modeling purposes is indicated.

The adult killer whale for which CT scan data were available and the adult killer whale modeled were similar enough in size so that the available morphology and anatomy data from CT scans could be used in assessment of the probable injury to an adult killer whale caused by turbine blade strike. The tissues of concern included the skin of the whale, other soft tissue, and mandibular bone. Very little is known about the biomechanical properties of whale tissue, particularly the skin, which functions to resist mechanical and other damage and to spread the force of an impact across a region that minimizes the forces acting on underlying tissues. For the purposes of this analysis, several natural and synthetic rubber material properties were considered as surrogates for SRKW skin.

Comparison of the maximum force acting on soft tissue and bone, estimated by SNL using the finite element models of the turbine blade and whale, with the tissue biomechanics data developed by PNNL provided the basis for assessment of probable injury to SRKW. The analysis found that the maximum levels of stress acting on whale tissue and bone corresponded to tissue response (strain) in the elastic range where whale tissue would be expected to return to their normal shape when the force of the turbine blade was removed without causing permanent change to the tissue. In addition the stresses and strains estimated using the blade and whale models were well below the yield strength for similar material including natural and synthetic rubber and human skin, by a factor of 3 or more.

PNNL examined the available literature on blunt force head trauma in marine mammals and interacted with marine veterinarians with experience in caring for injured animals and performing necropsies on animals found dead.

The results of these analyses provide the following insights into the potential risk of encounter to a SRKW with an OpenHydro tidal turbine in Admiralty Inlet:

- PNNL/SNL analyses determined that a SRKW is not likely to experience significant tissue injury from impact by an OpenHydro turbine blade.
- If whale skin behaves similarly to the materials considered as surrogates for the upper dermal layers of whale skin, it is expected that in the case of a strike, whale skin tissue and the underlying soft

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tissue would deform, absorb the force of the strike, and return to normal condition after the pressure was removed. These data indicate that the skin would not be torn by blade strike. Using limited data on the strike pressure needed to fracture the mandibular bone (jawbone) of a North Atlantic Right Whale, and assuming the SRKW mandibles have similar biomechanical properties to those of Right Whales, the highest stress predicted by the model (about 3750 kPa) is highly unlikely to result in the fracture of a SRKW mandible. The available literature and best professional judgment of marine veterinarians did not significantly inform the outcome of the analyses.

There are a number of areas where the PNNL/SNL analysis could not provide insight:

- PNNL/SNL analyses could not provide insight into the potential for subtler changes to SRKWs from an encounter with the turbine, such as changes in behavior; and
- PNNL/SNL analyses do not adequately inform turbine interactions for other whales with other turbines.

The PNNL/SNL analyses were limited by the available time frame in which results were needed and focused on the mechanical response of whale tissues and bone to blade strike. Additional information on the biomechanical properties of marine mammal tissues and finite model refinements could help to further fine-tune this analysis. This analysis concentrated on the open center design specific to the OpenHydro turbine; the results may not be directly comparable to other turbine designs.

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Acknowledgments

This study was conceived through the joint efforts of the Department of Energy (DOE), the National Oceanic and Atmospheric Administration (NOAA), Snohomish PUD, OpenHydro, the University of Washington – Northwest National Marine Renewable Energy Center (UW-NNMREC), Pacific Northwest National Laboratory (PNNL) and Sandia National Laboratories (SNL). Understanding the potential severity of strike from an OpenHydro turbine blade on a Southern Resident Killer Whale (SRKW) in Admiralty Inlet, Puget Sound, is a necessary step in the responsible deployment of tidal turbines in these waters.

Rich Jepsen and Kurt at Metzinger at SNL undertook the engineering analysis, based on turbine specifications supplied by OpenHydro, and tidal velocities supplied by UW- NNMREC. Sandia analyses were passed on to the biomechanical analysis team at PNNL.

Tom Carlson, Mike Watkins and their team at PNNL examined the physiological and biomechanical properties of SRKWs and analyzed the likely effect of impacts, drawing from the engineering analysis.

Dr. Ted Cranfield at the University of California Santa Cruz kindly supplied the team with CT scans of the head of a SRKW.

Drs. Michael Moore of Woods Hole Oceanographic Institute, William McLellan of University of North Carolina-Wilmington, Dr. Steven Raverty of Province of British Columbia and University of British Columbia, Dr. Regina Campbell-Malone of Johns Hopkins University, Dr. James McBain of SeaWorld, and Dr. Joe Gaydos of the SeaDoc Society generously shared their expertise and experience in marine mammal injury and mortality.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Contents

Summary iii
Acknowledgments vii
1.0 Introduction 1
2.0 Engineering Analysis of Impact 3
2.1 Geometry and Operational Characteristics of OpenHydro Turbine 3
2.1.1 Turbine Design and Blade Material Properties 3
2.1.2 Rotor Rotation Rates and Blade Speed 5
2.2 Blade Impact Scenarios and Physical Characteristics of a SRKW 5
2.2.1 Blade Impact Scenarios 6
2.2.2 Material Properties for SRKW 9
2.3 Analysis with Finite Element Model 10
2.3.1 Model Set-up 10
2.3.2 Impact Analysis Results 12
2.3.3 Including Forward Velocity of SRKW 17
3.0 Biological Assessment of Consequences of Impact 18
3.1 Whale Head Morphology 18
3.2 Tissue Models and Biomechanical Data 21
3.3 Biomechanics of Human Skin 26
3.4 Consequence of Turbine Blade Impact on Whale Tissue 27
4.0 Additional Information to Inform Strike Modeling: Blunt Force Trauma and Real World Experience 29
4.1 Blunt Force Trauma Research 29
4.2 Assessments from Marine Veterinarians 30
4.2.1 Selected observation of Marine Mammal Strike from Marine Veterinarians 30
5.0 Discussion and Conclusions 32
5.1 Interpretation of Engineering and Biomechanical Analyses 32
5.2 Uncertainty of Outcomes of Analyses 32
5.3 Additional Information to Inform Analyses 34
5.4 Next Steps 34
5.5 Conclusion 34
6.0 References 36

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Figures

Figure 1. Front view of blade with spacing dimensions of blade edges 4
Figure 2. Isometric view with spacing between blade faces 4
Figure 3. Angles between inner blade edges 4
Figure 4. Angles between outer blade edges 4
Figure 5. Probability distribution of velocity at blade tip. 5
Figure 6. Basic dimensions measured for SRKW (Durban et al. 2009) 6
Figure 7. Maximum dimensions reported for an adult male SRKW 6
Figure 8. Plot of probability distribution for velocity at a location of 0.4 m from the tip of the blade. 7
Figure 9. "Maximum velocity" SRKW and blade impact scenario schematic 8
Figure 10. Stress-Strain curve for whale blubber (Soldevilla et al. 2005) 10
Figure 11. Finite element mesh 11
Figure 12. Finite element mesh - impact region 12
Figure 13. Impact Force 13
Figure 14. Strain, standard blade, 1 m/s at peak load 14
Figure 15. Pressure, standard blade, 1 m/s at peak load 14
Figure 16. Strain, standard blade, 3 m/s at peak load 15
Figure 17. Pressure, standard blade, 3 m/s at peak load 15
Figure 18. Maximum strain (log strain) and stress versus impact velocity 16
Figure 19. A sagittal CT scan of the head of an adult killer whale. 19
Figure 20. CT scan of a transverse slice through the head of a killer whale. 19
Figure 21. Intensity values along a vertical transect through a transverse slice of CT scan data for the head of a killer whale 20
Figure 22. Description of material toughness in the context of stress-strain dynamics 22
Figure 23. Structure of whale epidermis (Winn 2006) 24
Figure 24. Examples of stress-strain characteristics for some manmade elastomers 24
Figure 25. Relationship between stress and strain for human skin 27

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Tables

Table 1. Resultant SRKW impact velocity for 5 m/s blade velocity combined with a range of forward velocities 9
Table 2. Elastic Modulus Table (Soldevilla et al. 2005) 9
Table 3. Material Properties Used for Analysis 12
Table 4. Peak Stress and Strain from Computational Simulations 13
Table 5. Peak Stress and Strain from Equations 1 and 2 16
Table 6. Comparative epidermal ranges reported for baleen whale species (Winn 2006) 23
Table 7. Properties of Various elastomers (Schaefer 2009) 25
Table 8. Table of the mechanical properties of various elastomers 26
Table 9. Level of certainty associated with each input to the engineering and biomechanical analyses 33

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

1.0 Introduction

Snohomish Public Utility District #1 (SnoPUD) has proposed to deploy two OpenHydro tidal turbines in Admiralty Inlet, Puget Sound. Due to the presence of the highly endangered Southern Resident Killer Whale (SRKW) population in Puget Sound and Admiralty Inlet, the National Oceanic and Atmospheric Administration (NOAA Fisheries) has expressed concern that the turbines may cause a risk to the SRKW population. Because SRKW spend 97% of their time within the top 30 meters of the water column and only dive to the turbine depth (approximately 55 meters) to feed, the chance of a SRKW encountering a tidal turbine is negligibly small. However, due to their endangered status, there are concerns regarding the potential severity of a strike on a SRKW should it occur. Because the SRKW numbers are so small, significant injury of a single animal could place the population in jeopardy.

To resolve this issue, Pacific Northwest National Laboratory (PNNL) and Sandia National Laboratories (SNL) were tasked by the Department of Energy to carry out an analysis of the mechanics and biological consequences of a tidal turbine blade strike on a SRKW. In doing so, the potential level of injury from such an interaction can be estimated and used to inform NOAA Fisheries on how to proceed with the permitting process for the tidal energy project.

The approach taken was:

1) PNNL and SNL developed a scenario for the most severe strike of a SRKW, consisting of a large male SRKW placing its rostrum into the tidal turbine out of curiosity.

2) SNL analyzed the geometry, mass, material properties and speed characteristics of the tidal turbines and calculated the amount of force a tidal turbine blade is capable of creating. This force calculation was coupled with the dimensions and material properties of an adult SRKW weighing approximately 4000 kilograms to develop a model simulation of a blade impact on the head of an adult SRKW.

3) PNNL used a computed tomography (CT) scan of an adult SRKW head, similar in size to the hypothetical SRKW used in the engineering analysis, to understand the morphology and anatomy of a SRKW head. Scientific literature and surrogate synthetic rubber materials were used to support estimates of the biomechanical properties of whale skin and soft tissues and to determine how these tissues resist mechanical damages by spreading force across the region of impact. This analysis was used to estimate the level of injury that might occur from an encounter between a turbine blade and a SRKW.

4) By combining the maximum force calculations of the tidal turbine blade acting on the SRKW soft tissue and bone with SRKW tissue biomechanics and head anatomy data, PNNL and SNL were able to estimate the potential effects of an encounter between a SRKW and a tidal turbine blade.

5) PNNL examined the scientific literature on blunt force trauma to determine whether there are appropriate analogues to effects of a tidal turbine blade on the head region of a SRKW.

6) PNNL sought real world examples of strike on the head region of SRKWs or other marine mammals through discussions with marine veterinarians who routinely treat or research injured

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

marine mammals. The purpose of the real world examples was to provide a semi-quantitative validation of the modeling results.

The engineering studies, biomechanical analyses, blunt force head trauma literature review, and model validation effort are discussed and synthesized in the discussion/conclusion section of this report to demonstrate how these analyses were used to provide information that may assist NOAA Fisheries in their permitting decisions for the tidal energy project in Admiralty Inlet, WA. This strike analysis relies heavily on modeling the forces exerted from a moving turbine blade and estimating the biomechanics of SRKW tissues; each step in the analysis process introduces a level of uncertainty into the result, stemming largely from the uncertainty surrounding the available input data. A brief analysis of the level of accuracy associated with each portion of the analysis is provided in the discussion/conclusion section of this report as well.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

2.0 Engineering Analysis of Impact

This section outlines the engineering analysis performed by SNL to determine the stresses on a SRKW from a potential impact with a tidal turbine blade. The analysis entailed determining the relevant geometry, mass, material, and speed characteristics of the OpenHydro turbine, rotor, and blade. SRKW dimensions and material properties were determined along with possible impact scenarios for the study.

2.1 Geometry and Operational Characteristics of OpenHydro Turbine

Relevant information was gathered on the geometry and operation of the OpenHydro turbines to be deployed in Puget Sound by:

a. Obtaining design drawings with the necessary details of the blade assembly and rotor for the OpenHydro turbine. Key details include the number, location, shape, and angle of the blades, with dimensions of the leading edge of the blades.

b. Obtaining information on the materials and construction detail of the turbine blade assembly and rotor to compute blade mass and other physical properties.

c. Obtaining information on the operating characteristics of the turbine including rpm/ blade speed at the range of tidal flows expected in Admiralty Inlet.

All of the above data was supplied by OpenHydro with assistance from the University of Washington and is summarized below. It should be noted that designs are not finalized and some parameters such as materials and moment of inertia are proprietary. In these cases, estimates are used based on consultation with Open Hydro. Overall, the dimensions and material properties supplied by OpenHydro were sufficient for the analysis.

2.1.1 Turbine Design and Blade Material Properties

The proposed turbine for deployment in Admiralty Inlet is an open center OpenHydro tidal turbine with a nominal diameter of 6 m; the diameter of the turbine blades within the duct is 4.8 m. The turbine has a mass of 6,200 kg. Figures 1 and 2 show the spacing between the turbine blade faces. Figures 3 and 4 show the angles between the outer and inner blade edges.

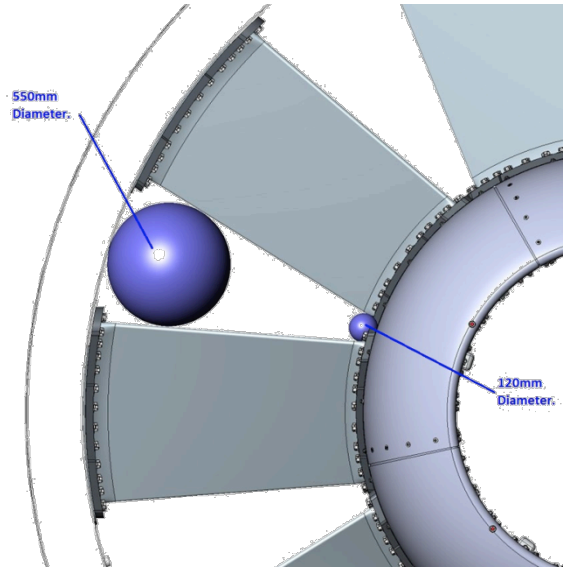

Figure 1. Front view of blade with spacing dimensions of blade edges

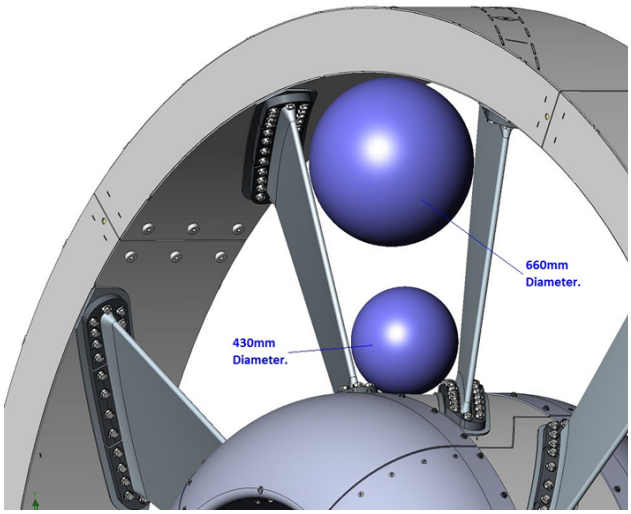

Figure 2. Isometric view with spacing between blade faces

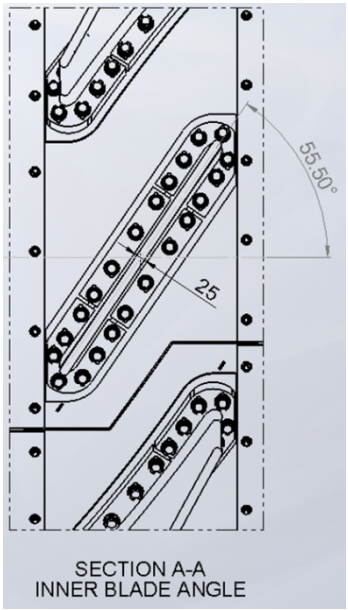

Figure 3. Angles between inner blade edges

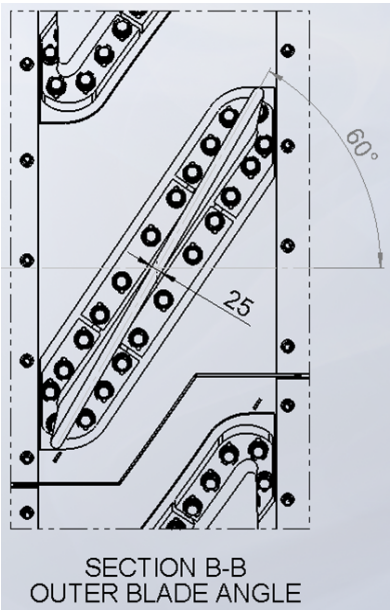

Figure 4. Angles between outer blade edges

Based on communications with OpenHydro, the blade material properties could be adequately estimated using a stiff plastic or composite material. Using either fiberglass composite or plastic resin

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

such as Delrin would be adequate because either is far stiffer than the SRKW material properties. An elastic modulus (material property defined as stress over strain for elastic deformation under an applied force) of 7 kPa was chosen for the blade based on information provided by OpenHydro.

The moment of inertia for the turbine could be adequately estimated assuming the rotor is a solid disc with a mass of 6,200 kg and diameter of 4.8 m.

2.1.2 Rotor Rotation Rates and Blade Speed

From the information supplied by OpenHydro, and the expected tidal velocities within the Admiralty Inlet deployment site supplied by UW-NNMREC, the blade velocities can be calculated anywhere along the radius of the blade edge. **Figure 5** shows the probabilities for the maximum velocity possible velocity that occurs at the blade tip. Note that this is not an expected impact location for an SRKW. The maximum expected impact scenario is discussed in the following section.

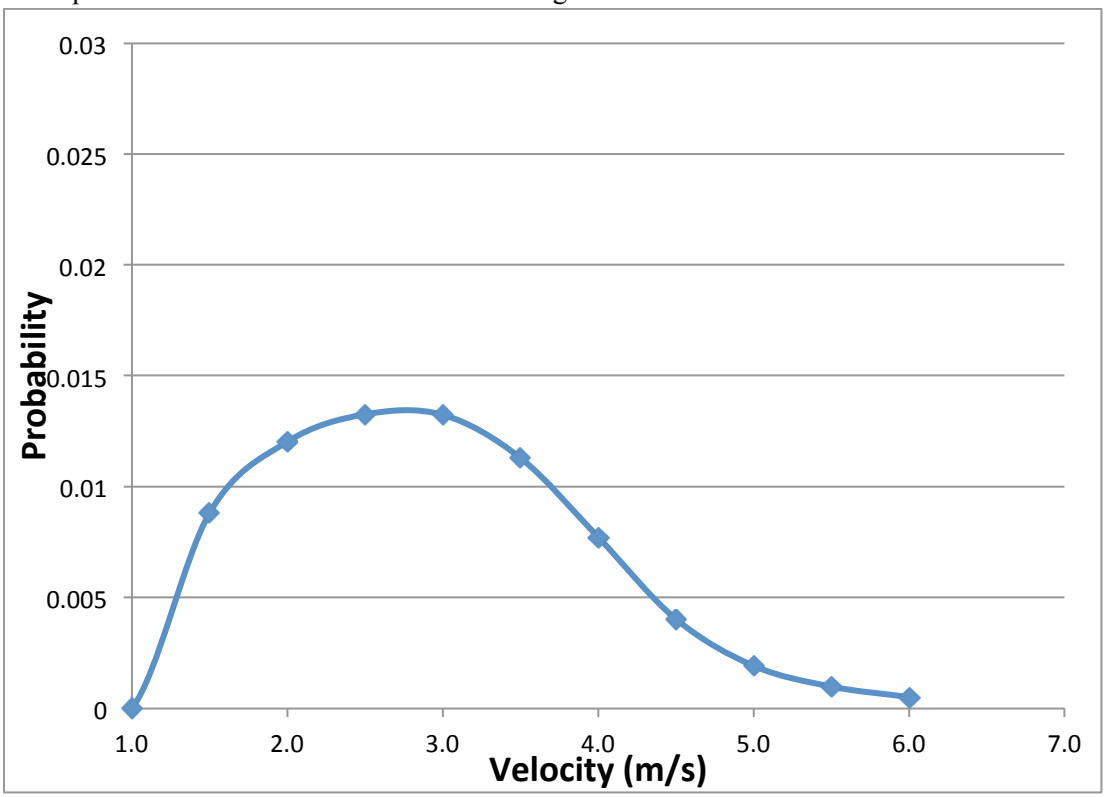

Figure 5. Probability distribution of velocity at blade tip.
At low tidal velocity (26% of the time), the blade is stationary (not shown here).

2.2 Blade Impact Scenarios and Physical Characteristics of a SRKW

2.2.1 Blade Impact Scenarios

A recent publication from Durban et al. 2009 contains field data for adult male SRKWs. An adult male was chosen because it has the greatest mass, forcing the affected tissue to absorb a maximum amount of the energy; this will result in little momentum exchange being converted to move the whale mass. The largest adult male reported by Durban et al. was used (Figure 6); the tail section was not simulated in the model. . The mass associated with the large adult male SRKW was approximately 4,000 kg; this value was used for model analysis.

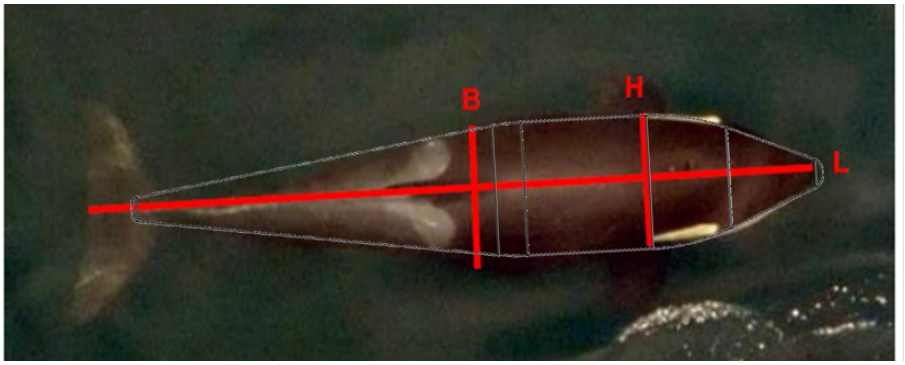

Figure 6. Basic dimensions measured for SRKW (Durban et al. 2009)

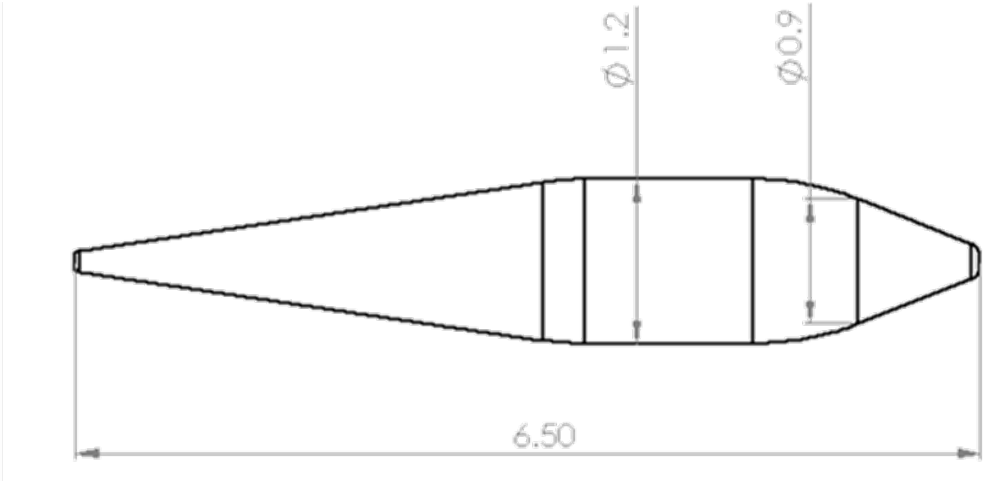

Figure 7. Maximum dimensions reported for an adult male SRKW

It will be difficult, if not impossible, for an adult SRKW to impact the blade at the furthest radius from the center of rotation due to the geometry limitations of the turbine and whale. Therefore, the blade velocity used was at the location where the head of the whale could be inserted furthest into the turbine rotor (reference to cross section radii in Figure 8**Error! Reference source not found.**). This causes the ost absorption by the tissue due to impact and is the most conservative scenario. The most severe impact

with respect to tissue damage would be for a large mass (i.e., adult male) to be hit as close to its center of mass as possible. This forces the tissue to mitigate more of the impact rather than simply moving the mass (whale) out of the way.

The most severe case for tissue impact mitigation occurs when the nose of an adult SRKW fits perfectly between the blades at the furthest most radii. This is approximately 0.4 m from the tip of the SRKW nose and at a 2.0 m radius on the blade. The probability distribution as a function of blade velocity is demonstrated in **Figure 8**.

A much smaller, juvenile SRKW was also examined with regard to comparative geometry and momentum transfer. In this case, the smaller head of the juvenile SRKW allows for a longer radius of the blade to make impact and impart velocities about 10 percent higher than what an adult would experience. However, this is largely overshadowed by the much-reduced mass of the juvenile (~500kg) compared to the adult (~4,000kg). Basic physics dictates that momentum is determined solely by velocity and mass (momentum = mv) of the objects; each of these quantities has equal weight in determining transfer of momentum between colliding objects. Therefore, a 10 percent increase in blade velocity is outweighed by an 800 percent reduction in mass. It follows that the momentum transfer to motion of the juvenile would be at least 7 times more than compared to an adult meaning that the impact to the tissue should be at least 7 times less for a juvenile SRKW. So, unless juvenile SRKW tissue is more than 7 times more sensitive to impact force, the impact case for an adult male SRKW is, by far, the most severe.

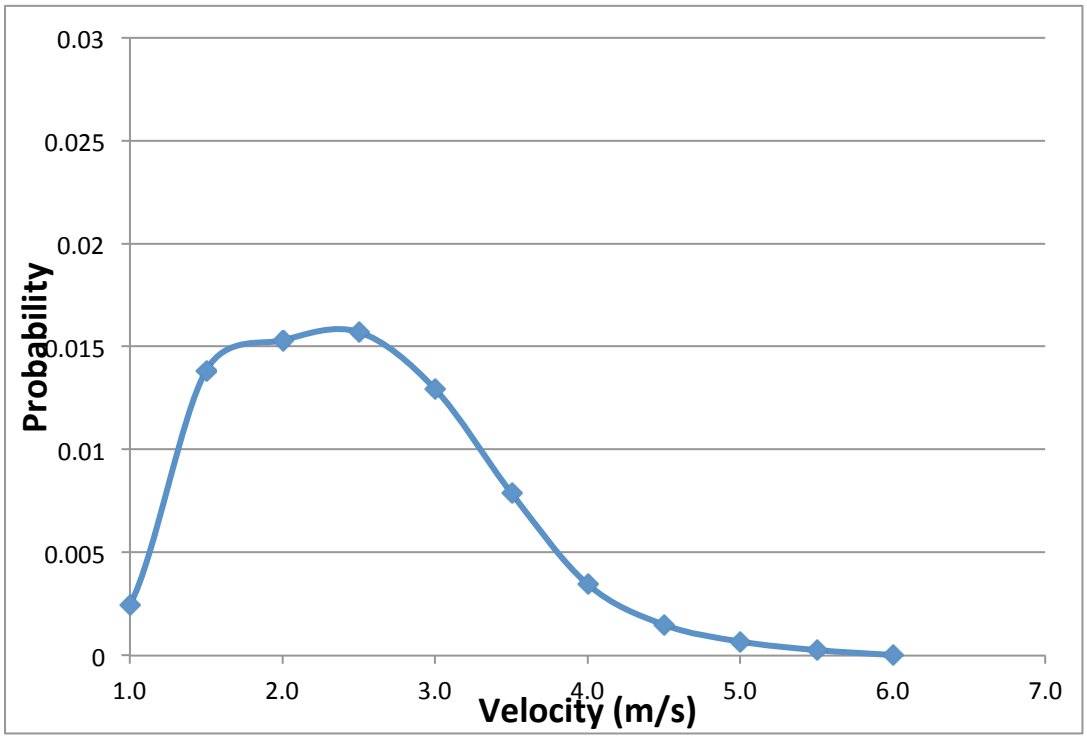

Figure 8. Plot of probability distribution for velocity at a location of 0.4 m from the tip of the blade.

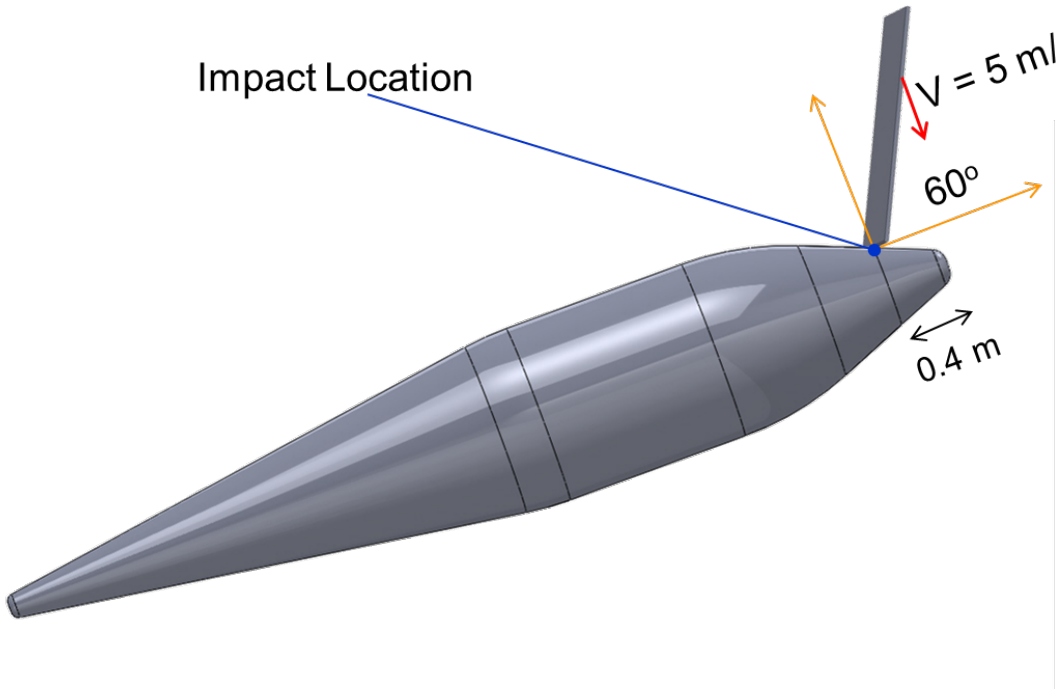

Figure 9. "Maximum velocity" SRKW and blade impact scenario schematic

Other scenarios were roughly considered but have been discounted as they are seen to be too implausible including:

1. A very generalized and conservative closed form solution. This would have a fixed "whale" mass upon impact and include only a single elastic modulus for the whale tissue (blubber).
2. FEA model using blade and whale models from Figure 9 and a variable elastic modulus for whale tissue (blubber). The whale model will be fixed and thus force the tissue to absorb the impact.

The primary problem with these scenarios is the overly simplistic "fixing" of the SRKW mass. The "fixed" scenario forces the SRKW tissue to absorb all the impact which is grossly incorrect since the body is, in reality, free to both translate and rotate away from the impact point. The fact that the impact location on the SRKW is a great distance from the center of gravity of the body (~2-3 m) also means that momentum transfer into rotation is significant in this case and should not be excluded from the analysis.

One could also analyze the inclusion of the forward motion of the SRKW by determining the threshold velocity for ramming versus that of curious inspection upon impact with the blade. The blade and forward motion of the SRKW are basically perpendicular, meaning that the resultant velocity vector can be calculated using the Pythagorean theorem. **Table 1** shows the resulting blade impact velocity for a range of forward velocities when the blade is moving at 5 m/s:

Table 1. Resultant SRKW impact velocity for 5 m/s blade velocity combined with a range of forward velocities

Forward Velocity (m/s)	Resultant Impact Velocity Vector (m/s)
1	5.1
2	5.4
3	5.8
4	6.4
5	7.1
6	7.8
7	8.6
8	9.4
9	10.3
10	11.2

As the forward velocity starts to significantly (>10 percent increase) affect the resultant velocity above the maximum blade velocity of 5 m/s, the result approaches ramming scenario (forward velocity >3 m/s). Previous meetings and discussions have discounted the ramming scenario (in which a SRKW collides with the turbine while swimming at top speed, as in Table 1). The curiosity or "inspection" scenario has the SRKW moving at a forward velocity of 3 m/sec or less (Noren 2011; William and Noren 2009). The additional computational resources necessary to model both masses (blade and SRKW) moving do not seem warranted for a possible increase in velocity that is about 10 percent. Instead, this scenario will be extrapolated from "blade velocity only" simulations.

2.2.2 Material Properties for SRKW

Material properties for a Cuvier's Beaked whale are available via tissue sample testing and CT scanning scanning from Soldevilla et al. 2005.

Table 2 shows the elastic modulus for several tissue types.

Table 2. Elastic Modulus Table (Soldevilla et al. 2005)

	Forehead tissues			Mandible tissues	
Stress (kPa)	Blubber	Acoustic fat	Connective tissue	Blubber	Acoustic fat
2.5	59	75	124	158	78
5	208	153	149	220	215
10	411	212	279	400	303
20	712	412	618	650	420
30	1006	626	1030	913	587
40	1200	739	1295	991	726
50	1410	910	1510	1174	934

These stresses are somewhat lower than what is expected for the impact scenario analysis and extrapolation may be required to determine the elastic modulus at higher stress states. **Figure 10** shows

the curve developed by Soldevilla et al., 2005 for stress vs. strain of the whale blubber. This figure suggests that the strain and stress reach an asymptote near 1,800 kPa. In addition, the blubber and connective tissue have very similar elastic moduli and the same value could be reasonably used to represent each. Therefore, as a conservative estimate, 1,800 kPa will be used for the elastic modulus of all "non-bone" tissues in the head region.

Data provided by PNNL for the structure of the head region from McKenna (2005) provide sufficient detail to reconstruct the dimensions of bone matter in the head for use in the model analysis. The material properties of the bone matter can be extracted from Table 4.5 in Campbell-Malone (2007); here are several values for elastic moduli of Right Whale mandible bone as a function of direction. The average value is approximately 300 MPa for both directional and bone type (trabecular or cortical); this value was used for model analysis.

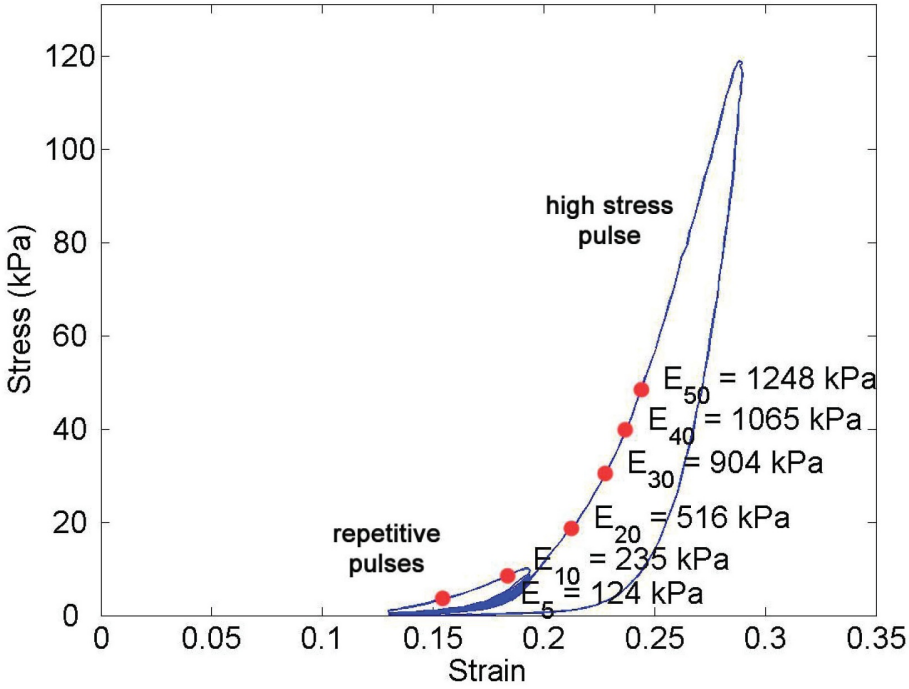

Figure 10. Stress-Strain curve for whale blubber (Soldevilla et al. 2005)

2.3 Analysis with Finite Element Model

2.3.1 Model Set-up

Closed form solutions are available for certain impact scenarios. However, the large deformations and the evolving nature of the contact interface for a blade striking a large mammal suggest the need for a finite element analysis. **Figure 11** and **Figure 12** show the model domain created for this study. Note that a symmetry plane is used to reduce the model size. The dimensions are based on a 4000 kg adult SRKW, as shown in figure 6. The turbine rotor is represented by a single blade (shown in light blue) that is

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

constrained to move in one direction. The ballast elements on the end of the blade (shown in dark blue) are given a very large density so the linear momentum of this massive (4460 kg) blade corresponds to the angular momentum of the rotor. The skin, blubber, and bone are shown in black, red, and green, respectively. For the engineering analysis, the skin has the same properties as blubber. The model domain does not include the surrounding water that is expected to have a modest effect on the peak loads; this simplification reduces the model size and complexity. Including the surrounding water in the domain necessitates significantly more computational resources than are currently available with the funding and schedule restraints of the project. The average magnitude of the velocity for the whale body upon impact is quite slow (~1 m/s or less) and the drag forces in water are $F = 1/2\ A\ C_D\ r\ V^2$, with C_D (drag coefficient) being approximately 1 for a cylindrical shape. This means the restraining forces by the water on the body are a few hundred pounds, which is quite small in comparison to the average 4,000 kg of an adult SRKW. Therefore the surrounding water should not have a large effect at these speeds.

Table 3 lists the material properties used for the engineering study. All materials are treated as linear elastic since the available material data are limited. The elastic modulus of the blubber is based on the slope of a stress-strain curve (**Figure 10**) at the maximum value (120 kPa). The Poisson ratio for the nearly incompressible blubber and bone were chosen to match the measured sound speeds. The blubber and bone materials use a Neo-Hookean constitutive model that is valid for large deformations.

More complex material models could be utilized provided actual test data for the skin and blubber was available. Highly elastic materials such as skin, blubber, and rubber respond differently in tension and compression and the load-deflection behavior can be very nonlinear. These materials can be represented with a hyperelastic constitutive model such as the Mooney-Rivlin model available in in the Sandia code, Presto (Koteras et al. 2006). These models have parameters which must be determined by testing specimens under different loading conditions (tension, compression, and shear). The tests are then analyzed with the chosen parameters to ensure the fit adequately represents the measured behavior. Some finite element codes automate the process and accept various types of test data and determine the parameters for the selected constitutive model. However, these essential data are not available for skin, blubber, or rubber; a linear elastic treatment was employed instead.

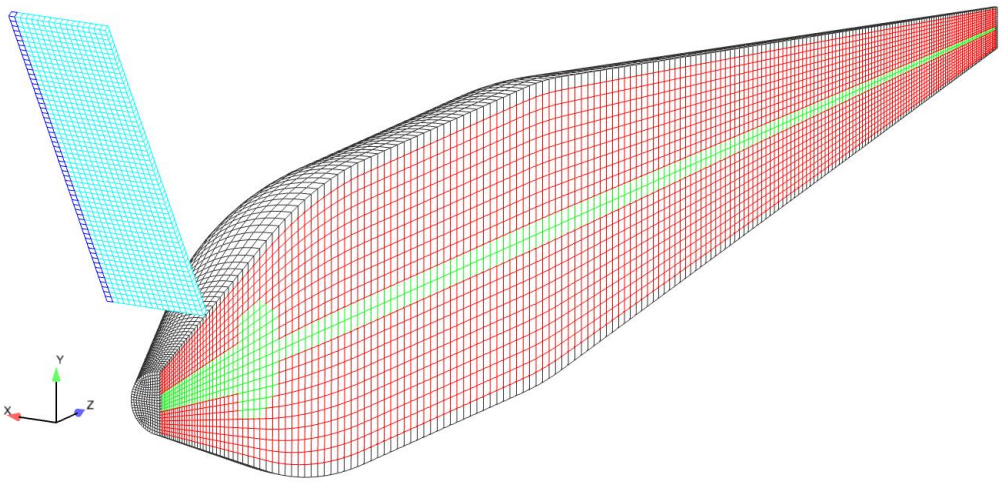

Figure 11. Finite element mesh

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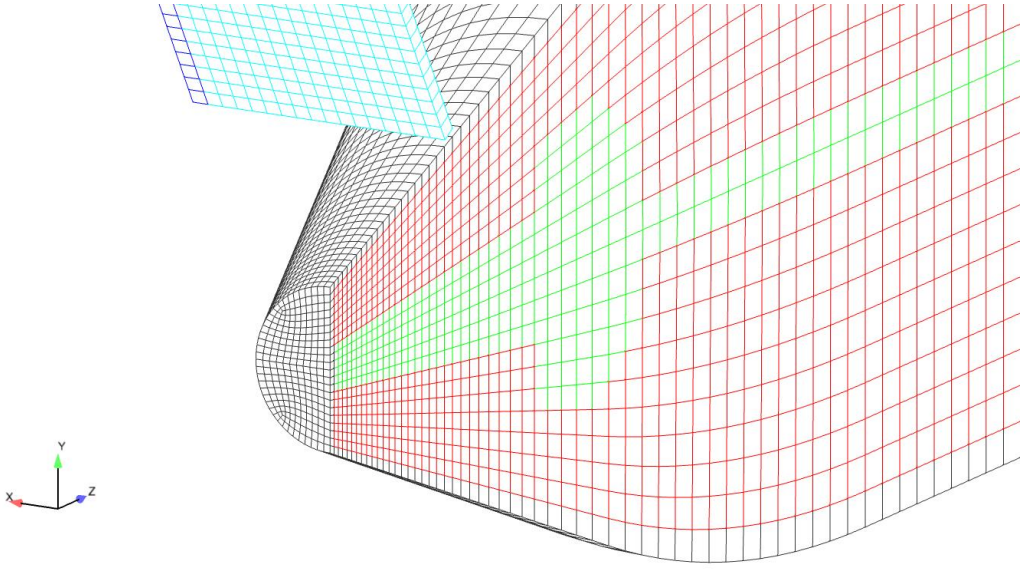

Figure 12. Finite element mesh - impact region

Table 3. Material Properties Used for Analysis

Material	Elastic Modulus (MPa)	Density (kg/m3)	Poisson's Ratio
Blubber*	1.8	1000	0.4998
Bone*	300	1000	0.4745
Blade	7000	1200	0.3
Ballast	7000	2325100	0.3

* Blubber and bone constitutive models are valid for large deformations.

2.3.2 Impact Analysis Results

The transient dynamics code Presto was used to consider impact speeds of 1 to 5 m/s. This range is based on the shapes of the MHK device and a SRKW, as well as the expected range of the rotor's angular speeds. In these simulations, the heavy blade is given an initial velocity and its edges are allowed to translate, but not rotate. The blade slows a small amount as it pushes the whale out of the way. **Figure 13** shows the force-time histories for several velocity cases. Due to element distortion issues, the simulations with the standard blade could not run to completion for speeds greater than 3 m/s. This is a computational artifact because large shear deformations caused an element nearest the impact to invert, but does not necessarily indicate tissue damage. To get results at higher impact speeds, a cylinder was added to the end of the blade. This particular modification may not be practical, but it is instructive. As shown in **Figure 13**, the modified blade loads the whale in a similar fashion. However, the distributed contact reduces the localized shear deformations in the tissue and allows higher impact speeds to be considered.

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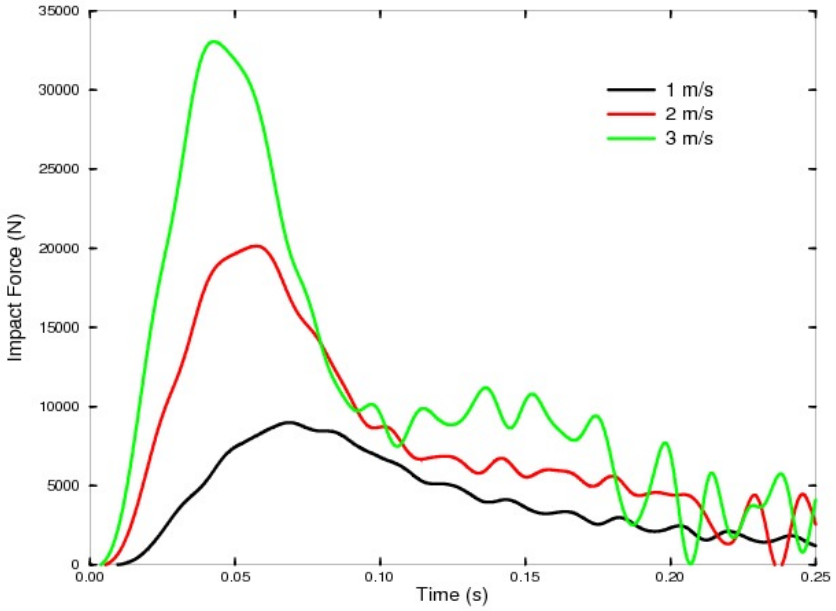

Figure 13. Impact Force

Figures 14 through 17 show the strain and pressure contours in the blubber and skin at approximately peak load for two impact velocity cases of 1 and 3 m/s. **Table 4** shows the peak stress and strain for each simulation. Although the images in these figures show what appears to be dramatic depression of the tissue, and the maximum principal (logarithmic) strains might cause tearing in many structural materials (steel, glass composites, etc.), these levels are quite acceptable for materials like human skin, tissue or natural rubber. For comparison, one could produce similarly proportional depression and strain (with little discomfort) by simply pressing one's index finger into one's thigh.

Table 4. Peak Stress and Strain from Computational Simulations

Blade Speed (m/s)	Blade Type	Maximum Principal Log Strain	Maximum Pressure (kPa)
1	Standard	0.26	950
2	Standard	0.41	1650
3	Standard	0.57	2340
4	Standard	n/a	n/a
5	Standard	n/a	n/a

It should be noted that the peak strains and pressures listed in **Table 4** occur in small volumes of tissue and are affected by the element size. Nevertheless, it is reasonable to compare results for different speeds and blade types since the same whale model was used for all of the simulations.

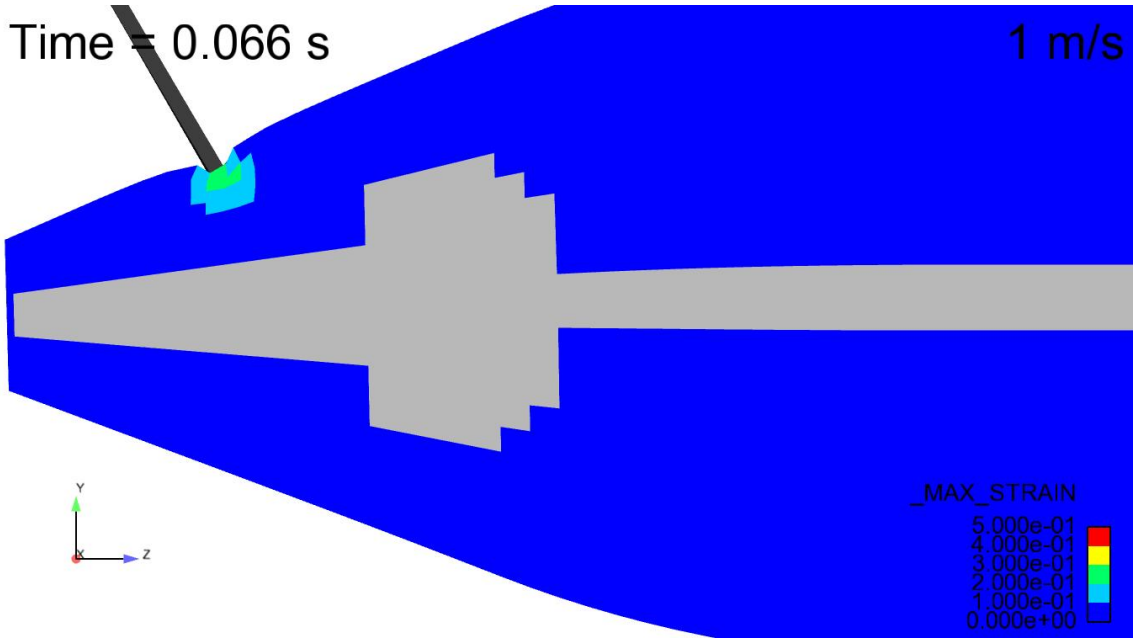

Figure 14. Strain, standard blade, 1 m/s at peak load

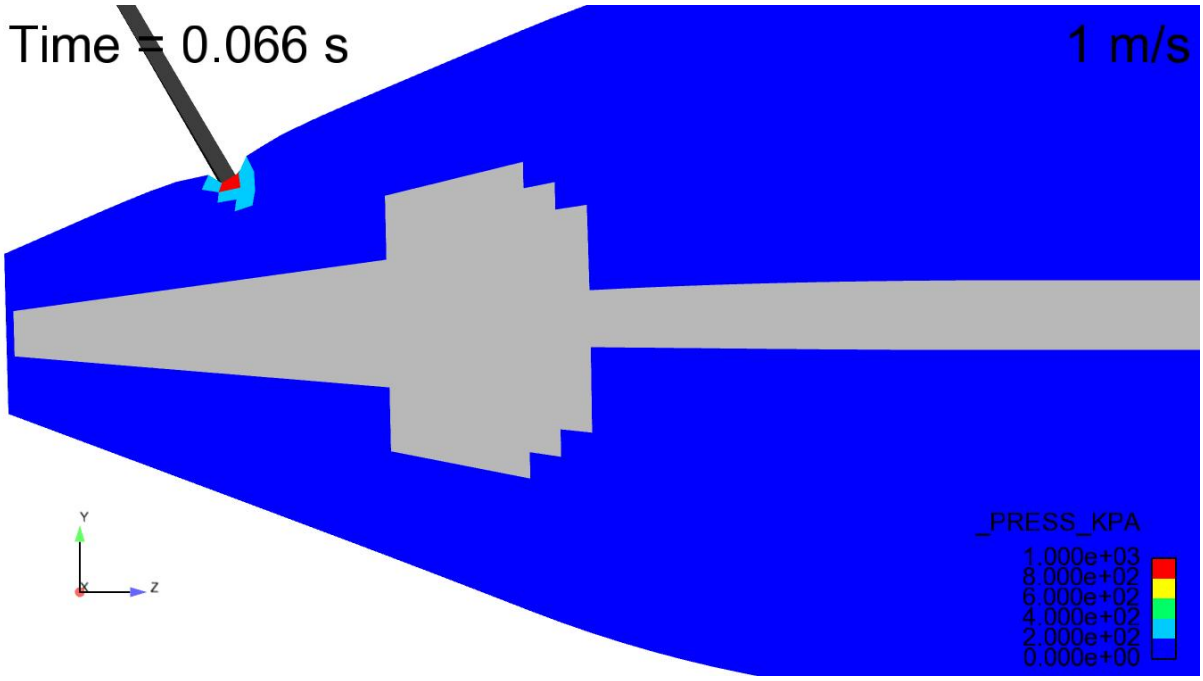

Figure 15. Pressure, standard blade, 1 m/s at peak load

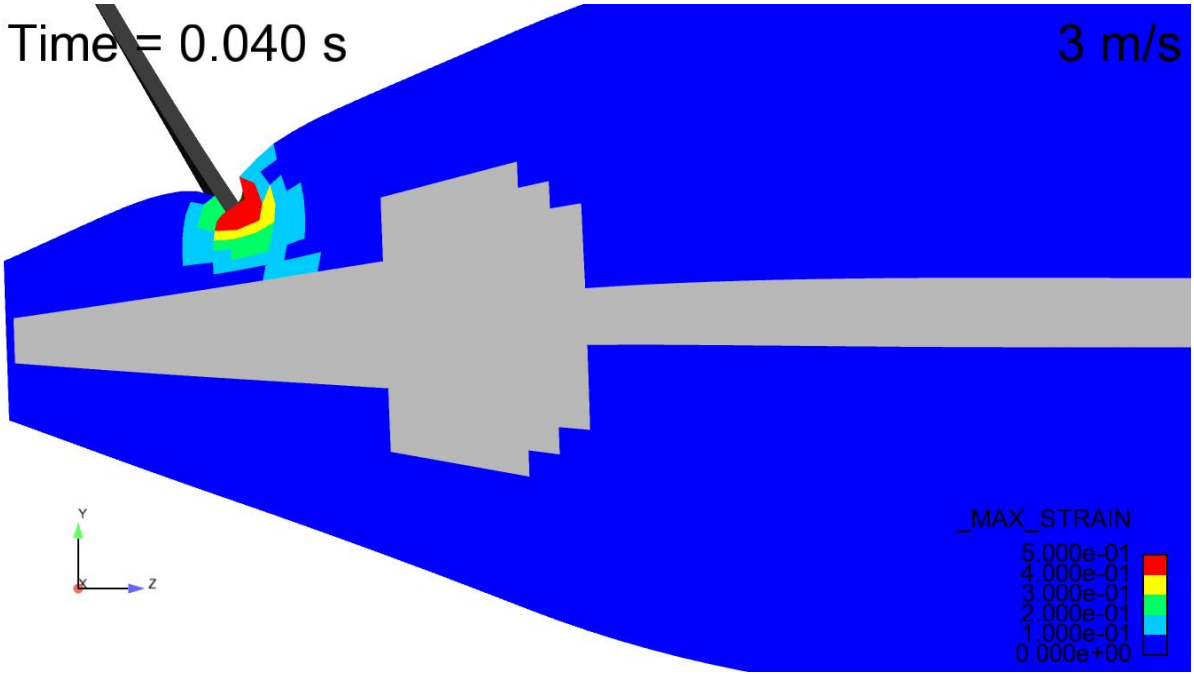

Figure 16. Strain, standard blade, 3 m/s at peak load

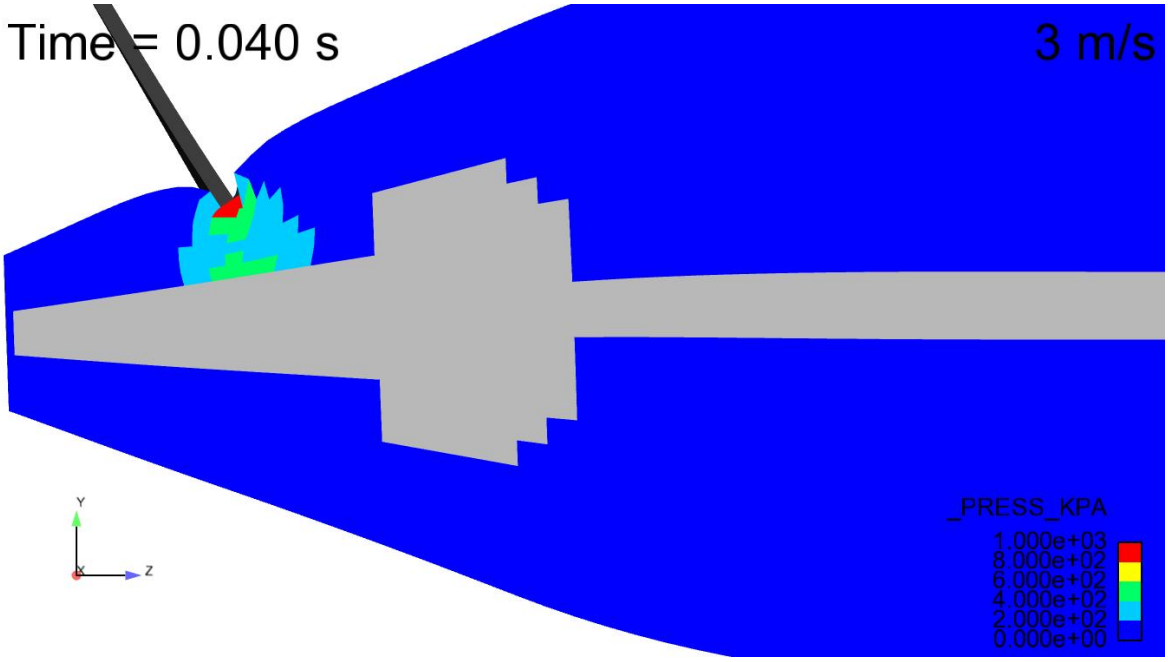

Figure 17. Pressure, standard blade, 3 m/s at peak load

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

The model simulations could not be computed for impact velocities above 3 m/s due the computational artifact of element distortion and inversion. However, one could extend the trend from 1 to 3 m/s simulations to estimate strain and stress at the higher velocities. **Figure 18** shows a plot of maximum strain and stress verses impact velocity. The relationship is linear within the velocity ranges at which the turbine operates and is indicative of the linear material model used for the tissue. Based on the linear correlation, the following equations can be used to predict strain and stress for velocities between 1 and 5 m/s:

$$\text{Strain} = 0.1 + 0.15V \quad (1)$$

$$\text{Stress} = 250 + 700V \quad (2)$$

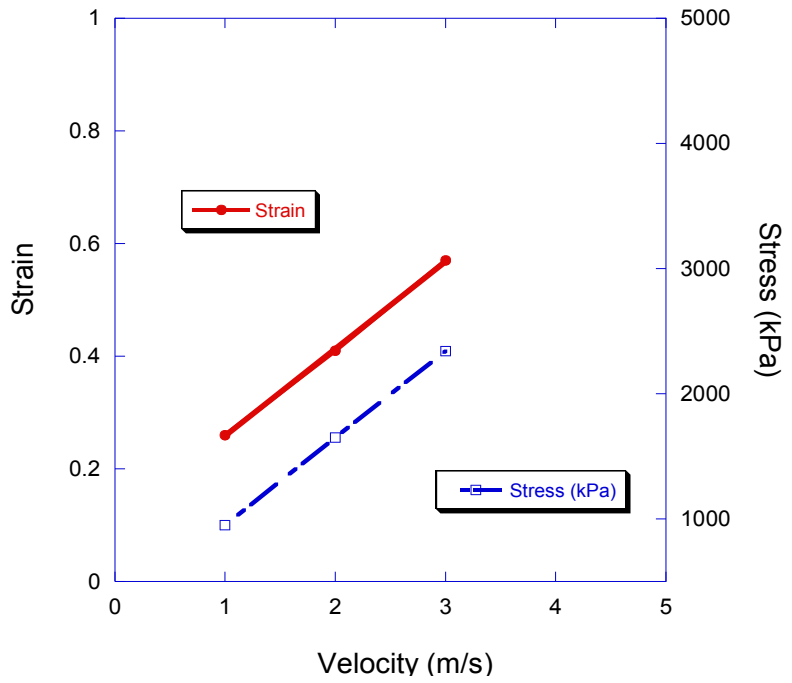

Figure 18. Maximum strain (log strain) and stress versus impact velocity

Table 5 summarizes the peak strain and stress from equations 1 and 2. These would be reasonable values for determining tissue effects due to impact.

Table 5. Peak Stress and Strain from Equations 1 and 2

Blade Speed (m/s)	Maximum Principal Log Strain	Maximum Elongation (%)	Maximum Pressure (kPa)
1	0.25	28	950
2	0.40	49	1650
3	0.55	73	2350
4	0.70	101	3050
5	0.85	134	3750

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

2.3.3 Including Forward Velocity of SRKW

One could include the contribution of a forward swim velocity of the SRKW by using equations 1 and 2 and data from **Table 1**. Results from Noren (2011) for swimming speeds of killer whales under various scenarios suggest that a maximum swimming speed of 3 m/s is reasonable. This would create a net impact of 5.8 m/s if the blade was moving at its maximum speed of 5 m/s. Using equations 1 and 2, the resulting stress would be 4310 kPa and the log strain would be 0.97 or 163 percent.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

3.0 Biological Assessment of Consequences of Impact

This section discusses the biological assessment by PNNL to determine the effect a blade strike would have on an adult male SRKW, using CT scan data of an adult SRKW. The biomechanical properties of SRKW skin and other soft tissues were also examined in order to determine how these tissues would react at the speed and force of a moving tidal turbine blade.

3.1 Whale Head Morphology

The engineering analysis modeled an adult killer whale that was approximately 650 cm in length, not considering the whale's flukes, and weighed 4,000 kg. PNNL was able to locate CT scan data for the head of an adult female that weighed approximately 5,300 kg and was roughly 670 cm in length, including the flukes. Because of the similarity in size to the modeled case, the CT scan data is a reasonable example of the size and location of features in the head of a killer whale of the size modeled in the engineering analysis. The CT scan data presented in this report, which has not been published, were made available by Ted Cranford of Quantitative Morphology Consulting, Inc. and are reproduced here with his permission.

Figure 19 shows a sagittal slice through the head of the whale. The location of the transverse slice shown in **Figure 20** is located approximately 40cm from the anterior tip of the whale's head. The intersection of the transverse slice line and the upper surface of the whale's head is the approximate location modeled as the location of impact of the turbine blade on the upper surface of the whale's head.

Figure 20 shows the CT scan for a transverse slice through the head of the whale as indicated in **Figure 19**. This slice intersects the lower mandibles of the whale's jaw, which are the "hook" shaped images to the right and left of center. The hollow voids in the whale's lower mandibles are filled with acoustic fat and other soft tissue and are believed to have a function in the reception of sound by the whale.

The whale's head is approximately 912 mm thick along the transverse slice line shown in **Figure 19**. In **Figure 19** it appears that the mouth of the whale may have been somewhat agape when head was scanned. However, even considering this condition it is clear from **Figure 19** and **Figure 20** that the outline of the whale's head is oblong in shape, being compressed laterally. These images and data were not available when the finite element model of the whale's head used in the engineering analysis was constructed or when assessment of the extent of exposure of the whale's head to the turbine's blades was made. Given the turbine blade spacing of 550 mm shown in **Figure 1**, assuming that the approach of the whale would be straight toward the blade assembly, it seems that whales the size of this adult female would most likely not be able to extend their head into the blade assembly (blade length on the order of 1,250 mm) to the extent used in the model, even more so if the turbine's shroud were considered in the analysis. Modeling the location of blade strike further posterior on the whale's head makes the assessment of the force of the strike absorbed by tissue conservative because the amount of blade strike energy that would have gone into "pushing" the whale away from the blade is increased as the location of strike is moved away from the center of mass of the whale.

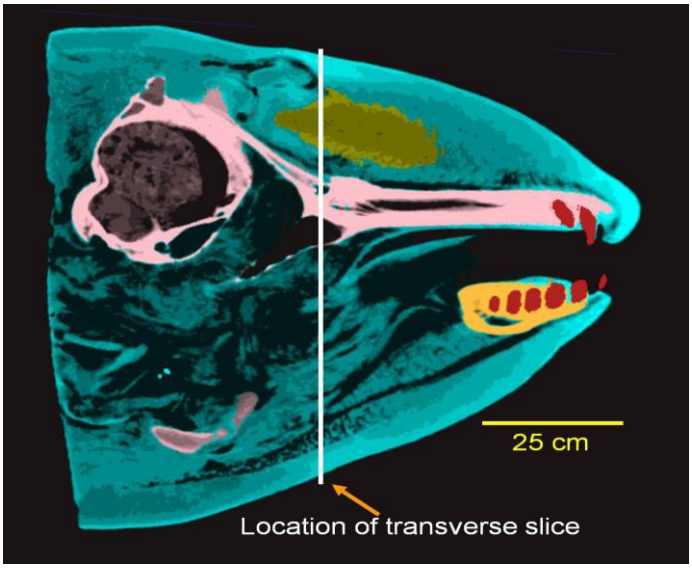

Figure 19. A sagittal CT scan of the head of an adult killer whale.
Bone is shown as white, teeth as red, voids are black, and other tissues in various other colors. Portions of the upper mandible of the whale's jaw and a cross section through the whale's skull are clear.

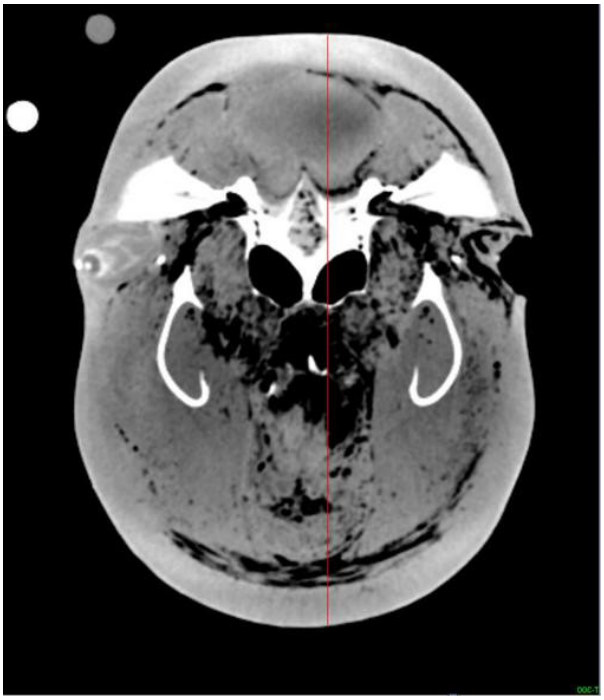

Figure 20. CT scan of a transverse slice through the head of a killer whale.
Approximately 40 cm from the tip of the whale's snout. The red line identifies a transect through the slice where CT scan image intensity values were sampled. In this figure bone is white, voids are black, and other tissues are gray.

Figure 21 shows the CT scan image intensity data along a vertical transect through the transverse CT scan slice shown in **Figure 20**. CT scan image intensity data is proportional to the density of the tissue

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

and bone. The x-axis is incremented in index units that correspond to a physical length through the head of the whale of approximately 2.5mm each. The y-axis indicates the transmissivity of the tissue to the radiation. In **Figure 21** the first data points on the left are for higher density skin and fibroelastic connective tissues, followed by lower density adipose and other tissue. Bone has the highest image pixel intensity. These data can be used to estimate the thickness of various tissues and the location of bone relative to the surface of the whale's head. Along this transect, it is estimated that the high density tissue of the whale's skin and fibroelastic tissue are approximately 50 mm thick and the lower density adipose and connective tissue between this layer and the upper mandible bone is on the order of 200 mm thick. In total there is approximately 250 mm (9.8 in) of tissue with varying density and biomechanical properties between the upper surface of the whale's head and upper mandible bone, along the transect shown in **Figure 20**. The tissues overlying the mandible in whales probably act as a "bumper" that absorbs and redistributes stresses applied to the surface of the whale (Campbell-Malone 2007).

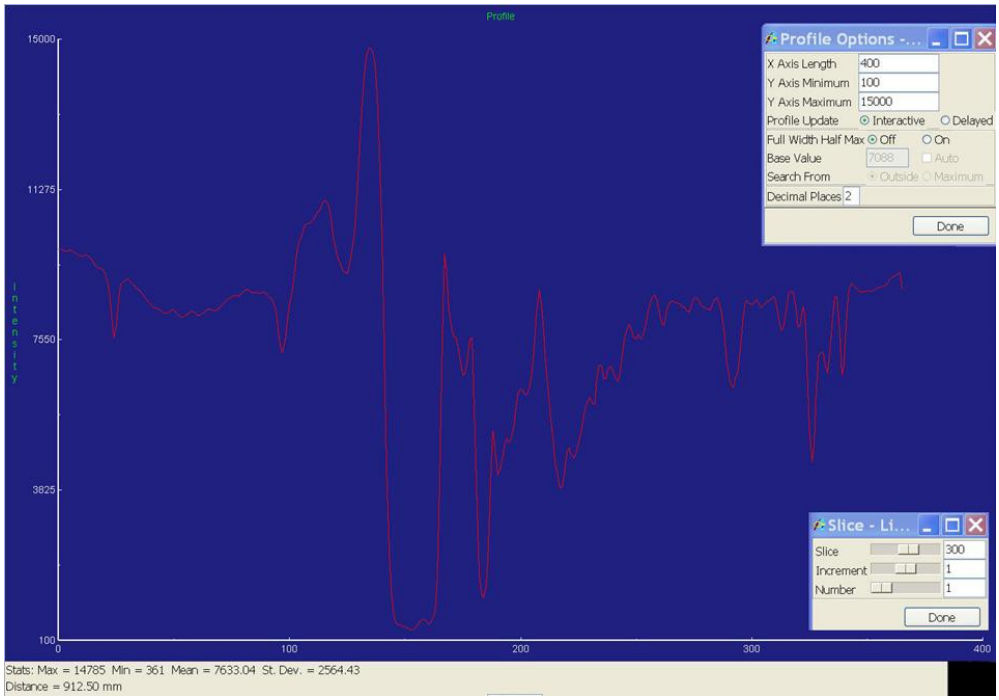

Figure 21. Intensity values along a vertical transect through a transverse slice of CT scan data for the head of a killer whale

The engineering analysis used the biomechanical properties of a single tissue (blubber) to model the SRKW head tissue at and below the location of the blade strike, as there were no biomechanical data for SRKW skin and higher density fibroelastic tissues at the time of the analysis. However the CT scan data makes it clear that there are multiple layers of differing densities, and likely different biomechanical properties. Based on these findings, the forces modeled and potential effects on the SRKW strike by a turbine blade are conservative. By adding biomechanical information on the high-density skin and fibroelastic layer, the force of a blade strike would be distributed over a larger tissue area and would probably result in lower maximum pressures.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

3.2 Tissue Models and Biomechanical Data

Review of the published and gray literature, augmented by contact with known marine mammal researchers, determined that there are limited data for the biomechanical properties of whale tissue in general and for killer whales in particular. The majority of biomechanical data available has been taken primarily to investigate the production and reception of sound by those species that use echolocation to communicate and find food. For this reason, there is limited information on the elastic region of tissue and bone stress-strain relationships, and few available studies examining other tissue properties such as the stress at which tissue mechanically fails. Hanson examined the failure of harbor porpoise dorsal fin tissue from the stress from radio tags (Hanson 2001). There is ample biomechanical information over a range of stresses for blubber (Soldevilla et.al 2005), and some information for whale bone (Campbell-Malone 2007). However there are almost no biomechanical data for whale skin and higher density fibroelastic tissue. The engineering assessment includes information on how available soft tissue and bone biomechanical information was abstracted from identified sources.

Because it is known that the skin layer plays an important role in mitigating impacts to the surface of all animal including whales, an effort was made to examine available information and to identify a material with known properties that might be used as a surrogate for whale skin. We performed a literature review to determine if mechanical properties could be identified for killer whale skin.

The modulus of toughness is an important stress-strain feature of a material (such as whale skin) and is characterized by its ability to absorb energy. The modulus is equal to the area under the stress-strain curve from the origin through the ultimate yield or rupture point for the material. As the term implies, toughness refers to the ability of a material to absorb energy without breaking. Unlike the modulus of elasticity, which is the constant of proportionality between stress and strain for elastic materials that respond linearly to stress, the “modulus of toughness,” UT, is a characteristic associated with susceptibility to puncture and laceration damage from mechanical trauma. The modulus of toughness is defined as the measure of a material’s ability to plastically deform without fracturing. This is represented graphically in **Figure 22**. It is related to impact strength through the following equation:

$$U_t = 1/3(\varepsilon_{Br})(\sigma_{yp} + 2\sigma_{ult}) \quad (3)$$

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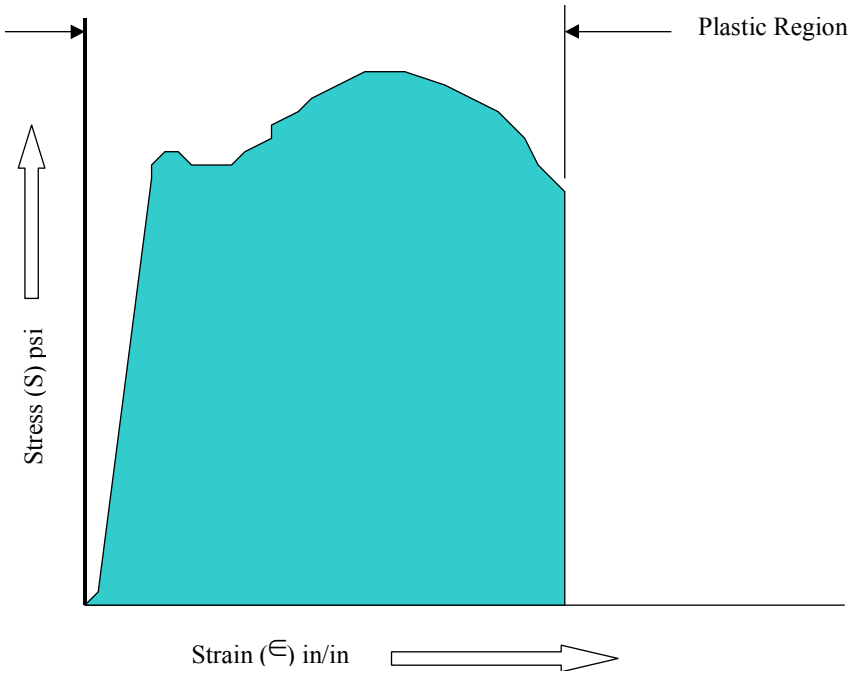

Figure 22. Description of material toughness in the context of stress-strain dynamics

The literature review determined that very little information exists for mechanical properties of whale skin. J.P. Winn (2006) in a master thesis that investigated the physical response of whale tissue to entanglement reported that:

> "The dermal layer is composed of an extensively cross-linked network of collagen fibers that may function as an elastic recoil mechanism during swimming activities. However, to date the only structural studies on cetacean epidermis have been measurements of epidermal thickness and evaluations of surface properties, including surface roughness and resistance to biofouling. Epidermal thickness … ranging from a minimum of 1.4 mm to a maximum of 25 mm in fin (*Balaenoptera physalus*) and bowhead whales (*Balaena mysticetus)* respectively. There have been no published studies on the mechanical properties of the cetacean epidermis."

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Table 6. Comparative epidermal ranges reported for baleen whale species (Winn 2006)

	Epidermis Thickness:							
Species	Gender	Length (cm)	Maximum Thickness (mm)	Source	Gender	Length (cm)	Minimum Thickness (mm)	Source
Balaena mysticetus	-	-	25.0	Haldiman *et al.* 1985	-	-	8.6	Haldiman *et al.* 1985
Balaenoptera acutorostrata	-	-	3.0	Singarajah 1984	-	-	3.0	Singarajah 1984
Balaenoptera acutorostrata	F	708	3.0	Sokolov 1982	F	708	1.4	Sokolov 1982
Balaenoptera physalus	M	1565	3.9	Sokolov 1982	F	1600	2.5	Giacometti 1967
Eubalaena glacialis	M	1075	13.2	Sokolov 1982	F	1630	8.6	Sokolov 1982
Megaptera novaeangliae	M	857	5.6	Jones and Pfeiffer 1994	M	857	4.3	Jones and Pfeiffer 1994

TABLE 1. Comparative epidermal thickness ranges reported for baleen whale species.

Winn's thesis contains results from abrasion tests on whale epidermis using 6.4-mm and 9.5-mm float line. Tests used straight pull and oscillatory pull under load to evaluate the effects of movement of rope across whale skin. The intent of the experiments was to model injury to the skin of whales struggling to free themselves from entanglement.

"Observations from both bowhead and right whales indicate that the primary strength in the epidermis is oriented in a vertical direction while laterally the structure is more elastic with lower strength. From a structural standpoint, this type of fiber integration would have several mechanical advantages. Strong vertically oriented fibers would both increase the abrasion resistance of the epidermis and may help to decrease the compressibility of the layer (**Figure 23**). As a lateral abrading force is applied to the surface of the epidermis, the strong vertical fibers would start to bend, orienting in the direction of the applied load. This flexure would allow the load to be applied in line with the vertical fibers that are anchored through the entire epidermal layer. Retaining elastic elements between these vertical fibers would maintain the flexibility needed in the epidermis allowing the epidermis to stretch during normal swimming activities. This elasticity may be graded through the stratum intermedium as the degree of keratinization and flattening of the epidermal cells has been noted to increase with distance from the sratum germinativum."

Winn also reports that

"The depth of penetration and character of the dermal papillae may also substantially influence the strength of the epidermis as a unit. Assuming that a more multidirectional orientation of collagen fibers in the dermal material enhances the tensile properties of the dermis, the volume of this dermal material interwoven within the epidermis would substantially influence the structural characteristics of the layer."

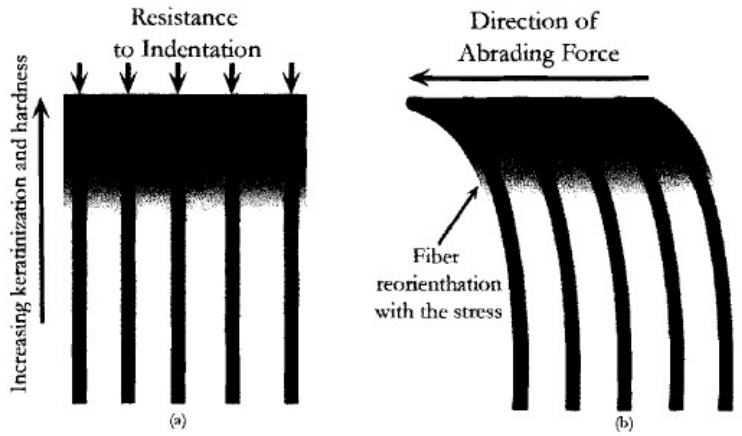

FIGURE 11. Structural advantages of a vertical fiber orientation within the epidermis. Fibers provide resistance to: (a) indentation and (b) lateral abrasion.

Figure 23. Structure of whale epidermis (Winn 2006)

Based on the information from Winn (2006), in the absence of biomechanical data for whale skin, it is hyperelastic material (http://en.wikipedia.org/wiki/Hyperelastic_material) was used to model the SRKW skin layer. **Figure 24** and

Table 7 below show properties of rubber and various elastomers.

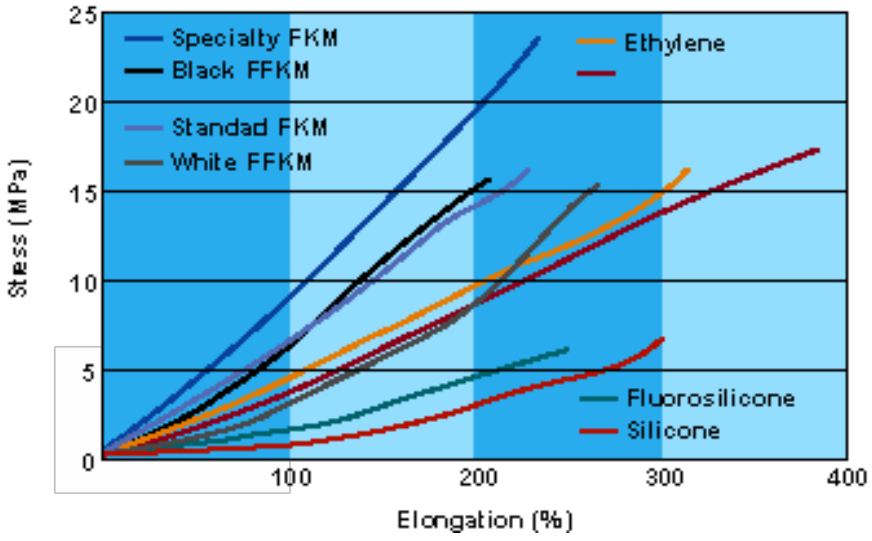

Figure 24. Examples of stress-strain characteristics for some manmade elastomers (The Physics of Rubber, http://www.allsealsinc.com/allseals/Orings/or13.htm)

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Table 7. Properties of Various elastomers (Schaefer 2009)

TABLE 33.2 Relative Properties of Various Elastomers

ASTM designation	NR	BR	SBR	IIR CIIR	EPM EPDM	CSM	CR	NBR	HNBR	ACM ANM	T	FKM	FVMQ	VMQ MQ, PMQ, PVMQ	AU EU	GPO	CO ECO
Durometer range	30–90	40–90	40–80	40–90	40–90	45–100	30–95	40–95	35–95	40–90	40–85	60–90	40–80	30–90	35–100	40–90	40–90
Tensile max, psi	4500	3000	3500	3000	2500	4000	4000	4000	4500	2500	1500	3000	1500	1500	5000	3000	2500
Elongation max., %	650	650	600	850	600	500	600	650	650	450	450	300	400	900	750	600	350
Compression set	A	B	B	B	B-A	C-B	B	B	B-A	B	D	B-A	C-B	B-A	D	B-A	B-A
Creep	A	B	B	B	C-B	C	B	B	B	C	D	B	B	C-A	C-A	B	B
Resilience	High	High	Med.	Low	Med.	Low	High	Med.-Low	Med.	Med.	Low	Low	Low	High-Low	High-Low	High	Med.-Low
Abrasion resistance	A	A	A	C	B	A	A	A	A	C-B	D	B	D	B	A	B	C-B
Tear resistance	A	B	C	B	C	B	B	B	B	D-C	D	B	D	C-B	A	A	C-A
Heat aging at 212°F	C-B	C	B	A	B-A	B-A	B	B	A	A	C-B	A	A	A	B	B-A	B-A
T_g, °C	–73	–102	–62	–73	–65	–17	–43	–26	–32	–24, –54	–59	–23	–69	–127, –86	–23, –34	–67	–25, –46
Weather resistance	D-B	D	D	A	A	A	B	D	A	A	B	A	A	A	A	A	B
Oxidation resistance	B	B	C	A	A	A	A	B	A	A	B	A	A	A	B	B	B
Ozone resistance	NR-C	NR	NR	A	A	A	A	C	A	B	A	A	A	A	A	A	A
Solvent resistance																	
Water	A	A	B-A	A	A	B	B	B-A	A	D	B	A	A	A	C-B	C-B	B
Ketones	B	B	B	A	B-A	B	C	D	D	D	A	NR	D	B-C	D	C-D	C-D
Chlorohydrocarbons	NR	NR	NR	NR	NR	D	D	C	C	B	C-A	A	B-A	NR	C-B	A-D	A-B
Kerosene	NR	NR	NR	NR	NR	B	B	A	A	A	A	A	A	D-C	B	A-C	A
Benzol	NR	NR	NR	NR	NR	C-D	C-D	B	B	C-B	C-B	A	B-A	NR	C-B	NR	B-A
Alcohols	B-A	B	B	B-A	B-A	A	A	C-B	C-B	D	B	C-A	C-B	C-B	B	C	A
Water glycol	B-A	B-A	B	B-A	A	B	B	B	A	C-B	A	A	A	A	C-B	B	C
Lubricating oils	NR	NR	NR	NR	NR	A-B	B-C	A	A	A	A	A	A	B-C	A-B	D	A

A = excellent, B = good, C = fair, D = use with caution, NR = not recommended

SOURCE: *Seals Eastern, Inc.*

Table 8 shows mechanical properties from Matbase and Matweb for a wide variety of elastomers. In order to understand the effects of the whale skin layer from turbine blade impact, it would be advantageous to run multiple models with hyperelastic materials. Materials such as natural rubber and fluorosilicone rubber fall into this category and have properties that bound those of the materials in this category.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Table 8. Table of the mechanical properties of various elastomers

(**http://www.matbase.com** and **http://www.matweb.com/**)

Material	Ultimate Yield Stress (kPa)	Elongation/ Strain %	Young's Modulus (MPa)
Butadiene Rubber	15000	200 - 400	
Chloroprene Rubber (CR)	25000	100 - 400	
Chlorosulph PE	20000	200 - 500	2 - 15
Ethenepropenediene Rubber	20000	250 - 500	2 - 10
Liquid Silicon Rubber	7000	250 - 550	—
Natural Rubber (NR)	30000	750 - 850	1 - 5
Nitrile Rubber (NBR)	20000	200 - 500	2 - 5
Silicon Rubber (SI, Q, VMQ)	8000	200 - 800	1 - 5
Styrenebutadiene Rubber (SBR)	25000	250 - 700	2 - 10
Urethane Rubber	30000	300 - 400	2 - 10
Butyl Rubber (IIR, CIIR, BIIR)	17000	400 - 800	—
Chlorosolfonated Polyethylene Rubber	21000	200 - 500	—
Epiclorohydrin Rubber (CO, ECO)	17000	150 - 500	—
Ethylene Propylene Rubber (EPM, EPDM)	17000	600	—
Fluorosilicone Rubber (FMQ, FVMQ, FSI)	8600	100 - 400	—
Hydrogenated Nitrile Rubber (HNBR)	30000	100 - 400	—
Natural Rubber, Not Vulcanized (NR, IR,	27600	500	—
Natural Rubber, Vulcanized (NR, IR,	28000	100 - 800	—
Polybutadiene Rubber (BR)	17000	300 - 800	—
Polychloroprene Rubber (CR)	28000	100 - 800	—
Polynorbornene Rubber (PNR)	24000	—	—
Polyphosphazene Rubber (PZ, FZ)	14000	—	—
Propylene Oxide Rubber (GPO)	17000	—	—

3.3 Biomechanics of Human Skin

Human skin has the same basic construction as SRKW skin with an epidermis, dermis, hypodermis and a fourth layer connecting the skin to underlying tissue. Human skin has been found be behave as a non-homogenous, anisotropic, non-linear viscoelastic material (Hendriks 2001). A basic function of the skin is to protect the body from mechanical injury.

The stress-strain relationship for human skin is shown in **Figure 25** (copied from Figure 2 in Silver et al. 2001). The top line in **Figure 25** is the true stress-strain curve for human skin; the two below are elastic and viscous stress-strain curves.

The relationship between stress and strain for human skin show trends that are similar to those predicted for whale blubber in the engineering analysis performed here (Table 5). The engineering analysis did not include the epidermis and dermis layers that give skin many of its composite biomechanical properties. The engineering analysis estimated that at a pressure of 2.35 MPa at a turbine

speed of 3 m/s, would elongate the blubber by about 73 percent. In **Figure 25** it can be seen that this same level of stress experienced by human skin would result in an elongation (strain) of about 60 percent. At the highest turbine speed for which the response of blubber is considered in the engineering analysis (5 m/s) an elongation of 134 percent was predicted at a pressure of 3.75 MPa. In **Figure 25** it can be seen that for human skin this level of stress would result in only a small increase in elongation, for a stress of 2.35 MPa. The different results between the elongation of blubber and whale skin is probably due to the more viscous nature of blubber and the lower level of elasticity of whale skin. In fact, it is likely that whale skin, because of the differences in the dermal layer between humans and whales, would have a stress-strain curve that would have a steeper slope than that shown for human skin.

It seems highly likely that consideration of the epidermal and dermal layers of whale skin, in addition to the hypodermis (blubber), would result in values for strain lower than those predicted for blubber alone, and at lower stress levels than are likely to damage SRKW skin, within the elastic region.

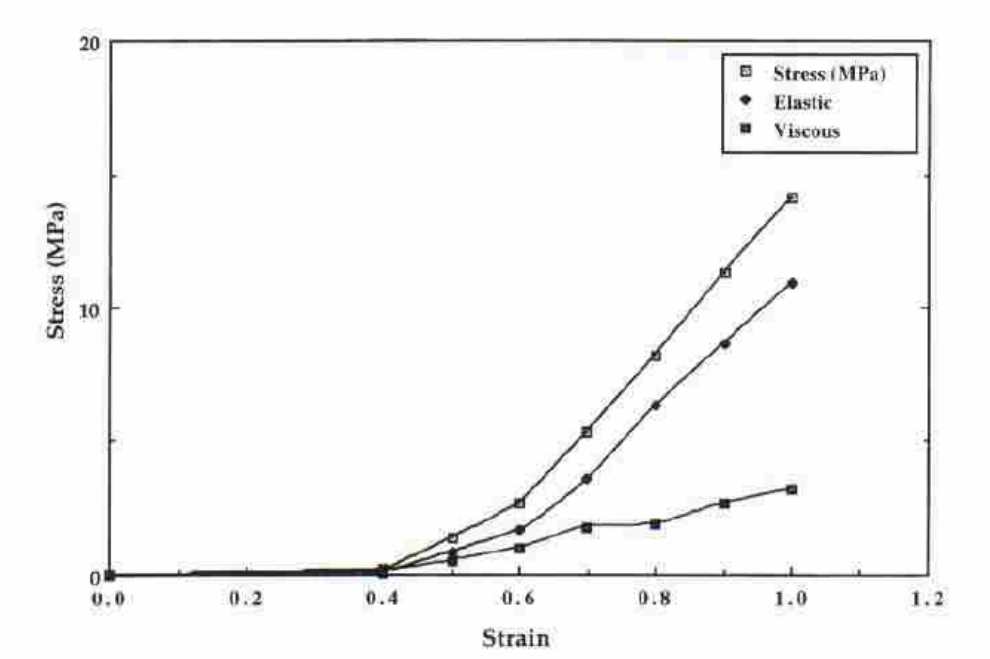

Figure 25. Relationship between stress and strain for human skin
showing true stress (unfilled squares), elastic (diamond symbols), and viscous (filled squares) components (Silver et al., 2001)

3.4 Consequence of Turbine Blade Impact on Whale Tissue

The consequence of tidal turbine blade impact on whale tissue can be roughly estimated from the model data in Table 4. The data in Table 4 are worst case for the soft tissue found below the skin and fibroelastic layers of whale tissue. The reason that they are worst case is that the likely properties of the skin and associated fibrous layer would have acted as a membrane and would have distributed the force of the blade strike over a larger area of underlying tissue.

If it can be assumed that whale skin can be modeled as a hyperelastic material, the stress-elongation curves in Figure 18 indicate that at the maximum pressure of 3.75 MPa (3750 kPa) the response of whale

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

skin would remain in the elastic range for all the materials presented. Elongation percentages at the highest turbine blade speed would be in the range from approximately 25 percent to 200 percent with that for materials in the middle of the range of about 100 percent. At all other blade speeds elongation would be less. Because the response of these materials is elastic over the range of pressures in Table 4, it is expected that if whale skin behaves similarly to these materials, at strike whale skin tissue would deform and, in conjunction with underlying soft tissue, absorb the force of the strike and would return to normal condition a short time after the pressure was removed. These data indicate that the skin would not fail, i.e. be torn by the impact at even the highest exposure pressures.

The analysis of the blubber mechanical property data conducted during model construction based on measured biomechanical properties of blubber suggests that blubber has properties that are similar to rubber like as well. As such the whale blubber would display elastic properties with elongation response to stress without deformation within the range of pressures predicted by the engineering analysis. It is possible that within this range of pressure and resulting deformation that the tissues experiencing the highest pressures would bruise. It is expected that the pressures listed in Table 4 would not be realized because the skin and underlying fibrous fatty tissue would deform to distribute the force of the strike across a greater area of tissue.

Campbell-Malone (2007) gives a value for the ultimate compressive strength for trabecular right whale mandible bone of 17.95 MPa. The ultimate strength for cortical bone would be higher. If this value can be used for killer whale mandibular bone, the highest pressure predicted (3.75 MPa) is well below the pressure at which this bone would be expected to fracture. Because the skin and other tissues overlaying the killer whale mandible would absorb most if not all of the pressure from the blade strike the pressure on the whale's mandible would likely be an order of magnitude or so below pressure likely to cause fracture.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

4.0 Additional Information to Inform Strike Modeling: Blunt Force Trauma and Real World Experience

4.1 Blunt Force Trauma Research

Additional information on potential effects of a turbine blade strike to a SRKW from a blade strike can be gleaned from research and monitoring results of animal head trauma. PNNL researchers searched peer reviewed and gray literature on blunt force traumas of marine and terrestrial mammals. Blunt trauma refers to physical trauma caused to a body part, either by impact, injury or physical attack; this trauma is in contract to a penetrating trauma in which the body suffers an invasive injury.

Peer reviewed literature was accessed using Web-of-Science (WoS) and gray literature accessed from Google searches and cited references in papers identified from the WoS searches. A key index for evaluating the severity of head trauma in humans and other animals has been developed, known as head injury criteria (HIC). Although such an index is not available for marine mammals, the process of developing a HIC might be instructive. While searching for pertinent literature on blunt force trauma, PNNL researchers looked for papers that might support the development of a marine mammal HIC or other types of risk assessment tools for interactions with objects. Literature on large and small terrestrial mammals was also reviewed. This literature review supports some insights into blunt force head trauma in a variety of mammal species, and also sheds light on tools and methods that may be useful in assessing and modeling head trauma on SRKWs and other marine mammals.

Initial literature searches were focused on marine mammal and whale head trauma, with most results describing consequences of collisions between ships and marine mammals, and also for underwater detonations; however the forces associated with ship collisions and underwater explosions exert many times the forces modeled for the tidal turbine blades. However, few studies incorporate information on the forces that caused the trauma, which prevents direct comparison beyond the specific event or collision incident, and provides limited insight into the tidal blade strike scenario. One notable exception is Tsukrov et al. (2009); this study developed a 3-D finite element mesh model to predict the mechanical behavior of a right whale's mandibular bone under strain, combined with the potential forces exerted by a whale-ship collision. This information provides insight into how a similar approach could be used to develop mechanical models of the SRKW skull and brain. If these biomechanical models were combined with biological models of brain trauma the result might inform the potential effects of blade strike on the head of a SRKW.

By widening the scope of the literature search to other animal studies and studies related to traumatic brain injury (TBI) and HIC development, it became apparent that the animal research community segregates head trauma into three main categories: clinical (research directly involving human subjects), large animal, and small animal studies. Literature focused on larger animals showed that porcine studies are most valuable with detailed descriptions of brain trauma in pigs after controlled, laboratory-induced head injury, from the sub-cellular to the whole brain level of biological organization. Literature on equine and canine head trauma is more limited; quantitative results on other livestock were not found.

The literature reflects a trend towards increasing reliance on small animal models for head trauma research, which offer advantages associated with cost, animal welfare/ethical concerns, well-defined

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

protocols for inducing head injury, and more sophisticated analytical tools. Most of the small animal models are for rodents. The increasing use of rodent model systems for studying TBI also coincides with the use of *in vitro* systems, including isolated brain tissue slices and axonal cell cultures, allowing for better characterization of the cellular mechanisms of injury.
The results of the literature search are available online through the *Tethys* database:
http://mhk.pnnl.gov/wiki/index.php/Orca_Strike_Analysis

4.2 Assessments from Marine Veterinarians

In the absence of field observations to validate the outcome of the strike analysis, PNNL researchers sought input from marine veterinarians familiar with the effects of head trauma and other injuries in cetaceans and other marine mammals. The veterinarians provided professional insights into effects on marine mammals recovered from strandings, and from observations of animals in captivity. In almost all cases, the insight gained from the veterinarians consisted of their best professional judgment and was described through anecdotes rather than through the presentation of data and drawing of conclusions.

4.2.1 Selected observation of Marine Mammal Strike from Marine Veterinarians

Pertinent observations include:

When marine mammals are struck, it is not uncommon to see bruising in the underlying tissue, even if the skin is not broken. They look at pink discoloration in the blubber layer as a focal point to investigate for underlying damage, including bone fracture. They see blunt force head trauma in large whales, generally because they have been struck by ships, but strandings of smaller whales are almost always due to entanglements in fishing gear (M. Moore, pers. comm.).

Evidence on the effects of propeller strike on smaller marine mammals is most commonly studied in manatees. The dermal layers are thick in manatees as compared to most cetaceans. Mortality in manatees from boat strike is generally due to the combined effects of lacerations and blunt force trauma to the skeleton including the skull. However, manatees have very powerful bone regenerative capabilities (W. McLellan, pers. comm.). Key references include: Lightsey et al. 2006; Rommel et al. 2007; and Kipps and McLellan 2002).

Other marine mammal evidence of interest includes infanticide of harbor porpoise calves caused by attacks from bottlenose dolphins. Porpoise calves (as well as some bottlenose dolphin calves) have died from head trauma due to ramming by the adults. The injuries to the calves are not consistent with other forms of trauma such as boat strike, fisheries interactions, predation or underwater blasts (W. McLellan, pers. comm.). Key references include: Patterson et al. 1998; and Dunn et al 2002.

Almost all the quantitative evidence of severe or lethal outcomes for cetaceans have occurred due to ship strikes, particularly strikes of North Atlantic Right Whales (NARW) in the Atlantic. Modeling and laboratory efforts have helped to interpret necropsy findings that indicate that lethal encounters are generally the result of forces capable of breaking the NARW jawbone, often the result of multiple microfractures; these models have taken the speed and forces imparted by the ships, as well as the area

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

and time of impact, into account. The forces exerted by ships, as the product of mass times acceleration, are many times greater than the mass and acceleration generated by tidal turbine blades. Controlled laboratory blunt force trauma experiments with pigs yield the closest analogue to marine mammals (R. Campbell-Malone, pers. comm.). Key references include: Campbell-Malone et al. 2008; and Knowlton and Kraus 2001.

Captive killer whales tend to avoid stationery objects underwater, so that curiosity is the only likely scenario where an animal might encounter a turbine. The animals most likely to approach an underwater object are young; older animals are wary. The adults will examine an object but will seldom approach closely. Neonates will be protected by their mothers from harm. The young adolescent orcas, particularly those that do not have a parent nearby might approach an object. However, the danger from turbines underwater is likely to be small as compared to the risk to these animals from ships moving at speed with high inertia and rotating propellers (J. McBain, pers. comm.).

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

5.0 Discussion and Conclusions

5.1 Interpretation of Engineering and Biomechanical Analyses

The consequence of tidal turbine blade impact on whale tissue can be roughly estimated from the model data in Table 4 that shows that the peak stresses and strains that can be expected from impact from the tidal turbine blade modeled will be 3750 kPa for the turbine impacting the stationary body of a SRKW, with a 73% elongation of the material, or a 2365 kPa for the impacts with a SRKW swimming toward the turbine with a 93% elongation. These levels of stress are well below what is expected to cause a failure mode in a surrogate material such as natural rubber (10,000 to 30,000 kPa), and less than the strain expected to cause rupture of human skin (100-300%).

Assuming that the SRKW skin can be modeled as a hyperelastic material, the stress-elongation curves in Figure 18 indicate that at the maximum pressure of 3.75 MPa (3750 kPa), the response of whale skin would remain in the elastic range. Elongation percentages at the highest turbine blade speed would be in the range from approximately 25 percent to 200 percent. At all other blade speeds elongation would be less. Because the response of these materials is elastic over the range of pressures in Table 4, it is expected that if whale skin behaves similarly to these materials, the whale skin tissue would deform and, in conjunction with underlying soft tissue, absorb the force of the strike and return to its normal condition shortly after the pressure is removed. These data indicate that the skin would not be torn by the impact at even the highest exposure pressures.

The published biomechanical properties of blubber indicate that it will react to deformation in a manner similar to rubber, displaying properties of deformation that are likely to represent bruising.

Because the engineering analysis considered a whale made entirely of blubber, these results probably represent the worst-case outcome for the soft tissue found below the skin and fibroelastic layers of the SRKW body. This overestimate of potential harm stems from the fact that the skin and associated fibrous layer would probably act as a membrane, distributing the force of the blade strike over a larger area of underlying tissue.

Campbell-Malone (2007) provides a value for the ultimate compressive strength for trabecular right whale mandible bone of 17.95 MPa. The ultimate strength for cortical bone is likely to be higher. If this value can be used for killer whale mandibular bone, the highest pressure predicted for turbine blade strike (3.75 MPa) is well below the pressure at which this bone would be expected to fracture. Because the skin and other tissues over the SRKW mandible are likely to absorb most of the pressure from the blade strike, the pressure on the SRKW mandible could be estimated to be an order of magnitude or so below pressures likely to cause fracture.

5.2 Uncertainty of Outcomes of Analyses

The overall uncertainty of the engineering and biomechanical analyses can best be estimated by assessing the accuracy of each piece of information that informed the analyses. The modeling techniques used are well documented and are unlikely to have introduced significant uncertainty. Table 9 summarizes the uncertainty of each specific information source.

Table 9. Level of certainty associated with each input to the engineering and biomechanical analyses

Portion of Analysis	Specific Input to Analysis	Accuracy/Level of **Certainty** of Information	Explanation
Modeling of Strike Forces	Geometry of SRKW approach to turbine	High	Geometry of turbine based on detailed drawings from turbine manufacturer; geometry of SRKW based on reports for several SRKWs studied. Chose "worst case for injury" approach of SRKW swimming directly into outer edge of turbine.
	Speed and forces modeled for turbine, as they vary with tidal current speed	High	Turbine speeds and tidal current values are well known, supplied from manufacturer; multiple model runs to determine forces.
	Orientation of animal with turbine blade, transfer of momentum	Medium	Limited model runs for orientation of animal, to ensure choice of "worst case for injury" scenario. Based on engineering judgment.
	Non-linear model for materials	Medium	Does not include model for dermal layers (modeled all-blubber whale) or non-linear model for any materials, leading to overestimate of potential harm to SRKW from turbine.
Biomechanics of orca tissues	Information on tissue thickness and properties of skin	Medium	No direct measures for head of SRKW; information adapted from CT scans of SRKW and literature on other species. Based on professional judgment.
	Information on tissue thickness and properties of blubber	High	Good biomechanical property values from literature to estimate deformation of blubber and transfer of force to underlying tissue & bone.
	Information on tissue thickness and properties of bone	Medium	Biomechanics of impact on bone well understood; used other species in absence of information on SRKW. Based on professional judgment.
	Information on tissue thickness and properties of mellon	Low	Tissue thickness from CT scan and necropsy data, biomechanical values from literature. Properties from blubber used in model because of similar biomechanical properties.
	Effects of blunt force trauma	Medium	Good understanding and copious literature for humans and livestock; little information for marine mammals. Some anecdotal information may be gleaned from interviews. Based on professional judgment.
Sensory response to impact	Post-trauma effects on SRKW	Low	No literature on effects. Potential for anecdotal information from interviews. Not used in model.

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5.3 Additional Information to Inform Analyses

In assessing the available blunt force trauma literature, there appears to be is a paucity of data on head injuries in marine mammals that can be associated with reliable estimate of the forces involved. The best available information is associated with whale-ship collisions and to a lesser extent, data from underwater detonations. Of the available animal surrogate models, the pig provides the most detailed information on head trauma in a large animal model. Recent studies with rodents and *in vitro* models coupled to some type of computational analysis appear to offer a tractable alternative to traditional animal testing; however, rodent brains reside in the skull and react very differently than those of higher mammals, including cetaceans (R. Campbell-Malone, pers. comm.). The information gleaned from the literature may be of value in future marine mammal assessments where post-mortem (from stranding or other natural cause of death) brain tissue may become available for testing, and more direct measurements of force causing trauma can be made.

Although some interesting insights can be drawn from the anecdotes and professional judgment of veterinarians who care for injured marine mammals and perform necropsies on dead animals, there is no research available that directly informs the SRKW interaction with tidal turbine scenario.

5.4 Next Steps

The engineering and biomechanical analyses reported on here indicate that insight can be provided into potential interactions between marine animals and turbines. However it is clear that the information base of mechanical properties for marine mammal tissues lacks key pieces critical to the analyses. We propose the collection of an enhanced database of marine mammal biomaterial properties. This information could be collected through a coordinated action to recover more biomechanical information on marine mammal tissue and bone as a routine part of the existing necropsies on animals found dead. Also of importance is data on specific properties and operational modes of turbines that could cause harm to marine animals; for example, material properties that can be used on the leading edges of turbine blades to decrease potential harm to animals. Animal models are needed that can connect the biomechanical properties of marine mammals and design criteria for turbines, allowing for a modeling application to evaluate the design of turbines before deployment.

It is also important to note that the analyses performed here do not necessarily inform interactions between tidal turbine blades from devices with designs different than the open center OpenHydro turbine, nor are these analytical outcomes necessarily transferable to turbine blade interactions with other marine mammals. We propose that analyses of additional turbine designs, interacting with other marine mammals potentially at risk, be performed. Of particular interest are studies that link turbines with unducted blades and vertical axis turbines, with marine mammals that differ in size, body conformation, and mass from the adult SRKW.

5.5 Conclusion

Little is known about the potential effects of tidal turbine blade impacts on SRKW; the engineering and biomechanical approach in this study demonstrates that insight can be provided, even in the absence of definitive data. By modeling the speed and potential force exerted by an OpenHydro tidal turbine blade, SNL was able to estimate the maximum force of tidal turbine blades acting upon soft tissue and

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

bone of a SRKW. Coupled with PNNL's biomechanical analysis of whale blubber and tissue the model provided a basis for assessing the potential injury to a SRKW. A review of existing literature and interaction with marine veterinarians experienced with injured marine mammals did not elucidate the outcome greatly. The PNNL and SNL analyses determined that an adult male SRKW weighing approximately 4000 kilograms is not likely to experience significant tissue injury from impact by an OpenHydro tidal turbine blade; based on a number of assumptions, SRKW skin and the underlying soft tissue should absorb the force of the strike without external damage to the skin or fracturing of the mandibular bone. However, key information required to fully understand the biomechanical properties of marine mammal tissues are lacking, limiting the results of the analyses. To address the lack of data, conservative estimates were made and the worst-case scenario was used for the modeling studies. The addition of improved biomechanical data could significantly alter the conclusions reached by these analyses; having used conservative estimates, the risk to the SRKW is most likely to decrease with improved data.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

6.0 References

Baird, R.W., Hanson, B. 2004. Behavior of the "southern resident" killer whales. Cascadia Research Collective, Olympia, WA. Report AB133F-03-SE-1070.

Campbell-Malone R. 2007. *Biomechanics of North Atlantic Right Whale Bone: Mandibular Fracture as a Fatal Endpoint for Blunt Vessel-Whale Collision Modeling*, Massachusetts Institute of Technology, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts.

Campbell-Malone R, Barco SG, Daoust PY, Knowlton AR, McLellan WA, Rotstein DS, Moore MJ (2008) Gross and histologic evidence of sharp and blunt trauma in North Atlantic right whales (*Eubalaena glacialis*) killed by vessels. J Zoo Wildl Med 39:37–55

Durban J, H Fearnbach, D Ellifrit, and K Balcomb. 2009. *Size and Body Condition of Southern Resident Killer Whales*. Contract report to the Northwest Regional Office, National Marine Fisheries Service. Order number AB133F08SE4742, Requisition Number NFFP5000-8-43300.

Dunn, D. G., Barco, S. G., Pabst, D. A. & McLellan, W. A. (2002). Evidence for infanticide in bottlenose dolphins of the Western North Atlantic. Journal of Wildlife Diseases 38, 505–510.

Hanson, M.B., 2001. An evaluation of the relationship between small cetacean tag design and attachment durations: a bioengineering approach. Ph.D. Thesis, University of Washington, Seattle, Washington, 208pp.

Hendriks, FM. 2001. *Mechanical behavior of human skin in vivo, a literature review*. Koninklijke Philips Electronics N.V. Amsterdam, the Netherlands, Report 2001/820.

Kipps EK, McLellan WA, Rommel SA, Pabst DA. 2002. Skin density and its influence on buoyancy in the manatee (*Trichechus manatus latirostris*), harbor porpoise (*Phocoena phocoena*) and bottlenose dolphin (*Tursiops truncatus*). Mar Mamm Sci 18:765–778.

Knowlton, A. R. & Kraus, S. D. 2001 Mortality and serious injury of northern right whales (*Eubalaena glacialis*) in the western North Atlantic Ocean. *J. Cetacean Res. Mngmt* (Special Issue) **2**, 193–208.

Koteras J R, AS Gullerud, NK Crane, and JD Hales. 2006. *Presto User's Guide Version 2.6*. Sandia National Laboratories, Albuquerque, New Mexico, SAND2006-6093.

Lightsey JD, Rommel SA, Costidis AM, Pitchford TD (2006) Methods used during gross necropsy to determine watercraft- related mortality in the Florida manatee (*Trichechus manatus latirostris*). J Zoo Wildl Med 37:262–275

McKenna FA. 2005. *Comparative Morphology of the Odontocete Melon: Functional and Evolutionary Interpretations*. San Diego State University, San Diego, California.

Noren DP 2011. "Estimated field metabolic rates and prey requirements of resident killer whales. *Marine Mammal Science*, 27(1):60-77.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Patterson IAP, Reid RJ, Wilson B, Grellier K, Ross HM, Thompson PM, *1998*. Evidence for infanticide in bottlenose dolphins: an explanation for violent interactions with harbour porpoises? *Proc R Soc Lond B 265*: *1*-4.

Rommel SA, Costidis AM, Pitchford TD, Lightsev JD, Snyder RH, Haubald EM. 2007. Forensic methods for characterizing watercraft from watercraft-induced wounds on the Florida Manatee (Trichechus manatus latirostris). Marine Mammal Science 23: 110–132.

Schaefer RJ. 2009. "Mechanical Properties of Rubber." In *Harris Shock and Vibration Handbook*, eds. AG Piersal and TL Paez, McGraw Hill, New York, New York.

Sliver, FH, JW Freeman, and D DeVore. 2001. "Viscoelastic properties of human skin and precessed dermis." *Skin Research and Technology*, 18-23.

Soldevilla MS, MF McKenna, SM Wiggins, RE Shadwick, TW Cranford, and JA Hildebrand. 2005. "Cuvier's beaked whale (Ziphius cavirostris) head tissues: physical properties and CT imaging." *Journal of Experimental Biology*, 208:2319-2332.

Williams R, Noren DP (2009) Swimming speed, respiration rate, and estimated cost of transport in adult killer whales. Mar Mammal Sci 25: 327–350

Winn, JP. 2006. *Modeling Large Whale Entanglement Injuries: An Experimental Analysis of the Influence of Tissue Compliance, Line Tension, and Draw-Length on Epidermal Abrasion Resistance,* University of Maine, Orono, Maine.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

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Attachment 2

November 15, 2012, draft "A framework for detection of tidal turbine sound: A pre-installation case study for Admiralty Inlet, Puget Sound, Washington (USA)"

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A framework for detection of tidal turbine sound: A pre-installation case study for Admiralty Inlet, Puget Sound, Washington (USA)

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Abstract

The development of sustainable tidal power generation schemes is contingent upon demonstrating the environmental compatibility of this technology. Among the existing environmental uncertainties is the effect that the sound produced by tidal turbines might have on fish, diving seabirds, and marine mammals. Consequently, it is desirable to better understand these interactions through pilot-scale monitoring before commercial-scale deployments are undertaken. Effective monitoring plans must account for the extent of sound and the potential for this sound to cause detectable changes. This study presents a framework that synthesizes information about turbine sound and underwater ambient noise to evaluate the detectability of turbine sound by particular groups of marine animals. Because both turbine sound and ambient noise vary in time, sound detection by a marine animal at a given distance from the project is probabilistic. The framework is applied to a case study for a proposed pilot project in northern Admiralty Inlet, Puget Sound, Washington (USA). The time distribution of turbine sound is derived from measurements of a similar tidal turbine and convolved with the time distribution of ambient noise measured at the case study site. Results suggest that characterizing turbine sound and studying marine mammal responsiveness at this location will be challenging due to existing ambient noise associated with high vessel traffic density and bedload transport. The case study provides instructive guidance for high-priority data needs to reduce uncertainty in the framework for evaluating the acoustic effects of tidal energy projects.

1 Introduction

Sustainable power generation schemes must be technically, economically, socially, and environmentally viable. Consequently, a renewable resource is a necessary, but not sufficient condition for sustainable power generation. As new power generation schemes are proposed, it is desirable to evaluate their sustainability at the pilot scale. This enables early results to inform the engineering design process and improve their sustainability at the commercial scale.

Tidal hydrokinetic power generation harnesses the kinetic power in swiftly moving tidal currents. Tidal hydrokinetic power is predictable, intense, and often in close proximity to electrical loads. It may also be more environmentally compatible than tidal barrage power generation, which relies on impoundment similar to conventional hydropower (Twidell and Weir, 2006). Environmental impacts are possible from large-scale, hydrokinetic tidal power generation, but uncertain in that the severity and frequency of possible stressor-receptor interactions has not been established (Cada et al., 2007; Polagye et al., 2011). For this study, a hierarchical framework is used to quantify environmental concerns. For the purposes of

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

this paper, we describe the lowest level as a “stressor”, a characteristic of tidal turbine operation, such as production of sound. A “change” is a detectable alteration to the natural environmental caused by a stressor. An “effect” is a change that exceeds a threshold denoting environmental significance, with “impacts” being negative effects and “benefits” being positive effects[1].

Among the areas of environmental concern for tidal energy are acoustic impacts, whereby the sound from tidal turbine operation could lead to physiological (e.g., temporary threshold shift) or behavioral alteration for fish, diving birds, or marine mammals. Similar concerns exist for other forms of anthropogenic noise, such as vessel traffic (Hatch et al., 2008; McQuinn et al., 2011; McKenna et al., 2012; Bassett et al., in press) and are grouped under the broad heading of Population Consequences of Acoustic Disturbances (PCAD, NRC 2005). After Hawkins and Popper (2012), we refer to acoustic pressure and particle velocity produced by a tidal turbine as “sound”, whereas acoustic pressure and particle velocity from other sources that may mask this sound are referred to as “noise”.

Given the broad range of potential environmental impacts and limited resources available (both private and public), prioritization of environmental studies at pilot projects is required (Polagye et al., 2011). Pre-installation estimates for the acoustic effects of a tidal energy project are, therefore, needed to evaluate the effectiveness of monitoring plans that are intended to provide information about the extent of the acoustic stressor (i.e., turbine sound) and receptor (e.g., marine mammal) response. Such estimates will be specific to a particular turbine (or turbine array) and location. Since ambient noise and tidal turbine sound will vary in time, the spatial extent of the acoustic effect will expand and contract, accordingly. For a marine animal at a fixed point in space, exposure to this effect will be probabilistic.

This paper presents a framework for assessing the environmental consequences of turbine sound in a probabilistic manner. Knowledge gaps leading to uncertainty in the estimate are highlighted. The framework is then applied to produce a pre-installation estimate of the acoustic effects of a pilot tidal power project proposed in northern Admiralty Inlet, Puget Sound, Washington (USA). This type of estimate bounds the potential for environmental effects for pilot projects and helps to develop effective post-installation monitoring strategies for these projects.

The probability of detecting turbine sound relative to ambient noise may be expressed in terms of the “signal excess” (NRC, 2003)

$$SE = RL - NL \tag{1}$$

where *SE* is the signal excess, *RL* is the received level of the sound source, and *NL* is the background ambient noise. If the signal excess is positive, the sound will be detected by the receiver. The received level is related to the source level (*SL*) by

$$RL = SL - TL + AG \tag{2}$$

where *TL* is the transmission loss and *AG* is the gain associated with signal processing (either biological or computational). Therefore, in order to evaluate the detection of turbine sound, information is required about the sound produced by the turbine and ambient noise.

[1] These definitions were adopted over the course of discussion during a workshop sponsored by the National Science Foundation, “Marine Hydrokinetic Energy and the Environment”, Oct 6-7, 2011, at the University of Minnesota.

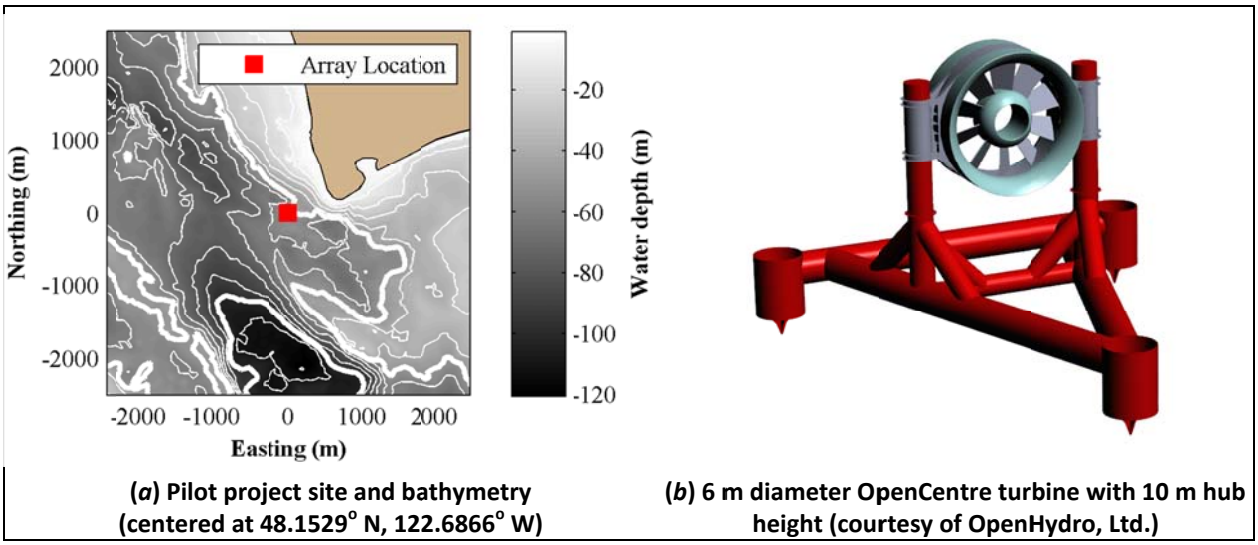
20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

§2 provides background information for the case study and the framework for assessing turbine sound detection. Background information includes sound measurements from the type of turbine proposed for the case study deployment and site-specific ambient noise in the case study area. The study methodology consists of a model to estimate received sound levels in the vicinity of the proposed pilot project and probabilistic detection by a receiver (e.g., hydrophone, marine mammal). The implementation of the methodology emphasizes simplicity and transparency. §3 presents case study results for detection of turbine sound for different types of receivers in the context of ambient noise variability. §4 discusses the implications of these results towards the design of environmental study plans for the case study pilot project, as well as the distance at which acoustic cues might be detected by fish and marine mammals. §5 concludes with a summary of results and recommendations for future research to close knowledge gaps.

2 Background and Methodology

2.1 Case Study Project Description

Snohomish County Public Utility District (www.snopud.com) and OpenHydro, Ltd. (www.openhydro.com) have proposed to deploy a pilot-scale tidal energy project in northern Admiralty Inlet, Puget Sound, Washington (Snohomish PUD, 2012). Water depth in the project area varies between 50 and 60 m (Figure 1*a*) and tidal currents at this location exceed 3 m/s. Numerous species of fish and marine mammals are known to occur in the project area. The proposed project consists of two turbines located 70 m apart on the seabed. The turbines have shrouded, horizontal axis rotors, are deployed on gravity-anchored foundations (Figure 1*b*), and are connected to shore by submarine power cables. This type of turbine has a single moving part – the multi-bladed rotor is supported by water-lubricated rim bearings. Power take-off is by a direct-drive permanent magnet generator in the shroud. The turbine blades are symmetric, fixed pitch. The turbine is controlled to maintain a constant tip-speed ratio in operation. Project parameters are summarized in Table 1, but as for most pilot projects, are subject to change as the technology evolves. The size of these turbines and the overall scale of the project are pre-commercial, in that the primary objective of the project is to deliver engineering, environmental, and economic data, rather than cost-competitive, utility-scale power generation. These data are essential to establish the feasibility of larger-scale power generation projects.



(*a*) Pilot project site and bathymetry (centered at 48.1529° N, 122.6866° W)

(*b*) 6 m diameter OpenCentre turbine with 10 m hub height (courtesy of OpenHydro, Ltd.)

Figure 1 – Case study turbine site and technology

Table 1 – Pilot project turbine parameters

Parameter	Value
Number of turbines	2
Turbine diameter (shroud diameter)	6 m
Water depth	50 - 60 m
Hub height (relative to seabed)	10 m
Cut-in speed ($u_{cut\text{-}in}$)	0.7 m/s
Rated speed (u_{rated})	3.2 m/s

During operation, turbine power output (P) varies in time with inflow velocity (u) as

$$\begin{aligned} P(t) &= 0 && u(t) < u_{cut-in} \\ P(t) &= \frac{1}{2}\rho u(t)^3 A\eta && u_{cut-in} \le u(t) \le u_{rated} \\ P(t) &\approx \frac{1}{2}\rho u_{rated}^3 A\eta && u(t) > u_{cut-in} \end{aligned} \quad (3)$$

where ρ is seawater density (1025 kg/m^3), A is the swept area (defined by the turbine diameter), and η is the water-to-wire power conversion efficiency, assumed to be independent of current velocity. When the inflow velocity is less than the cut-in speed, the turbine does not rotate and no power is generated. Beyond cut-in speed, the power extracted increases with the third power of inflow velocity, until the rated velocity is reached. Beyond this point, the turbine tip-speed ratio is controlled to reduce efficiency and maintain a constant power output independent of inflow velocity. This is a simplified model for turbine operation that does not account for reduced power output during off-axis flow conditions (Polagye and Thomson, in press) or velocity-dependent efficiency.

Current velocities at the location of the proposed pilot project have been characterized by bottom-mounted Doppler profilers (Polagye and Thomson, in press). Because the turbines are designed to operate in more energetic flows, the rated speed is exceeded less than 1% of the time. The cumulative probability distributions for inflow velocity and kinetic power density ($1/2\,\rho u(t)^3$) at the deployment locations are shown in Figure 2 (Snohomish PUD, 2012). These distributions are derived from five

minute ensemble average current velocities at turbine hub height. As discussed in Thomson et al. (2012), this ensemble period filters most turbulence from observations. Since the responsiveness of tidal turbines to turbulent length and time scales has not been established, excluding the contribution of turbulence is acceptable for leading-order analysis.

While operationally significant variations in resource intensity can occur over length scales as short as 100 m in Admiralty Inlet (Polagye and Thomson, in press), the variation in resource intensity between the locations the two turbines are proposed to be deployed is relatively minor. Consequently, the inflow velocity and power extraction for Turbine 1 is taken as a representative distribution for both turbines.

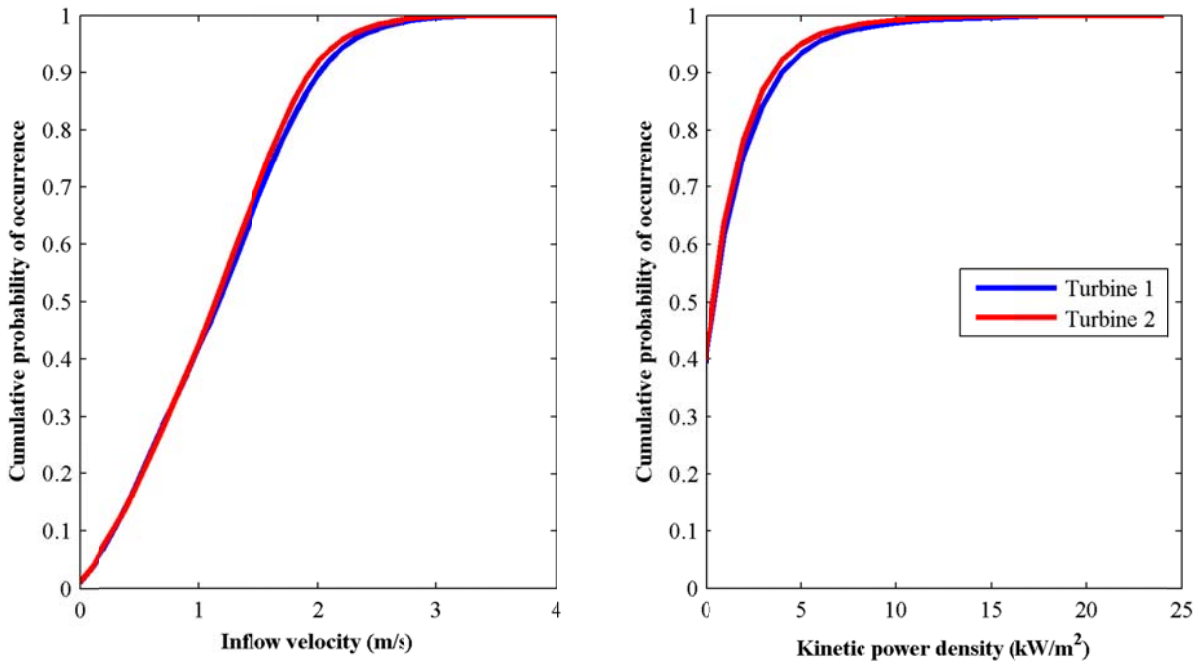


Figure 2 – Cumulative probability distributions for velocity and power output at the deployment locations.

2.2 Presentation of Frequency-Dependent Information

The quantities of interest for this study (e.g., turbine sound, ambient noise) are frequency-dependent and could be interpreted in spectral, one-third octave, octave, and decadal levels, M-weighted broadband levels (Southhall et al. 2007), or unweighted broadband levels. For the purposes of this case study, all data and results are presented in one-third octave bands (TOBs) since this bandwidth is used by the biological community to generalize the width of the auditory filter in mammals (e.g., Richardson et al. 1995; Miller, 2006). Standard one-third octave band center frequencies are 100, 125, 160, 200, 250, 315, 400, 500, 630, and 800 Hz (repeating by a power of ten for lower and higher frequency decades) (ISO 266:1997; ANSI/ASA S1.11-2004).

2.3 Tidal Turbine Source Spectrum

To date, there has been no comprehensive characterization of sound produced by tidal turbines. Some acoustic data have been collected from demonstration projects (Davidson and Mallows, 2005; Verdant Power, 2010; Ocean Renewable Power Company, 2011), but generally lack context (e.g., quantification of turbine generating state). This limited data set is, in part, attributable to the challenge of collecting acoustic data in such high velocity environments (Bassett, 2010). Here, we present a re-analysis of

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

acoustic data collected from an operating OpenHydro turbine at the European Marine Energy Centre (EMEC), originally described in Barr (2010).

2.3.1 Data Collection

Measurements were conducted by the Scottish Association for Marine Science (SAMS) on August 23, 2010. The weather conditions during data collection were Beaufort wind force 4, sea state 3, 0.5 m swell, and raining lightly. The data collection package ("Drifting Ears") consists of an autonomous hydrophone suspended 5 m beneath a surface drogue. The position of the drifter is logged by a GPS on the drogue. The hydrophone records 16-bit sound continuously at 96 kHz. The hydrophone and pre-amplifier has an effective sensitivity of-160 dB re 1 V·µPa and a flat frequency response between 20 Hz and 50 kHz. This customized approach addresses deficiencies in traditional acoustic measurements (e.g., a hydrophone fixed on the seabed or attached to a large, floating platform) because these expose the hydrophone element to contaminating flow noise from surface friction/turbulence around the element, cable strum, or noise from the seabed mooring. All of these are either non-propagating noise or noise that would not occur in the absence of the measuring device. As tidal energy sites are specifically chosen because of their high flow speeds, these are prime considerations when monitoring ambient sound and device acoustic output. The "Drifting Ears" design maximizes the advantages of recording sound from a drifting platform while minimizing the disadvantages associated with a boat (Barr, 2010). Turbine parameters during data acquisition are summarized in Table 2. SAMS intended to collect data over the full range of tidal currents and turbine operating conditions, but this effort was confounded by high levels of anthropogenic noise from other activities at EMEC (e.g., vessel traffic, commissioning of other turbines). The re-analysis presented here is for measurements at a single turbine operating state (thick line segment in Figure 3).

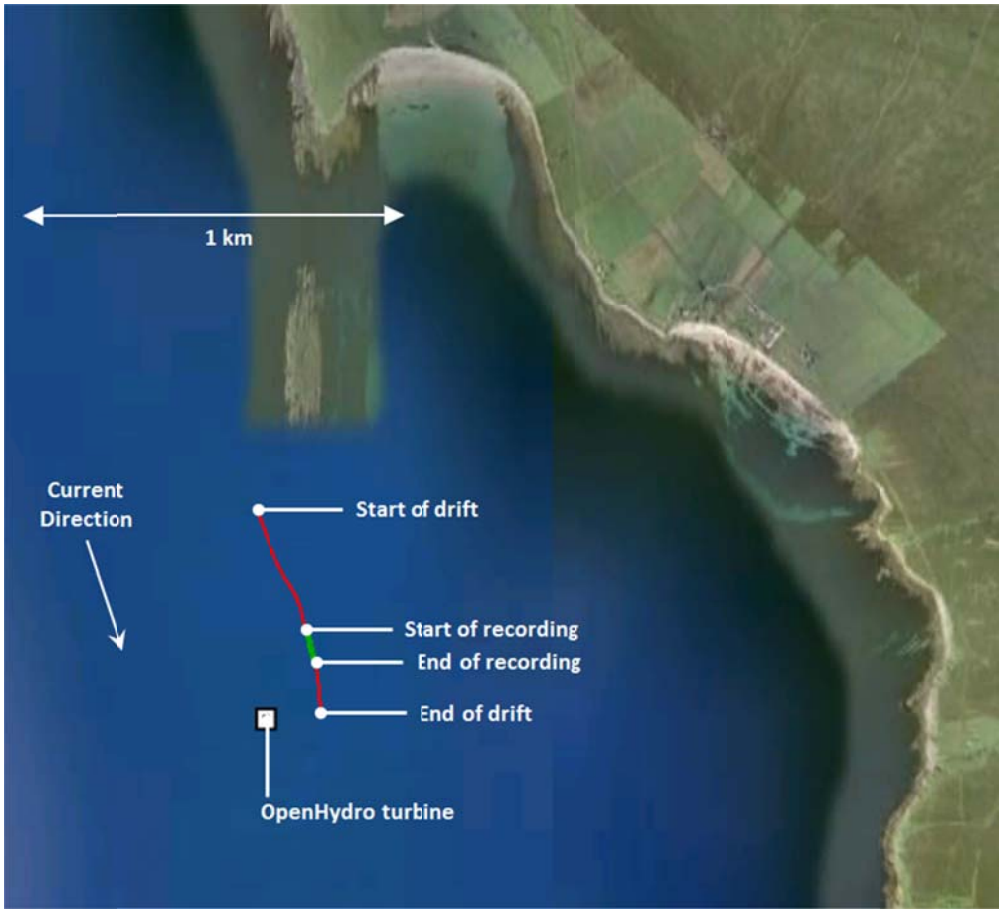


Figure 3 – Drifting hydrophone track during measurements at EMEC by SAMS. Satellite imagery from Google Earth.

Table 2 – Turbine parameters during acoustic data collection at EMEC by SAMS

Parameter	Value
Turbine diameter (shroud diameter)	6 m
Water depth (mean sea level)	15 m
Hub height (relative to seabed)	8 m
Current speed (m/s)	1.8 m/s
Distance to turbine (m)	190-260 m

2.3.2 Source Level – EMEC Turbine (measurement)

For this re-analysis, the manufacturer calibration sensitivity is used to convert the recorded voltage to pressure. This is a simplified approach suitable only for leading order analysis. SAMS field calibrates all drifters using a pistophone and reference hydrophone at the start of a survey, but the data are processed via proprietary format that did not lend itself to our third-party re-analysis. A 64 s recording with the hydrophone in close proximity to the turbine is divided into eight second intervals. Over this interval, the relative separation between turbine and drifting hydrophone is approximately constant. Each interval is analyzed in MATLAB using 2^{16} element windows with 50% overlap and a variance-preserving Hamming filter (Emery and Thomson, 2001). The resulting spectra have low uncertainty (22 degrees of freedom), a bandwidth of 1.5 Hz, and maximum resolvable frequency of 48 kHz (Nyquist frequency).

Figure 4 presents turbine noise recordings in one-third octave sound pressure levels (TOLs)[2]. The recorded turbine noise is "red" with intensity decreasing at 13 dB/decade. Tonal clusters are apparent around 12.5, 16, 40, 160, 500, and 1600 Hz and may be associated with turbine operation. The tonal peak at 10 000 Hz is not associated with turbine operation, but is rather caused by an acoustic harassment device (seal deterrent) operating at a nearby fish farm (Barr, 2010). Since ambient noise profiles were not collected co-temporal with turbine sound, the relative contributions of each to the observations cannot be readily quantified. Therefore, we conservatively assume that all acoustic energy in the recordings (except the 10 000 Hz tonal peak) is attributable to turbine operation. The increase between 10 000 and 30 000 Hz may, however, be associated with rain (e.g., Ma et al., 2005).

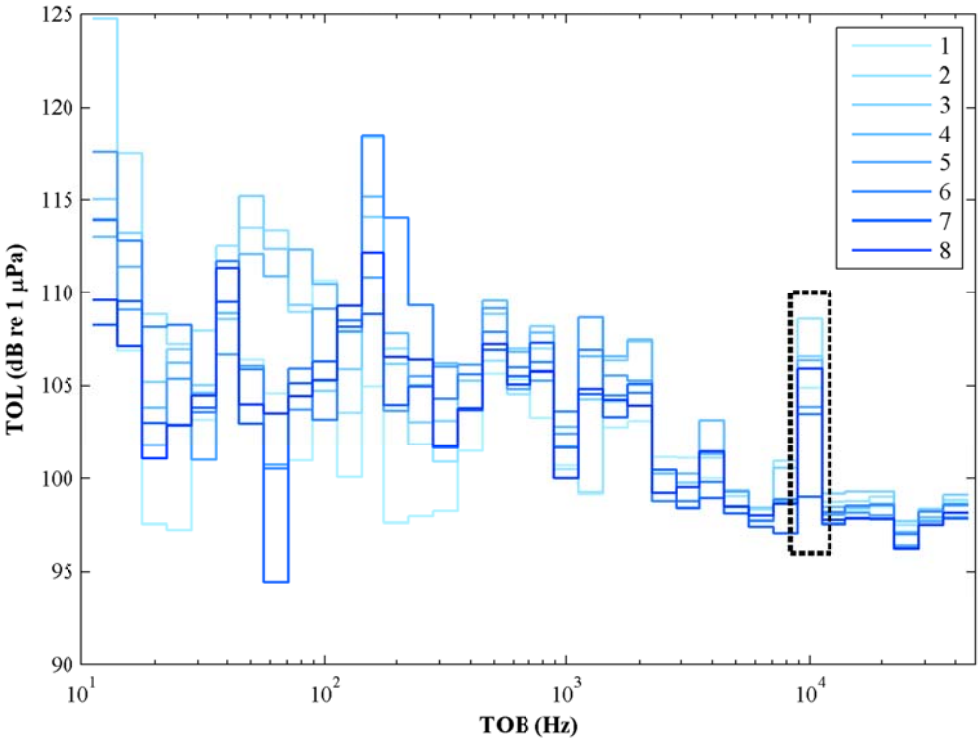


Figure 4 – Received one-third octave sound pressure levels from 8, 8 sec measurements of an OpenHydro turbine at EMEC (64 s total drift time). Dotted rectangle outlines TOL influenced by acoustic harassment device.

Source levels in each TOB for each 8 s interval are calculated using the SONAR equation (Urich, 1983)

$$SL = RL + TL \tag{4}$$

where *SL* is the one-third octave source level (dB re 1 µPa at 1 m), *RL* is the received level, and *TL* is the transmission loss associated with acoustic spreading and absorption. Acoustic spreading is modeled as spherical propagation (20log*D* transmission loss) within 8 m of the turbine (distance from hub height to water surface and seabed) and cylindrical spreading (10log*D* transmission loss) beyond this distance. It is implicitly assumed that there is no azimuthal variability in either transmission loss or source levels. The

[2] In presenting this figure, the hydrophone response is assumed to be linear to 10 Hz. The response is only strictly linear to 20 Hz, but, as discussed later in this section, only TOLs with TOB center frequencies of at least 25 Hz are retained in calculating the reference source level.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

latter assumption is discussed further in §2.3.3. Sound absorption is calculated from the frequency-dependent relation given by Anslie and McColm (1998). In equation form,

$$SL(f) = RL(f) + 20\log_{10}(D_s) + 10\log_{10}(D/D_s) + \alpha(f) \quad (5)$$

where D is the slant distance between the turbine and drifting hydrophone, D_s is the extent of spherical spreading, and α is the frequency-dependent absorption coefficient. Using logarithm identities, this simplifies to

$$SL(f) = RL(f) + 10\log_{10}(D_s D) + \alpha(f)\ . \quad (6)$$

More complicated descriptions of sound propagation (e.g., Marsh and Shulkin, 1962) are not well-suited for this location given the acoustic reflection from the hard seabed.

The water depth defines the minimum sound frequency ($f_{\text{cut-off}}$) that will freely propagate as (NRC, 2003)

$$f_{cut-off} = \frac{c_w}{4h\sqrt{1-\frac{c_w^2}{c_s^2}}} \quad (7)$$

where h is the water depth and c_s and c_w are the sound propagation speed in the substrate and water, respectively. For hard substrates, the sound propagation speed of the substrate is much greater than water and the denominator asymptotes to $4h$. This suggests a cut-off frequency of ~20 Hz, given a water depth of ~20 m between the sound source (turbine) and receiver ("Drifting Ears"). Sound at frequencies below the cut-off will continue to propagate, but in a much reduced and site-specific manner (e.g., "hyperspherical" spreading as described by Tougaard et al., 2009). Consequently, we restrict our analysis to TOBs with center frequencies greater than 25 Hz.

Figure 5 shows source spectra for the eight intervals and an average spectrum based on the mean of the rms pressure squared (i.e., linear space) in each third octave band. As observed by McQuinn et al. (2011) and Merchant et al. (2012) this biases the mean towards higher intensity sound and, therefore, will result in an optimistic estimate for sound detection. For both the individual and average spectra, the source level from 7 – 11 kHz has been replaced by a linear decrease (dB/decade) to remove the peak associated with the acoustic harassment device. Given the degrees of freedom in the underlying spectra, the variations amongst the 8 second intervals are attributable to non-stationary received levels, either because of variations in turbine power output with turbulence (mean flow is quasi-stationary over 64 s measurement duration), fluctuations in ambient noise levels not associated with turbine operation, and/or local variations in the transmission loss not captured by the simple model.

The average spectrum is taken as a reference spectrum for turbine noise at an inflow velocity of 1.8 m/s.

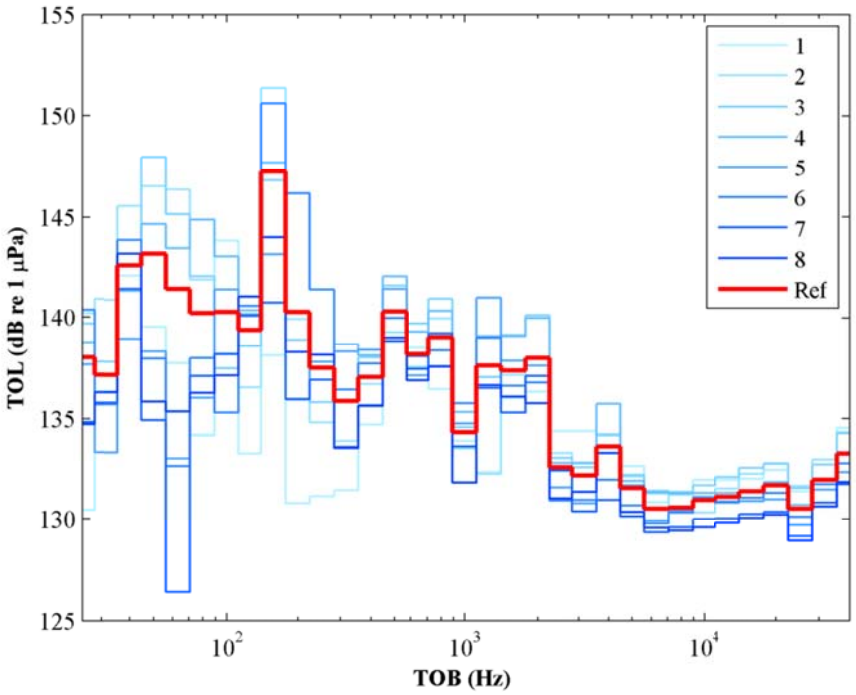


Figure 5 – One-third octave source levels from measurements of an OpenHydro turbine at EMEC, heavy line indicates the reference spectrum, the mean of the 8 measurements (acoustic harassment device removed by linear interpolation).

2.3.3 Source Level – Admiralty Inlet Case Study (estimate)

The reference spectrum from measured data at EMEC corresponds to a specific power generation state. Over the course of operation, a turbine would encounter a range of inflow velocities and a scaling relation is, therefore, needed to extend the reference spectrum to other conditions.

The sound produced by aerodynamic or hydrodynamic flow over immersed bodies may be described as being of one of three multipole types in origin (Ross, 1976; Dowling and Efowcs, 1983). Monopole sources are produced by changes in volume (e.g., bubble collapse), are omnidirectional, and have an acoustic radiation efficiency proportional to the Mach number (M) of the flow

$$M = U / c \tag{8}$$

where U is the local flow velocity and c is the phase speed of the medium. Dipole sources are produced by external forces (e.g., flow-induced vibration), have a directivity pattern, and have an acoustic radiation efficiency proportional to M^3. Quadrupole sources are produced by fluid shear (e.g., directly by turbulence), have a directivity pattern, and an acoustic radiation efficiency proportional to M^5. In a tidal energy context, Mach numbers are quite low. For example, a turbine operating in a 3 m/s flow with a tip speed ratio (ratio of tip velocity to free stream velocity) of 2 would have a local Mach number of 0.01 at the rotor tip. Consequently, a dipole source would radiate sound 10,000 times less efficiently than a monopole source and a quadropole source would radiate sound 10,000 times less efficiently than a dipole source. For this reason, while quadropole sources can be important in the study of atmospheric sound, they can be entirely neglected in ocean environments (Ross, 1976). Cavitation is a monopole sound source and would dominate over dipole sources if it were to occur. However, tidal turbines are designed to avoid cavitating (in addition to intense sound, cavitation degrades hydrodynamic

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

performance and can erode the surface of turbine blades). Video observations of the OpenHydro turbine at EMEC indicate that it does not cavitate under any flow conditions.

The dominant noise sources for tidal turbines are likely to be identical to wind turbines, namely, mechanical vibration of the rotor due to inflow turbulence and the trailing edge boundary layer (Oerlermans and Schepers, 2009). Both of these are external forcings and produce sounds with dipole source characteristics. Tidal turbine support structure vibration may also produce sound with dipole source characteristics, but would be expected to be much less intense than rotor vibration noise, as is the case for wind turbine support structures, and are likely to be negligible (Polagye et al., 2011, §3.4). Hubbard and Shepherd (1991) also note that mechanical noise (e.g., generator noise) can be important for small wind turbines. However, given that the OpenHydro turbine described in this case study utilizes a direct drive between rotor and generator on water lubricated bearings, significant mechanical noise would not be expected. Tidal turbines with speed-increasing gearboxes may produce significant mechanical noise at relatively high frequencies (e.g., 1-10 kHz) (Davidson and Mallows, 2005).

The intensity and frequency of sound produced by inflow turbulence and the trailing edge boundary layer for wind turbines depends, among other factors, on the specific blade profile, angle of attack, rotation rate, and relative inflow velocity. Complex empirical relations have been developed to describe these by multiple authors (e.g., Grosveld, 1985; Hubbard and Shepherd, 1991; Oerlermans and Schepers, 2009), but simpler, leading order relations exist between broadband sound pressure levels and turbine power generation. For example, Lowson (1992) presents data indicating a roughly linear relationship between broadband sound pressure levels and turbine power output. Similarly, Oerlermans and Schepers (2009) present measurements from modern turbines that show a linear relationship between broadband sound pressure level and turbine power output for approximately 2/3 of the power curve (sound pressure levels declining more rapidly near the cut-in speed). This would suggest that it is possible to predict broadband sound pressure levels, with reasonable accuracy, on the basis of turbine power output. In order to scale acoustic measurements from a small tidal turbine to a much larger commercial prototype, Davidson and Mallows (2005) adopted this hypothesis. This was not, however, based on wind turbine literature, but rather on an empirical result by Hazelwood and Connelly (2005) who demonstrated that sound pressure level generated by underwater mechanical processes scaled linearly with the power input. Davidson and Mallows hypothesized that the same relation would hold for power extracted by a turbine. This is a reasonable assumption, given that Grosveld (1985) noted similarly, “Although the concept of extracting energy from the flow by a wind turbine rotor is the opposite of that of a helicopter rotor…the noise generating mechanisms show many similarities and an analogy between the two concepts is justified.”

Based on the limited measurements from tidal turbines and analogues from wind turbine studies, we proceed under three necessary assumptions related to the spectral content of turbine sound, its directivity, and its relation to turbine power output.

First, we assume that the frequency content of the rotor is “frozen” and does not vary with inflow velocity. This is the weakest of the assumptions and likely incorrect, but, as discussed in §2.5, is acceptable within the context of this specific case study. Formulations for trailing edge noise, such as the semi-empirical relation developed by Brooks, Pope, and Marcolini (1989), show that 1/3 octave band sound pressure levels are a non-linear, empirical function of the Strouhal number. Therefore, for a

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

turbine operating at a constant tip speed ratio, the spectral content of turbine sound would be expected to vary, to some extent, with inflow velocity. If the fundamental frequency for a tidal turbine is taken to be the product of the number of blades and their rotation rate (Hubbard and Shepherd, 1991), the OpenHydro turbine operating at EMEC would have a fundamental frequency of 2-3 Hz. It is possible that the peak in 12.5 Hz band could be a harmonic of this fundamental frequency.

Second, we assume that a tidal turbine radiates sound in an omnidirectional manner, even though there is expected to be some directivity (i.e., dipole source). The primary reason for this assumption is that directivity patterns for tidal turbines have not been measured. An omnidirectional source approximation is conservative in that it will somewhat overstate the region ensonified by turbine sound for the case study because the measurements of the OpenHydro turbine obtained at EMEC were obtained nearly on-axis. For wind turbines, measurements show that broadband received levels are relatively invariant over a wide range of azimuthal positions at equal distance from the source. For example, Oerlermans and Schepers (2009) report a variation in broadband received levels of ± 2 dB with a 120^o degree arc. The drifting measurements obtained from the OpenHydro turbine at EMEC (Figure 3) is within this region and likely capture the maximum received levels at a given radial distance from the turbine.

Third, we assume that the broadband sound pressure level produced by a tidal turbine is linearly related to output power. Based on studies of wind turbines and underwater mechanical processes, this appears to be reasonable and accurate.

In combination, these three assumptions lead to a treatment of the turbine as an omnidirectional source whose intensity and frequency content is a linear function of turbine power output. If the source level for a specific frequency at a reference power generation state (P_0) is related to the acoustic pressure (p_o) at this state by

$$SL(f, P_0) = 10\log\left(\frac{p_0^2}{p_{ref}^2}\right) \qquad \text{(dB re } p_{ref} \text{ at 1 m)}, \tag{9}$$

then the source level for a similar turbine at a different power generation state would be given by

$$SL(f, P) = SL_0(f, P_0) + 10\log\left(\frac{P^2}{P_0^2}\right) \tag{10}$$

where P is given by (3) as a function of inflow velocity and turbine specifications (e.g., efficiency, cut-in speed). Since the swept area and efficiency of the turbine monitored at EMEC are identical for the turbines proposed for Puget Sound, substituting (3) into (10) and simplifying terms yields

$$SL(f, P) = SL_0(f, P) + 10\log\left(\frac{u^6}{u_0^6}\right) \tag{11}$$

where u_0 is the inflow velocity corresponding to the reference measurements (here, measurements at EMEC). This suggests that the source level for a tidal turbine should be a strong function of inflow velocity and is consistent with a theoretical derivation of wind turbine sound by Lowson (1992). We do note, however, that Oerlermans and López (2005) observed a fifth power dependence on velocity in their study so this approximation is likely subject to moderate uncertainty.

Below cut-in speed, when the turbine would not rotate, sound from the flow around the support structure and stationary rotor is unlikely to be detectable at a significant distance. In other words, $SL(f,0) \approx 0$. Above rated speed, the source level might be expected to take on a constant value, but, as noted in §2.1, the rated speed is only exceeded 1% of the time and, for simplicity, (11) is used to estimate the turbine source level for any velocity greater than cut-in.

2.4 Characteristics of Ambient Noise in Admiralty Inlet

Pre-installation site characterization studies at the case study location have included long-term, low-duty cycle ambient noise measurements using an autonomous hydrophone on the seabed, as described in Bassett et al. (2010), Bassett et al. (in press), and Bassett et al. (submitted). These measurements provide site-specific information, as well as general characteristics of high energy tidal environments. The measurement system consists of a self-contained data acquisition and storage system (Loggerhead Instruments DSG) with a hydrophone (HTI-96-Min) and internal preamplier. The hydrophone has an effective sensitivity of -165.5 dB re 1µPa V^{-1}. The frequency response of the hydrophone and data acquisition system is flat (± 3 dB) from 20 Hz to 30 kHz. Digitized 16-bit data are written to a SD card.

For the purposes of this analysis, ambient noise is partitioned into a low frequency component (f < 1000 Hz) and high-frequency component (f > 1000 Hz). In the low frequency regime, ambient noise is independent of current velocity, but ambient noise is correlated with current velocity at higher frequencies due to sediment generated noise (Bassett et al., *submitted*). The contributions of various sources to the ambient noise budget are visualized in Figure 6 in a manner similar to the classic "Wenz" curves describing ocean noise (Wenz, 1962).

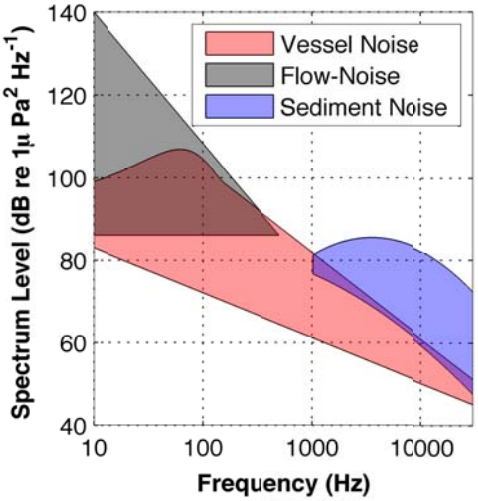


Figure 6 – Relative intensity and distribution of noise sources associated with strong tidal currents.

2.4.1 Low Frequency Ambient Noise (25 Hz – 1000 Hz)

As demonstrated in Bassett et al. (in press), ambient noise in northern Admiralty Inlet, particularly at frequencies below 1000 Hz, is dominated by vessel traffic and is insensitive to spatial position over length scales on the order of 1-2 km. This is attributed to a traffic separation zone that forces the majority of vessel traffic to follow a regular pattern while transiting the inlet. Percentile pressure spectral densities presented in Bassett et al. (in press) are shown in Figure 7, along with the reference source spectrum for turbine sound. These statistics exclude periods with depth-averaged currents

greater than 0.4 m/s to avoid bias from non-propagating pseudo-sound. During strong tidal currents, the turbulent eddies shed by the hydrophone element give rise to high-intensity pseudo-sound at frequencies less than 500 Hz (range of affected frequencies corresponds to the extent of the inertial subrange) (Bassett et al., submitted). This sound is non-propagating and is appropriately not included in an ambient noise budget (Polagye et al. 2011, §3.4). In this frequency regime (25 Hz – 1000 Hz), tidal currents do not generate propagating sound and, therefore, ambient noise and tidal current velocity are uncorrelated. In other words, over time, all ambient noise states are equally probable for turbine power generation states.

The tonal peak in ambient noise spectra at 1500 Hz is likely a measurement artifact of coherent sound reflection from the seafloor. Sound pressure levels at this frequency are consistently 6 dB greater than surrounding frequencies (consistent with coherent addition) and the separation between hydrophone and the seabed is 1 m, corresponding to a frequency of 1500 Hz in seawater.

Turbine sound at low frequencies is similar to the ambient noise distribution, excepting the tonal peaks previously discussed (e.g., relative peak at 160 Hz).

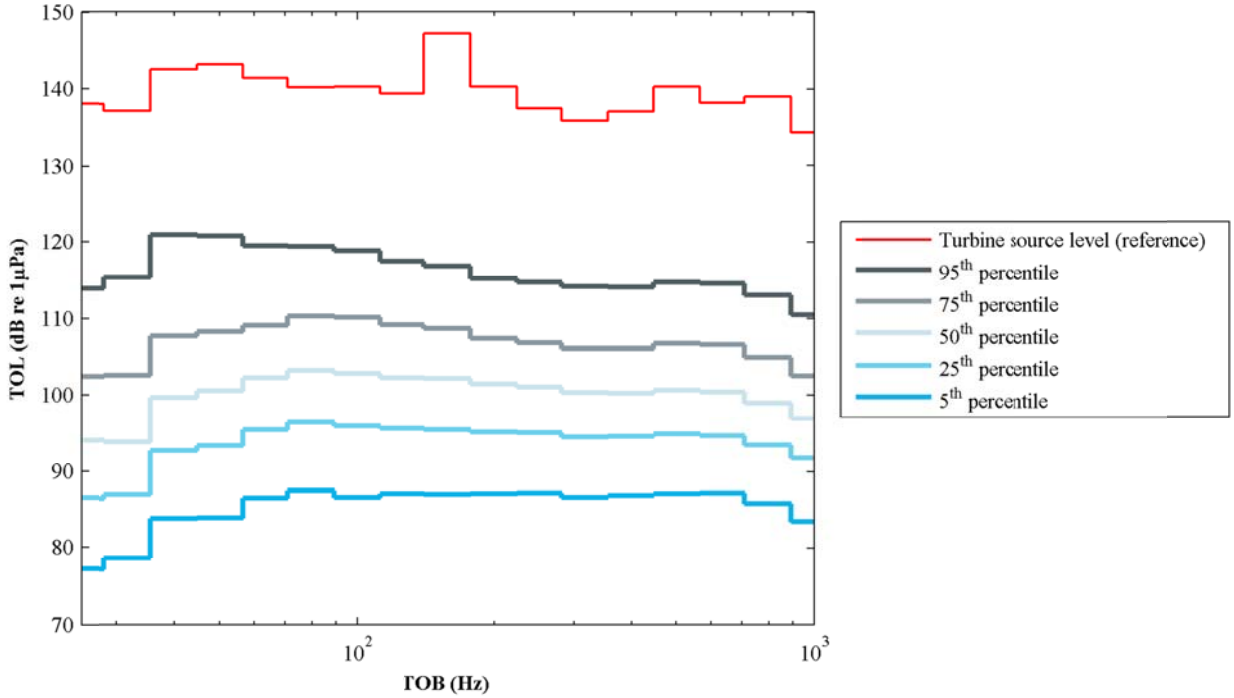


Figure 7 – Percentile TOLs for ambient noise (25 – 1000 Hz)

2.4.2 High Frequency Ambient Noise (1000 Hz – 25 000 Hz)

Strong currents mobilize sediments on the seabed (in this case, gravel and shell hash mixed amongst the predominant cobble overburden). This generates propagating noise at frequencies greater than 1000 Hz, with intensity dependent upon current velocity, as shown in Figure 6. Vessel traffic, breaking waves, and precipitation also contribute to the ambient noise budget, but, particularly during periods of strong currents are dominated by bedload transport (Bassett et al., submitted). Therefore, at these frequencies sound generated by the turbine is correlated with ambient noise.

The same underlying dataset as for low-frequency ambient noise is again used, but for the high-frequency analysis, measurements at all velocities are retained and ambient noise distributions are stratified by hub-height velocity. Median TOLs as a function of velocity are presented in Figure 8 and show a clear increase in median TOLs as a function of velocity, most pronounced for TOBs with center frequencies greater than 4 kHz.

Turbine sound is relatively flat in this frequency regime. It should, however, be noted that the spectrum of turbine sound, particularly at frequencies exceeding 6000 Hz closely resembles the ambient noise spectrum from Admiralty Inlet when hub height velocities would be 2.0±0.2 m/s. Since turbine sound data were collected in a similar current regime (hub height velocity ~1.8 m/s), it is possible that the reference spectrum of "turbine sound" at this frequency is, in fact, bedload transport at the EMEC site. If this is the case, estimates for turbine sound would be biased relative to ambient in these frequencies, since source levels are estimated to scale with the sixth power of current velocity, while Bassett et al. (submitted) suggests that ambient noise from bedload transport scales with the square of current velocity.

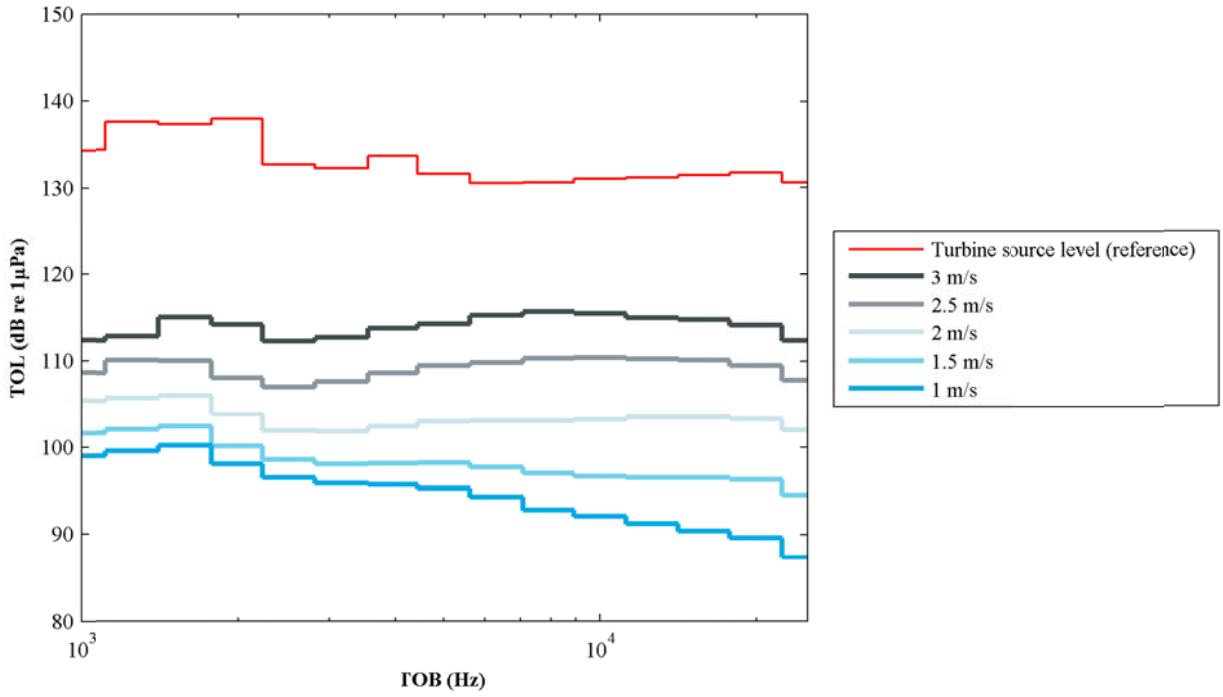


Figure 8 – Median TOLs for ambient noise as a function of velocity (1000 – 25 000 Hz)

2.5 Detection of Turbine Noise Relative to Ambient Noise

As described in the introduction, the effect of turbine noise relative to other sources of ambient noise is quantified in terms of the "signal excess" (NRC, 2003)

$$SE = RL - NL = SL - TL + AG - NL$$

where *SE* is the signal excess, *RL* is the received level, *SL* is the source level, *TL* is the transmission loss, *AG* is the auditory gain of the receiver (i.e., signal processing, either computational or biological), and *NL* is the noise level. All of these terms are frequency dependent (in this case study, represented by one-third octave bands). The signal excess must also be considered in terms of receiver hearing thresholds.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Specifically, if, for some distance from the turbines and power generation state, a TOL is less than the hearing threshold for the receiver in that TOB, the noise from the turbines will not be detected, regardless of ambient noise level. *SE* for a receiver is, therefore, given by

$$SE = \max(RL, 0) \qquad RL \geq HT \tag{12}$$

$$SE = 0 \qquad RL < HT \tag{13}$$

where *HT* is the hearing threshold of the receiver. In other words, this representation of *SE* is always non-negative. A positive signal excess denotes detection of sound by a receiver.

Noise levels (*NL*) for the case study site are as presented in §2.4. The frequency space for this analysis span the three decades from 25 Hz to 25 000 Hz and is separated into low-frequency and high-frequency regimes at 1000 Hz. The lower limit is set by the lowest resolvable frequency for characterized turbine noise, while the upper limit corresponds to the highest frequency for which ambient noise has been characterized at the case study site.

In the follow sub-sections, the model for received levels is described, followed by a discussion of *AG* and *HT* associated detection of sound by different receivers. As discussed in §2.3.3, it is assumed that the frequency content of turbine noise is independent of flow velocity. This is a weak assumption, but because the probability distribution of ambient noise in one-third octave band changes slowly, it is a reasonable assumption within the context of this specific case study. A different model for turbine sound would be required if the ambient noise distribution changed rapidly over the frequencies of interest.

2.5.1 Received Level Model

As described by (11), the turbine source level is expected to vary with inflow velocity. Received levels at a slant distance (*D*) from the turbine are modeled using the SONAR equation as

$$RL(x, y, z, f, P) = SL(f, P) - 20\log_{10}(D) - \alpha(f)D \qquad D \leq D_s \tag{14}$$

$$RL(x, y, z, f, P) = SL(f, P) - 10\log_{10}(DD_s) - \alpha(f)D \qquad D > D_s \tag{15}$$

where D_s is the transition from spherical to cylindrical spreading. For the case study site, D_s is assumed to be 30 m, based on a hub height of 10 m in 55 m of water. Because received levels depend logarithmically on D_s, results are relatively insensitive to perturbations about this assumed value. This is a simplified approach to modeling received levels. It assumes that the sound from turbines is omnidirectional and parameterizes the effect of the acoustic waveguide (surface, seabed) in a way that neglects the potential for interference patterns, the effect of shallow water adjacent to the headland, or signal attenuation by the seabed. As established in the introduction, our objective is not a comprehensive treatment of turbine sound, but rather to advance an approach for probabilistic assessment of sound detection that can inform the study of acoustic effects. Parabolic equation modeling for the case study site (Bassett et al., in press) suggest that this is a conservative approach, in that transmission losses vary with azimuthal position and are somewhat greater than those predicted by this simple model. In other words, in combination with the assumption of an omnidirectional source, the simple transmission loss model predicts received levels that are likely higher than those that would actually occur and provides an upper bound for the extent of turbine sound detection.

The source levels for both turbines are assumed to be equal, given their close proximity and similar measured velocity distributions. Received levels for the pair of turbines are calculated according to equations (14) and (15) in MATLAB (www.mathworks.com) using a three-dimensional grid with a horizontal resolution of 10 m. Vertical levels are subsequently described in the context of specific study objectives. The grid extent is 5000 m in each horizontal dimension. Turbines are positioned at [x,y,*z*] coordinates [35 m, 2 m, -45 m] and [-35 m, -2 m, -45 m] (z = 0 corresponds to the surface, downward negative). The sounds produced by the pair of turbines is assumed to be incoherent, such that the total acoustic pressure (p_{total}) at a grid node is given by

$$p_{total} = \left(p_1^2 + p_2^2\right)^{1/2}. \quad (16)$$

These two pressures are, in general, unequal, because of the differences in distance between a grid node and each source. In terms of the received sound pressure levels calculated by (14) or (15)

$$RL(x, y, z, f, P) = 10\log_{10}\left(10^{RL_1/10} + 10^{RL_2/10}\right), \quad (17)$$

where RL_1 and RL_2 are the received levels from pair of turbines at a the receiver position (*x*,*y*,*z*).

2.5.2 Effectiveness of Studies to Characterize Turbine Sound

For studies intended to characterize the sound produced by a turbine, the receiver will most likely be a drifting hydrophone (or hydrophone array) either deployed from a surface vessel or drogue (e.g., "Drifting Ears") in order to minimize contamination by pseudo-noise during strong currents. It may also be possible to use stationary hydrophones equipped with flow shields that suppress pseudo-noise (Lee et al., 2011). A properly specified hydrophone will be equally sensitive to all frequencies of interest and, therefore, *HT*(*f*) is assumed to be +0 dB for all frequencies. Our experience with noise measurements at the case study site suggests that accurate quantification of turbine sound relative to other ambient sources with similar frequency distribution (e.g., vessel traffic) will likely require a signal excess of at least +5 dB, assuming no auditory gain through signal processing algorithms (*AG* = +0 dB). The characterization of turbine sound in a TOB, therefore, requires *SE* ≥ +5 dB.

The effectiveness of a sound characterization study is quantified as the fraction of TOBs in which turbine sound is likely to be identified at a given distance from the turbines and power generation state. Tonal clusters in the turbine spectra will be most easily identified relative to ambient noise, but are an incomplete representation of the turbine sound profile. For the purposes of this study, likely identification is defined as identification to at least the 75th percentile ambient noise level. Recalling that power generation by the turbines (*P*) is a function of current velocity (*u*), then the likely identification of turbine sound in a TOB ($\tilde{I}_f$) at a given point in space and current velocity is defined as

$$\tilde{I}_f(x, y, z, f, u) = 1 \qquad RL(x, y, z, f, u) - NL_{75\%} \geq 5\,\text{dB} \quad (18)$$

$$\tilde{I}_f(x, y, z, f, u) = 0 \qquad RL(x, y, z, f, u) - NL_{75\%} < 5\,\text{dB} \quad (19)$$

where $NL_{75\%}$ is the 75th percentile ambient noise level. The fraction of TOBs with likely identification ($\tilde{I}$) is then given as

$$\tilde{I} = \frac{1}{N}\sum \tilde{I}_f \qquad (20)$$

where *N* is total number of TOBs (31 in the three decades between 25 and 25 000 Hz). $\tilde{I}$ is evaluated for four current velocities: 1.0, 1.5, 2.0, and 2.5 m/s. The first represents conditions shortly after the turbine cuts in and begins rotating, while the latter represents a strong tidal exchange at the case study site.

2.5.3 Marine Animal Detection of Turbine Sound

One objective of marine mammal monitoring studies at pilot-scale tidal energy projects is to identify potential behavioral responses to the noise produced by operating turbines. In this case, the receiver is biological and the signal excess for detection depends upon species- and frequency-specific hearing thresholds.

Aquatic species have evolved to detect conspecific signals in noisy environments. For example, hearing mechanisms that enhance signal detection in noise include directional cues that aid in spatial release from masking and temporal cues that aid in co-modulation masking release (Branstetter and Finneran, 2008; Holt and Schusterman, 2007). For example, Miller (2006) chose *AG* = +6 dB to evaluate killer whale active space. However, we assume that hearing mechanisms are not likely to have evolved to detect anthropogenic sound relative to similar background ambient noise. Therefore, signal processing capabilities are likely to be less sensitive for turbine sound than for conspecific calls and we assume that *AG* = +0 dB for all biological receivers. We also assume that marine animal hearing is unlikely to be affected by pseudo-noise, regardless of relative motion between currents and the animal.

For biological receivers, we select four species for which hearing thresholds are relatively well understood to represent classes of marine animals. For each representative species, the probability of turbine sound detection within the case study area is evaluated for six one-third octave bands (50 Hz, 160 Hz, 500 Hz, 2000 Hz, 8000 Hz, and 25 000 Hz). The first four TOBs correspond to relative amplitude peaks in the turbine source spectrum (i.e., frequencies with the highest expected signal to noise ratio at the case study site). Note, also, that this excludes from analysis the measurement artifact in ambient noise levels at 1500 Hz. These first four TOBs are also frequencies for which ambient noise will be uncorrelated with turbine sound. The two TOBs at the highest frequencies correspond to important frequencies for marine mammal communication where ambient noise and turbine sound are correlated due to bedload transport (§2.4.2).

For these TOBs, behavioral hearing thresholds of representative species are presented in Table 3. Atlantic cod (*Gadus morhua)* are chosen as a representative fish species, with audiograms adopted from Chapman and Hawkins (1973). This species is also likely sensitive to acoustic particle velocity in the TOB centered at 50 Hz and this threshold may be indicative of particle velocity detection, rather than sensitivity to pressure fluctuations. To date there have been no measurements of particle velocity around operating tidal turbines and this threshold is precautionary. Killer whales (*Orcinus orca*) are chosen as a representative mid-frequency cetacean. This is motivated by an interest in assessing the potential effects of the proposed case study project on endangered Southern Resident killer whales (NMFS 2005). However, there are no killer whale hearing thresholds available at any frequency below 1 kHz. Wartzok and Ketten (1999) present an audiogram for these frequencies using data from Hall and Johnson (1971), but the original paper states that thresholds for frequencies below 10 kHz were likely

noise masked and that later it was determined that the subject likely had high-frequency hearing loss, as discussed in Hemilä et al. (2001). Here, we adopt thresholds presented in Szymanski et al. (1999) for frequencies above 1 kHz and use bottlenose dolphin (*Tursiops truncatus*) audiograms (Johnson, 1967) as a conservative proxy for lower frequencies. High frequency cetaceans are represented by harbor porpoise (*Phocoena phocoena*), using audiograms from Kastelein et al. (2002). Harbor seals (*Phoca vitulina*) are taken as a representative pinniped in water, with thresholds drawn from recent work by Kastelein et al. (2009).

These hearing thresholds are subject to high uncertainty since audiometric data are limited for all aquatic species and the hearing thresholds selected for this case study are often for one or a few individuals tested in a laboratory and may not be representative of the species as a whole, let alone an entire class of marine animals. Additionally, since hearing thresholds for low-frequency cetaceans are not available (Southall et al., 2007), this analysis excludes an entire class of cetaceans that may be occasionally present in the case study area (Snohomish PUD, 2012). Detection of turbine sound by low-frequency cetaceans is discussed qualitatively in §4, following presentation and discussion of quantitative results for other species. Similarly, diving birds might also be exposed to turbine sound (Polagye et al., 2011, §4.6), but their auditory capabilities are even less well understood than low-frequency cetaceans.

Table 3 – Hearing thresholds (*HT*) in dB re 1 µPa based on rms measurements for representative species (∞ denotes no auditory responsiveness in this TOB)

	TOB Center Frequency (Hz)	**50**	**160**	**500**	**2000**	**8000**	**25 000**
Class	**Representative Species**						
Fish	Atlantic cod (*Gadus morhua)* (Chapman and Hawkins, 1973)	83	75	110[a]	∞	∞	∞
Mid-frequency cetaceans	Killer whale (*Orcinus orca)* (Szymanski et al. 1999; Johnson, 1967)	∞	120[b]	98	63[c]	57[d]	40[b]
High-frequency cetaceans	Harbor porpoise (*Phocoena phocoena*) (Kastelein et al., 2002)	∞	∞	92	72	59	39[b]
Pinnipeds	Harbor seal (*Phoca vitulina*) (Kastelein et al. 2009)	∞	74[b]	63	57	60	58

[a] Based on threshold at 470 Hz.

[b] Interpolated from behavioral audiogram.

[c] No behavioral thresholds available at this frequency. Value in table is 9 dB below the reported physiological threshold since ABR thresholds are reported in dB peak to peak and not dB rms.

[d] As measured, from behavioral audiogram.

Because received levels and ambient noise levels vary in time, for some frequencies in a correlated manner, the potential for a marine animal to detect turbine sound at a particular point in space is represented as a probability. The mathematical description of this is

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

$$p\left(d_{x,y,z,f}\right)=\sum_{i}\left(\sum_{j}d\left(NL_j,RL_i,HT\right)p\left(NL_j\middle|RL_i\right)\right)p\left(RL_i\right) \quad (21)$$

where $p(x)$ represents a probability and d is the detection of turbine sound at a particular position in space and TOB. The first term on the right hand side corresponds to the detection of turbine sound at a particular position in space and TOB, given an ambient noise level, a received level, and species hearing threshold. The second term is the probability of that ambient noise level occurring given a received level. For the low frequency regime, ambient noise is independent of received levels, but for the high frequency regime, these are correlated due to sound produced by bedload transport. The product of these two terms, summed over all possible ambient noise levels, yields the probability of detecting turbine sound for a given received level. The product of this summation and the final term in equation (21), summed over all possible received levels yields the overall probability of detecting turbine sound. For this case study, ambient noise levels probability distributions are discretized to 4 dB resolution, while received levels from turbine sound are discretized to 1 dB resolution. Received levels in the context of sound detection by marine animals are evaluated at a 30 m depth relative to the sea surface, which is nominally mid-water level.

Some studies that evaluate behavioral responses of marine animal to turbine sound are able to quantify responsiveness in terms of changes to activity state, attraction, or avoidance. Because behavioral responses are not uniquely determined by received levels, but are rather a complicated function of many variables such as sound type, initial behavioral state, direction of motion relative to the source of the sound, and the individual experiences of a marine animal (Southall et al., 2007), we have chosen to focus on the detection of turbine sound. Because the zone of responsiveness cannot exceed the zone of detection (Richardson et al., 1995), the spatial extent over which sound could be detected by different classes of marine animas provides an instructive upper bound to the extent of a survey area for responsiveness studies (i.e., marine animals cannot respond to sound they cannot detect).

2.5.4 Warning Distance and Time

While sound from turbines is generally discussed in the context of potential environmental impacts, this sound may also provide a cue to alert marine animals to the presence of a device (Carter, 2007). Awareness of an operating turbine may allow a marine animal to avoid potentially more significant risks, such as entanglement, collision, or blade strike. For a turbine with a constant tip-speed ratio, the level of injury from blade strike increases with current speed, though as demonstrated through numerical simulation by Carlson et al. (2012) blade strike, even at high current velocity, may not cause serious injury. While tactile detection of the “bow wake” upstream of the turbine, echolocation by odontocetes, and visual detection are also possible mechanisms by which marine animals might become aware of the turbine, sound is assumed to be the primary detection mechanism. Carter’s (2007) analysis was subject to high uncertainty in both received levels and ambient noise levels and predicted warning times ranging from minutes to less than a second, depending on the assumptions made. Therefore, it is instructive to revisit this question with improved information. In the present analysis, the warning distance (D_{warn}) is defined as the minimum distance from the turbine for which a marine animal would be expected to detect turbine sound (in any TOB), given an ambient noise level and inflow velocity. Warning time (T_{warn}) is approximated by

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

$$T_{warn} = D_{warn} / u \,, \tag{22}$$

under the assumption that a marine animal would not be moving at a significantly different velocity than the mean current. For the case study, detection is evaluated at a depth of 45 m relative to surface, the turbine hub height.

3 Results

3.1 Probability Distribution of Turbine Source Levels

Given the probability distribution of inflow velocities provided in Figure 2 and turbine design parameters in Table 1, application of (7) yields the distribution of turbine source levels shown in Figure 9. The maximum broadband (25 - 25 000 Hz) source level is estimated to be 172 dB re 1µPa at 1m, corresponding to an inflow velocity of 3.6 m/s. This source level will occur infrequently during turbine operation (< 0.01% of time) and represents a considerable extrapolation from reference measurements. Received levels for the turbines in this case study are, therefore, never expected to rise to a level that would be categorized as injurious (e.g., causing permanent threshold shifts). This is defined as 180 dB re 1µPa by the National Marine Fisheries Service (Southall et al., 2007). Likewise, predictions of low intensity sound at periods around cut-in speed (common occurrence) are also subject to high uncertainty due to the necessary extrapolation from measurements.

Broadband received levels in the vicinity of the project for four inflow velocities are shown in Figure 10, at a depth of 30 m relative to the surface. The pattern from the pair of sources is only apparent at close range (e.g., within 100 m). At more distant locations, received levels are indistinguishable from those associated with a point source. The dashed black contours denote the 120 dB isobel, the current regulatory threshold for behavioral harassment of marine mammals in the United States (Southall et al, 2007).

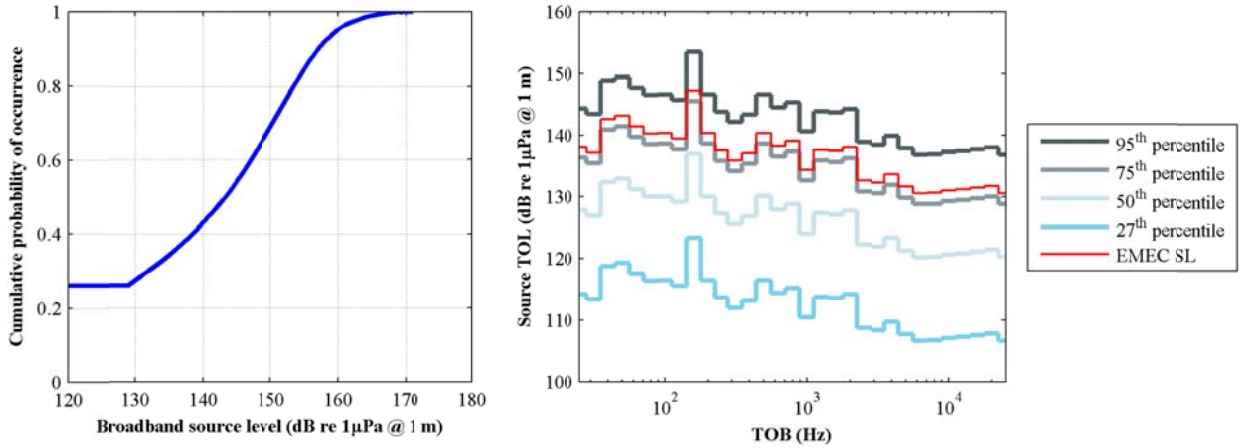


Figure 9 – Probability distribution of turbine source levels. (left) Broadband (25 – 25 000 Hz). (right) One-third octave source levels for select percentiles. Turbine operation begins at the 27th percentile currents.

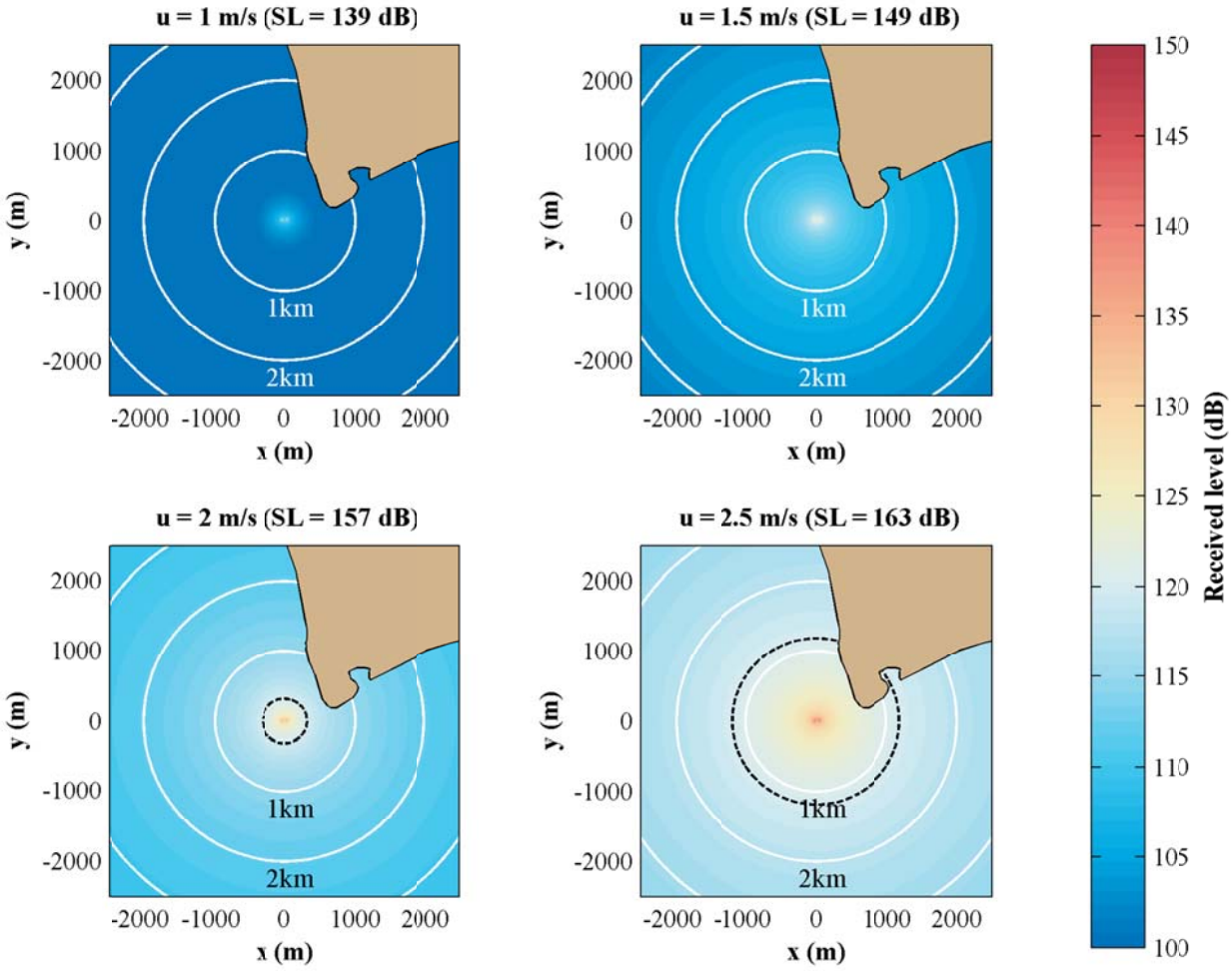


Figure 10 – Broadband (25 - 25 000 Hz) received levels at four inflow velocities (30 m depth relative to surface). Dashed black contour denotes the 120 dB isobel (regulatory harassment threshold at the case study location). The 120 dB isobel is not present at 1 m s^{-1} inflow velocity and restricted to less than 100 m distance at 1.5 m s^{-1}.

3.2 Effectiveness of Studies to Characterize Turbine Sound

Figure 11 shows the fraction of TOBs (25 Hz – 25 000 Hz) in which turbine sound characterization studies have at least a 75% change of distinguishing the turbine sound from ambient noise (§2.5.2). This is evaluated for four different current velocities. The first corresponds to conditions shortly after the turbine cuts in and begins to rotate. The last corresponds to a strong tidal exchange at the case study site. These results suggest that for the case study site, it will only be possible to fully characterize turbine sound when currents are faster than 2 m/s and then, only at relatively close range (< 500 m). For a site with lower ambient noise levels (e.g., less vessel traffic) or an array of turbines with a higher source level (e.g., more turbines, larger turbines) characterization would be possible under a broader range of current velocities.

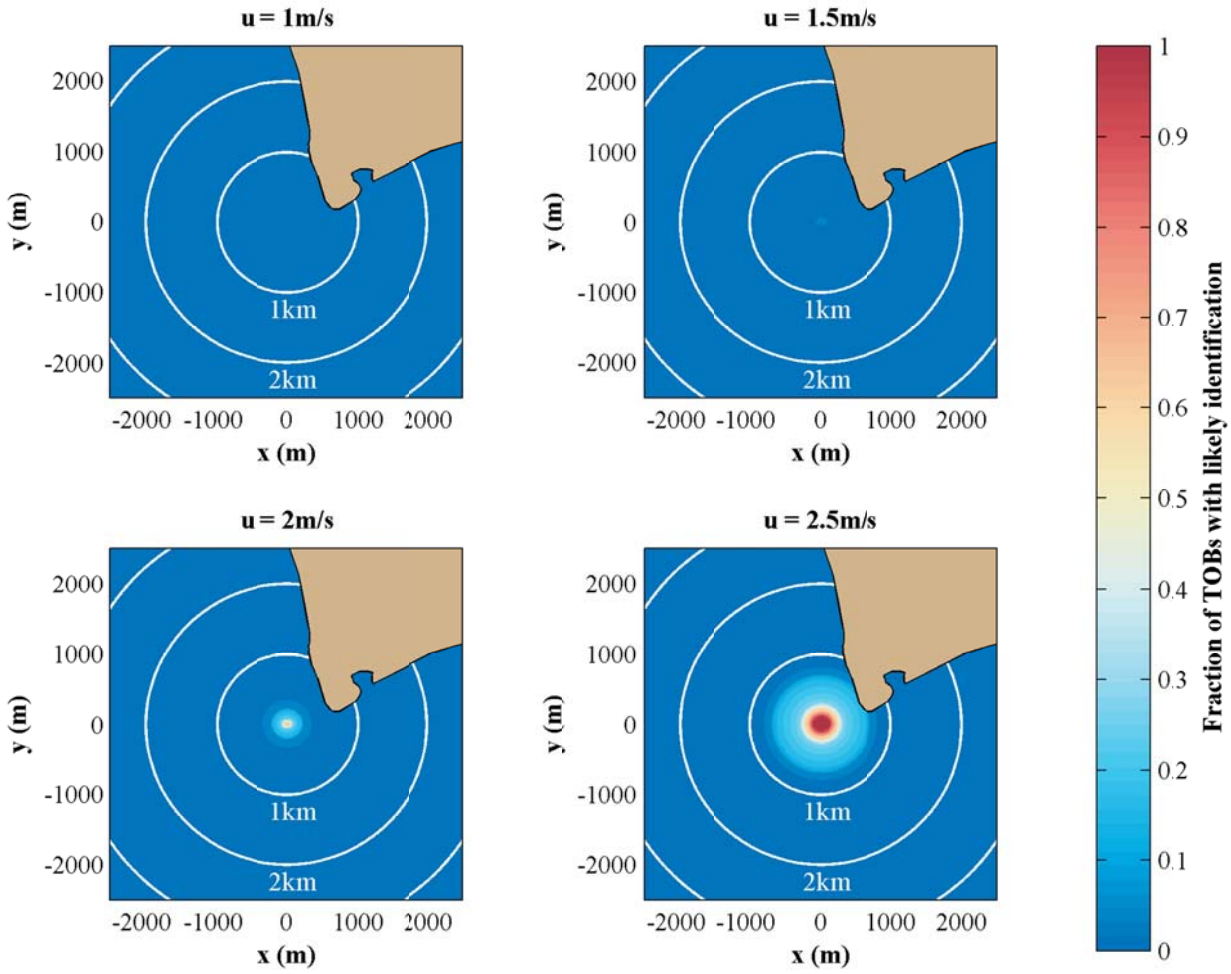


Figure 11 – Fraction of one-third octave bands likely to be identified at four inflow velocities by a drifting hydrophone receiver (5 m depth relative to surface).

3.3 Effectiveness of Studies to Monitor Animal Responsiveness to Turbine Sound

As discussed in §2.5.3, four representative species are used to quantify the probability of fish, mid-frequency cetaceans, high-frequency cetaceans, and pinnipeds detecting the sound produced by turbines. Results are presented in Figure 12 – Figure 15, which show the probability of a marine animal class detecting turbine sound at a given distance from the turbines over all possible combinations of ambient noise and turbine sound. Because turbines are not expected to generate significant sound while idle, the maximum possible detection probability is the percentage of time the turbines are expected to operate (73%).

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

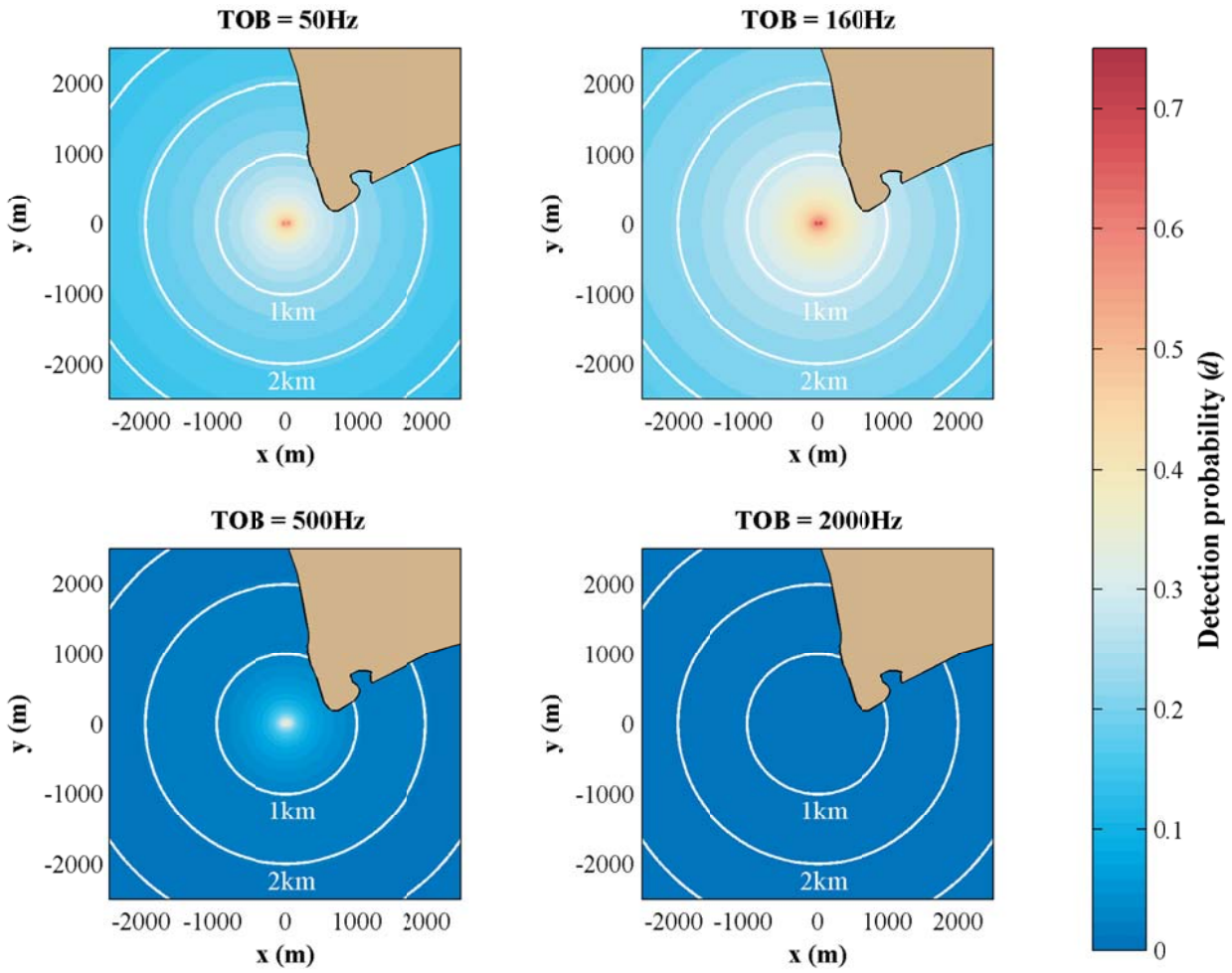


Figure 12 – Probability of fish (Atlantic cod) detecting turbine noise (30 m depth relative to surface). No detection at any distance for 2000 Hz and above.

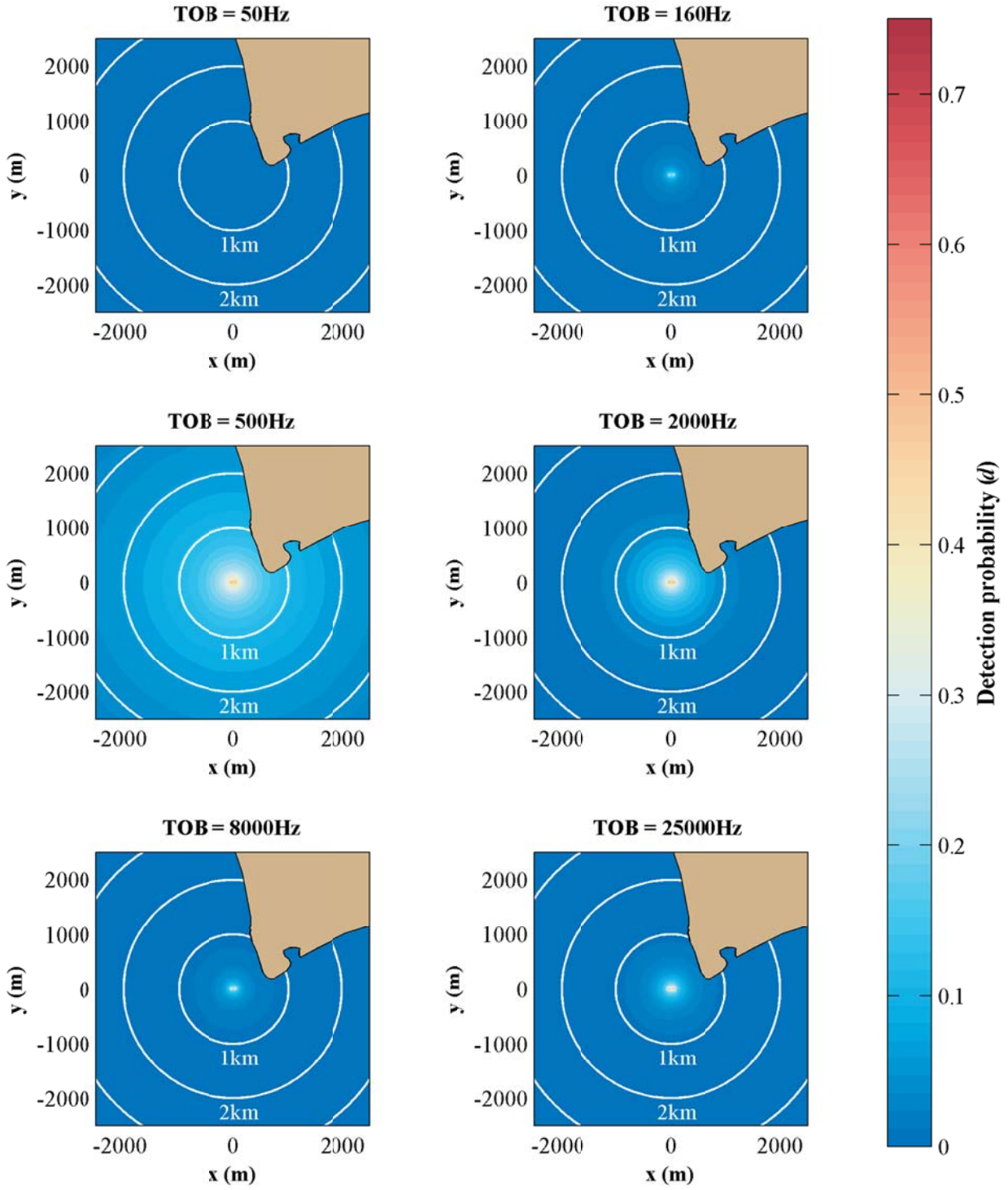


Figure 13 – Probability of mid-frequency cetacean (killer whale) detecting turbine noise (30 m depth relative to surface).

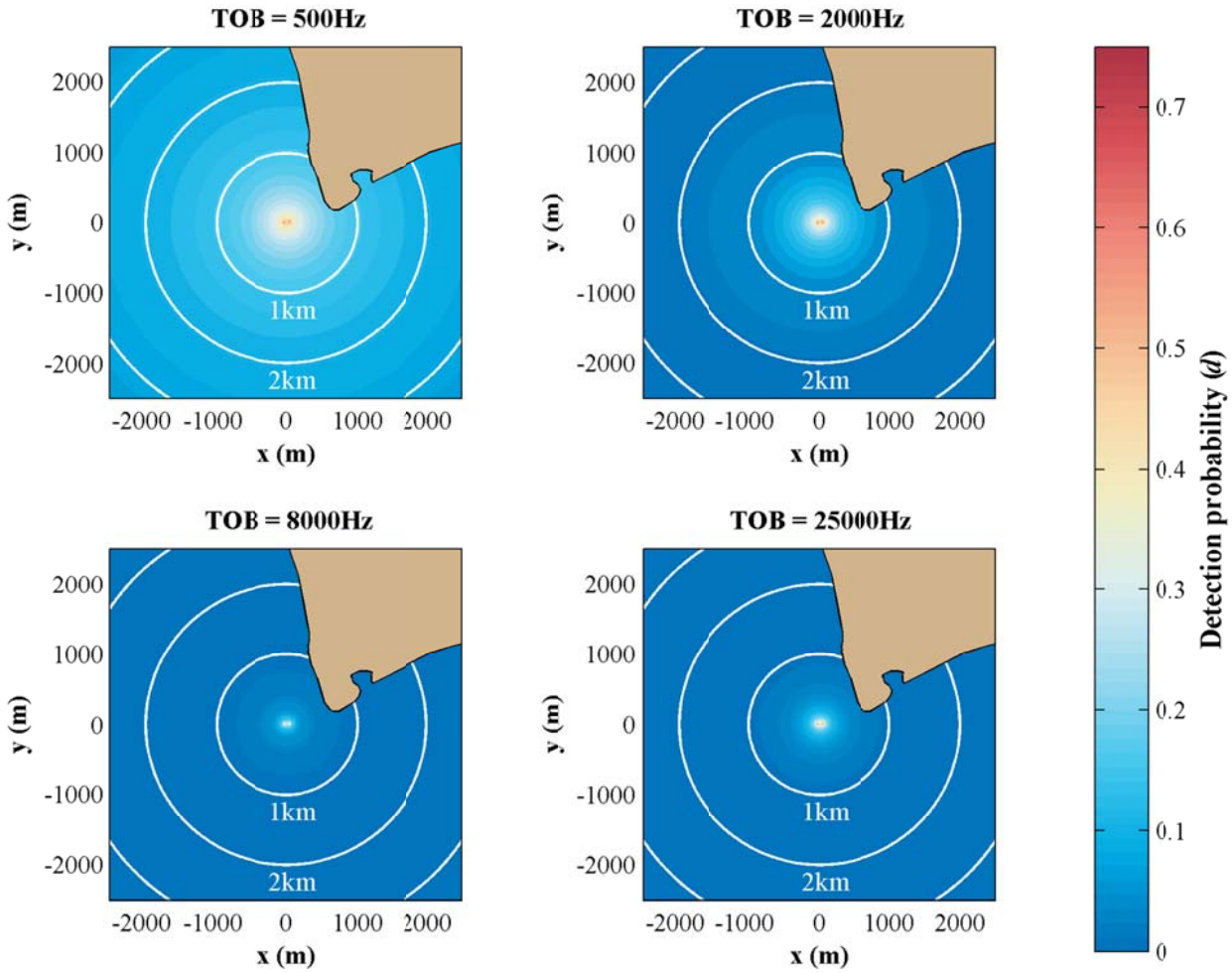


Figure 14 – Probability of high-frequency cetacean (harbor porpoise) detecting turbine noise (30 m depth relative to surface). No detection at any distance below 500 Hz.

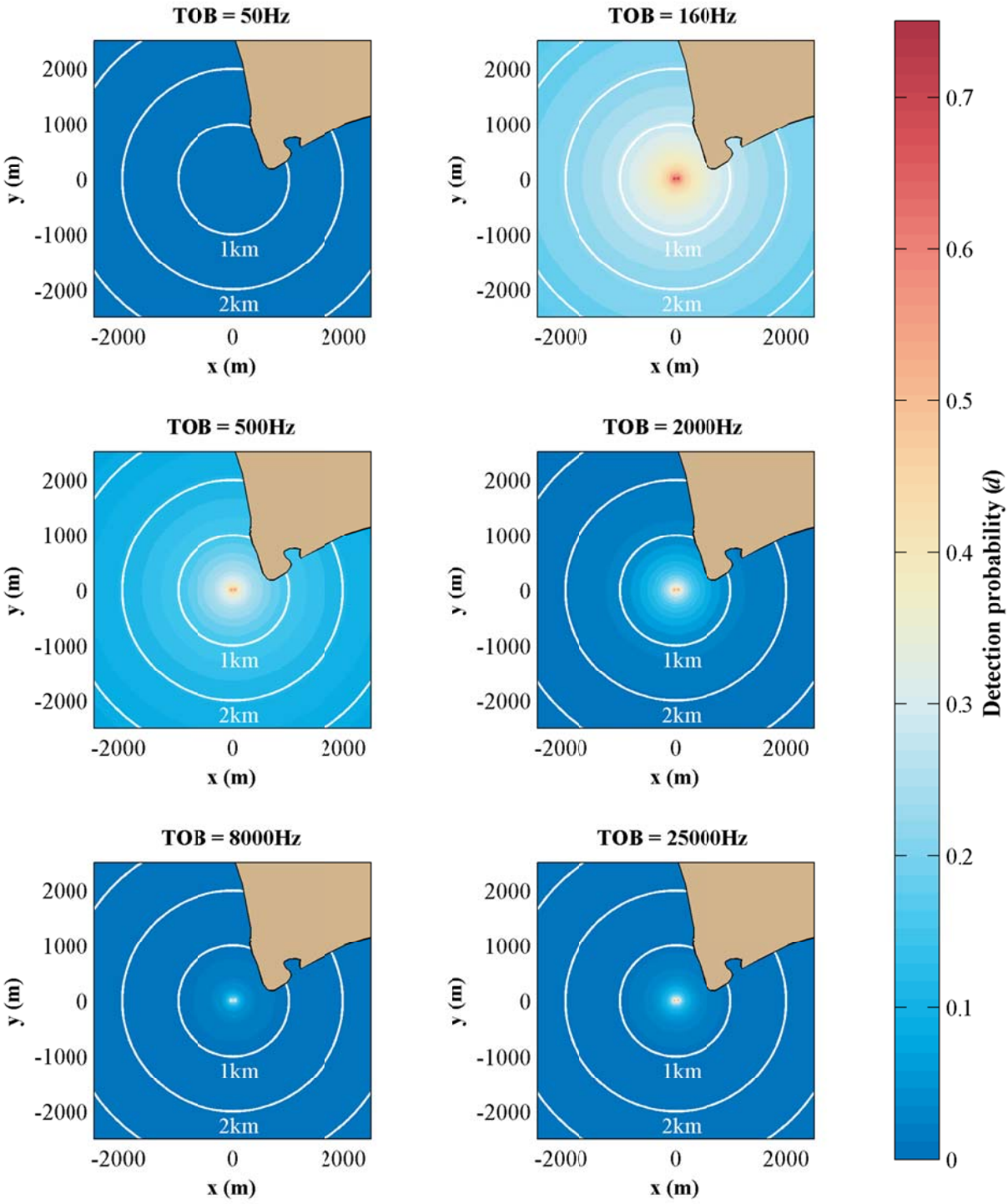


Figure 15 – Probability of pinniped (harbor seal) detecting turbine noise (30 m depth relative to surface).

While these results are subject to significant uncertainty due to underlying knowledge gaps and necessary simplifications, they provide several insights relative to the design of marine animal studies for pilot-scale tidal energy installations. Fish are likely to detect turbine sound at greater ranges than mid- or high-frequency cetaceans or pinnipeds. For example, at a range of 1 km, this exercise suggests that fish may be able to detect turbine sound almost 40% of the time, whereas detection rates of this

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

magnitude are likely to be restricted to, at most, a few hundred meters of the turbines for the other taxonomic groups. For mid- and high-frequency cetaceans, detection of turbine sound is unlikely (i.e., probability < 25%) beyond a few hundred meters. Pinnipeds are more likely to detect turbine sound, with 25% detection probability at a range of approximately 1 km. Again, we emphasize that these are probabilistic estimates for detection, not an observable behavioral response.

3.4 Warning Distance and Time

Warning distances and times (§2.5.4) are shown for the 5th, 50th, and 95th ambient noise percentiles in Figure 16 for the four classes of marine animals. Warning distance is defined as the minimum distance at which a marine animal would detect turbine sound at any frequency, given an ambient noise level and current velocity (directly related to received levels). Warning time is the ratio of warning distance to current velocity, corresponding to a case in which a marine animal is moving at the same speed as the currents. The bottom row of the figure is the probability distribution of velocity at the case study site, is independent of the ambient noise percentile, and is provided for context (i.e., percentage of time a given warning distance is likely for a given ambient noise percentile).

For this case study, during the quietest periods (i.e., 5th ambient noise percentile), all marine animals are predicted to detect turbine sound at a range of at least 100 m, resulting in a warning time of at least a few minutes. During the loudest periods (i.e., 95th ambient noise percentile), the turbines will not be audible at appreciable range (i.e., > 10 m) at velocities below 1 m/s and only at a range on the order of 50 m until currents exceed 2 m/s. However, this still implies a warning time of at least a minute for currents faster than 1 m/s, unless the animal is swimming quickly with the currents. For median ambient noise conditions, warning times are predicted to be at least a minute for any current velocity.

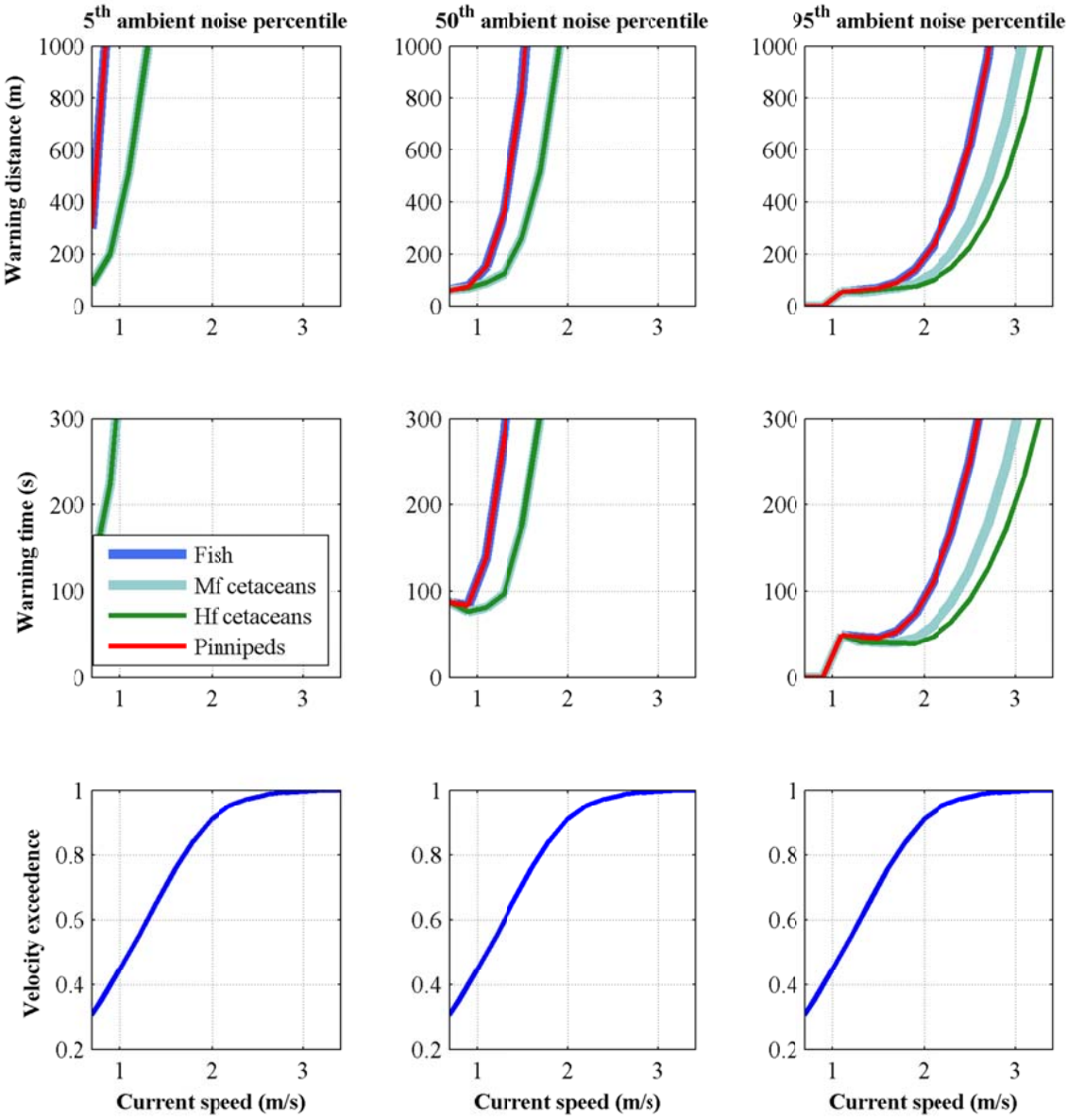


Figure 16 – Warning distance (45 m depth relative to surface) as a function of current velocity. Warning times for fish and pinnipeds at the 5th ambient noise percentile are greater than 300 s for all current speeds after turbine cut-in. Velocity exceedence is the cumulative probability distribution of current speed.

4 Discussion

In terms of potential environmental interactions presented in §1, turbine sound from the case study project will cause measurable changes in the environment, but we predict that these acoustic changes are unlikely to be of sufficient biological significance to be considered an impact. This has a number of implications for post-installation monitoring and mitigation.

4.1 Structure and Effectiveness of Post-Installation Monitoring Plans

A significant uncertainty in this pre-installation case study is the relation between turbine sound (intensity and frequency) and power generation state. Here, we have applied analogues from the wind

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

turbine literature and underwater noise studies to hypothesize that tidal turbine sound will strongly depend upon current velocity. Developing accurate, data-driven expressions for variations in sound intensity *and* spectral content with current velocity and corresponding power generation state represents a critical research need. As shown by Figure 11, if our hypothesis is correct, characterizing turbine sound at this location will be difficult when currents are less than 2 m/s. However, currents faster than 2 m/s occur only 20% of the time (Figure 2). Further, if studies are intended to estimate the source level based on a regression through multiple co-temporal measurements at different distances (as could be accomplished through simultaneous deployment of multiple, drifting hydrophones), turbine sound is expected to only be identifiable at limited distances under the most common operating conditions. At this site, study effectiveness can be improved by collecting data at times when ambient noise is known to be low, such as the early morning hours (0200 – 0500 local time when shipping traffic is at its daily minimum, Bassett et al., in press). However, peak tidal currents and acceptable weather may not routinely coincide with minimal ambient noise conditions.

Similar considerations apply to monitoring marine animal responsiveness to turbine sound. The pre-installation case study suggests that observations should be stratified by signal excess since the range at which a behavioral response might be observed will expand and contract with current velocity and ambient noise levels. In other words, stratifying observations solely by whether the turbines are operating or idle ignores the wide range of signal excess for a marine mammal at a particular point in space. This also suggests an upper limit for the functional extent of a survey area since the spatial extent of detectable turbine noise is limited in comparison to the spatial extent of northern Admiralty Inlet (5000 m wide at narrowest point). Within a few hundred meters of the turbines, the probability of turbine noise being detected by mid- and high frequency cetaceans drops below 25%, and to similar levels for pinnipeds at about 1 km. This suggests that observations should be focused on the immediate vicinity of the turbines (e.g., no more than several hundred meters) in order to observe, with high spatial resolution, any behavioral changes. For example, shoreline observers using a combination of theodolite and video camera should be able to achieve meter-scale accuracy (Denardo et al., 2001), enabling a fine spatial stratification for observations. Unlike studies that aim to characterize turbine sound, observers will not be able to routinely take advantage of known low-ambient noise periods (i.e., periods with routinely higher signal excess such as 0200-0500 local time) given the lack of ambient light for visual observations and the limited resolution of currently available infrared detectors (Graber et al., 2011).

In Admiralty Inlet, with water depths exceeding 60 m, the low-frequency propagation cut-off is less than 10 Hz (7). As observed from the measurements at EMEC, turbines sound is likely to have tonal peaks at frequencies below the 25 Hz limit considered in this analysis. Ambient noise levels are lower at these frequencies for the case study site (Bassett et al., in press) and hearing sensitivity of low-frequency cetaceans at these frequencies has likely evolved to be at least as sensitive as those of fish. Consequently, low-frequency cetaceans may detect turbine sound at greater distances than medium-frequency cetaceans, high-frequency cetaceans, or pinnipeds making them a potentially interesting indicator group for behavioral response. However, low-frequency cetaceans are not as common in Admiralty Inlet (relatively few transits per year, Snohomish PUD, 2012) which would greatly limit the statistical power of studies to detect behavioral changes.

Click detectors are increasingly popular passive acoustic tools for studying the responsiveness of high-frequency cetaceans (e.g., harbor porpoise) to offshore activities. For example, click detectors have been used successfully to monitor the response of harbor porpoise to pile driving for offshore wind farm installations (Tougaard et al. 2009).These autonomous hydrophones log information about echolocation click trains and can be used to assess trends in presence/absence of marine mammals. Click detectors have been deployed at the case study site to establish baseline harbor porpoise activity (Collar et al., 2012) and could be used for before and after comparisons of detection positive minutes under various stratifications of environmental conditions. However, in the frequencies of highest sensitivity for harbor porpoise hearing, the area over which turbine noise is detectable more than 50% of the time is estimated to be much smaller than the effective range for a click detector (100-200 m). This would suggest a need to stratify analysis by current velocity in order to obtain high signal to noise ratio for analysis. However, harbor porpoise are so ubiquitously present at this location that autocorrelation time scales for detection positive minutes are on the order of several hours. Over these time scales, turbine sound and ambient noise are non-stationary, confounding such an analysis.

This discussion is not intended to discourage studies of turbine sound or marine mammal responsiveness to this sound at pilot tidal energy projects, but rather to provide a framework for structuring such studies and guidance from a case study at a representative pilot project. Monitoring is likely to be more effective under a broader range of ambient noise conditions when turbines have higher source levels (including similar turbines at different sites with velocity distributions skewed towards higher speeds), projects involve a larger number of turbines, and/or when ambient noise is lower. The converse is true for turbines with lower source levels and/or for sites with higher ambient noise. For example, greater statistical power would be expected for an installation that is detectable to a range of several kilometers in frequency bands audible to marine mammals commonly occurring at a particular site. Such a situation could correspond to a pilot project located where low-frequency cetaceans are common. A better understanding of the acoustic stressor for tidal turbines can, and should, be obtained from pilot scale projects.

4.2 Warning Distance and Time

Results from the case study indicate that the warning distance (i.e., minimum distance that detection of turbine noise is possible) is a strong function of both ambient noise and current velocity for all receiver classes. For all cases considered, warning distance and time increase nearly monotonically with current velocity. This suggests an inherent mitigation measure for the risk of blade strike for turbines operating at a fixed tip speed ratio. As blade rotation rates increase and the consequences of strike become potentially significant, turbine sound is audible at increasingly greater distances and marine animals have increasingly greater time to react through avoidance or evasion. Significantly, warning distance increases as a power of current velocity, meaning that the warning time is likely greatest during the strongest currents. There are still likely to be times at which the acoustic cues from a turbine are entirely masked by ambient noise, specifically at currents near cut-in speed during periods of high ambient noise. However, low current speeds correspond to the least consequential collisions or blade strikes.

As for the evaluating the spatial extent of marine animal responsiveness to turbine sound, it is important to emphasize that detection of the acoustic cue from a turbine is not sufficient to elicit avoidance or evasion. We note that experience and behavioral context might affect responses to turbine sound in

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

unpredictable ways. As a specific example, marine animals are unlikely to interpret the signal excess of turbine sound as a warning of collision risk until they learn to associate the sound from the turbine with its physical presence; this learning will occur over time. Similarly, marine animals may be less vigilant if they are engaged in certain behaviors, such as feeding (Ryer and Olla, 1998). In combination, these factors suggest that there may be a broader range of ambient noise and power generation states under which marine animals would have limited time to react to the presence of turbines.

5 Conclusions and Recommendations for Future Investigations

This study presents a framework for evaluating turbine sound in the context of ambient noise, as well as a pre-installation case study for a proposed pilot-scale deployment in northern Admiralty Inlet, Puget Sound, Washington. Measurements of a similar turbine at the European Marine Energy Centre are assessed and a simple scaling relation is used to predict turbine sound at the case study site. For this case study, it is predicted that the sound from turbine operation is not likely to be routinely detected by marine animals at distances greater than a few hundred meters from the project. This suggests that targeted, thoughtful approaches will be required to characterize turbine sound and the responsiveness of marine animals to this sound.

The number of variables inherent to the problem complicates discussions about environmental impacts of sound from this type of source. Variables include spatial positioning of receivers and sources (x,y,z), time-variations in ambient noise, time-variations in turbine sound, and hearing sensitivity that varies with sound frequency and species. The results of the case study are, by necessity, presented in probabilistic terms that focus on a representative subset of the data produced by such an analysis. Just as communication of this type of probabilistic information is challenging, regulatory agencies involved in the permitting of marine renewable energy projects will be similarly challenged to interpret the biological significance of such information. Developing common frameworks to treat this type of problem is essential and this research represents a first step in that direction.

This case study also highlights a number of high-priority considerations for future studies of turbine sound. First, the relation between power generation state and sound produced by turbines should be rigorously established, with respect to intensity, frequency, and directivity. The estimates presented in the case study, based on analogues from the wind energy and underwater noise literature suggest that understanding these relations will be crucial to developing accurate probabilistic models for the effects of turbine sound for large-scale installations. Second, this study has only considered detection of sound, not responsiveness of marine animals to this sound. For these magnitude of received levels, Ellison et al. (2012) suggests that a context-based, rather than a dose-response, model is likely to be most effective in interpreting and predicting marine animal response. Such models require a thorough understanding of the characteristics of the received sound, as well as the behavioral state/history of the marine animal. These, and other, uncertainties are only likely to be reduced through careful monitoring of pilot-scale turbine installations and improved understanding of marine animal responsiveness to sound from various sources. Finally, the lack of audiograms for some marine animals, such as low-frequency cetaceans and diving seabirds, is an impediment to applying this framework to other environments. This gap may be best addressed through laboratory and mesocosm experiments.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

The case study provides instructive guidance for the range of information needed to plan post-installation monitoring of tidal energy projects. Information needs include empirical data on the probability distribution of turbine sound, a model for sound transmission, the probability distribution of ambient noise, and any correlation between turbine sound and ambient noise.

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References

Ainslie, M.A. and J.G. McColm (1998) A simplified formula for viscous and chemical absorption in sea water, *J. Acoust. Soc. Am.*, 103(3):1671-1672.

Barr, S. (2010) Acoustic characterisation of the Open-Centre turbine. Technical report to Snohomish Public Utility District by OpenHydro.

Basset, C., J. Thomson, and B. Polagye (2010) Characteristics of underwater ambient noise at a proposed tidal energy site in Puget Sound, *MTS/IEEE Oceans 2010*, Seattle, WA September 20-23, 2010.

Bassett, C., B. Polagye, M. Holt, and J. Thomson (*in press*) A vessel noise budget for Admiralty Inlet, Puget Sound, WA (USA), *J. Acoust. Soc. Am.*

Bassett, C., J. Thomson, and B. Polagye (*submitted*) Sediment generated noise and bed stress in a tidal channel, Submitted to *J. Geo. Res.*

Branstetter, B.K and J. J. Finneran (2008) Comodulation masking release in bottlenose dolphins (*Tursiops truncatus*), *J. Acoust. Soc. Am.*, 124: 325-633.

Brooks, T.F., D.S. Pope, M.A. Marcolini (1989) Airfoil self-noise and prediction, NASA Reference Publication 1218, July, 1989, pp. 146.

Cada, G., J. Ahlgrimm, M. Bahleda, T. Bigford, S. Damiani-Stavrakas, D. Hall, R. Moursund, and M. Sale.(2007) Potential impacts of hydrokinetic and wave energy conversion technologies on aquatic environments, *Fisheries* 32(4):174-181.

Carlson, T.J., J.L. Elster, M.E. Jones, B.E. Watson, A.E. Copping, M. Watkins, R. Jepsen, and K. Metzinger (2012) Assessment of strike of adult killer whales by an OpenHydro tidal turbine blade, Pacific Northwest National Laboratory technical report, PNNL-21177

Carter, C. (2007) Marine renewable energy devices: A collision risk for marine mammals? Masters thesis, University of Aberdeen, UK.

Chapman, C. J. and A.D. Hawkins (1973) Field study of hearing in cod, *Gadus morhua* L, *J. Comp. Physiol.*, 85, 147–167.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Collar, C., J. Spahr, B. Polagye, J. Thomson, C. Bassett, J. Graber, R. Cavagnaro, J. Talbert, A. deKlerk, A. Reay-Ellers, D. Tollit, J. Wood, A. Copping, T. Carlson, and M. Halvorsen (2012) Study of the acoustic effects of hydrokinetic tidal turbines in Admiralty Inlet, Puget Sound, Final report to the US Department of Energy under DOE Award DE-EE0002654.

Davison, A. and T. Mallows (2005) Strangford Lough Marine Current Turbine environmental statement, Royal Haskoning technical report 9P5161/R/TM/Edin, June 15, 2005.

Denardo, C., M. Dougherty, G. Hastie, R. Leaper, B. Wilson, and P.M. Thompson (2001) A new technique to measure spatial relationships with groups of free-ranging coastal cetaceans, *J. Appl. Ecol.*, 38(4):888-895.

Dowling, A.P. and J.E. Efowcs Williams (1983) "Sound and sources of sound", Chichester, New York, Halsted Press.

Emery, W.J. and R.E. Thomson (2001) "Data analysis methods in physical oceanography", Elsevier, B.V., Amsterdam, The Netherlands.

Ellison, W.T., B.L. Southall, C.W. Clark, and A.S. Frankel (2012) A new context-based approach to assess marine mammal behavioral responses to anthropogenic sounds. *Cons. Bio.,* 26(1):21-28.

Graber, J., J. Thomson, B. Polagye, and A. Jessup (2011) Land-based infrared imagery for marine mammal detection, *SPIE Photonics+Optics*, San Diego, CA, August 20-25, 2011.

Grosveld, F.W. (1985) Prediction of broadband noise from horizontal axis wind turbines, *J. Propulsion and Power*, 1(4):292-300.

Hall, J. D., and C. S. Johnson. 1972. Auditory thresholds of a killer whale *Orcinus orca* Linnaeus. J. Acoust. Soc. Am. 51: 515–517.

Hatch, L. C. Clark, R. Merrick, S. Van Parijs, D. Ponirakis, K. Schwehr, M. Thompson, and D. Wiley (2008) Characterizing the relative contributions of large vessels to total ocean noise fields: A case study using the Gerry E. Studds Stellwagen Bank National Marine Sanctuary, *Environmental Management,* 42:735-752.

Hawkins, A.D. and A.N. Popper (2012) Effects of Noise on Fish, Fisheries, and Invertebrates in the U.S. Atlantic and Arctic from Energy Industry Sound-Generating Activities, Literature synthesis prepared for the Bureau of Ocean Energy Management (BOEM), http://www.boemsoundworkshop.com

Hazelwood, R. and Connelly, J. (2005) Estimation of underwater noise – a simplified method. *International J. Soc. Underwater Technology*, 26:51-57.

Hemilä, S., S. Nummela, T. Reuter (2001) Modeling whale audiograms: effects of bone mass on high-frequency hearing, *Hearing Research*, 151: 221-226.

Holt, M.M. and R.J. Schusterman (2007) Spatial release from masking of aerial tones in pinnipeds, *J. Acoust. Soc. Am.*, 121: 1219-1225.

Hubbard, H.H. and K.P. Shepherd (1991) Aeroacoustics of large wind turbines, *J. Acoust. Soc. Am.*, 89(6): 2495-2508.

Johnson, C. S. (1967) Sound detection thresholds in marine mammals, *In* W. N. Tavolga (ed.), "Marine Bioacoustics", 2:247–260, Pergamon Press, Oxford.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Kastelein, R.A., P. Bunskoek, M. Hagedoorn, W. Au, and D. de Haan (2002) Audiogram of a harbor porpoise (*Phocoena phocoena*) measured with narrow-band frequency-modulated signals, *J. Acoust. Soc. Am.*, 112(1):334-344.

Kastelein, R.A., P.J. Wensveen, L. Hoek, W.C. Verboom, J.M. Terhune (2009) Underwater detection of tonal signals between 0.125 and 100 kHz by harbor seals (*Phoca vitulina*). *J. Acoust. Soc. Am.*, 125: 1222–1229.

Lee, S., S-R. Kim, Y-K. Lee, J.R. Yoon, and P-H. Lee (2011) Experiment on effect of screening hydrophone for reduction of flow-induced ambient noise in ocean, *Jap. J. Appl. Phys.*, 50, DOI: 10.1143/JJAP.50.07HG02.

Lowson, M.V. (1992) Applications of aero-acoustic analysis to wind turbine noise control, *Wind Engineering*, 16(3): 126-140

Ma, B., J. Nystuen, and R-C. Lien (2005) Prediction of underwater sound levels from rain and wind, *J. Acoust. Soc. Am.*, 117(6):3555-3565.

Marsh H.W. and M. Schulkin (1962) Shallow water transmission, *J. Acoust. Soc. Am.*, 34:863–864

McKenna, M., D. Ross, S. Wiggins, and J. Hilderbrand (2012) Underwater radiated noise from modern commercial ships, *J. Acoust. Soc. Am.*, 131(1):92-103.

McQuinn, I.H., V. Lesage, D. Carrier G. Larrivee, Y. Samson, S. Chartrand, R. Michaud, and J. Theriault (2011) A threatened beluga (*Delphinapterus leucas*) population in the traffic lane: Vessel-generated noise characteristics of the Sageunay-St. Lawrence Marine Park, Canada, *J. Acoust. Soc. Am.*, 130(6):3661-3673.

Merchant, N.D., P. Blondel, D.T. Dakin, and J. Dorocicz (2012) Averaging underwater noise levels for environmental assessment of shipping, *J. Acoust. Soc. Am.*, 132(4):EL 343-349.

Miller, P. (2006) Diversity in sound pressure levels and estimated active space of resident killer whale vocalizations, *J. Comp. Phys. A Neuroethology, Sensory, Neural, and Behavioral Physiology*, 192(5):449-459.

National Marine Fisheries Service (NMFS), U.S. Federal Register (2005) Endangered and threatened wildlife and plants: Endangered status for Southern Resident killer whales. FR 70(217):69903–69912 (18 November 2005).

National Research Council of the U.S. National Academies (NRC) (2003) *Ocean Noise and Marine Mammals*, National Academy Press, Washington, DC.

National Research Council of the U.S. National Academies (NRC) (2005) Marine Mammal Populations and Ocean Noise: Determining When Ocean Noise Causes Biologically Significant Effects. National Academy Press, Washington, DC.

Ocean Renewable Power Company (2011) Application of ORPC Maine, LLC for a hydrokinetic pilot project license for the Cobscook Bay Tidal Energy Project, Federal Energy Regulatory Commission Docket P-12711, Sept. 1, 2011.

Oerlermans, S. and B.M. López (2005) Acoustic array measurements on a full scale wind turbine, *11th AIAA/CEAS Aeroacoustics Conference*, AIAA 2005-2963, 23-25 May 2005, Monterey, CA.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Oerlermans, S. and J.G. Schepers (2009) Prediction of wind turbine noise and validation against experiment, *Int. J. Aeroacoustics*, 8(6): 555-584.

Polagye, B., B. Van Cleve, A. Copping, and K. Kirkendall, K. (eds.) (2011) Environmental effects of tidal energy development: Proceedings of a scientific workshop, March 22-25, 2010. NOAA Technical Memorandum NMFS F/SPO-116.

Polagye, B. and J. Thomson (*in press*) Tidal energy resource characterization: methodology and field study in Admiralty Inlet, Puget Sound, U.S., *Proc. IMechE, Part A: J. Power and Energy*.

Richardson, W.J., C.R. Greene, C.I. Malme, and D.H. Thomson (1995) Marine mammals and noise, Academic Press, Elsevier, San Diego, CA, USA.

Ross, D. (1976) Mechanics of Underwater Noise, Final report, Tetra Tech Inc., http://www.dtic.mil/cgi-bin/GetTRDoc?Location=U2&doc=GetTRDoc.pdf&AD=ADA075101

Ryer, C.H. and B.L. Olla (1998) Shifting the balance between foraging and predator avoidance: the importance of food distribution for a schooling pelagic forager, *Environmental Biology of Fishes*, 52: 467-475.

Snohomish Public Utility District (2012), Final license application for the Admiralty Inlet tidal project, Federal Energy Regulatory Commission Docket P-12690, Mar. 1, 2012.

Southall, B., Bowles, A., Ellison, W., Finneran, J., Gentry, R., Greene, C., Kastak, D., Ketten, D., Miller, J., Nachtigall, P., Richardson, W., Thomas, J., Tyack, P. (2007) Marine mammal noise exposure criteria: initial scientific recommendations. *Aquatic Mammals*, 33 (4).

Szymanski, M. D., D. E. Bain, K. Kiehl, S. Pennington, S. Wong, and K. R. Henry (1999) Killer whale (*Orcinus orca*) hearing: Auditory brainstem response and behavioral audiograms, *J. Acoust. Soc. Am.*, 106: 1134–1141.

Thomson, J., B. Polagye, V. Durgesh, and M. Richmond (2012) Measurements of turbulence at two tidal energy sites in Puget Sound, WA (USA), *J. Ocen Eng.*, 37(3)

Tougaard, J., O.D. Henriksen, and L.A. Miller (2009) Underwater noise from three types of offshore wind turbines: Estimation of impact zones for harbor porpoises and harbor seals, J. Acoust. Soc. Am., 125(6):3766–3773.

Twidell, J. and T. Weir (2006) “Renewable energy resources”, Taylor & Francis, New York, NY.

Urick, R. (1983) “Principles of Underwater Sound”, McGraw-Hill.

Verdant Power (2010) Final license application for hydrokinetic pilot project license for Roosevelt Island tidal energy project, Federal Energy Regulatory Commission Docket P-12611, Dec. 29, 2010.

Wartzok, D. and D.R. Ketten (1999) Marine mammal sensory systems, in *Biology of Marine Mammals*, J. Reynolds and S. Rommel (eds.), Smithsonian Institution Press, pp. 117-175.

Wenz, G. (1962) Acoustic ambient noise in the ocean: Spectra and sources, *J. Acoust. Soc. Am.*, 34:1936-1956.

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Attachment 3

Power Analysis for Ability to Detect Changes related to Southern Resident Killer Whales

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Power Analysis for Ability to Detect Changes related to Southern Resident Killer Whales

Introduction

The power of a statistical test is a measure of the likelihood that a finding of no significant difference is actually true. This metric is important for monitoring studies, as there needs to be confidence in a finding of no impact. As power increases, confidence in the finding of no impact increases. Power is calculated as $1 - \beta$ where β is the probability of committing a type II error (the false negative rate). Given the type I error rate (α or the false positive rate) and effect size, an a priori calculation of sample size for various levels of power can be calculated. This analysis aims to do that for the various metrics proposed in the Marine Mammal Monitoring and Mitigation Plan to assess changes in killer whale behavior.

Methods

The following monitoring variables have been proposed in the Marine Mammal Monitoring and Mitigation Plan: Point of Closest Approach (POCA), directionality of transit, surfacing interval, surface behavior state, surface active behavior (SAB), click rate, and call rate. A power analysis for surface behavior state was not calculated as this was beyond the capabilities of the software used. G*Power 3.1.3 was used for all power calculations. POCA means were considered to be independent, whereas all other variables were considered to be matched pairs (repeated measures).

The threshold of change evaluated here is a 30% change in the means of a metric. Power calculations depend on the type I error probability and the effect size. Type I error rate was set at 0.05. Statistical effect size (*ES*) is based on the change in means as well as the standard deviation of that population as

$$ES = \frac{\overline{x_a} - \overline{x_o}}{s}$$

where $\overline{x_a}$ is the mean of the impact group, $\overline{x_o}$ is the mean of the control group and *s* is their standard deviation. To use plausible means and standard deviations, the literature on Southern Resident killer whales (SRKW) was surveyed. If that data was not reported for SRKW, then data from studies on Northern Resident killer whales (NRKW) was used. For studies that reported standard error, this was multiplied by the square root of the sample size to determine the standard deviation. Table 1 shows the values used and the resulting effect sizes that were used to calculate power and sample size.

Table 1 - Input variables and studies from which they were taken to calculate effect size.

Study	Variable	Mean	SE	N	SD	30% change in mean	Effect Size	Notes
Noren et al. 2009	POCA	131.7	6.5	193	90.30	171.2	0.44	all vessels in 2006
Williams et al. 2002	Directionality of transit	85	3	16	12.00	110.5	2.13	males only
Williams et al. 2002	Surfacing interval	42	2	16	8.00	54.6	1.58	males only
Williams et al. 2002	SAB	1.2	0.3	16	1.20	1.6	0.30	males only
Beneze et al. 2011	Click rate	83.9		370	78.10	109.1	0.32	all behaviors
Scurci 2011	Call rate	3.68		58	4.40	4.78	0.25	all behaviors

Results

Power varied by sample size for the different variables with directionality and surfacing interval having the highest power at low sample sizes and POCA having the lowest power (Figure 1). Table 2 lists estimated sample sizes needed for low and high levels of power.

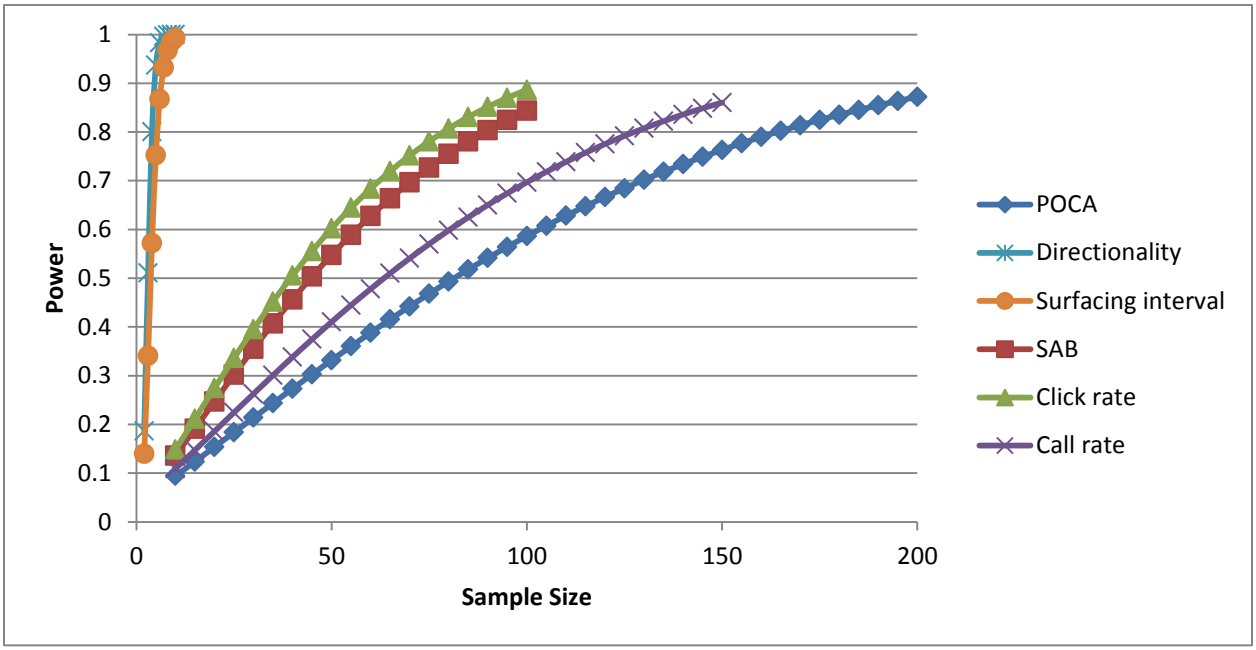

Figure 1 - Effect of sample size on power for the six metrics proposed for the monitoring plan (30% change).

Table 2 – Sample sizes needed for high and low power levels.

Variable	Sample size needed (power=0.2, alpha=0.05)	Sample size needed (power=0.8, alpha=0.05)
POCA	28	166
Directionality of transit	3	4
Surfacing interval	3	6
SAB	16	90
Click rate	15	79
Call rate	22	128

Conclusions

Given the large difference in effect size for each of these metrics; it is not surprising that power varies so much for a given sample size. This variance in effect size is largely dependent on the standard deviation used to calculate effect size. Given that the standard deviations used for these calculations were reported for studies in other areas on this and other populations of killer whales, these results should be interpreted more as upper and lower bounds of potential power for tests used in the Marine Mammal Monitoring and Mitigation Plan. POCA will have the lowest power since it will be tested with independent means. All other variables will use a repeated measures test and will therefore have higher power. How much power will depend largely on their standard deviations.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

References

Beneze, E. L., Wood, J. D., Veirs, S., & Veirs, V. (2011). Are click rates in killer whales an indicator of group behavior and foraging hotspots? *Journal of the Acoustical Society of America*, *129*(4), 2607.

Noren, D. P., Johnson, A., Rehder, D., & Larson, A. (2009) Close approaches by vessels elicit surface active behaviors by southern resident killer whales. *Endangered Species Research*, *8*, 179-192.

Scurci, K. (2011) Testing the motivation-structural rules hypothesis in Southern Resident killer whales (*Oricnus orca*). Senior Thesis. College of the Atlantic.

Williams, R., Trites, A. W., & Bain, D. E. (2002) Behavioural responses of killer whales (Orcinus orca) to whale-watching boats: opportunistic observations and experimental approaches. *Journal of Zoology*, *256*(2), 255–270.

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ADMIRALTY INLET PILOT TIDAL PROJECT
FERC PROJECT NO. 12690

NEAR-TURBINE MONITORING AND MITIGATION PLAN

Submitted by:
Public Utility District No. 1 of Snohomish County

November 16, 2012

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

TABLE OF CONTENTS

1.0 INTRODUCTION 1

2.0 PROJECT DESCRIPTION 1

3.0 BACKGROUND INFORMATION 4

3.1 Near-turbine Monitoring Experience 4

3.1.1 Verdant Power (East River, New York, United States) 4

3.1.2 Ocean Renewable Power Company (Eastport, Maine, United States) 4

3.1.3 OpenHydro (European Marine Energy Center, Orkney Islands, Scotland, United Kingdom) 4

3.1.4 OpenHydro (Fundy Ocean Research Centre for Energy, Minas Passage, Nova Scotia, Canada) 5

3.1.5 Marine Current Turbines (Strangford Lough, Northern Ireland, United Kingdom). 5

3.2 Environmental Risk 8

3.2.1 Probability of Encounter 8

3.2.2 Consequences of Encounter 8

4.0 PLAN OBJECTIVES AND GOALS 9

5.0 POST-INSTALLATION MONITORING PLAN 10

5.1 Imaging System Details 10

5.2 Presence and Absence of Marine Animals 13

5.2.1 Objective 13

5.2.2 Data Collection 14

5.2.3 Data Analysis 15

5.2.4 Reporting and Adaptive Management 16

5.3 Optimized Strobe Illumination 17

5.3.1 Objective 17

5.3.2 Data Collection 17

5.3.3 Data Analysis 19

5.3.4 Reporting and Adaptive Management 20

5.4 Interaction with the Turbine Rotor 20

5.4.1 Objective 20

5.4.2 Data Collection 20

5.4.3 Data Analysis 21

5.4.4 Reporting and Adaptive Management 21

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

5.5 Artificial Reef Effect 22
5.5.1 Objective 22
5.5.2 Data Collection 22
5.5.3 Data Analysis 23
5.5.4 Reporting and Adaptive Management 23
5.6 Turbine Avoidance 23
5.6.1 Objective 23
5.6.2 Data Collection 23
5.6.3 Data Analysis. 24
5.6.4 Reporting and Adaptive Management 24
6.0 APPROACH TO ADAPTIVE MANAGEMENT AND MITIGATION 24
7.0 REFERENCES 26

LIST OF FIGURES

Figure 1 – Conceptual instrumentation layout (fixed and recoverable). Instrumentation shown on a 4th Generation turbine (higher rotor solidity than 7th Generation turbine). The general dimensions of the subsea based and support structure are approximately constant between technology generations for the same rotor size. 2

Figure 2– Turbine deployment location in northern Admiralty Inlet. Blue triangles denote turbines, each of which is connected back to shore via a separate power cable. Dashed red polygon to the east of Keystone Harbor is a marine protected area. 3

Figure 3 – Unlighted video observation of OpenHydro turbine at EMEC. In this image, fish are aggregating downstream of the turbine. Current velocity is below cut-in speed for the turbine. 5

Figure 4 – Camera system assembly 11

Figure 5 – Optical camera system field of view on the OpenHydro turbines for two configurations: directed across the rotor (green prism) and directed at the rotor (red prism). 12

Figure 6 – Camera system field testing 13

LIST OF TABLES

Table 1 – Comparison of near-turbine monitoring at worldwide hydrokinetic projects 7

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

1.0 INTRODUCTION

Close range interactions between marine life and tidal turbines are of significant interest to resource agencies. These potential interactions include collision/strike, aggregation, or avoidance and receptors include fish, marine mammals, and diving seabirds. In the case of strike/collision, concerns relate to elevated proximate or ultimate mortality, while in the cases of aggregation and avoidance, concerns center around indirect effects such as altered predator/prey dynamics, reef effects, and increased energetic expenditures that could lead to decreased fitness. These interactions are all hypothetically possible, though considered highly uncertain in terms of significance and frequency (Polagye et al., 2011). While laboratory and field studies conducted to date provide some guidance, field observations of full-scale devices are needed to rigorously address these questions. This plan is focused on fish interactions, though, as discussed in § 6, observations of marine mammals or diving seabirds will trigger adaptive management actions, which could include additional studies focused on these taxonomic groups.

The primary technology that will be used to assess close range interactions between marine life and tidal turbines are optical stereo cameras. As summarized in §5.1, this is likely to be the most effective technology option for characterizing close range interactions and the specific species involved in these interactions. However, the potential disturbances due to artificial lighting and data bandwidths associated with monitoring suggest that a judicious approach to hypothesis testing will be required. Because of the significant uncertainties associated with the effectiveness of near-turbine monitoring (the development of the monitoring technology is an active research project), this plan describes the extent of initial studies, but the District will conduct monitoring studies for the duration of the project. Maintenance and adaptable configuration of the camera systems will be enabled by a recoverable instrumentation module (described in the Monitoring Plan Summary). In the latter stages of the project, the recoverable instrumentation module would also support the use of technologies suitable for studying avoidance behavior over distances on the order of 100 m (e.g., active acoustics).

2.0 PROJECT DESCRIPTION

The demonstration project proposed by Snohomish County Public Utility District consists of two turbines manufactured by OpenHydro, an Irish turbine developer. Each of these turbines has a 6 m diameter outer shroud, as shown in Figure 1. These will be deployed on a gravity tri-frame, with tubular cans contacting the seabed at the vertices. Turbine hub height will be 10 m above the seabed. The OpenHydro turbines are fixed-pitch, high-solidity rotors with an open center. The rotor cassette is the single moving part and is supported by water-lubricated bearings. A permanent magnet generator is contained in the shroud surrounding the blades. Anti-fouling coatings are applied to the interior surface of the shroud, hub, and rotor blades, but the gravity frame (steel, ballasted by concrete and aggregate) is left uncoated. The turbine shown in Figure 1 represents the 6 m version of 4th Generation technology. The turbines deployed in Puget Sound will be 6 m variants of 7th Generation technology – the principle differences being fewer blades and more streamlined central hub.

The turbines will be deployed in northern Admiralty Inlet, Puget Sound, Washington. Admiralty Inlet is a constricted sill separating the deep Main Basin of Puget Sound from the Straits of Juan

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

de Fuca and Straits of Georgia. At the narrowest point, between Admiralty Head and Point Wilson, the channel is approximately 5 km wide and 70 m deep. Excepting a small exchange through Deception Pass, the entire tidal prism of Puget Sound passes through this constriction, giving rise to tidal currents that routinely exceed 3 m/s (6 knots) at mid-water. The project site is approximately 1 km SE of Admiralty Head in 55 m of water (Figure 2). The project location was chosen on the basis of strong tidal currents (intensified by the proximity to the headland), negligible seabed slope (necessary to deploy the gravity foundation), separation from high vessel traffic areas (federal navigation lanes, ferry route), and ease of cable routing back to shore.

Each turbine will be connected to shore by a separate power cable. These cables will also provide power for monitoring instrumentation and fiber optic communication with the turbine and monitoring instrumentation. Turbine monitoring systems are grouped into two categories – instruments that will be deployed for the duration of the demonstration project (fixed) and instruments that will be periodically recovered for maintenance (recoverable). This will be enabled by an Adaptable Monitoring Package (AMP) consisting of a self-aligning frame with instrumentation and a wet-mate power and fiber connector.

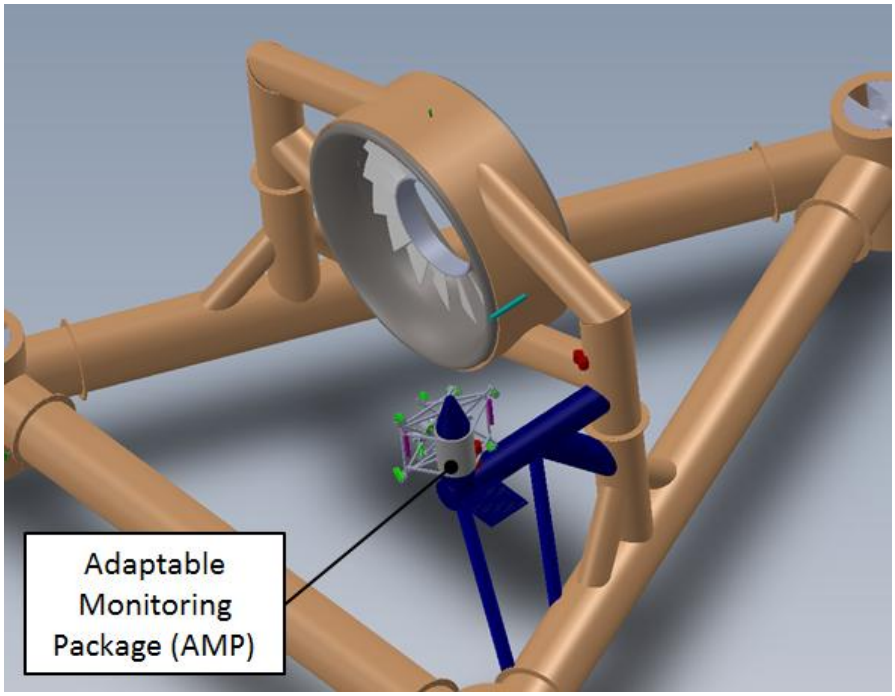


Figure 1 – Conceptual instrumentation layout (fixed and recoverable). Instrumentation shown on a 4th Generation turbine (higher rotor solidity than 7th Generation turbine). The general dimensions of the subsea based and support structure are approximately constant between technology generations for the same rotor size.

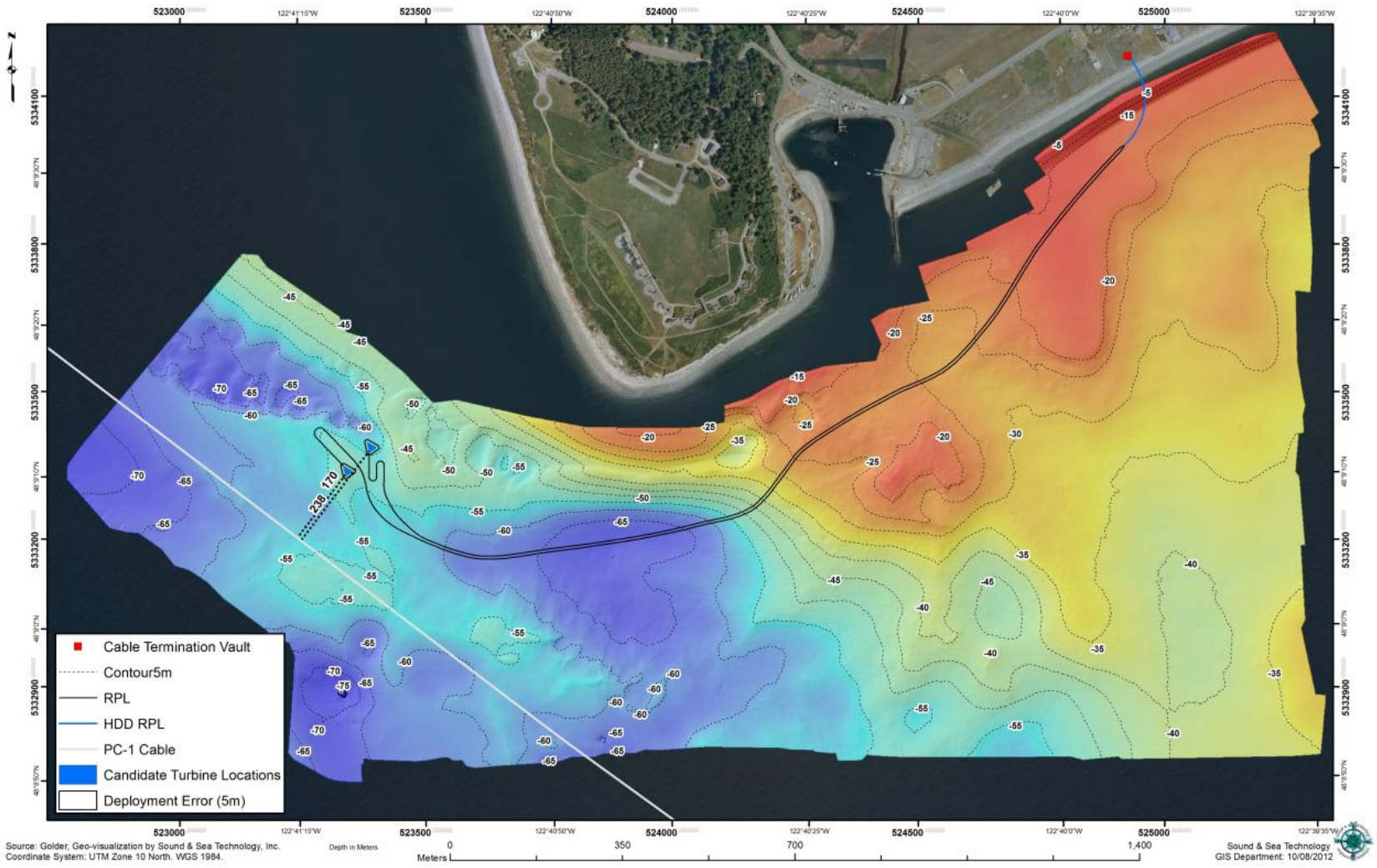


Figure 2 – Turbine deployment location in northern Admiralty Inlet. Blue triangles denote turbines, each of which is connected back to shore via a separate power cable. Dashed red polygon to the east of Keystone Harbor is a marine protected area.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

3.0 BACKGROUND INFORMATION

3.1 Near-turbine Monitoring Experience

Near-turbine monitoring programs have been undertaken at several tidal hydrokinetic projects with mixed results. These are described briefly here to provide context for the current plan.

3.1.1 Verdant Power (East River, New York, United States)

Verdant Power operated an array of turbines near Roosevelt Island in the East River of New York from 2005 through 2008. The project used a combination of split beam hydroacoustic transducers (BioSonics) deployed from shore and a vessel-deployed acoustic camera (DIDSON) to monitor for effects on fish. The array of split beam transducers (24 in total) was able to monitor for targets passing through the project area, but could not be used to detect strike or identify species. The cost of the split beam array exceeded the cost of the turbines and the knowledge gained from this activity was not considered proportional to its cost (Polagye et al., 2011). Vessel-based DIDSON observations (3+ days) detected a single fish passing through the vicinity of one turbine during operation (the fish traveled along hydrodynamic stream lines and was not struck by the rotor). Verdant Power concluded that DIDSON could be an effective tool for strike monitoring if used for short-term deployments (2 to 3 weeks) coinciding with periods of peak fish abundance. However, in their opinion, the quantity of data produced, instrument reliability, and high cost precluded long-term deployments. The next stage of project development, planned to begin in the summer of 2012, will utilize split-beam echosounders and acoustic cameras on a targeted, seasonal basis.

3.1.2 Ocean Renewable Power Company (Eastport, Maine, United States)

Ocean Renewable Power Company (ORPC) tested a cross-flow turbine (BETA Turbine Generator Unit) from a barge near Eastport, Maine for two years (2010-2011). Periodically, an acoustic camera (DIDSON) was deployed to monitor fish behavior around the operating rotor. The acoustic camera was deployed from the same barge as the generator in a downward looking orientation across the turbine rotor. These observations are described in Viehman (2012) and are the first observations of natural fish passage around and through a tidal turbine. While the positioning of the sonars did not allow fish to be tracked through the turbine, schools were observed entering the turbine and, having passed through, aggregated in the wake before continuing onwards. 40% of individual fish were observed to interact with the turbine in some way (i.e., passing through the turbine or resting in the wake). Reaction distance and the type of interaction were observed to depend on the turbine state, fish size, and grouping, with schools interacting less than individuals. Avoidance behavior was less apparent at night, suggesting that visual cues play a role in fish avoidance of turbines.

3.1.3 OpenHydro (European Marine Energy Center, Orkney Islands, Scotland, United Kingdom)

OpenHydro used unlighted video to monitor fish interactions with its turbine at the European Marine Energy Center (EMEC). This has been successful at detecting fish aggregation in the turbine wake during periods of relatively low currents (e.g., < 1.5 m/s). No strike of fish or

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

marine mammals has been observed and fish have not been observed to pass through the turbine once it begins rotating. The test turbine at EMEC is deployed within the photic zone and monitoring can be conducted during daylight hours only. A representative image from video observations is presented in Figure 3.

Figure 3 – Unlighted video observation of OpenHydro turbine at EMEC. In this image, fish are aggregating downstream of the turbine. Current velocity is below cut-in speed for the turbine.

3.1.4 OpenHydro (Fundy Ocean Research Centre for Energy, Minas Passage, Nova Scotia, Canada)

In the Bay of Fundy, the Fundy Ocean Research Centre for Energy (FORCE) has responsibility for monitoring environmental effects of deployed devices, including the OpenHydro turbine installed in the fall of 2009. Preliminary investigations of both video and active acoustics suggested that these tools would be ineffective given the physical environment (high turbidity, aeration) in the Bay of Fundy. Additionally, the lack of a power and data cable would have precluded deployment alongside the OpenHydro turbine, regardless of potential effectiveness. Rather than attempt direct monitoring during the OpenHydro test, FORCE deployed an array of Vemco fish tag receivers (8 VR2Ws) around the turbine foundation and another array (8 VR2Ws) in a line across the channel to the east of the turbine. Over the course of the turbine deployment (November 2009 to November 2010), approximately 100 fish were tagged and released in the upper Bay of Fundy. Vemco receivers have been recovered and analysis of collected data is underway. This array may succeed at detecting presence/absence of individuals and providing some tracking capability, but cannot directly monitor for strike.

3.1.5 Marine Current Turbines (Strangford Lough, Northern Ireland, United Kingdom)

The Marine Current Turbine (MCT) deployment in Strangford Lough is the largest prototype deployed to date with twin 16 meter diameter rotors and a rated power output of 1.2 megawatts (MW). Their environmental monitoring framework has no provision for strike monitoring. While this was initially requested by the regulator (Northern Ireland Environmental Agency), the

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

requirement was waived after subsequent determination that strike could not be monitored for in a meaningful way. Emphasis was instead placed on monitoring for behavioral changes among marine mammals (harbor seal, harbor porpoise) in the project area, changes to benthic habitat, and mitigating the risk for harbor seal strike by temporary shutdown.

A comparison of these efforts is presented in Table 1 using the following metrics:

- *Deployment platform*: How was the monitoring technology deployed (shore, seabed, or vessel)?
- *Instrument recovery*: How was the monitoring technology recovered/maintained?
- *Percentage of rotor imaged*: How much of the turbine rotor was imaged during monitoring?
- *Maximum duty cycle*: For the particular technology, what is the upper limit on the duty cycle? (Most data are collected on lower duty cycles or subsampled.)
- *Species identification*: Was it possible to identify observed species?
- *Functional range*: What is the maximum range for monitoring?
- *Cost*: A qualitative assessment of monitoring technology cost.
- *Reliability*: A qualitative assessment of monitoring technology reliability.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Table 1 – Comparison of near-turbine monitoring at worldwide hydrokinetic projects

Turbine (Location)	Verdant Power		OpenHydro (EMEC)	OpenHydro (FORCE)	Marine Current Turbines	ORPC
Turbine Type	Horizontal axis		Horizontal axis	Horizontal axis	Dual horizontal axis	Cross flow
Turbine Size	5 m		6 m	10 m	16 m	2.6 m
Water depth	10 m		15 m	40 m	35 m	-
Monitoring technology	Split-Beam Echosounder	Acoustic Camera	Unlighted Video	Fish Tags	None	Acoustic Camera
Supplier	BioSonics DTX	Sound Metrics DIDSON	GigE vision camera	Vemco VR2W	-	Sound Metrics DIDSON
Deployment platform	Shore	Vessel	Frame attached to turbine	Seabed	-	Vessel
Deployment duration	> 1 year	A few days	3 years[1]	1 year[2]	-	> 1 month
Instrument recovery	Divers	At surface	Integrated lift	Acoustic release[3]	-	At surface
% rotor imaged	0% (beams parallel to turbine rotor)	50-100%	100% of one side	0 %	-	N/A (upstream and downstream monitoring)
Maximum duty cycle	100%[5]	100%	Daylight hours only	100 %	-	100%
Species identification	No	Partial	Yes	Yes	-	Partial
Functional range	> 50 m	10 m	10 m	> 100m	-	10 m
Cost	Very High (exceeded turbine engineering cost)	High (> $100k per camera)	Moderate (low equipment, high processing)	Proportional to tagging effort	-	High (> $100k per camera)
Reliability	High	Poor	High	Moderate	-	High

- [1] Subsampling during this time period
- [2] Turbine damaged within first two weeks of deployment – all blades failed
- [3] Location/orientation of receiver not critical to function (in comparison to video and hydroacoustics)
- [4] Cross-section of turbine imaged
- [5] While sampling was conducted continually, only one of the three hydroacoustic transducers in each of the eight arrays could sample at a time due to acoustic signal interference

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

3.2 Environmental Risk

Environmental risk is the product of the probability of encounter and the consequence of encounter.

3.2.1 Probability of Encounter

Marine animal abundance in Admiralty Inlet will vary with diel, seasonal, and tidal current cycles. For fish, mobile hydroacoustics transect surveys conducted by Dawson and McClure (2010) found that during some seasons (February 2010), there were order of magnitude differences in target densities when comparing night to day conditions under similar current velocities. The differences in densities between fast versus slow current velocities were particularly evident at night; typically mean target densities were substantially higher under slow current velocities (as compared to fast current velocities) at night, whereas target densities were similar during the day, regardless of current velocity. In contrast, video studies conducted by OpenHydro at a turbine in Ireland suggests that low current velocities during the day may be conducive to high densities of benthopelagic fish species in the presence of the turbine structure but that these fish are absent during periods of stronger currents (Sue Barr, OpenHydro, memo November 2010).

Mobile hydroacoustic transect surveys, ground-truthing trawls, and autonomous, bottom-mounted hydroacoustic surveys were undertaken in May/June 2011 by the University of Washington under a hydroacoustic technology evaluation project funded under the National Oceanographic Partnership Program. Data analysis is ongoing, but preliminary results indicate significant "patchiness" in fish densities and that periods of strong currents may alter diel patterns that are typically observed for certain species (Sandra Parker-Stetter, pers. comm., April 2011).

3.2.2 Consequences of Encounter

Field observations to date, albeit limited in extent, have not observed an incidence of strike, suggesting that strike/collision has been a rare occurrence for deployments to date. These have included the release of tagged fish through small turbine in a riverine environment (Normandeau, 2009), as well as two flume studies overseen by the Electric Power Research Institute. In the first, conducted at Alden Labs, rainbow trout and largemouth bass were released immediately upstream of two turbines (a cross-flow variant and a horizontal axis device). Survival rates ranged for 98-100% and were not statistically significant relative to the control population. Video observations of fish introduced to the cross-flow turbine exhibited strong avoidance behavior, attempting to swim upstream or around the turbine when possible. Those fish that did pass through the turbines and were struck by the rotor, did not exhibit behavior suggestive of stunning or severe injury. Survival rates were much higher than predicted using a model based on strike consequences for conventional hydropower turbines. The second set of experiments was conducted at the Conte Lab, using a vertical axis turbine and involved salmon smolts and American shad. Again, survival for fish exposed to the turbine was not significantly different from survival among control groups.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

In summary, experience to date suggests that fish may encounter the turbine in operation, but that the consequences of encounter would be expected to be low. However, given that data from prior experience relate to laboratory studies, different turbines, or different species than are known to be present in Admiralty Inlet, further field study of near-turbine interactions by marine mammals is warranted.

4.0 PLAN OBJECTIVES AND GOALS

The goal of the Near-Turbine Monitoring and Mitigation Plan is to confirm the environmental analyses, including effects on species listed under the Endangered Species Act (ESA) and/or species in the Washington State Priority Habitat and Species (PHS) List and, where possible, their designated critical habitat, and conduct any monitoring required for incidental take. The goal is also to mitigate for proposed effects, based on information gathered through this Plan. In implementing the plan, four hypotheses will be tested:

- *Hypothesis 1*: Strobe illumination may result in a species-specific startle response, avoidance response, or attraction.
- *Hypothesis 2*: The turbines may attract marine animals due to the area of refuge offered by the low-velocity wake.
- *Hypothesis 3*: Marine animals are unlikely to pass through the rotor or open center during turbine operation. Investigation of this hypothesis will test the assumption that although listed and other aquatic species may be shown near the turbine rotor, these aquatic species will not be struck by a moving turbine rotor.
- *Hypothesis 4*: The turbines may attract marine animals due to an artificial reef effect.
- *Hypothesis 5*: Fish may avoid the turbine due to its pressure field or sound (particle velocity or acoustic pressure).

Additionally, in conjunction with the Marine Mammal Monitoring and Mitigation Plan, the plan will also test the assumption that there will be no interaction between marine mammals and the moving turbine rotor beyond that specified in the Project Marine Mammal Protection Act authorization. This information will also inform, as needed, the development and implementation of adequate mitigation measures in consultation with the MARC.

To accomplish these goals, the District will:

1. Develop and test a system capable of identifying species composition and life stage in the direct vicinity of the turbine rotors and assessing the frequency with which targets pass through the turbine rotor;
2. Implement the tested system in conjunction with Project installation;
3. Examine potential for artificial lighting to affect behavior of fish;
4. Collect, manage, and analyze system data relevant to plan objectives;
5. Confer with the MARC to consider modification to this Plan and project operations in response to the collected and analyzed results; and
6. Use information collected by this system to inform, as needed, the development and implementation of adequate mitigation measures in consultation with the MARC and after NMFS' approval, including studies to assess artificial reef effects and avoidance behavior, and determine any necessary project modifications.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

5.0 POST-INSTALLATION MONITORING PLAN

Near-turbine monitoring studies will be conducted in sequence on a seasonal basis during the first year of operation. The appropriate sampling structure for each seasonal sequence will be iteratively developed (in consultation with the MARC) from the starting point described in this plan. In other words, as information is developed by the project, study methods and analysis techniques are likely to be refined. The seasonal study sequence will consist of:

- Presence/absence study (§5.2) to evaluate conditions (e.g., time of day, current velocity) for which species presence or absence is likely. A secondary objective of this study will be to determine the effectiveness of the camera system to identify species under different environmental conditions.
- Artificial lighting study (§5.3) to develop guidelines for strobe frequency, duration, and interval that allow for observation of interactions with the turbine rotor (aggregation, strike, passage) without altering marine animal behavior. This study will utilize an acoustic camera with a field of view similar to the optical camera.
- Turbine interaction study (§5.4) to evaluate the frequency and type of interactions between marine animals and the turbine rotor.

The results of each study will inform the next in the sequence. Given the time that will be required to process and interpret collected data, the timing of the plans described in this section may need to be modified, in consultation with the MARC, to avoid prematurely committing resources to studies of unknown effectiveness. For example, if lighting effects have not yet been established, then collecting and analyzing data about turbine interactions may not be advisable. Given the exploratory nature of these studies, closer coordination with the MARC is likely to be required in implementing this plan than other plans, where tools and analysis methodologies are well-established.

In addition to the three seasonal monitoring activities described above, the outline of a plan to study artificial reef behavior is presented in §5.5 and, similarly, avoidance behavior is presented in §5.6. The specific timing and approach to implement these portions of the plan will be strongly influenced by the information gained from preceding studies.

5.1 Imaging System Details

The imaging system that will be utilized for the implementation of this plan is a prototype developed by the Northwest National Marine Renewable Energy Center (NNMREC) on behalf of the District. No off-the-shelf systems were available with the required adaptability and research-grade customized underwater imaging systems are relatively common (Howland et al., 2006; Rosenkranz et al., 2008; Williams et al., 2010). The prototype system is shown in Figure 4. It consists of a pair of high-resolution (2 Mpx) machine vision cameras (AlliedVision Manta G-201) illuminated by a quartet of strobes (Excelitas MVS 5002). Power distribution and communications are routed through a main electronics bottle that steps shore power at 400 V DC down to 12 V DC for the cameras and strobes and converts fiber optic media to copper for the Gigabit Ethernet communications network. Bottle temperature/humidity and power control are monitored over an RS-232 subnet. The system also includes a number of biofouling mitigation

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

measures, including copper rings around the optical ports and mechanical wipers. The field of view (FOV) for each camera is 54^o x 42^o (horizontal x vertical).

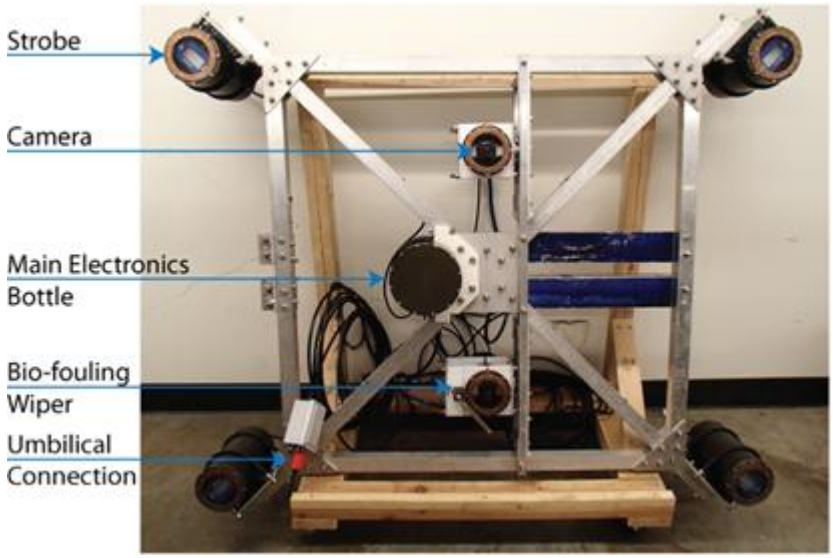


Figure 4 – Camera system assembly

In addition to the optical stereo cameras, an acoustic camera (BlueView P900-2250) will be incorporated in line with the optical cameras to study the effect of artificial illumination on marine animal behavior (not shown in Figure 4). The acoustic camera produces 2D imagery with a 45^o horizontal field of view and 20^o beam spread in the vertical. The optical camera, in contrast, produces 3D imagery and, through image rectification, the camera pair can provide absolute size, speed, and location of targets.

The field of view for the camera system when deployed on an OpenHydro turbine is shown in Figure 5. The degree of transparency in the fields of view is a qualitative description of system effectiveness. At close range (out to 3 m, least transparent), taxonomic classification will be most likely and target resolution will be highest. At increasing distance (out to 5 m and 7 m), resolution will decrease (same number of pixels over a greater area) and backscatter from naturally occurring flocculent (i.e., biological "snow") will decrease contrast. These factors will reduce the ability of the camera system to detect targets and capture images suitable for taxonomic classification at these distances.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

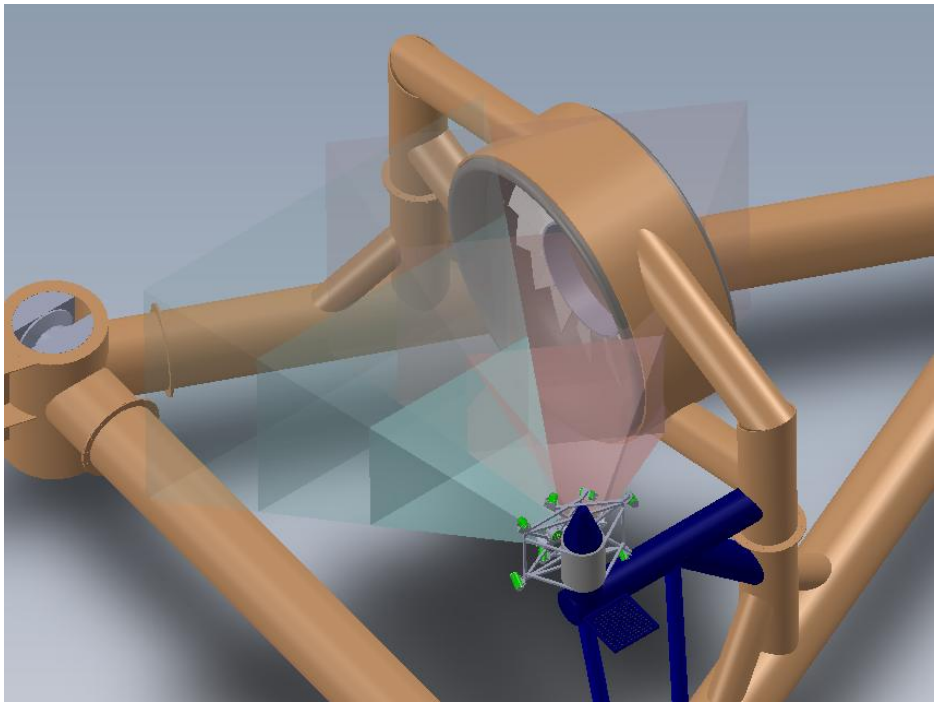


Figure 5 – Optical camera system field of view on the OpenHydro turbines for two configurations: directed across the rotor (green prism) and directed at the rotor (red prism).

It is likely that at least 150 pixels per target will be required for accurate taxonomic classification. This resolution will be possible for large targets (e.g., adult salmonids) at maximum distance and for small targets (e.g., herring) within a few meters of the camera system. Even given high resolution and lighting, some species will be difficult to distinguish. For example, depending on life stage, it can be difficult to accurately identify species of rockfish when they are in hand. Coloring and patterns may provide useful information for taxonomic classification, but length may also be a useful predictor. Determining the length of targets is possible using stereo imaging techniques, but will initially require manual identification and processing of targets and will only be carried out for cases where the additional information is likely to significantly improve taxonomic classification.

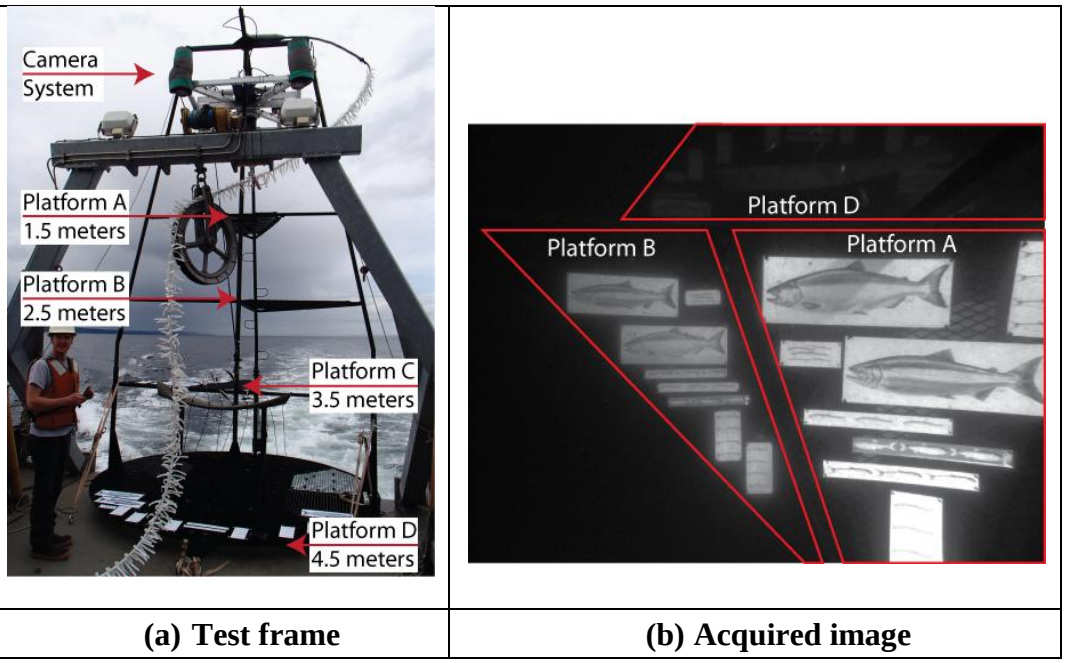
Due to a lack of ambient light, artificial illumination is required for these observations. Infrared or far-red illumination (Widder, 2005; Raymond and Widder, 2007) were considered to reduce behavioral effects. However, the rapid attenuation of red light in water makes observations at distances greater than 1-2 m difficult, even for high intensity red light. §5.3 describes seasonal studies to establish thresholds for full-spectrum strobe illumination that can inform proper use of the camera system for presence/absence, rotor interaction, and artificial reef studies. The camera-light separation shown in Figure 5 is 1 m. This was chosen to balance improvements in effective range associated with greater camera-light separation (Jaffe, 1988) against maintaining a reasonable footprint for the system.

The successful implementation of this plan is dependent upon being able to adapt instrumentation as new information about near-turbine interaction is discovered. In addition, even with biofouling mitigation measures, optical ports are unlikely to remain clear for periods

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

longer than 3-6 months. Consequently, the imaging system will be incorporated into the Adaptable Monitoring Package (AMP) described in the Monitoring Plan Summary (grey frame in Figure 1 and Figure 5). With a maintenance cycle of 3-6 months, this will provide a logical checkpoint for discussions with MARC to modify camera orientation on a seasonal basis.

The camera system has been progressing through a development cycle since mid-2011. Field trials conducted in Puget Sound in April using printed targets attached to a rigid target frame indicate that an effective range of greater than 5 m is possible, as shown in Figure 6.



(a) Test frame | **(b) Acquired image**

Figure 6 – Camera system field testing

In July, 2012, the system will undergo trials in Admiralty Inlet to further investigate the system range and assess the accuracy of stereo measurements. During this test, the acoustic camera will also be deployed for opportunistic studies of the effects of strobe illumination of marine life. Following these tests, a long-term (3-6 month) endurance test from a dock in Sequim Bay is planned.

Each turbine would be equipped with an imaging system for the proposed project. As described in the Monitoring Plan Summary, cameras cannot be deployed to both sides of the rotor, as this would interfere with turbine recovery operations, but by deploying one turbine frame 180^{o} rotated relative to the other, "upstream" and "downstream" observations will be possible on ebb and flood (albeit not for the same turbine).

5.2 Presence and Absence of Marine Animals

5.2.1 Objective

Observations of the OpenHydro turbine at EMEC have shown that fish (specifically, pollock) aggregate in the turbine wake during low-velocity conditions because this offers an energetically preferable area of refuge. As water velocity increases, fish are observed to leave the area.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

The objective of this study is to determine the likely conditions for presence and absence of marine animals at close range (i.e., within the camera system field of view) of the turbine rotor. In other words, under what conditions are specific marine animals likely to be present or absent? The sub-objectives are:

- Determine if the ability of the camera system to make species identification of marine animals is dependent upon environmental conditions.
- Evaluate the extent to which marine animal presence/absence is dependent upon environmental conditions.
- Evaluate the extent to which marine animal density is dependent upon environmental conditions.

An additional objective of this study is to inform a decision whether, based on the information gathered by the study, project operations should be modified to ensure resource protection.

5.2.2 Data Collection

Equipment Description

The primary systems to be used in this test are the optical cameras described in §5.1. Current velocity will be monitored using Doppler profilers on the subsea base. The cameras will be oriented towards the turbine rotor, for subsequent studies of interactions between marine animals and the turbine rotor (§5.4).

Survey Procedure

During a survey, individual stereo camera frames will be captured by the optical camera system at a rate of one frame every 15 minutes. At this lighting interval and duration, the effect of the strobe should not confound observations (i.e., absence in a captured frame would not be correlated with avoidance of the strobe flash from the prior frame, particularly at moderate current velocities). For example, O'Driscoll et al. (2012) used a long duration light for observations and determined, based on active sonar observations, that behavior returned to normal within 30 minutes. The time for resumption of normal behavioral following strobe illumination will be verified by the testing described in §5.3 and, if necessary, strobe intervals could be increased to reduce the potential for bias. Similarly, if the time for resumption of normal behavior is determined to be less than 15 minutes, observations could be made at a higher duty cycle to increase statistical power.

Surveys will be conducted four times during the first year to address seasonal variations. Of these four surveys, two will be chosen to coincide with likely presence of migratory species. Survey duration will be fifteen days to encompass a complete neap-spring cycle and, therefore, the full range of hub-height currents. At a sample rate of one frame every fifteen minutes captured by the camera systems on each turbine, this will produce 2880 images for review and analysis for each seasonal survey.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

5.2.3 Data Analysis

Captured frames will be classified by:

- Time of day (6 hour blocks) (4 bins)
- Mean hub-height current velocity (0 to 3.5 m/s in 0.5 m/s increments) (6 bins) – as measured by a five minute average of Doppler measurements centered on the time of image acquisition.
- Current direction (ebb or flood) (2 bins) – as measured by a five minute average of Doppler measurements center on the time of image acquisition.
- Turbine being observed (2 bins)
- Season (1 bin – repeated applications of this methodology will enable comparison between seasons and years)

This yields 96 possible case combinations. If uniformly distributed, there would be approximately 30 images for each of these combinations. In practice, some combinations, particularly observations during the strongest currents, will have fewer samples since these conditions occur less frequently.

All frames will be initially screened to identify potential fish targets. Those with possible targets will be passed on to expert review to qualitatively rank the identification capability of the camera system. Expert input to the development of this plan suggests that species-level identification may be *very* challenging, even for high-resolution optical images. Multiple experts, with progressive levels of expertise, will be used to achieve the lowest level of taxonomic classification possible. Since the length of a target may be a discriminator, determination of target length using stereo imaging may be required. It may also be helpful to describe distance of target from camera. Evaluating either of these parameters will, initially, require manual processing of stereo image pairs and will only be undertaken for images in which this additional information would be useful. Each frame will be assigned a qualitative ranking:

- *Rank 1*: Species classification of at least 75% of targets (species noted, with qualitative certainty probability – low, med, high).
- *Rank 2*: Genus classification of at least 75% of targets (genus noted, with qualitative certainty probability).
- *Rank 3*: Family classification of at least 75% of targets (family noted, with qualitative certainty probability).
- *Rank 4*: Unable to differentiate aquatic species from debris for at least 75% targets.
- *Rank 5*: Insufficient image quality to detect targets.

The number of targets in the field of view will also be qualitatively ranked:

- *Rank 1*: High animal density (>50 animals in FOV)
- *Rank 2*: Moderate animal density (10 - 50 in FOV)
- *Rank 3*: Low animal density (1 - 10 in FOV)
- *Rank 4*: No animals present in FOV

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Animal density and classification potential for each of the 96 case combinations described previously will be evaluated. Results will be interpreted by taxonomic groups. The highest level groups will be:

- Resident fish – fish with small home ranges relative to the scale of the project (e.g., rockfish)
- Migratory fish – fish with large home ranges relative to the scale of the project (e.g., ratfish, salmon)
- Marine mammals
- Diving seabirds

Each of these groups will be further sub-divided into listed and unlisted species, as possible based on expert identification.

Analysis will be undertaken to identify conditions (e.g., time of day, current velocity) that are likely to result in biologically significant presence of a species group near the turbine. For a listed resident fish, this might be an individual, while for the most common species, this might be a large school. Similarly, conditions that are likely to result in no members of a species group near the turbine will also be identified. In combination, these factors will be used to establish an order of magnitude estimate for the frequency of occurrence (probability of encounter) of species groups. This will serve to inform resource protection measures, as well as structure illumination (§5.3), close range interaction (§5.4), and artificial reef (§5.5) studies.

Finally, in consultation with the MARC, results from the initial study will be used to determine a minimum statistically valid sampling rate for further studies of taxonomic groups (e.g., listed resident fish) using potential power analysis, including an evaluation of how much data review will be required to evaluate interactions with potentially rare, but important, taxonomic groups.

5.2.4 Reporting and Adaptive Management

A preliminary, oral report will be made to the MARC within 15 days of study initiation to provide informal feedback on observations. Interim written and oral reports will be made to the MARC within 90 days of each survey completion. A final report will be made to the MARC within 120 days of the first year of operation, summarizing presence/absence trends.

Based on reported results, the MARC will determine an appropriate sampling and analysis approach for remainder of project to ensure resource protection.

While some species may not be observed near the turbine, if *no* species of fish are detected near the turbine (i.e., common species such as ratfish or dogfish) then it is likely that the turbine is causing avoidance (provided that avoidance from the strobes can be eliminated as a plausible hypothesis by the study described in §5.3). This result would suggest a need to understand the range over which avoidance is occurring, rather than proceeding to studies of rotor interactions. In conjunction with the MARC and with NMFS approval, as provided in section 6.0, this information will be used to inform project modifications, where necessary, to provide mitigation and resource protection.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

5.3 Optimized Strobe Illumination

5.3.1 Objective

Artificial illumination is necessary for optical image capture at the depth of the project. Pre-installation monitoring of light levels using a photosynthetically active radiation (PAR) sensor at hub height for a 90 day period confirmed light levels are likely below camera sensitivity. Additionally, in order to "freeze" motion and produce a crisp image of objects moving at velocities on the order of several meters per second an exposure time of 2-50 µs is recommended (Gallager et al., 2004). This cannot be achieved with a mechanical shutter, but is within the capabilities of machine vision strobes in dark environments (i.e., strobe acts as a virtual shutter). However, the use of strobe illumination may affect behavior of marine animals in a manner that depends upon a number of factors including strobe rate and duration of illumination, organism or fish species and life stage, and hydrodynamic conditions.

Fish behavior in response to strobe lights may be complex; based on studies at dams on the Columbia River (Johnson et al. 2003, Johnson et al. 2005, Simmons et al. 2006), there was a wide range of attraction and avoidance behaviors that varied with time of day and species. Johnson et al. (2005) also found some complexity in the reaction to the strobe light; fish appeared to be attracted to the strobe lights from further distances, yet tended to stay >10 m from the strobe lights (a close-range avoidance response). Lab experiments showed that Chinook salmon tended to avoid strobe lights even after an hour of exposure, on average moving about 7.3 m away from the light source (Richards et al. 2007). However, the aforementioned studies were conducted in freshwater and may not necessarily be applicable to marine settings. Marine fish behavior in response to lighting appears to be similarly complex, with great variation among different species and life stages, from avoidance to attraction, or no reaction to lights (Marchesan et al. 2005, Stoner et al. 2008, Ryer et al. 2009).

The objective of this study is to establish species- and season-specific thresholds for fish responsiveness to the strobes (duration and strobe frequency) that will inform appropriate use of the camera system for studies of presence/absence (§5.2), interaction with the moving rotor (§5.4), and artificial reef effects (§5.5). In other words, this study will develop operating guidelines for the strobes that minimize behavioral changes associated with its operation. It is unlikely that these thresholds will be absolute and close consultation with the MARC will be required to develop these guidelines.

5.3.2 Data Collection

Equipment Description

The primary systems to be used in this test are the optical and acoustic cameras described in §5.1. The cameras will be oriented towards the turbine rotor, for subsequent studies of interactions between marine animals and the turbine rotor (§5.4). Current velocity will be monitored using Doppler profilers on the subsea base.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Survey Procedure

During the first year of turbine operation, the illumination study described here will be conducted four times in order to establish seasonal variation in strobe responsiveness. This is necessary because ambient lighting levels and species presence are also expected to vary with season. Illumination studies would follow presence/absence studies (§5.2) and would precede seasonal observations of interactions with the turbine rotor (§5.4). Each seasonal illumination period would occur within a two week period, in order to obtain information about lighting effects over a range of hub-height current velocities.

Rotor interaction studies (§5.4) could involve image capture with a strobe rates up to 10 Hz and durations of up to 60 seconds. Longer duration observations are technically possible, but with stereo camera data rates > 100 MB/s at 10 Hz, data archiving and processing for longer duration observations is not likely to be initially feasible. Three aspects of the lighting duty cycle are controllable: strobe frequency (up to 10 Hz), duration of lighting (up to 60 seconds, as explained above), and the time between successive lighting periods. Because it will be time-intensive to collect and post-process data for illumination studies (manual triggering and review of stereo camera and acoustic camera imagery), these will be undertaken for a limited subset of possible strobe configurations. The list of configurations may be refined in consultation with the MARC, but will likely include:

- *Configuration 1*: Single frame by the optical camera system and strobes. This corresponds to the proposed configuration for presence/absence studies.

The next three configurations correspond to potential configurations for rotor interaction studies.

- *Configuration 2*: 10 Hz strobe frequency for 10 seconds.
- *Configuration 3*: 10 Hz strobe frequency for 30 seconds.
- *Configuration 4*: 10 Hz strobe frequency for 60 seconds.

The number of data sets captured for each case will be determined in consultation with the MARC, but will likely be on the order of 5-10.

Each strobe configuration will be tested for a similar set of stratifying covariates as is determined to be appropriate for the presence/absence study (§5.2). However, because the primary concern for close-range interaction is rotor strike, illumination effects will only be studied for velocities greater than 1 m/s. In each test, acoustic camera imagery will collected continuously for 5 minutes prior to strobe activation and 15 minutes after deactivation to enable a before and after comparison without lighting stimulus. Information from the acoustic camera will serve to detect strong startle responses, avoidance responses, and the "cool down" time required for behavior to return to normal once the strobe is "off". If normal behavior does not resume within 15 minutes for a particular environmental condition (e.g., quiescent water), the observation window will be sequentially increased until the time constant for resumption of normal behavior is identified.

Data collection will be manually triggered by an operator when targets are within the acoustic camera's field of view. The timing of observations will be informed by conditions when marine animal presence is likely, based on preliminary results from §5.2, and structured to provide

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

observations over a range of current velocities. No more than 30 hours of observer time will be devoted to collecting these data during a single seasonal study. If species presence is determined to be very sparse from the results of §5.2, to the extent that very few observations are anticipated with 30 hours of observer time, the MARC will be convened to develop an alternative study methodology.

5.3.3 Data Analysis

The optical and acoustic camera imagery will be analyzed to evaluate attraction and avoidance in response to strobe illumination. Because the field of view for the acoustic camera is somewhat smaller than the optical camera, the optical camera field of view will be truncated in post-processing such that viewed area is equivalent for the two types of cameras. The range of the acoustic camera is, however, greater than the optical camera (10+ m versus 5+ m). To the extent possible, the species of fish present in the field of view will be noted, using the same progressive, expert review approach outlined in §5.2. Given the limited number of data sets that are likely feasible to collect for this type of study, the taxonomic groups outlined in § 5.2 may need to be aggregated to achieve sufficient statistical power to detect change.

Qualitative Analysis of Avoidance: A startle response would be indicated by fish leaving the area observed by the acoustic camera when the strobe is turned "on". Avoidance would be indicated by sustained absence of fish within the field of view while the strobe is "on".

The acoustic camera imagery would be evaluated before, during and after the optical camera imagery is collected to evaluate the time after the strobe is turned "off" for fish to resume pre-strobe behavior within the camera field of view. While this will likely be a subjective judgment initially, it will provide guidance for evaluating the minimum cool down time (i.e., illumination interval) to avoid affecting species behavior during different conditions. For example, it is likely that illumination intervals could be shorter during periods of strong currents since fish would be unlikely to hold position near the turbine for extended periods of time.

A combination of responses (similar to those described by other researchers, as noted above) may also be indicated. For instance, fish could come into the field of the acoustic camera during the lighted period, staying out of range of the optical camera, but subsequently come into range of the optical camera once the lighted period has ended. This, more subtle, avoidance could be evaluated in follow-on studies by evaluating fish density at specific ranges to the camera systems, but is not a focus of initial studies.

Quantitative Analysis of Attraction: For the optical camera imagery, the observers will estimate the maximum number of fish for a given species (to the extent possible) within the field of view as a function of time (*Max N*, a commonly used metric, e.g., Merritt et al. 2011; Cappo et al. 2004; Cappo et al. 2007; Harvey et al. 2007) and note observed behavior. If attraction occurs, the number of fish observed over the time period that the strobe is "on" should increase. Similarly to avoidance/startle analysis, the time required for the number of fish to return to pre-strobe levels will serve to bound the possible illumination interval.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

5.3.4 Reporting and Adaptive Management

A preliminary oral report will be made to MARC within 15 days of study initiation to provide informal feedback on the effect of the camera. Interim oral and written reports will be provided to the MARC within 90 days of each seasonal survey completion.

Results of the study will inform the operation of the camera system for sequential studies (e.g., interaction with the turbine rotor). If particularly strong avoidance or attraction is observed for some combinations of conditions (e.g., time of day, current velocity), regardless of strobe configuration, alternative approaches to studying marine animal interaction with the turbine rotor may be required.

If species presence is determined to be very sparse from the results of §5.2, to the extent that very few observations are anticipated with 30 hours of observer time, the MARC will be convened to develop an alternative study methodology to establish strobe illumination thresholds.

5.4 Interaction with the Turbine Rotor

5.4.1 Objective

Optical camera observations of the OpenHydro turbine at EMEC have not shown aquatic species (fish or marine mammals) to pass through the rotor or open center during turbine operation. Passage through the turbine during operation poses a risk of blade strike. Active acoustic observations of the Ocean Renewable Power Company turbine in Eastport, Maine indicate that smaller fish may swim through the turbine during all operating states. The differences between these observations may be associated with the species involved or type of device. Certainly, concern over potential injury or mortality associated with blade strike represents a critical uncertainty associated with potential environmental impacts of tidal energy development.

The objective of this study is to characterize how marine animals interact with the turbine rotor, and to inform a decision whether, based on the information gathered by the study, project operations should be modified to ensure resource protection. This study will occur seasonally after the strobe illumination study (§5.3) and the presence/absence study (§5.2).

5.4.2 Data Collection

Equipment Description

The primary systems to be used in this test are the optical cameras described in §5.1. Current velocity will be monitored using Doppler profilers on the subsea base. The cameras will be oriented towards the turbine rotor to maximize the portion of the turbine within the field of view.

Survey Procedure

Studies of interactions with the turbine rotor will require high frame rates (i.e., up to 10 Hz) for moderate durations (up to 60 s). The maximum possible frame rate and duration found to not likely cause a significant behavioral disturbance (§5.3) will be utilized. The camera system will

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

operate on a randomized duty-cycle to avoid "training" fish with the strobe (pers. comm., Kurt Fresh, NWFSC). Observations will target conditions during which species of particular interest (i.e., listed species) or large aggregations are likely to be present at close range to the turbine rotor, based on preliminary results from the presence/absence study (§5.2). The number of instances for which images are captured will be determined, in consultation with the MARC, based on the results of the power analysis (§5.2) and the feasibility of data archiving and review. During the first year of operation, studies will be conducted seasonally within a two week window on the same schedule as presence/absence studies. In addition to limiting the volume of data collected to that which is feasible for analysis, this will result in relatively long (e.g., fortnightly) periods in which the strobe will not be activated. "Dark" periods of this duration are recommended to avoid training of fish and marine mammals (pers. comm., Kurt Fresh, NWFSC).

5.4.3 Data Analysis

Observations will be stratified based on the results of the identified factors influencing presence/absence (§5.2). As for the strobe illumination study, only velocities exceeding 1 m/s will be studied as interactions with a stationary or slowly rotating turbine are of lesser interest (strobe illumination would also be expected to have a greater effect on behavior during quiescent periods). Identification of taxonomic groupings for marine animals involved in rotor interactions will utilize a similar progressive, expert review.

The qualitative strike/collision risk will be assessed for each observation as:

- *Rank 1*: Targets observed passing through the turbine blades. Number of targets also noted. Unless the number of targets in the field of view is very high, with targets in the near-field masking those closer to the rotor, it should be possible to determine if passage has occurred.
- *Rank 2*: Targets observed passing through the open center of the turbine. Number of targets also noted.
- *Rank 3*: Targets observed in field of view, but not passing through turbine rotor
- *Rank 4*: No targets observed in the field of view

5.4.4 Reporting and Adaptive Management

A preliminary, oral report will be made to the MARC within 15 days of study initiation to provide informal feedback on observations. An interim oral and written report will be provided to the MARC within 90 days of each seasonal study. Based on report results and analytical effort, the MARC will determine an appropriate sampling and analysis approach for remainder of project to ensure resource protection, and will determine whether project modifications are necessary.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

5.5 Artificial Reef Effect

5.5.1 Objective

It is likely that the turbine support structure will act as an artificial reef and attract fish that associate with complex habitat. This may have positive or negative effects, depending on the attracted species.

The objective of this study is to characterize how marine animals are using the turbine support structure over all stages of the tide, and to ensure resource protection based on the results of the study. This will be correlated with information about the colonization of the subsea base and turbine support structure collected by the Benthic Habitat Monitoring and Mitigation Plan.

Since reef effects are a lower priority than strike/collision, this study will be conducted after the seasonal presence/absence, artificial illumination, and rotor interaction studies planned for the first year of operation.

5.5.2 Data Collection

Equipment Description

The primary systems to be used in this test are the optical and acoustic cameras described in §5.1. Current velocity will be monitored using Doppler profilers on the subsea base. The cameras will be oriented towards the support frame (upright section, including junction with subsea base). Because maintenance cycles to recover, clean, and reconfigure the camera system will occur three times each year, this study will not begin until at least the second year of project operation (i.e., seasonal rotor interaction studies require that the camera system be oriented towards the turbine rotor). Consequently, this study plan is less defined than the preceding plans, as its implementation will depend upon the lessons learned from preceding studies and any further rotor interaction monitoring determined to be necessary by the MARC. For example, depending upon results from the first year of operation, the camera on one turbine foundation might be re-tasked for an artificial reef study, while the other remains oriented at the turbine rotor to assess annual trends in presence/absence.

Survey Procedure

The general survey structure will mirror that of the presence/absence study described previously. Depending on the effect of strobe illumination during weak currents, a subset of observations could be complimented by acoustic camera imagery (e.g., 30 seconds observation prior to single frame capture by the strobes). This would enable behavioral observations using the acoustic cameras and species identification using optical camera imagery during periods of weak currents. The duration and intensity of the study will be determined, in consultation with the MARC, based on the results of the other studies described in this plan.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

5.5.3 Data Analysis

Data analysis will also mirror that of the previously described presence/absence study. Approaches to data analysis will be developed in consultation with the MARC based on the effectiveness of the preceding studies during the first year of operation.

5.5.4 Reporting and Adaptive Management

Reporting and adaptive management triggers for artificial reef studies will be developed in consultation with the MARC.

5.6 Turbine Avoidance

5.6.1 Objective

In addition to direct interaction and attraction/aggregation, fish may avoid the turbines. This could occur at relatively close range (within a few rotor diameters) as they detect hydrodynamic pressure changes upstream of the turbine on their lateral line system. Detection of acoustic particle velocity may be possible for some fish species at similar distances by the same biological mechanism. At greater distances, up to several hundred meters, fish may exhibit avoidance behavior in response to acoustic pressure (i.e., turbine sound), though fish behavioral responses to sound are not well understood (Hawkins and Popper, 2012). Avoidance at close range, if preventing strike or collision, could be beneficial. However, avoidance at greater range would be undesirable, since a large array could create a barrier to migratory species.

Since avoidance of the pilot-scale turbines is a lower priority than strike/collision, this study will be conducted after the seasonal presence/absence, artificial illumination, and rotor interaction studies planned for the first year of operation.

5.6.2 Data Collection

The effective range of the optical camera system is expected to be no greater than 7 m for target detection and will be more limited for taxonomic identification. Consequently, the optical cameras may be effective at studying fish avoidance to the turbines caused by hydrodynamic pressure or acoustic particle velocity, as these would be expected no more than 1-2 diameters upstream of the turbine rotor (i.e., 6-12 m). Studies of avoidance at greater distances in response to sound (e.g., 100 meters) would likely require active sonar (split beam or multi beam). Sonars operating at 900 kHz, for example, would be suitable for this application. However, sonar side bands may be audible to mid- and high-frequency cetaceans in the project area and the operation of such sonars would require study plans to be developed in consultation with resource agencies to avoid unacceptable incidental harassment of marine mammals.

For an avoidance study, the Adaptable Monitoring Package would be oriented away from the turbine rotor to detect targets upstream of the turbine. The acoustic camera (BlueView P900-2250) has a 900 kHz setting and could be used for investigation of avoidance behavior. If a higher resolution scientific echosounder is required (e.g., Simrad EK 60), a sonar of this type could be readily integrated into the Adaptable Monitoring Package given power and

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

communications capabilities (pers. comm. John Horne, University of Washington). Current velocity upstream of the turbine would be monitored by the outward looking Doppler profilers.

Duty cycles and operating states for optical cameras and sonars will be developed in consultation with the MARC based on the results from first year of observations for presence/absence, strobe effect, and turbine interaction studies as well as information about fish avoidance of turbines developed by other tidal energy demonstration projects.

5.6.3 Data Analysis

Approaches to data analysis and interpretation will be developed in consultation with the MARC. For example, to evaluate close-range avoidance, one option could be to operate the cameras in the same manner as the presence/absence studies (§5.2) and determine if there are statistically significant differences in presence/absence under given tidal, diel, and seasonal conditions for observations 1-2 diameters upstream of the turbine, compared to close-in to the turbine rotor. If presence is more likely upstream of the turbine under equivalent conditions, this could suggest avoidance. The use of an active sonar to evaluate avoidance behavior at greater distances would require that metrics be developed, in consultation with the MARC, to describe behavioral changes and estimate species composition of acoustic targets.

5.6.4 Reporting and Adaptive Management

Reporting and adaptive management triggers for avoidance studies will be developed in consultation with the MARC.

6.0 APPROACH TO ADAPTIVE MANAGEMENT AND MITIGATION

In implementing this plan, the District will consult with the MARC as appropriate on the technical issues described above and data interpretation associated with the monitoring. Such consultation will include consideration of results from the monitoring system test plan, subsequent adjustments to monitoring methods and, as needed, the development and implementation of adequate mitigation measures to avoid adverse impacts to aquatic resources. In particular, the District will adopt the triggers and subsequent actions described below.

The District will follow the procedures described in the Adaptive Management Framework when conferring with the MARC on implementation of the Acoustic Monitoring and Mitigation Plan and considering how to address the results of the monitoring.

Adaptive Management Trigger 1: If monitoring suggests injury or mortality to any ESA-listed species beyond that specified in the Project's Take Authorization, the turbine brake will be applied and the Project shut down. The District will notify the MARC within one week and coordinate with the MARC to determine if modifications to the Plan or project operations are necessary and if Project operations can be restarted.

Adaptive Management Trigger 2: If monitoring shows any aquatic species passing through the turbine rotor (within the limits specified in the Project's Take Authorization), the District will notify the MARC within two weeks and coordinate with the MARC to determine if modifications to the Plan or project operations are necessary.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Adaptive Management Trigger 3: If monitoring detects any marine mammals in the camera field of view, the District will notify the MARC within two weeks and coordinate with the MARC to determine if modifications to this Plan, the Marine Mammal Monitoring and Mitigation Plan, or project operations are necessary.

Adaptive Management Trigger 4: If monitoring detects any diving seabirds in the camera field of view, the District will notify the MARC within two weeks and coordinate with the MARC to determine if modifications to the Plan or project operations are necessary.

Adaptive Management Trigger 5: In the event of a monitoring system outage, the significance and immediacy of repair will depend on when the outage occurs within the life of the project and the information about environmental interactions that has been gathered to that time. The significance of an outage at an early stage of the project will also depend on whether endangered species, such as Southern Resident killer whales, are likely to be present in the project area during the outage[1]. As an example, if a monitoring system became inoperative within the first week of the turbine deployment and Southern Residents were frequently in the project area, this would be much more significant in terms of ensuring marine resource protection than if such an outage were to occur after four years of operation and monitoring. If the near-turbine monitoring package becomes inoperative, the default response of the District will be to mobilize a spare package and conduct an unscheduled maintenance intervention, changing out the inoperative package. The entire monitoring package (near-turbine monitoring, passive acoustic monitoring, etc.) is designed to be recovered to the surface, serviced, and reconnected to turbine power and data systems, as described in the Project Safeguard Plan. The District will change out the monitoring package as quickly as possible and appropriate, depending on the factors such as when the outage occurs, the availability of a vessel, and ocean conditions. Given the broad availability of vessels in Puget Sound that could support this type operation and the required met-ocean condition window, an unscheduled maintenance intervention would likely be completed within one week of the outage being detected[2]. Simultaneously, the District will notify the MARC of the outage and unscheduled maintenance intervention. In the unlikely event that the fault is determined to be on the shore side of the wet-mate connection (i.e., not a fault in the recoverable monitoring package, but a component of the system between the wet-mate and

[1] As an example, if the monitoring systems on one turbine was to become inoperative within the first week of the turbine deployment and Southern Residents were frequently in the project area, this would be much more significant in terms of ensuring marine resource protection than if such an outage were to occur after four years of operation and monitoring. As part of this example, if the outage occurs during a significant time, the District will conduct the repair as soon as possible, within the constraints of ocean conditions. As described in the project Safeguard Plan, marine resource protection can be ensured with a single, functional monitoring package. In this specific example (an outage of one monitoring package, including near-turbine and passive acoustic systems during a period of Southern Resident killer whale activity in Admiralty Inlet), the passive acoustic package on the other turbine would continue to provide coverage of the entire project area and rapid-response shoreline observers would be unaffected. The likelihood of the monitoring packages on both turbines simultaneously failing is extremely low, particularly in the early stages of the project, since both turbines will be deployed with the monitoring packages connected.

[2] The initial specifications for the AMP is for operations to be completed within a met-ocean window of 30 minutes with the currents fully set in one direction throughout the water column, a mean velocity less than 0.7 m/s, and a Sea State less than 3 on the Beaufort Scale. Based on analysis of current data collected within the project area, there is a 75% chance of at least one maintenance window occurring within 7 days of a fault notification and a 90% chance of at least one maintenance window occurring within 14 days of a fault notification.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

shore station), then the affected turbine may need to be recovered to the surface to conduct repairs, as described in the Project Safeguard Plan. The decision as to whether immediate recovery of the turbine is necessary will depend on many factors, including the status of the instrumentation package on the other turbine, stage in the project, presence/absence of species of concern, and information collected to date about environmental interactions. In the interim, the District may continue to operate the turbines unless NMFS requests that turbine operations cease. If immediate recovery is necessary, it will be accomplished as soon as vessel mobilization and met-ocean conditions allow.

By June 30 of each year, the District will develop and file an annual report to FERC fully describing its implementation of the plan during the previous calendar year and a list of the proposed activities during the current calendar year. The MARC will have at least 30 days to review and comment on a draft report prior to the District finalizing and filing the report with FERC. The annual report will provide the following:

- A summary of the monitoring results.
- A summary of any issues or concerns identified by members of the MARC during the year regarding implementation of the plan.
- A list of any changes to the Plan or project proposed by consensus of the MARC during the year.
- A list of plan activities planned for the current year.

7.0 REFERENCES

Cappo M., P. Speare, G. De'ath (2004) Comparison of baited remote underwater video stations (BRUVS) and prawn (shrimp) trawls for assessments of fish biodiversity in inter-reefal areas of the Great Barrier Reef Marine Park, *J. Exp. Mar. Biol. Ecol.*, 302:123-152.

Cappo M., G. De'ath, P. Speare (2007) Inter-reef vertebrate communities of the Great Barrier Marine Park determined by baited remote underwater video stations, *Mar. Ecol. Prog. Ser.*, 350:209-221.

Dawson, J. and B. McClure (2010) Snohomish County PUD No. 1 – Admiralty Inlet Pilot Tidal Energy Project Mobile Hydroacoustic Surveys. BioSonics, Inc.

Gallager, S.M., H. Singh, S. Tiwari, J. Howloand, P. Rago, and W. Overholtz (2004) High resolution underwater imaging and image processing for identifying essential fish habitat, *In* D.A. Somerton and C.T. Glendhill (eds.) Report of the National Marine Fisheries Service Workshop on Underwater Video Analysis, August 4-6, 2004, NOAA Technical Memorandum NMFS-F/SPO-68.

Hawkins, A.D. and A.N. Popper (2012) Effects of Noise on Fish, Fisheries, and Invertebrates in the U.S. Atlantic and Arctic from Energy Industry Sound-Generating Activities, Literature synthesis prepared for the Bureau of Ocean Energy Management (BOEM), http://www.boemsoundworkshop.com/documents/Literature_Synthesis_Effects_of_Noise_on_Fish_Fisheries_and_Invertebrates.pdf

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Harvey E.S., M. Cappo, J.J. Butler, N. Hall, G.A. Kendrick (2007) Bait attraction affects the performance of remote underwater video stations in assessment of demerasal fish community structure, *Mar. Ecol. Prog.Ser.*, 350:245-254.

Howland, J., Gallager, S., Singh, H., Girard, A., Abrams, L., Griber, C., Taylor, R., and Vine, N (2006) Development of a towed survey system for development by the fishing industry, *Proceedings of Oceans 2006*, September 18-21.

Jaffe, J. (1988) Underwater optical imaging: the design of optimal systems, *Oceanography*, 11(1):40-41.

Johnson R.L., C.A. McKinstry, C.S. Simmons, R. LeCaire, M.A. Simmons, C.B. Cook, S.L. Thorsten, S. Francis (2003) Chief Joseph Kokanee Enhancement Project; Strobe light deterrent efficacy test and fish behavior determination at Grand Coulee Dam third powerplant forebay. Prepared for the Bonneville Power Administration, US Department of Energy, Contract DE-AC06-76RL01830.

Johnson R.L., C.A. McKinstry, C.B. Cook, D.K. Tano, D.M. Faber, S. Francis, M.A. Simmons, C.S. Simmons, R.S. Brown, S.L. Thorsten, R. LeCaire (2005) Chief Joseph Kokanee Enhancement Project; Strobe light deterrent efficacy test and fish behavior determination at Grand Coulee Dam third powerplant forebay. Prepared for the Bonneville Power Administration, US Department of Energy, Contract DE-AC05-76RL01830.

Marchesan M., M. Spoto, L. Verinella, E.A. Ferrero (2005) Behavioural effects of artificial light on fish species of commercial interest, *Fish. Res.*, 73:171-185.

Merritt D., M.K. Donovan, C. Kelley, L. Waterhouse, M. Parke, K. Wong, J.C. Drazen (2011) BotCam: a baited camera system for nonextractive monitoring of bottomfish species, *Fish. Bull.*, 109:56-67.

Normandeau Associates (2009) An estimation of survival and injury of fish passed through the Hydro Green Energy hydrokinetic system, and a characterization of fish entrainment potential at the Mississippi Lock and Dam No. 2 hydroelectric project (FERC No. 4306), Hastings, MN, Final Report. Prepared for Hydro Green Energy, LLC. December 2009.

O'Driscoll, R.L., P. de Joux, R. Nelson, G.J. Macaulay, A.J. Dunford, P.M. Marriott, C. Stewart, and B.S. Miller (2012) Species identification in seamount fish aggregations using moored underwater video, *ICES Journal of Marine Science*, 69: 648-659.

Polagye, B., B. Van Cleve, A. Copping, and K. Kirkendall (eds.) (2011) Environmental effects of tidal energy development: Proceedings of a scientific workshop, March 22-25, 2010. *NOAA Technical Memorandum* NMFS F/SPO-116.

Raymond, E.H. and Widder, E.A. (2007) Behavioral responses of two deep-sea fish species to red, far-red, and white light, *Marine Ecology Progress Series*, 350:291-298.

Richards, N.S., S.R. Chipps, and M.L. Brown (2007) *North American Journal of Fisheries Management*, 27: 1310-1315, DOI: 10.1577/M06-239.1

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Rosenkranz, G., Gallager, S., Shepard, R., and Blakeslee, M. (2008) Development of a high-speed, megapixel benthic imaging system for coastal fisheries research in Alaska, *Fish. Res.*, 92:340-344.

Ryer, C.H., A.W. Stoner, P. J. Iseri, and M.L. Spencer (2009) *Mar. Ecol. Prog. Ser.*, 391: 97-106, DOI: 10.3354/meps08168.

Simmons, M., R. Johnson, C. McKinstry, C. Simmons, C. Cook, S. Thorsten, B. Nine, R. LeCaire, S. Francis (2006) Chief Joseph Kokanee Enhancement Project; Strobe Light Deterrent Efficacy Test and Fish Behavior Determination at Grand Coulee Dam Third Powerplant Forebay, 2005-2006 Annual Report, Project No. 199501100, 69 pp., (BPA Report DOE/BP-00000652-33)

Stoner, A.W., C.H. Ryer, S.J. Parker, P.J. Auster, and W.W. Wakefield (2008) *Can. J. Fish. Aquat. Sci.*, 65: 1230-1243, DOI: 10.1139/F08-032.

Viehman, H.A. (2012) Fish in a tidally dynamic region in Maine: hydroacoustic assessments in relation to tidal power development, Masters thesis, University of Maine.

Widder, E.A., Robison, B.H., Reisenbichler, K.R., Haddock, S.H.D. (2005) Using red light for *in situ* observations of deep-sea fishes. *Deep-Sea Research* 52:2077-2085.

Williams, K., Rooper, C.N., and Towler, R. (2010) Use of stereo camera systems for assessment of rockfish abundance in untrawlable areas and for recording pollock behavior during midwater trawls, *Fisheries Bulletin*, 108:352-362.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

ADMIRALTY INLET PILOT TIDAL PROJECT
FERC PROJECT NO. 12690

BENTHIC HABITAT MONITORING AND MITIGATION PLAN

Submitted by:
Public Utility District No. 1 of Snohomish County

November 16, 2012

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

TABLE OF CONTENTS

1.0 INTRODUCTION 1
2.0 PROJECT DESCRIPTION 1
3.0 BACKGROUND INFORMATION 3
3.1 Existing Benthic Habitat 3
3.2 Colonization of Hard Structure 8
4.0 PLAN OBJECTIVES AND GOALS 9
5.0 POST-INSTALLATION MONITORING AND MITIGATION PLAN 10
5.1 Colonization of Structure 10
5.1.1 Objective 10
5.1.2 Data Collection 10
5.1.3 Data Analysis 12
5.1.4 Reporting and Adaptive Management 12
5.2 Changes to Seabed Benthic Habitat around Subsea Base 13
5.2.1 Objectives 13
5.2.2 Data Collection 13
5.2.3 Data Analysis 13
5.2.4 Reporting and Adaptive Management 13
5.3 Colonization of Power Cables and Drill Hole Exit Point 14
5.3.1 Objectives 14
5.3.2 Data Collection 14
5.3.3 Data Analysis 14
5.3.4 Reporting and Adaptive Management 14
6.0 APPROACH TO ADAPTIVE MANAGEMENT AND MITIGATION 15
7.0 REFERENCES 16

Attachment 1 – Greene, H.G. (2011) Habitat characterization of the SnoPUD turbine site – Admiralty Head, Washington State, Technical Report, June 1, 2011.

Attachment 2 – Greene, H.G. (2012) Review of ROV Video Collected Within the Tidal Turbine Box Offshore of Admiralty Head, Washington, Technical Report, October 2012.

Attachment 3 – McCallister, M.A. (2012) Northwest Underwater Construction, LLC ROV Survey, Memorandum, September 26, 2012.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

LIST OF FIGURES

Figure 1 – Conceptual instrumentation layout (fixed and recoverable). Instrumentation shown on a 4th Generation turbine (higher rotor solidity than 7th Generation turbine). The general dimensions of the subsea based and support structure are approximately constant between technology generations for the same rotor size. 2

Figure 2 – Turbine deployment location in northern Admiralty Inlet. Blue triangles denote turbines, each of which is connected back to shore via a separate power cable. Dashed red polygon to the east of Keystone Harbor is a marine protected area. 3

Figure 3 – Benthic community structure in the vicinity of the demonstration project (Source: Sound & Sea Technology). 5

Figure 4 – ROV survey tracks from July, 2012 relative to turbine position and shore cable route (Source: Sound & Sea Technology). 6

Figure 5 – Seabed composition in the vicinity of the proposed demonstration project (Source: Sound & Sea Technology). 7

Figure 6 – Representative biofouling on Sea Spider instrumentation package (deployed May - August 2011) 9

Figure 7 – Focal observation points on subsea base for ROV survey 12

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

1.0 INTRODUCTION

If tidal turbines are colonized by marine life, they are likely to provide artificial habitat for fish and invertebrates. Turbines may, therefore, attract structure-oriented species, such as rockfish. This artificial habitat may be beneficial if it enables population growth for species of concern or it may be deleterious if it draws species away from natural habitat, increases the frequency of interactions between fish and the operating turbine, or enables population growth for undesirable species (Polagye et al., 2011). There is also a small potential for the turbine foundations to cause scouring of the seafloor in the immediate vicinity of the contact points with the seabed. While the effect of a pilot project on benthic habitat is likely to be on a small scale, an improved understanding of the rate at which marine life colonizes tidal turbines and which species are involved in the colonization is desirable to understand the potential impacts or benefits of larger-scale projects. And although the potential for a short-duration pilot project to cause meaningful scour given the composition of the seabed at the turbine site is small, it is desirable to confirm the lack of scour. This information will be gathered through surveys of the turbine by a remotely operated vehicle (ROV). The ROV may also provide opportunistic information about how fish use the artificial reef around slack water. The Near-turbine Monitoring and Mitigation Plan includes provisions for observing artificial reef and fish aggregation device (FAD) effects during non-slack periods.

Data collected under this plan will be presented to the Admiralty Inlet Marine Aquatic Resource Committee (MARC) for evaluation of the degree and nature of Project effects on benthic habitats in the Project vicinity. This data will also be used to determine if any modifications to the project are necessary for mitigation purposes. Additional details regarding instrumentation on the turbines are presented in the Monitoring Plan Summary.

2.0 PROJECT DESCRIPTION

The proposed demonstration project consists of two turbines manufactured by OpenHydro, an Irish turbine developer. Each of these turbines has a 6 m diameter outer shroud, as shown in Figure 1. These will be deployed on a gravity tri-frame, with tubular cans contacting the seabed at the vertices. Turbine hub height will be 10 m above the seabed. The OpenHydro turbines are fixed-pitch, high-solidity rotors with an open center. The rotor cassette is the single moving part and is supported by water-lubricated bearings. A permanent magnet generator is contained in the shroud surrounding the blades. Anti-fouling coatings are applied to the interior surface of the shroud, hub, and rotor blades, but the gravity frame (steel, ballasted by concrete and aggregate) is left bare. The turbine shown in Figure 1 represents the 6 m version of 4th Generation technology. The turbines deployed in Puget Sound will be 6 m variants of 7th Generation technology – the principle differences being fewer blades and more streamlined central hub.

The turbines will be deployed in northern Admiralty Inlet, Puget Sound, Washington. Admiralty Inlet is a constricted sill separating the deep Main Basin of Puget Sound from the Straits of Juan de Fuca and Straits of Georgia. At the narrowest point, between Admiralty Head and Point Wilson, the channel is approximately 5 km wide and 70 m deep. Excepting a small exchange through Deception Pass, the entire tidal prism of Puget Sound passes through this constriction, giving rise to tidal currents that routinely exceed 3 m/s (6 knots) at mid-water. The project site is

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

approximately 1 km SE of Admiralty Head in 55 m of water (Figure 2). The project location was chosen on the basis of strong tidal currents (intensified by the proximity to the headland), negligible seabed slope (necessary to deploy the gravity foundation), separation from high vessel traffic areas (federal navigation lanes, ferry route), and ease of cable routing back to shore.

Each turbine will be connected to shore by a separate power cable. These cables will also provide power for monitoring instrumentation and fiber optic communication with the turbine and monitoring instrumentation. Turbine monitoring systems are grouped into two categories – instruments that will be deployed for the duration of the demonstration project (fixed) and instruments that will be periodically recovered for maintenance (recoverable). This will be enabled by an Adaptable Monitoring Package (AMP) consisting of a self-aligning frame with instrumentation and a wet-mate power and fiber connector.

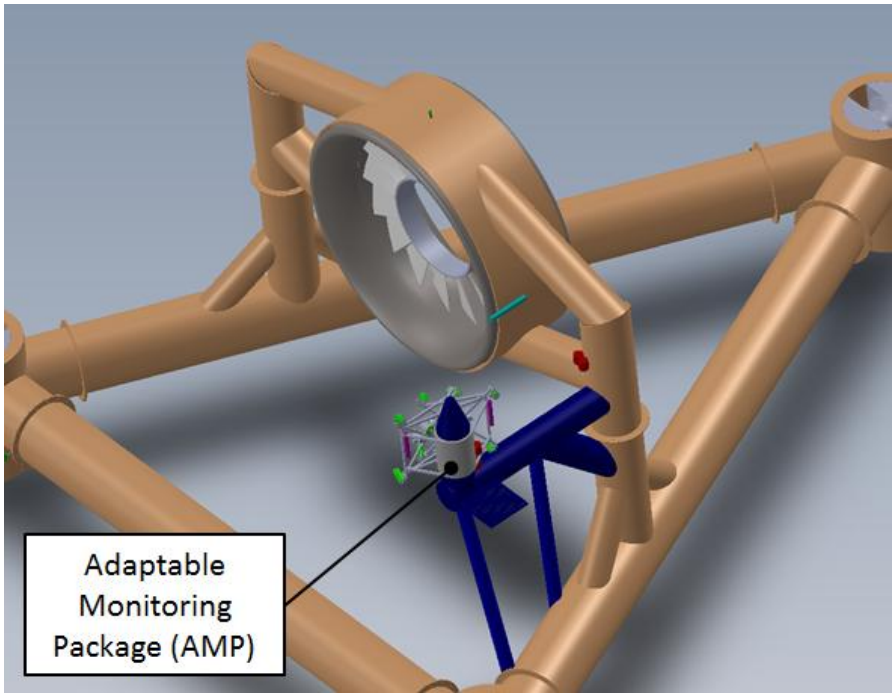


Figure 1 – Conceptual instrumentation layout (fixed and recoverable). Instrumentation shown on a 4th Generation turbine (higher rotor solidity than 7th Generation turbine). The general dimensions of the subsea based and support structure are approximately constant between technology generations for the same rotor size.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

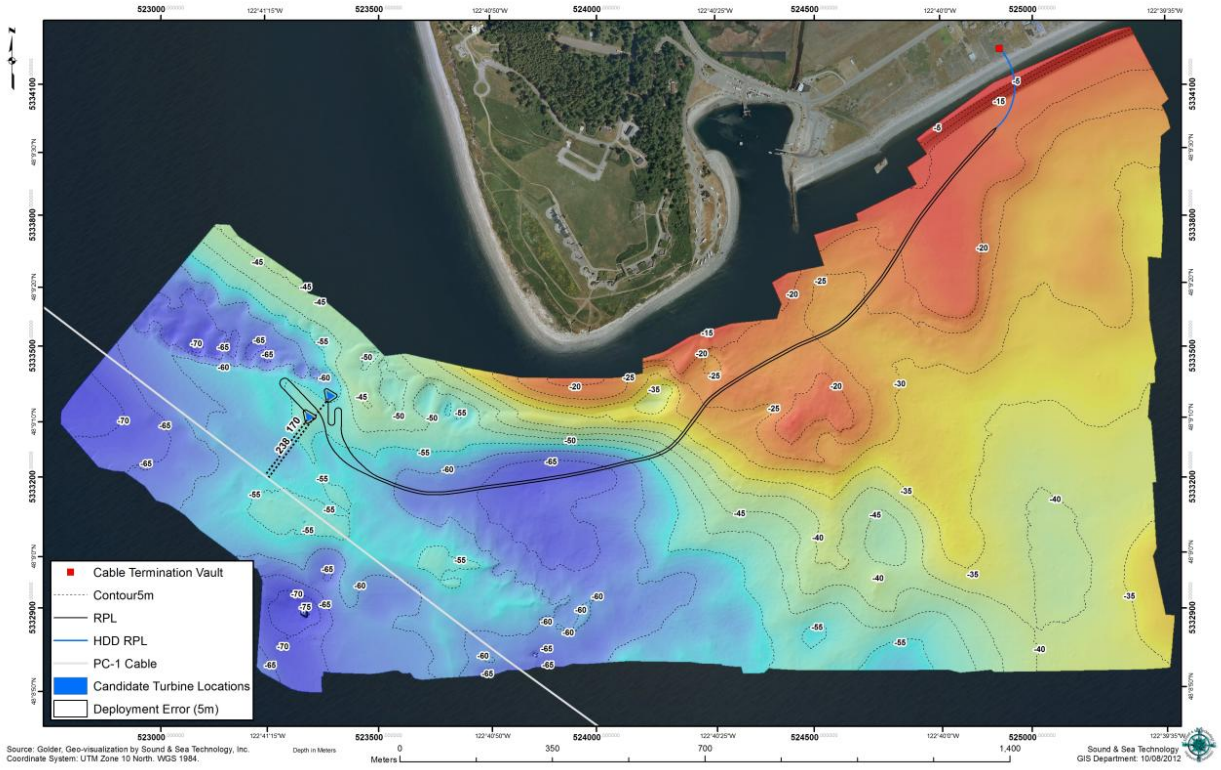


Figure 2 – Turbine deployment location in northern Admiralty Inlet. Blue triangles denote turbines, each of which is connected back to shore via a separate power cable. Dashed red polygon to the east of Keystone Harbor is a marine protected area.

3.0 BACKGROUND INFORMATION

3.1 Existing Benthic Habitat

In August, September, and October 2010, a remotely operated vehicle (ROV) was used to characterize the seabed and benthic communities in the proposed turbine deployment area using a transect survey pattern. Results are described in Greene (2011) and summarized in Figure 3. A second set of surveys was conducted in July 2012 along the cable route and in the turbine deployment area, as shown in Figure 4. The survey began at the exit point for shoreline directional drilling and proceeded along the cable route to the turbine deployment area. Figure 5 shows seabed composition over a broader area, inferred from multi-beam sonar data (Greene, 2011).

ROV surveys in 2010 and 2012 served to characterize the substrate and benthic communities. Substrate was classified as one or more of the following (in order of decreasing characteristic dimension): large boulder, medium boulder, small boulder, cobble, pebble, gravel, coarse sand, or clay. The characteristic dimension of the substrate was measured by a pair of ranging lasers. Organisms were classified as encrustations (e.g., sponges, tubeworms, barnacles, algae), sessile invertebrates (e.g., chiton, clams), mobile invertebrates (e.g., starfish, urchins), and fish (e.g., ratfish, sculpin). Video quality during the 2010 survey was superior to the survey in 2012 due,

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

primarily, to hardware differences (camera resolution, color) and future surveys will adopt hardware configurations in line with the 2010 surveys (as described in the methodology).

Surveys demonstrated that the substrate in the turbine deployment area is dominated by a mix of cobble-pebble-small boulder or cobble-pebble(57% and 28%, respectively; Greene, 2011). Small boulders (< 0.4 m characteristic size) were observed in moderate number, but there were relatively few larger boulders. The tidal currents have removed most of the fine-grained sediments. Smaller clasts (e.g., pebbles) are relatively unencrusted, suggesting these are mobilized during periods of strong currents. This observation is consistent with acoustic data collected from this site, which indicates sound produced by bedload transport (Bassett et al., *in prep*). Larger clasts (cobbles and boulders) are stable enough to be moderately or heavily encrusted.

Greene (2011) describes the turbine deployment area as supporting a "diverse and robust ecological community". In general, organisms are concentrated along transects with the most heterogeneous substrates. These are, conversely, the areas least suitable for the deployment of a gravity foundation turbine and the proposed turbine deployment locations do not overlap with the most ecologically active areas. Barnacles are prolific, occurring as individuals, clusters, and fields. Algae are similarly prolific, with approximately two-thirds being of a filamentous variety. Anemones are also common. Most were closed at slack water, opening to feed as currents increased during the survey. Clams were the most abundant sessile invertebrates observed, followed by chitin. Mobile invertebrates were also common, with green urchins accounting for 63% of all mobile invertebrates and five-legged, orange starfish accounting for 31%. Snails, shrimp, hermit crab, and crab were observed in small numbers (ten or less over the entire survey). One octopus was also observed during the 2010 and 2012 surveys. Approximately two hundred individual fish were counted during the 2010 survey. Of these, 49% were ratfish and 38% sculpin, with the remainder either lingcod, kelp greenling, pacific sand lance, or unidentified. The ecosystem composition observed during 2010 and 2012 were similar, but lower video quality during the 2012 survey precludes a quantitative comparison.

Figure 3 shows the representative benthic community structure in the vicinity of the turbines. The benthos is colonized in a relatively homogeneous manner, excepting fields of barnacles and anemones noted at the northwest and southeast corners of the survey area, respectively. While the July, 2012 survey data is insufficient to make such a spatially detailed representation of the benthic community (i.e., noting the locations of individual starfish), the survey data do not indicate any fields of barnacles or anemones at the proposed turbine sites. Conditions at the turbine sites are consistent with those in the eastern quadrant of the 2010 survey area – with colonization of the larger clasts by barnacles, sponges, and anemones.

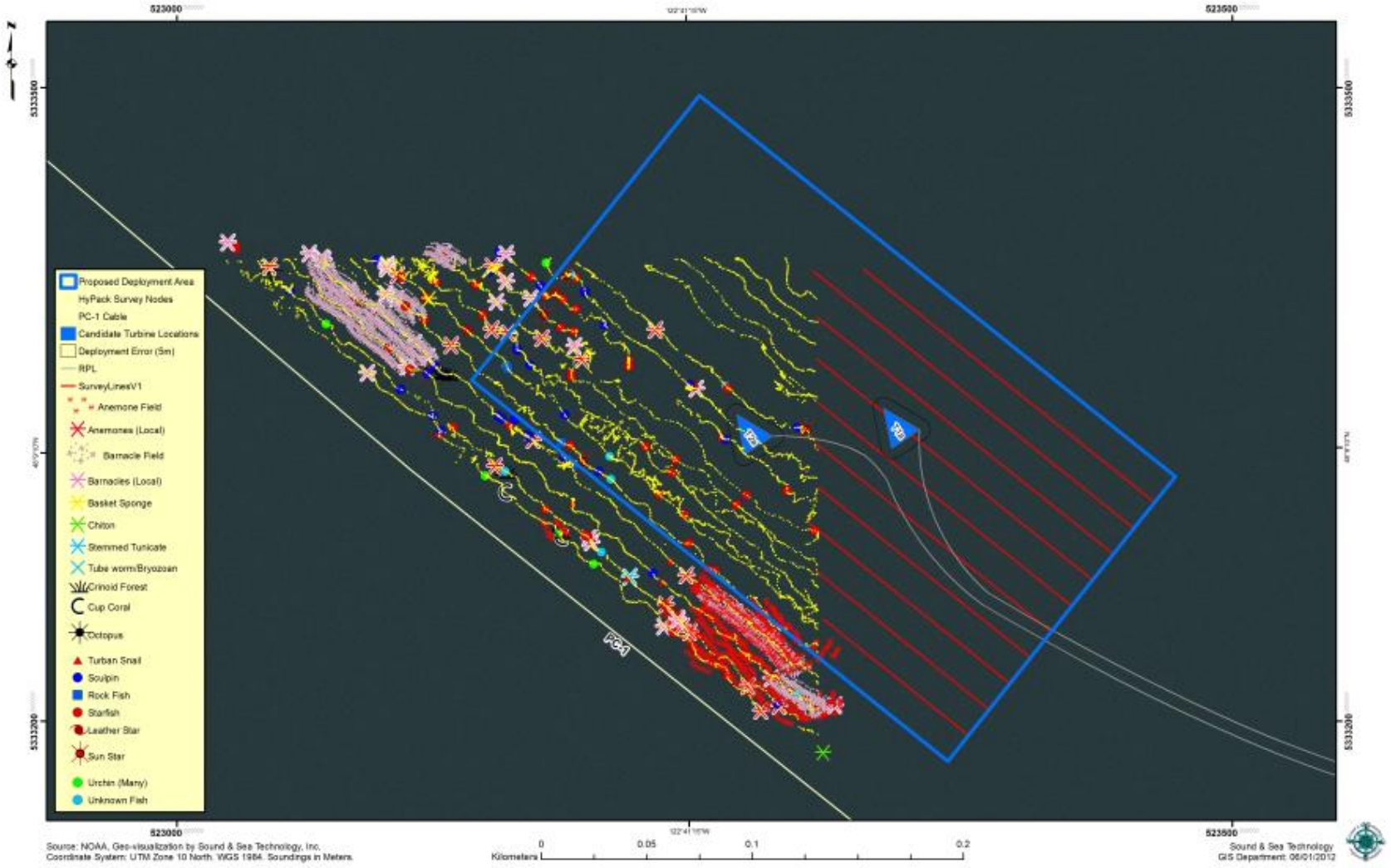


Figure 3 – Benthic community structure in the vicinity of the demonstration project (Source: Sound & Sea Technology).

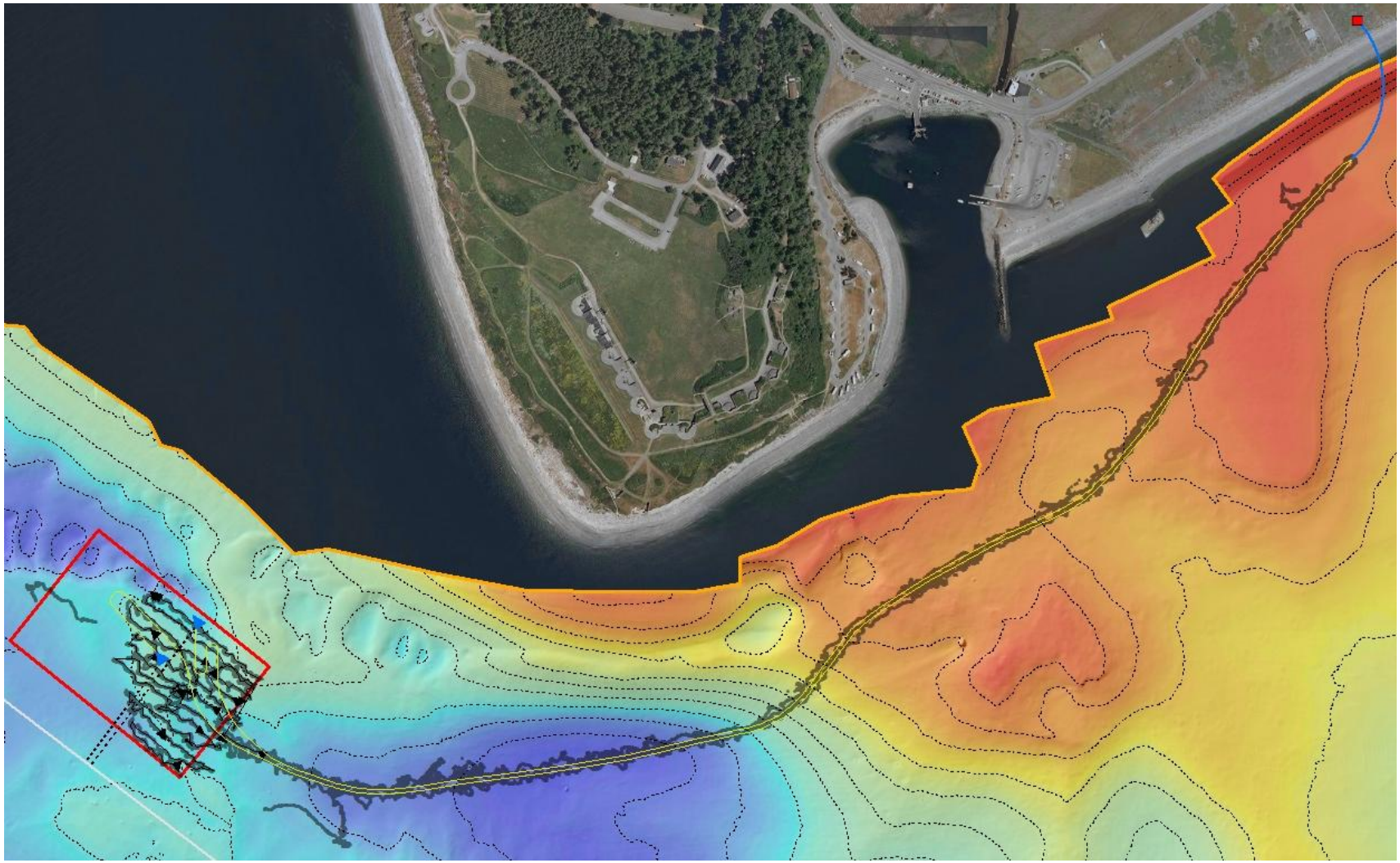


Figure 4 – ROV survey tracks from July, 2012 relative to turbine position and shore cable route (Source: Sound & Sea Technology).

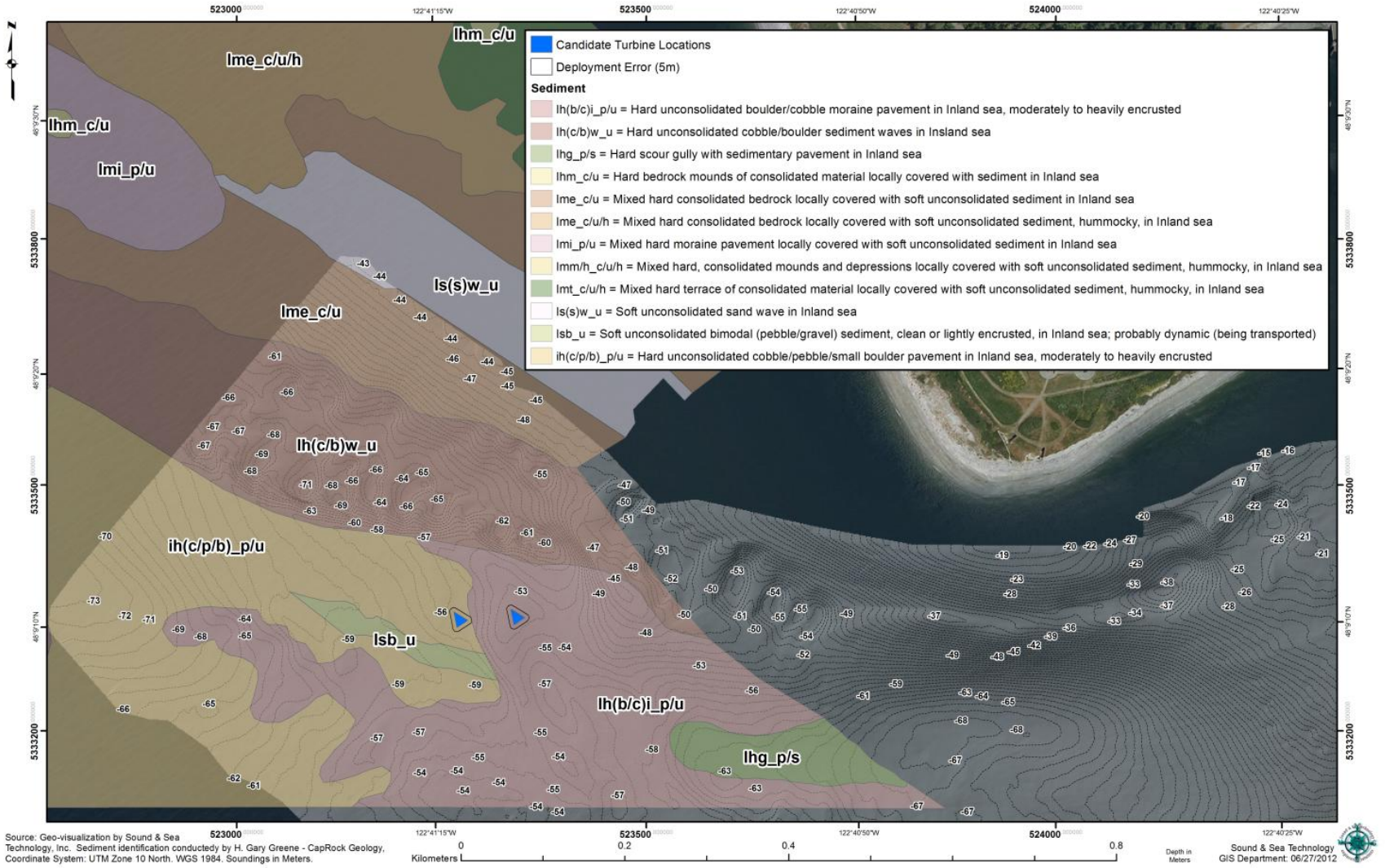


Figure 5 – Seabed composition in the vicinity of the proposed demonstration project (Source: Sound & Sea Technology).

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The July, 2012, survey also included the cable route to shore and horizontal directional drilling exit point. The cable route survey began in Keystone Harbor, near the Coupeville ferry landing, and proceeded southward to a depth of approximately 70 m due south of Admiralty Head, before rising to 55 m in the turbine deployment area.

Along this route, the substrate is initially soft, then, as depth increases, coarsens to "1) cobbles, pebbles and sand, with occasional piles of cobbles producing a rugged bottom, to 2) sand and gravel and 3) gravel and pebbles" (Greene, 2012). Scattered boulders were observed in water deeper than 30 m and one, small field of boulders was observed along the cable route, consisting of a half-dozen rocks approximately 1 m across. In shallow water, these clasts are heavily vegetated by algae (Greene, 2012). No geoduck clams were observed, but other types of clams were present, based on the shell fragments of butter and/or Manila clams (McCallister, 2012). No eelgrass was observed, nor was habitat suitable for eelgrass found in the survey (e.g., sandy bottom). As with the turbine deployment area, those clasts in deeper water "are heavily encrusted with sponges, barnacles, algae and bryozoans" (Greene, 2012). Along the cable route, one mud window was observed, indicating that the seabed along the cable route consists of a gravel/pebble/cobble pavement overlying mud.

There are several active and inactive power and communications cables on the seabed in the project area. Inactive cables include power and communications cables originally connecting military installations on Whidbey Island (Fort Casey), the Kitsap Peninsula (Fort Worden), and Marrowstone Island (Fort Flagler). These cables have been observed to be encrusted with marine life similar to the dominant cobble clast. Consequently, the colonization of the subsea cables for this project is not novel in this environment and only a limited number of survey points along the shore cable route will be monitored during the project.

3.2 Colonization of Hard Structure

While the turbines will be deployed beneath the photic zone, biofouling is to be expected, based on the colonization of cobbles and biofouling observed on Sea Spider instrumentation packages deployed by the University of Washington Northwest National Marine Renewable Energy Center. These packages have been recovered, cleaned, and redeployed every three months within the project area since mid-2009. Biofouling has seasonal variability, with the greatest biofouling generally observed in the May-August time frame and more limited fouling observed over other periods. Representative biofouling on an instrumentation package deployed in the project area from May-August 2011 is presented in Figure 6. Biofouling observed on the Sea Spider packages has included red algae, tubeworms, barnacles, and chitin. It is likely that unprotected surfaces on the turbine will be colonized in a similar manner (i.e., all surfaces on the subsea base, excluding the rotor and shroud, which will be protected by anti-fouling paint). Biofouling also shows a strong annual variability. From May 2009 – May 2010, very little biofouling was observed on any surfaces (e.g., instruments, floats, tripod frame). However, from May – August 2010, barnacles were recruited on virtually every surface on the instrumentation package. Conditions for the same period in 2011 bracketed these two extremes. In summary, colonization of the subsea base is expected to occur, even though the turbines will be deployed below the photic zone and the rate of colonization is expected to have both seasonal and annual variation.

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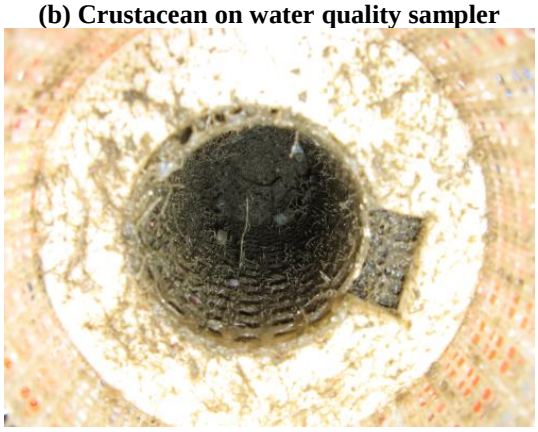
(a) Red algae on instrumentation cases

(b) Crustacean on water quality sampler

(c) Barnacles on composite panels (18 months exposure)



(d) Crabs and biofouling on interior of hydrophone flow shield

Figure 6 – Representative biofouling on Sea Spider instrumentation package (deployed May - August 2011)

4.0 PLAN OBJECTIVES AND GOALS

The goal of the Benthic Habitat Monitoring and Mitigation Plan is to describe the benthic habitat provided by the Project and changes to the existing benthic habitat where the Project directly contacts the seabed. To accomplish this goal, the Project will evaluate three hypotheses:

- *Hypothesis 1:* The turbine will be colonized and provide artificial habitat that supports different benthic communities than are currently present in the Project area.
- *Hypothesis 2*: The contact points between the turbines and the seabed will not result in deposition of fine sediments or scour.
- *Hypothesis 3*: The power cable and horizontal directional drill exit point will be colonized and are likely to return to pre-installation conditions over time.

To accomplish this goal, the District will 1) characterize colonization of the turbine structure, the subsea cable, and the horizontal directional drill exit point; 2) characterize scour and/or deposition where these structures contact the seabed; and 3) consult with the MARC to consider modification to this Plan in response to the results of benthic habitat monitoring efforts.

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Characterization surveys will be conducted by remotely operate vehicle (ROV) during periods of weak currents.

The extent to which the turbine serves as an artificial reef or fish aggregating device (FAD) will be further informed by observations from the Near-turbine Monitoring and Mitigation Plan. This study will complement and be coordinated with the District's use of an ROV to periodically inspect project components and monitor for derelict gear.

5.0 POST-INSTALLATION MONITORING AND MITIGATION PLAN

5.1 Colonization of Structure

5.1.1 Objective

Pre-installation surveys (Greene, 2011; Greene, 2012) have characterized the benthic habitat in the Project area as cobbles and boulders, colonized by barnacles, sponges, and algae. Smaller substrate (pebbles, gravel) are intermittently mobilized by strong currents and are generally free of encrustation. The turbine foundation will have considerably greater vertical relief (e.g., turbine shrouds will extend to 13 m above the seabed) and may support different benthic communities. Anecdotal reports from tidal energy projects in Europe indicate that turbine foundations are often colonized within a year of deployment. Information about how this project affects the local benthic community structure would provide information about how a larger array might affect the community and guidance for engineering refinements to foundations that promote desirable benthic communities (potential benefit) and minimize undesirable benthic communities (potential impact). The objective of this portion of the plan is to gather information about how the turbine structure is colonized (coverage, colonization rates, and species involved).

5.1.2 Data Collection

Equipment Description

Observations of the turbine structure will be conducted by a Remotely Operated Vehicle (ROV) with sufficient thrust capabilities to maneuver around the turbine during periods of relatively low currents (i.e., velocities < 1 m/s). Operation during stronger currents is not likely feasible given the capabilities of available ROVs in the region and the risks/challenges associated with umbilical management in strong currents.

"Slack" water in Admiralty Inlet is an ephemeral quantity. Often, the reversing of the currents from flood to ebb (or vice versa) are out of phase by nearly an hour between surface and seabed. Consequently, ROV operations will be scheduled around diurnal inequalities with protracted periods of weak currents. These will provide working windows of up to several hours a few times each year. This approach to ROV data collection was successfully demonstrated in July, 2012.

The ROV will be cabled back to the surface and video recorded using a standard digital format. The ROV will be equipped with high-resolution color and black & white cameras with sufficient lighting to illuminate the seabed. An example of a suitable ROV is the *Seaeye Cougar-XT* that

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

was used during 2010 benthic habitat surveys (Greene, 2011). Audio and written logs will be maintained during the survey.

Survey Procedure

Four ROV surveys will be conducted during the first year of turbine operation. Thereafter, there will be two surveys per year. During each survey, the ROV will perform a quick scan of both turbines, primarily to inspect for derelict gear (see Derelict Gear Removal Plan).

Focal observations of portions of one turbine will then be conducted. This subsampling approach is necessitated by limited bottom time for the ROV and justified given the close proximity of the two turbines (less than 100 m separation). Focal observation points are highlighted in Figure 7 and consist of:

- Subsea base member approximately perpendicular to the current direction (focal area #1)
- Subsea base member approximately parallel to the current direction (focal area #2)
- Junction of vertical supports for turbine with subsea base (focal area #3)
- Vertex of subsea base (focal area #4)

Each of these areas consists of the same substrate (mild steel) but will be subject to different hydrodynamic conditions that may preferentially support or inhibit colonization. During a focal inspection, the ROV operator will perform a slow pan of the area of interest, as constrained by tidal currents and umbilical management.

During each survey, the ROV will also inspect a comparison site on the seabed, roughly 5 m x 5 m in dimension at least 20 m away from the turbines. The purpose of characterizing this portion of the seabed is to observe any long-term changes to existing substrate and contrast this with colonization of the turbine foundation. The location of this survey area will be determined by consensus of the MARC following turbine installation.

During surveys, opportunistic sightings of fish, invertebrates, and marine mammals will be noted. However, because slack water is likely to be an incomplete description of site usage, artificial reef effects will be evaluated as part of the Near-turbine Monitoring and Mitigation Plan.

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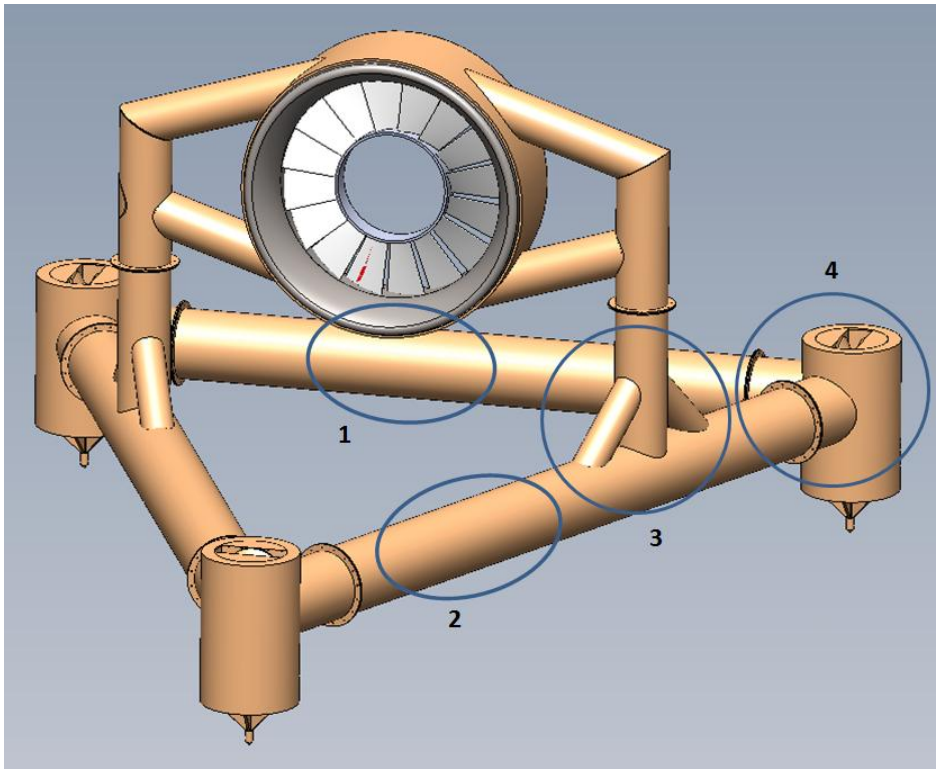

Figure 7 – Focal observation points on subsea base for ROV survey

5.1.3 Data Analysis

A benthic ecologist will review video footage from each survey. The percentage of coverage by each type of benthic fauna (e.g., algae, barnacles) will be quantified for each of the four focal areas on the turbine foundation and for the comparison site. Qualitative notes regarding rates of growth or retreat will also be included. The purpose of this analysis is to quantify the rate of colonization through comparison of sequential surveys and qualify the species involved in this colonization.

Incidental observations of fish, marine mammals, and invertebrates during the survey (focal study areas and general scan) will be reported, but the effect of the ROV lighting and timing restrictions on the surveys (i.e., surveys only during weak tidal currents) will limit these to qualitative, rather than quantitative, observations.

5.1.4 Reporting and Adaptive Management

A preliminary, oral report will be made to the MARC within 30 days of each ROV survey describing observations and presenting survey imagery/video. Written and oral reports describing the colonization of the subsea base will be presented to the MARC within 90 days of the conclusion of each calendar year of operation. If the general inspections of the turbine structure indicate that areas of the turbine are being colonized at a different rate or by different species than those that are the subject of focal monitoring, then, with the concurrence of the MARC, the focal monitoring areas will be adjusted to include these areas.

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5.2 Changes to Seabed Benthic Habitat around Subsea Base

5.2.1 Objectives

Pre-installation surveys indicate that the seabed in the project area is predominantly scoured of fine-grained sediments due to the strong tidal currents in the project area (Greene, 2011; Greene, 2012). Because turbidity is relatively low in Admiralty Inlet (Polagye and Thomson, 2010) and the currents reverse direction approximately every six hours no net accumulation of fine-grained sediments are expected in the turbine wake or around turbine structures. Further, the separation between the rotor and seabed (10 m hub height, 7 m from bottom of shroud to seabed) makes it likely that any sediment that begins to settle in the wake would be resuspended by currents before reaching the seabed. Accumulation of fine-grained sediments where none presently exist would, however, alter benthic communities and could be environmentally significant (i.e., rise to the level of an environmental change) for a large-scale installation. The most probable location for sediment accumulation or scour of existing bed material is at the contact points of the turbine foundations.

5.2.2 Data Collection

Equipment Description

The remotely operated vehicle (ROV) used for the colonization survey will also be used for this survey.

Collection Procedure

The ROV will inspect the three contact points between the seabed and the subsea base for each turbine. Observations will be recorded in a standard video format with associated audio and written logs for subsequent analysis. In addition to providing information about sediment deposition, this information is also necessary to evaluate turbine stability over time.

5.2.3 Data Analysis

Observations from sequential surveys will be reviewed to quantify scour, deposition, or other changes to the benthic environment at the inspection points. If scour or deposition is occurring, its spatial extent will be quantified.

5.2.4 Reporting and Adaptive Management

A preliminary, oral report will be made to the MARC within 30 days of each ROV survey describing observations and presenting survey imagery/video. Written and oral reports describing the colonization of the subsea base will be presented to the MARC within 90 days of the conclusion of each calendar year of operation.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

5.3 Colonization of Power Cables and Drill Hole Exit Point

5.3.1 Objectives

As for the subsea base, the power and data cables to shore are likely to be colonized by marine life. Unlike the subsea base, these will not have significant vertical relief, so the creation of different benthic habitat is unlikely and the primary interest is in determining the rate at which these cables are colonized and whether, over time, any significant cable movement occurs. Similarly, the rate at which the horizontal directional drill exit point is colonized and returned to a pre-installation state is of interest.

5.3.2 Data Collection

Equipment Description

The remotely operated vehicle (ROV) used for the colonization survey will also be used for this survey.

Collection Procedure

During each survey, the ROV will inspect the horizontal directional drill exit point and 2-3 representative locations along the cable route. The specific locations will be determined in consultation with the MARC following turbine and cable installation. Locations might be chosen based on a stratification of cable depth, habitat, or cable feature (e.g., a suspended segment). Observations will be recorded in a standard video format with associated audio and written logs for subsequent analysis.

5.3.3 Data Analysis

A benthic ecologist will review video footage from each survey. The percentage of coverage by each type of benthic fauna (e.g., algae, barnacles) will be quantified for the drill exit point and focal locations along the cable route. Qualitative notes regarding rates of growth or retreat will also be included. The purpose of this analysis is to quantify the rate of colonization through comparison of sequential surveys and compare pre- and post-installation colonization. Cable movement would be indicated by changes in orientation or scour of marine life from the cable and adjacent seabed.

5.3.4 Reporting and Adaptive Management

A preliminary, oral report will be made to the MARC within 30 days of each ROV survey describing observations and presenting survey imagery/video. Written and oral reports describing the colonization of the subsea base will be presented to the MARC within 90 days of the conclusion of each calendar year of operation.

The focal locations along the cable route will be determined by the MARC following turbine and cable installation.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

6.0 APPROACH TO ADAPTIVE MANAGEMENT AND MITIGATION

In implementing this Plan, the District will consult with the MARC as appropriate on the technical issues described above and data interpretation associated with the monitoring. Such consultation will include consideration of results from monitoring efforts and subsequent adjustments to monitoring methods. In particular, the District will adopt the triggers and subsequent actions described below.

The District will follow the procedures described in the Adaptive Management Framework when conferring with the MARC on implementation of the Acoustic Monitoring and Mitigation Plan and considering how to address the results of the monitoring.

Adaptive Management and Mitigation Trigger 1: If ROV scans of the turbine foundation indicate areas of colonization significantly different than those selected for focal study, the District, with the concurrence of the MARC, will modify focal study locations to include these areas.

Adaptive Management and Mitigation Trigger 2: If studies indicate that the species colonizing the turbines, the subsea cable, or the horizontal directional drill exit point are different from those on the seabed, the District will, after consultation with the MARC, take one or more of the following actions, as necessary:

- Modify the Monitoring and Mitigation Plan and/or sampling frequency to better understand colonization trends;
- Modify the Project to mitigate for effects if necessary; and/or
- Conduct additional sampling or studies.

Similar provisions apply if the species assemblage or density is markedly different from the pre-instillation survey conditions.

Adaptive Management and Mitigation Trigger 3: If surveys indicate significant erosion at the contact points between the subsea base and seabed, an evaluation of turbine stability will be undertaken, and the MARC consulted to determine if project modifications are necessary.

Adaptive Management and Mitigation Trigger 4: Following turbine installation, the MARC will select 2-3 focal survey locations along the cable route to evaluate the rate at which the cables are colonized by marine life.

By June 30 of each year, the District will develop and file an annual report to FERC fully describing its implementation of the Plan during the previous calendar year and a list of the proposed activities during the current calendar year. The MARC will have at least 30 days to review and comment on a draft report prior to the District finalizing and filing the report with FERC. The annual report will provide the following:

- A summary of the monitoring results.
- A summary of any issues or concerns identified by members of the MARC during the year regarding implementation of the Plan.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

- A list of any changes to the Plan or project proposed by consensus of the MARC during the year.
- A list of Plan activities planned for the current year.

7.0 REFERENCES

Basset, C., J. Thomson, and B. Polagye (*in preparation*) Contribution of bedload transport to ambient noise in a high-energy environment.

Greene, H.G. (2011) Habitat characterization of the SnoPUD turbine site – Admiralty Head, Washington State, Technical Report, June 1, 2011.

Greene, H.G. (2012) Review of ROV Video Collected Within the Tidal Turbine Box Offshore of Admiralty Head, Washington, Memorandum, October, 2012.

McCallister, M.A. (2012) Northwest Underwater Construction, LLC ROV Survey, Memorandum, September 26, 2012.

Polagye, B. and J. Thomson (2010) Admiralty Inlet water quality survey report: April 2009 – February 2010, Northwest National Marine Renewable Center, University of Washington, Seattle, WA.

Polagye, B., B. Van Cleve, A. Copping, and K. Kirkendall (eds.) (2011) Environmental effects of tidal energy development: Proceedings of a scientific workshop, March 22-25, 2010. *NOAA Technical Memorandum* NMFS F/SPO-116.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Attachment 1

Greene, H.G. (2011) Habitat characterization of the SnoPUD turbine site – Admiralty Head, Washington State, Technical Report, June 1, 2011.

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Habitat Characterization of the SnoPUD Turbine Site – Admiralty Head, Washington State – Final Report, June 1, 2011

H. Gary Greene
CapRock Geology

Introduction

A seafloor location identified to site a turbine for the conversion of tidal current energy into electrical power is being investigated offshore of Admiralty Head, Whidbey Island in Washington State, at the entrance to the greater Puget Sound region. This is a site of high tidal water exchanges and almost continuous strong currents, an ideal site for tidal energy conversion but a hindrance to seafloor examination. The area investigated is triangular in shape, located in water depths of approximately 90 to 200 feet, and close to land, 300 feet offshore of where the cable landfall is proposed.

Objective

The objective of this study is to map the potential marine benthic habitat types using remotely collected acoustic data and ROV video observations. Substrate type, morphology and variability were used to characterize bottom conditions and a rough census of the biology including presence of fish, epifauna, sessile and encrusting fauna and flora was undertaken.

Geology

Admiralty Inlet is located in the northern Puget Sound region and is part of the Salish Sea. Geographically it lies between Admiralty Head of Whidbey Island and Port Townsend to the west. The region is located over the subducting Juan de Fuca Plate, the active convergent boundary between the Juan de Fuca and the North American plates, and is periodically subjected to earthquakes associated with the relative motion between the two plates.

During the Pleistocene the region was heavily glaciated with the ice sculpturing the terrain into its present landforms and depositing glacial materials as tills, moraines and outwash deposits. These deposits are today represented as coarse-grain, loosely consolidated, well-rounded, plutonic and metamorphic rocks plucked from the Cascades to the east and transported to the west by the glaciers. The coarse-grain constituents are composed of boulders or drop stones, cobbles and pebbles that melted from the ice as a heterogeneous material. Advance outwash deposits of arckosic sands and silts from the ice fronts spread out across the region during the Frazer Glaciation followed by recessional outwash deposits occurring during the Vashon Stade of the Fraser, ~15Ka. These recessional outwash materials have been deposited onto clays that were laid down along the northern edge of a fresh-water proglacial lake.

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With glacial retreat and melting, sea level rise, strong tidal currents are now affecting the area where the glacial deposits have been winnowed of their fine-grain constituents leaving a coarse-grain lag in the form of a cobble, pebble and boulder pavement. Erosion of feeder banks and river input are now supplying fine-grain materials to the region.

Method

The *Seaeye Cougar-XT* ROV (Fig. 1) is a moderate size (344 kg, 758.4 lbs) electric vehicle that can work at depths of 2000 m (6,562 ft) or less and obtain speeds up to 3.2 knots (nm/h [5.93 kph, 3.68 mph]). It is outfitted with two hydraulic manipulators, not used on these surveys, a pan and tilt video camera and 6000 W of lighting. For the work in August the tether was hand managed while for the work in September and October a tether management system (TMS) and an ROV garage was used to better manage the umbilical. Speed of the vehicle was kept to a knot or less for all transect runs. Stops during transects were kept at a minimum although unavoidable at certain times when bottom currents were strong or the tether was fouled. Occasional stops were made to better image a feature or organism of interest on the seafloor.

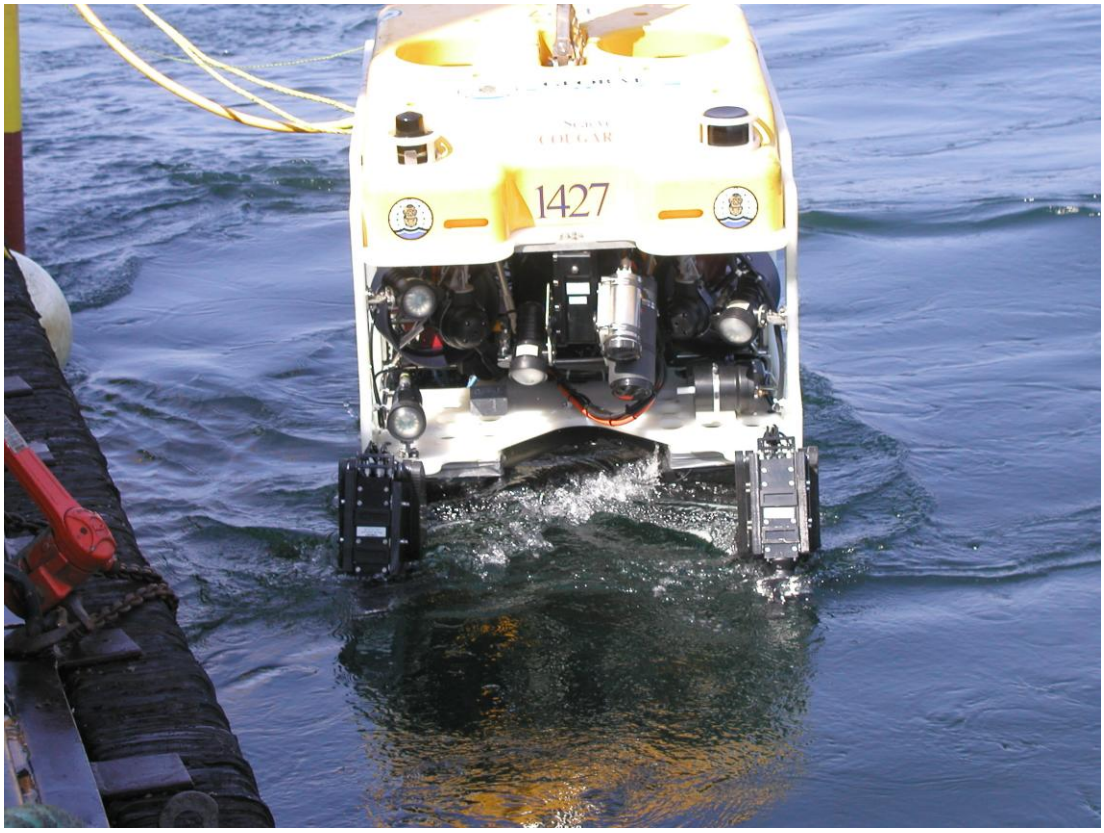

Figure 1. Seaeye Cougar- XT *ROV being lunched from a stationary vessel at the SnoPUD turbine site. Lighting, camera, lasers and the two manipulators are visible. Note strong current, even though this operation is occurring at slack tide.*

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

The first attempt to collect ROV video at the SnoPUD tidal energy site was undertaken between August 16 and 17, 2010. Unfortunately the support vessel *Prudhoe Bay* was too small for the tidal conditions and the anchors too light to keep the vessel in position and thus very limited observations could be done. Several transects were completed on August 18 but without onboard annotation of the video.

The second attempt to obtain video images of the seafloor within the SnoPUD tidal energy site was undertaken from aboard a large barge (Fig. 2) during the evening hours of September 29, 2010 after the barge supporting the ROV was properly anchored (see reports by McCallister, Sound and Sea Technologies). The second day of the operation, Thursday, September 30, was highly successful and the ROV performed well. However, on the third day, after the barge was positioned for the day's dives, the tether management system (TMS) aboard the ROV failed to operate and the day's dive delayed. On the fourth day the barge was re-positioned for the survey of the cable route (see Appendix I for onboard observational logs).

A total of 24 transects were observed and reported aboard the ROV support vessels. The, transects ranged in time from 3 minutes to 39 minutes with the average being about 16.5 minutes. Depth within the investigation area ranged from 55.8 m (183 ft) to 61 m (203 ft), a range of 6.1 m (20 ft) with an average depth of 59 m (194 ft). All units provided in this report are given in units measured during the observations followed by conversion to metric or English system.

All video collected during the surveys were reviewed and annotated based on time and include both transects and transits to transects (all transits are labeled with a "T" prior to the line number, e.g., T-24, meaning transit to line 24). In other words, all video recorded was reviewed (see Appendix II for video review logs). Substrate and ecological conditions were observed and noted. Where possible counts of various organisms and fish were made and totaled to estimate relative percentages. A statistical analysis was not made.

The geologic and ecologic categories selected for this study include substrate type and biological organisms and assemblages observed or counted during the ROV dives. Substrate is divided into coarse-grain and fine-grain components with anomalous large-grain clasts such as boulders counted and observations of lightly encrusted or clean sediment type noted. The ecology is broken down to encrusting, attached, sessile, epifaunal, and fish types of organisms observed or counted.

2.1. Observations vs. Counts

Observations were noted when benthic characteristics changed or a particular substrate or biological assemblage dominated the seafloor for a considerable time during a transect or transit. The decision not to count such characteristics was made when it was apparent that a characteristic was ubiquitous or homogeneous

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

throughout the investigation site. Therefore, noted observations are subjective, but when tallied can provide an estimate of relative abundances.

Figure 2. *Barge used in second attempt to collect ROV video of the SnoPUD turbine site. The ROV is housed in its garage beneath the tether management system under the launch and recovery block in the A-frame. Monitoring and control equipment is housed in the white shipping container to the left of the A-frame and one of the two green anchor winches used in positioning the barge through the four-point anchoring system is visible at left corner of the barge.*

Those characteristics selected for counting consist of distinct elements of the substrate such as boulders and those organisms that are not ubiquitous but were of significant quantity and definition to be counted such as anemones, various epifauna and fish. In this preliminary report common names of the organisms observed and counted are given – scientific names will be provided later, if possible, once expert biologists are contacted to view the organisms.

Both noted observations and counts were tallied and relative percentages of abundances are estimated for the various categories of substrate and organisms selected. Tables have been prepared and included in this report (Appendix III) to show where along a transect, or transit to a transect, various substrate type and

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

biology occur based on time. A GIS spatial presentation of the seafloor conditions and biology are presented in Plate 1, which shows the relationship of biological counts with ROV track lines. Another map (Plate 2) show the potential habitat types based on substrate interpreted from multibeam echosounder (MBES) bathymetry and backscatter and validated using the ROV.

2.2. Difficulties Encountered

The investigation area, the tidal turbine site, is by necessity a highly dynamic and energetic environment subjected to strong tidal flows. Even though timing of the ROV surveys was selected to occur when tidal flow was comparatively low, the water mass at the site was always restless and very seldom was true slack experienced. Quite the contrary, strong currents often over a knot in speed were encountered and affected the smooth, trouble-free operation of the ROV. These strong current situations and the presence of occasional boulders on the seafloor prevented the ROV from flying along a transect at a constant uniform altitude resulting in the visual footprint constantly changing. Thus, the seafloor would range from out-of-focus to in-focus with the consequential varying detail and the fluctuating ability to identify benthic organisms.

Much time was spent untangling the tether when wrapped around boulders. Although moderate to large size boulders were rare they did occur in sufficient numbers to tangle the tether. These occurrences, while time consuming to remedy, often allowed for detailed inspection of the seafloor and the discovery of previously unseen organisms.

Visibility varied throughout the survey and the presence of marine snow often prevented good observation of the seafloor from much more than a meter above the bottom. The best observations were accomplished when the vehicle was either sitting on the bottom or less than 0.5 m above.

The recorded video is of less quality and resolution than the image displayed on the pilot's monitor while surveying. Therefore, it was more difficult to identify organisms using the recorded video than it was when observing the seafloor from the pilot's monitor. The counts made of the organisms need to be considered as a minimum as it is suspected that many organisms were missed. Absolute identification of organisms was not possible due to water turbidity, excess ROV movement and at times poor quality video.

2.3. Substrate Classification

Substrate as used in the context of this study follows the definition of Gary et al. (1974) where in an ecological context it is "the substance, base or nutrient (or medium) on which an organism lives and grows or the surface to which a fixed organism is attached, e.g. soil, rocks . . ."

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Grain size, or clast sizes were measured using the laser scale attached to the ROV. Two red lasers spaced 10 cm (3.94 inches) apart and mounted in a parallel configuration to the camera housing provided a consistent and readable scale observable both in the pilot monitor and in the recorded video. The coarse grain size prevented any other way to obtain grain size measurement as no grab or dredge sampler would be able to collect a non-disturbed representative seafloor sample at the site. The only practical way to measure clast size is in situ observation using video.

The Wentworth Grade was modified for use in this study and is shown along with grain sizes and Phi scale in Table 1 below:

Wentworth Grade (modified)	Size Range (mm)	Size Range (cm)	Size Range (inches)	Phi Scale
Large Boulder (lgB)	>600 mm	>60 cm	26.3 inches	
Medium Boulder (mB)	400-600 mm	40-60 cm	15.8-26.3	
Small Boulder (smB)	256-400 mm	25.6-40 cm	10.1-15.8	<-8
Cobble (C)	64-256 mm	6.4-25.6 cm	2.5-10.1	-6
Pebble (P)	32-64 mm	3.2-6.4 cm	1.6-2.5	-5
Gravel (gr)	2-32 mm	0.2-3.2 cm	0.079-1.6	1 to -5
Sand - coarse (s)	0.5-2 mm	0.05-0.2 cm	0.020-0.079	0 to -1
Clay	<3.9micro m			>8

Table 1 *– Sediment grain size based on the Wentworth Scale modified for this study. Symbols in parentheses are codes used in the observational logs and tables (Appendix II and III).*

From a geologic perspective substrate is here divided into a coarse-grain component and a fine-grain component. The relative abundance of the grain sizes that represent a particular substrate type is based on the estimated percentage of grain sizes present at the time of the observation. For example, if a substrate type was comprised of three prominent clast sizes such as cobbles, pebbles and gravel where cobbles represent a third to a half of the clasts, pebbles represent less than a third and gravel is even less in abundance, then the call out for such a substrate would be C/P/gr in that order to indicate that the substrate is dominated by cobbles and pebbles with gravel being of tertiary importance. If, for example, only one constituent was present, such as cobbles, then the call out would be C/C indicating that both the primary and secondary sediment grain size are of the same clast size. Below are the sediment grain size combinations that are used to characterize the coarse –grain substrate types:

smB/C/P = small boulder/cobble/pebble
C/smB/P = cobble/small boulder/pebble

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

C/P/smB = cobble/pebble/small boulder
P/C/smB = pebble/cobble/small boulder
C/C = cobble/cobble (a single clast size)
C/P = cobble/pebble
P/C = pebble/cobble
lgB = large size boulder
mB = medium size boulder
smB = small size boulder

These grain size combinations are consistent with that used to describe marine benthic habitat characteristics by Lynch et al. (2004), Anderson and Yoklavich (2007), and Pacunski et al. (2008).

Below are the sediment grain size combinations that are used to characterize the fine-grain substrate types:

C/P/gr = cobble/pebble/gravel
P/C/gr = pebble/cobble/gravel
P/gr/C = pebble/gravel/cobble
gr/C/P = gravel/cobble/pebble
gr/P/C = gravel/pebble/cobble
gr/gr = gravel/gravel (single grain size)
s/s = sand/sand (single grain size)

See Plate 1 for spatial representation of the substrate types and Plate 2 for the habitat types.

2.4. Biology

The observed biology was divided into several different categories including the following, shown with the symbology used in the video logs and tables (see Appendices II and III; Plate 1):

Ubiquitous encrusting organisms – sponges, bryozoans and tubeworms (very seldom called out and no symbols (code) developed because these encrusting organisms were observed most everywhere, except in areas where lightly encrusted or clean substrate are noted. Four degrees of encrustation are noted:

1). Heavily encrusted (h/e) – approximately 80% or more of the substrate is encrusted
2). Moderately encrusted (m/e) – approximately 40-80% of substrate is encrusted
3). Lightly encrusted (l/e) – approximately less than 40% of substrate is encrusted
4). Clean – no apparent encrustation seen

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Other encrusting organisms, both fauna and flora:

Barnacles

1). Single, often scattered barnacles – B
2). Clusters of barnacles – B(clust)
3). Fields of barnacles – B(lots)

Algae

1). Crinoid-like/filamentous (Cri/filiAlgae) – green feather-like stemmed organisms (positively ID as crinoids by Waldo Wakefield 2/2011)
2). Algae – other types such as bladed algae

Attached organisms – anemones, five types based on color and patterns, and their state of feeding:

1). Purple/closed (p/c) – solid purple, no tentacles seen
2). Purple/open (p/o) – solid purple, tentacles seen
3). White/closed (w/c)- solid white or cream, no tentacles seen
4). White/open (w/o) – solid white or cream, tentacles seen
5). Stripped/closed (s/c) – pale purple with white stripes, no tentacles seen
6). Stripped/open (s/o) – pale purple with white stripes, tentacles seen
7). Pompom-like (pp) – anemone-like organism, may be a nudibranch
8). Anemone (A) – a different color (orange or yellow) or too obscure to identify color and pattern

Sessile organisms – those organisms that are fixed, sedentary or slightly mobile and consist of the following (no symbols constructed):

1). Stemmed or basket sponge – other than encrusting sponge
2). Tunicate
3). Chiton or limpid
4). Clams, living, open and closed

Primary Epifauna – mobile benthic organisms counted, including the following:

Starfish

1). Starfish – general five-legged, orange starfish (star)
2). Sun starfish – many legged sun starfish (sun)
3). Leather starfish – fat, leathery starfish (leath)

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Urchins

1). Green urchin – U
2). Purple urchin – U(pur)

Other Epifauna

1). Turban snail (turb)
2). Hermit crab (no symbol)
3). Octopus (no symbol)
4). Crab (no symbol)
5). Shrimp (no symbol)

Fish – both pelagic and benthic fish counted include the following:

1). Ratfish (rat)
2). Sculpin (no symbol)
3). Lingcod (ling) – *Ophiodon elongatus*
4). Kelp greenling (kelp) – kelp cod or *Sebastes* spp.
5). Unidentified fish (UnIDfish) – generally goby-like with black and white stripes
6). Pacific sand lance (PSL) – *Ammodytes hexapterus*

See Plate 1 for spatial representation of these organisms in relation to ROV track lines.

Discussion

From the video observations substrate and habitat types of the SnoPUD turbine site were characterized based on the methodologies described above. The marine benthic habitat at the turbine site is primarily a cobble-pebble-small boulder seafloor that provides substrate for encrusting and attached organisms (sponges, bryozoans, tube worms, anemones), as will as for various epifauna (starfish and urchins) and benthic fishes (primarily Sculpin, but some rockfish). Although probable that a considerably more diverse ecological system exists at the investigation site than is described here, the time and equipment required to comprehensively determine such a system was not practical as disturbance of the substrate would have been necessary. However, a good baseline is presented from which future observations and monitoring can be founded.

3.1. Substrate

The substrate that characterizes the SnoPUD turbine site is divided into a relative coarse-grain and fine-grain component with the coarse-grain component being the dominant one. The substrate types represented by three or less clast sizes based on how often noted from the video observations are here compared to each other. This

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

method, although not statistically robust and somewhat subjective, is used to determine the predominant substrate types of the site.

3.1.1. Coarse-Grain Substrate Component

The coarse-grain substrate component is composed of four clast size combinations with the cobble-pebble-small boulder (C/P/smB) dominating at 57% (126 noted) followed by cobble-pebble (C/P) at 28% (62 noted), pebble-cobble (P/C) at 9% (20 noted), pebble-cobble-small boulder (P/C/smB) at 4% (8 noted) and all others at 2% (4 noted) showing good observational correlations (Figs. 3 and 4). In addition, scattered boulders ranging from small to large were noted and found that the small boulders dominated (Fig. 5). See Appendices II and II for complete notations of the substrate based on the video review.

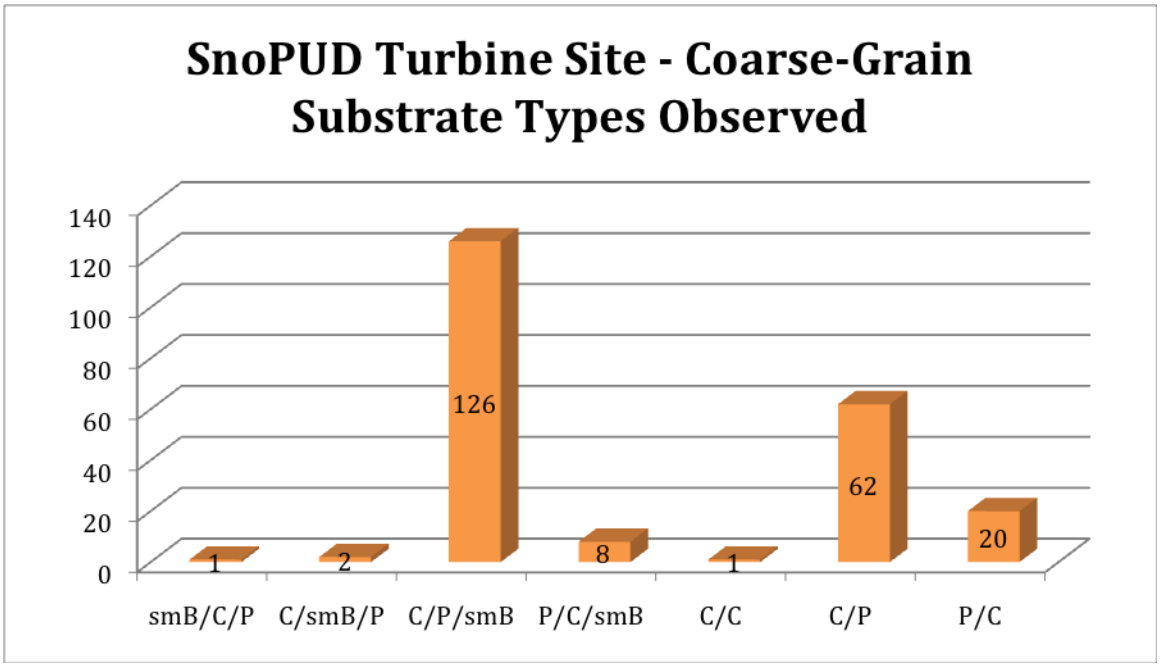

Figure 3. *Histogram of substrate types observed during the turbine site investigation. Numbers represent amount of times substrate type was observed and called out from the ROV video review.*

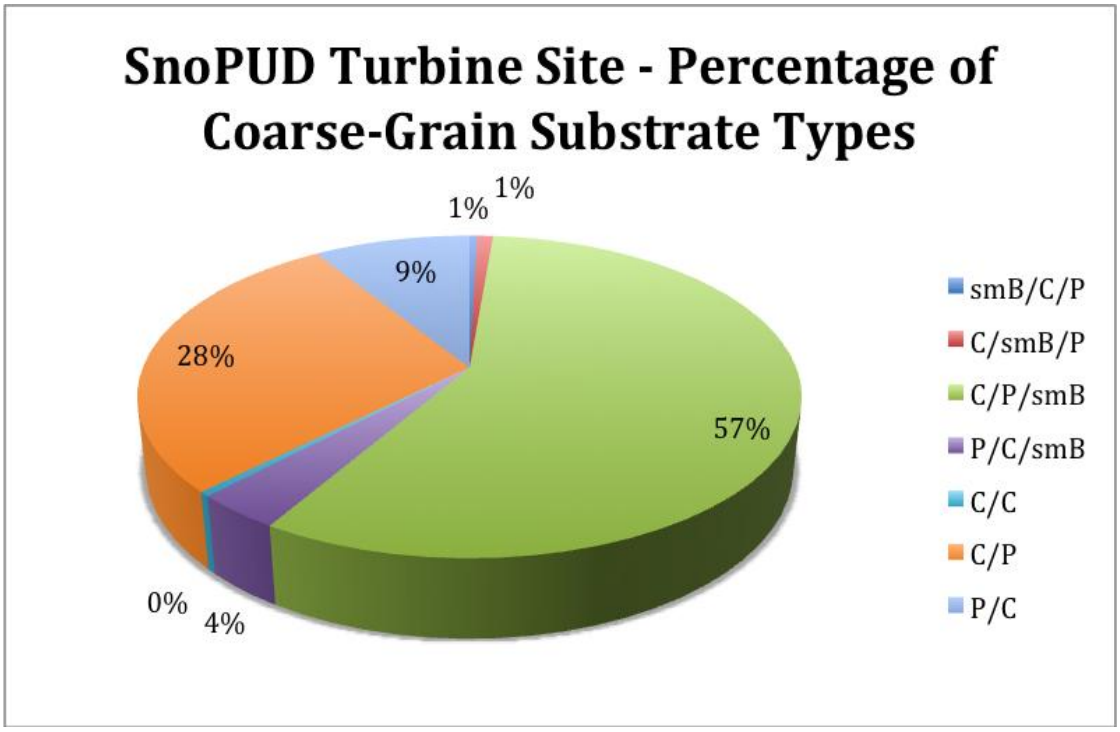

Figure 4. *Pie chart showing percentage of substrate types forming the benthic habitats of the turbine site with cobble-pebble-small boulders being the dominant form.*

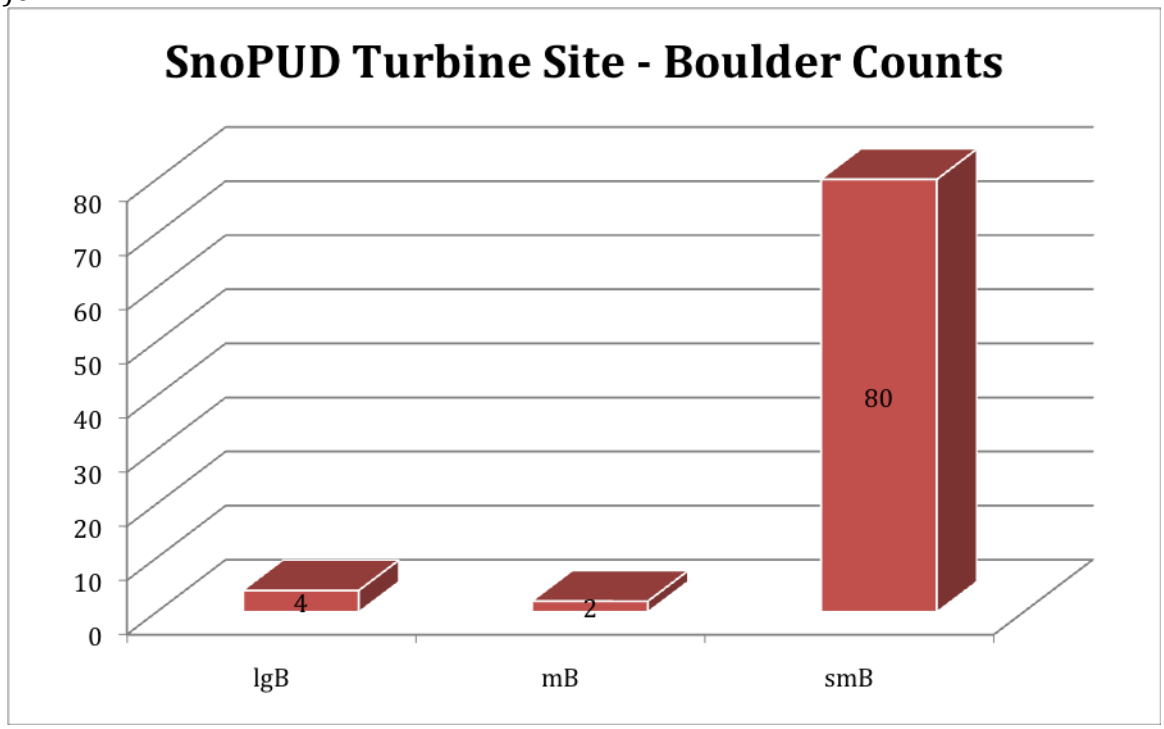

Figure 5. *Histogram showing numbers of boulder types observed in the video review. Small boulders are the most prominent of the scattered boulders observed.*

3.1.2. Fine-Grain Substrate Component

The relative fine-grain substrate is composed cobble-pebble-gravel (C/P/gr) at 34% (20 noted), pebble-cobble-gravel (P/C/gr) at 33% (19 noted), pebble-gravel-cobble (P/gr/C) at 24% (14 noted) and gravel-pebble-cobble (gr/P/C) at 9% (5 noted) with pebble-cobble-gravel and pebble-gravel-cobble being the dominant types (Figs. 6 and 7).

3.1.3. Combined Coarse-Grain and Fine-Grain Substrate Components

By combining the coarse-grain and fine-grain components it becomes apparent that the coarse-grain cobble-pebble-small boulder (C/P/smB) type is the most representative substrate of the turbine site as it represents the largest percentage grain size combinations at 45% while second most representative is cobble-pebble (C/P) at 22%, then pebble-cobble (P/C) at 7% and pebble-cobble-small boulder (P/C/smB) at 3% followed by the fine-grain constituents of cobble-pebble/gr (C/P/gr) and pebble-cobble-gravel (C/P/gr), both also at 7%, pebble-gravel-cobble at 5%, gravel-pebble-cobble at 2% and the rest at 1% or less (Fig. 8). Therefore, it can be confidently stated that the dominant substrate type at the turbine site is of a mixed cobble-pebble-small boulder and cobble-pebble clast size representing over two-thirds of the area investigated.

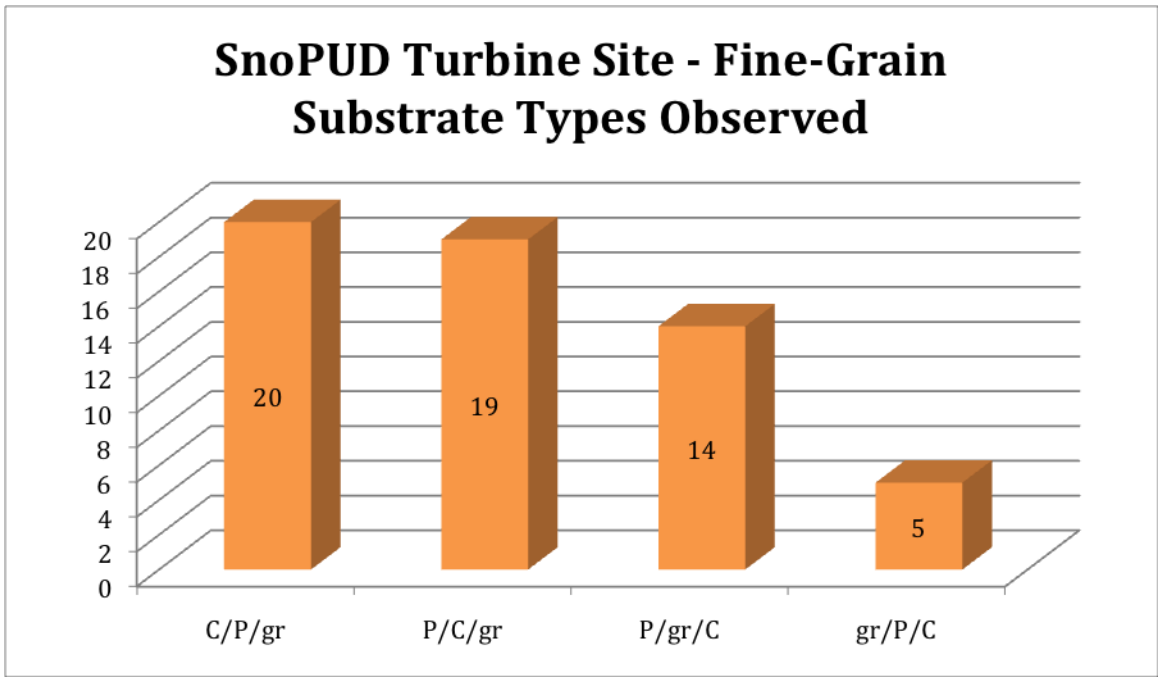

Figure 6. *Numbers of relative fine-grain substrate types noted during the video observations. Cobble-pebble-gravel and pebble-cobble gravel represent the dominant grain size.*

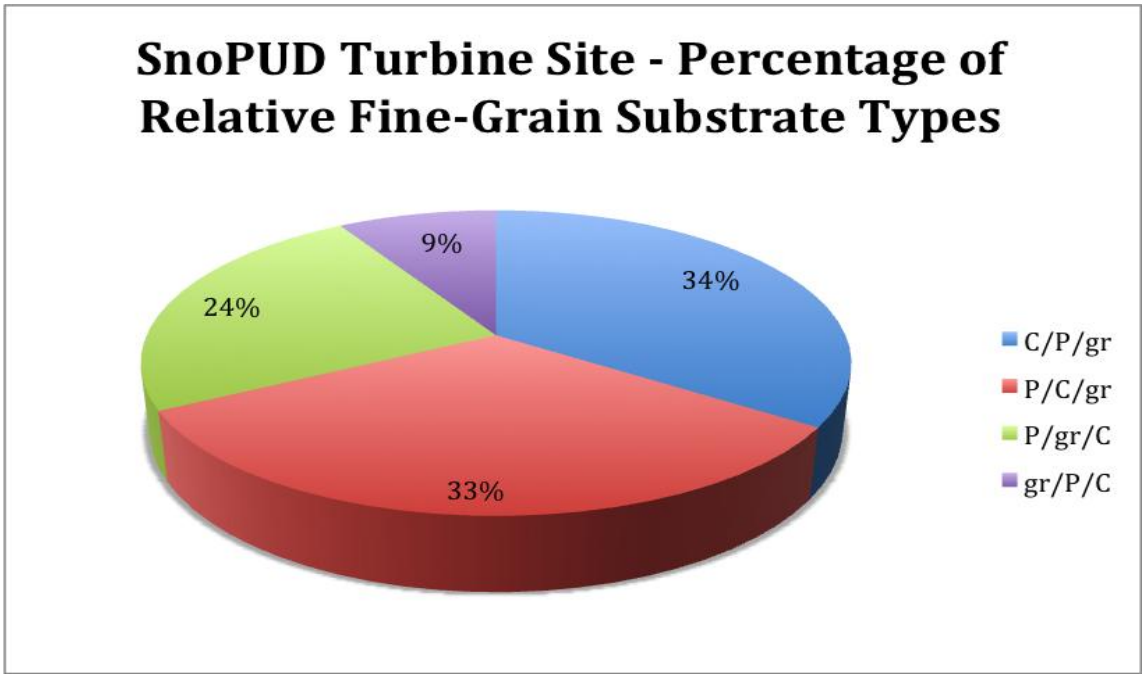

Figure 7. *Percentage of relative fine-grain sediment type observed in the video review. Cobble-pebble-gravel and pebble-cobble-gravel are equally represented and produce two-thirds of the fine-grain substrate types.*

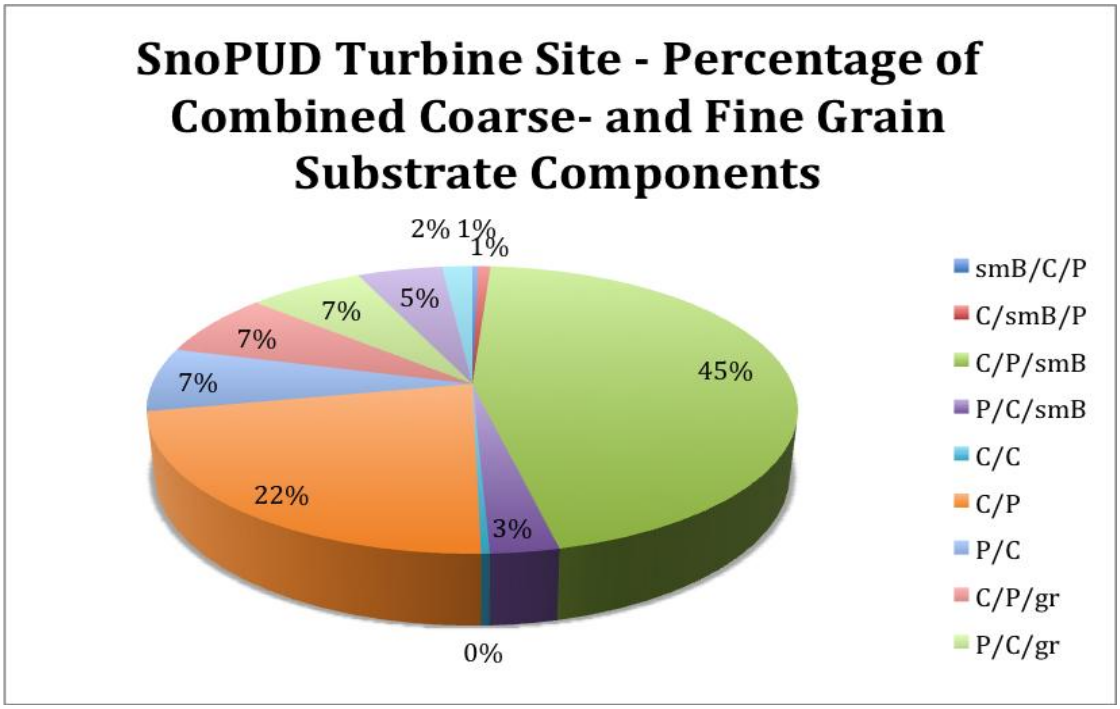

Figure 8. *Percentage of all substrate types observed from the ROV video indicating that the dominant substrate types consist of the cobble-pebble-small boulder and cobble-pebble clast sizes.*

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Cobbles, pebbles and small boulders are all generally well rounded with an occasional clast being sub-rounded. These clasts are also heavily encrusted with the exception of in areas that have been noted as lightly encrusted or clean. The relatively finer-grained material such as gravel and sands that were rarely observed all generally appear clean and may represent the transport of sediment through the area (see Plate 2). The dominant substrate is a lag deposit heavily winnowed from tidal current activity and represents a pavement where clast-to-clast contact exists and most fine-grain constituents have been removed.

The most diverse coarse-grain substrate types with varying grain sizes and patchiness exist along ROV transects 24S and 36N continued-2 (see Plate 1). For the fine-grain constituent the most diverse substrates are located along ROV transects 27S and 31S. However, throughout most of the turbine area the substrate is fairly homogeneous composed of cobbles, pebbles and small boulders with locally concentrated small boulder piles and individual large boulders (see Plate 1). This is a glacial lag deposit with fine grain size (sand and gravel) winnowed by the strong bottom currents. The largest boulders appear to be concentrated in the SE corner of the mapped area. All substrate exists as a pavement winnowed by strong bottom currents. The most stable substrate exists in the SE and NW corners of the mapped area (see Plate 1).

Lightly encrusted to clean substrate was found to diagonally cross the turbine site from the east central edge to the NW corner (see Plate 2). This clean substrate is composed of finer grained clasts consisting of pebbles and gravels that may be actively transiting the site during ebb tidal flow, however, more study on this phenomenon needs to be undertaken.

3.2. *Biology*

The benthic biology of the turbine site in relation to the substrate is dominated with encrusting organisms, primarily sponge, bryozoans and tubeworms. These organisms are ubiquitous and, therefore, no attempt to count them was made. Relative cover of the substrate by these organisms was attempted by noting if an area along an ROV transect was heavily, moderately or lightly encrusted or clean. No statistical analysis was made as it was apparent that most of the substrate in the investigation site is heavily encrusted, especially on the coarser grain clasts such as boulders and cobbles. It appears that because of the strong bottom currents boulders and cobbles are the most stable, unmovable, clasts and thus are static enough for encrusting growth to occur over time. The finer grain constituents, small pebbles, gravel and sand are relatively easily moved by the currents and are, therefore, tumbling through the area (saltation) without being encrusted.

Other biological components, including encrusting organisms, both of fauna and flora, sessile organisms, epifauna (invertebrates), attached organisms, and fish were found in reasonable numbers to count. Selected organisms, such as anemones,

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

starfish, urchins, and fish, were selected for counting while others, such as barnacles and algae, were noted but not comprehensively counted.

3.2.1. Selected Encrusting Organisms (Barnacles and Algae)

Barnacles and algae are prolific at the turbine site although there is patchiness to their distribution. In order to determine the amount of coverage that these organisms have they were noted in the video review in areas where they appeared to be concentrated; a direct count was not made.

Barnacles occurred as individuals, clusters and heavily concentrated in fields, lots of barnacles. Their concentrations were noted and show that at least 53% (166 notations) were made of individuals, B, while 28% (89 notations) for barnacle clusters, B(clust) and 19% for barnacle fields (59 notations), B(lots) were made (Fig. 9). This analysis basically suggests that most of the barnacles are scattered individuals while clusters and fields are less abundant (see Appendices II and III, Plate 1).

The algae community found at the site is composed of two basic types, a Crinoid-like or filamentous algae (Cri/filiAlgae)[1] and bladed algae, (A). Similar to how the barnacles were assessed, algae were not counted, but notations were made where they seemed to be present in large numbers that warranted mention (see Appendices II and III). From these notations it was found that the Crinoid-like or filamentous algae dominated the flora with 65% (106 notations) of the total and the remainder of the algae noted representing 35% (57 notations) of the total (Fig. 10).

Generally encrusting organisms (e.g., encrusting sponges, bryozoans, barnacles), as well as attached organisms (e.g., Crinoids, anemones) were ubiquitous in all the moderately and heavily encrusted areas, which are in all areas not mapped as clean substrate. However, where unusual concentrations of barnacles such as B(clust) and B(lots) as well as heavy concentrations of crinoids, Crinoids forests, were found they were symbolized on Plate 1 where they seemed to be concentrated in the northeastern and southwester corners of the surveyed site.

[1] These have since been identified as Crinoids by Waldo Wakefield (Wakefield, Personal Commun., 2/2011).

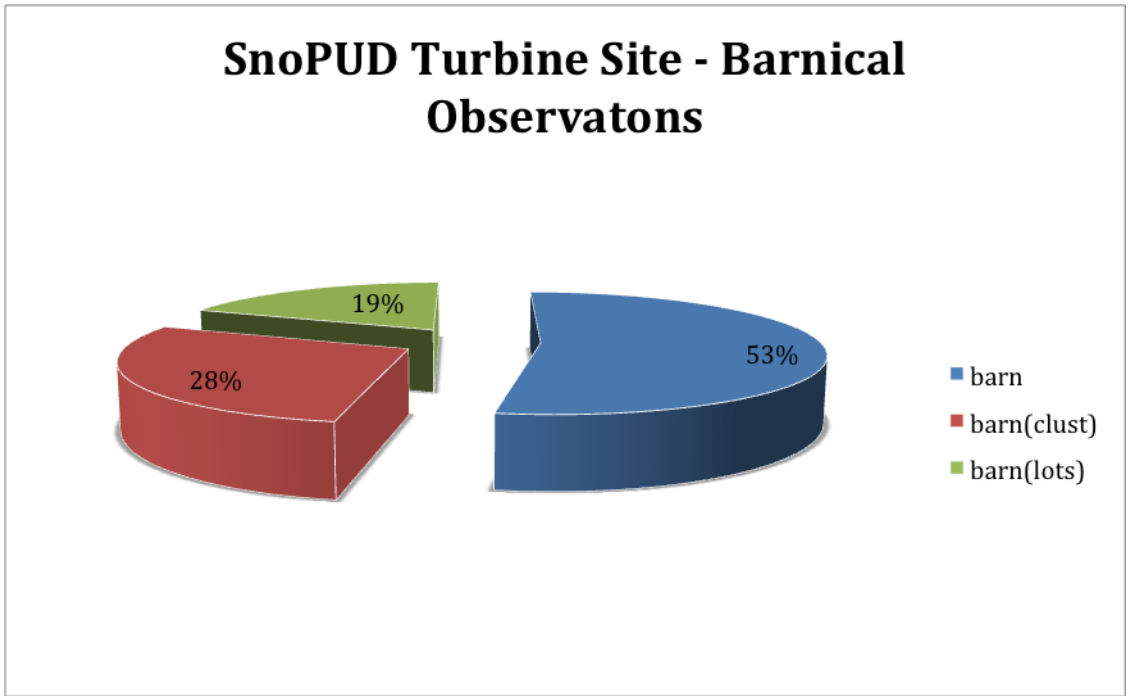

Figure 9. *Percentage of individual, barn, cluster, barn(clust) and highly concentrated or fields, barn(lots), of barnacles noted in the turbine site.*

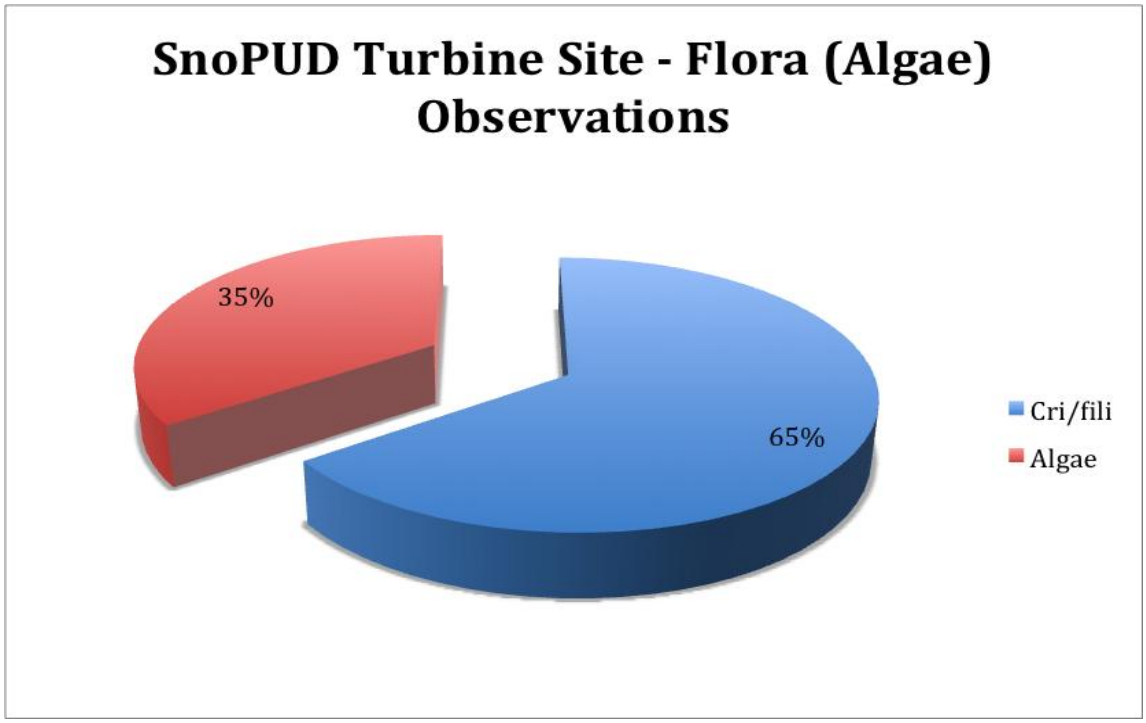

Figure 10. *Percentage of Crinoid-like or filamentous and bladed algae observed in the ROV video at the turbine site. The filamentous algae are the dominant form.*

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

The barnacles and algae were observed to be heavily concentrated along ROV transects 27S? (133 barnacle, 23 algae notations), 31S (251 barnacle, 17 algae notations), 36N continue (28 barnacle, 10 algae notations), and 31S (16 barnacle, 16 algae notations). Algae appeared to have a direct relationship with barnacles, as where large concentrations of barnacles occurred, such as clusters or in fields, a considerable amount of algae were attached to the barnacles (see Appendices II and III, Plate 1). The Crinoid-like or filamentous algae were observed attached to both barnacles and cobbles and boulders.

3.2.2 Attached Organisms (Anemones)

A variety of anemones were observed and counted in the turbine site. These organisms were relatively easy to identify and were generally solitary and thus easier to count than highly concentrated species. Three basic types were distinguished based on color and pattern (solid purple and white, and stripped white on purple) in addition to an orange or deep purple pompom-like anemone or nudibranch. Some anemones were not distinguishable enough to place into any of the above categories and, therefore, were just counted as an anemone (A). A total of 1,375 anemones were counted, a total of 1,869 if the pompom-like or nudibranch ones are included. In addition, the feeding state noted during the ROV survey indicated that most of the anemones were not feeding, but observations made during the time that tidal conditions changed from slack to flood, saw the anemones opening to feed (see Appendices II and III).

The most prolific anemones counted are the purple closed ones (p/c) at 49% (669 counts) followed by the white closed (w/c) at 23% (315 counted), purple open (p/o) at 12% (166 counted), anemones, general (A), at 9% (119 counts), stripped closed (s/c) at 6% (87 counts), white open (w/o) at 1% (15 counts) and stripped open (s/o) at >1% (4 counts), excluding the pompom-like organisms (Fig. 11).

If the pompom-like or nudibranch are included in the anemone count the purple (p/c) closed anemones still dominate at 36%, but the pompom-like or nudibranchs (pp) are found to be second in abundance at 26% followed by white closed (w/c) at 17%, purple open (p/o) at 9%, general anemones (A) at 6%, stripped closed (s/c) at 5%, white open (w/o) at 1% and stripped open (s/o) at >1% (Fig. 12).

The anemones varied in size ranging from ~4 cm to 12 cm in diameter when closed, the diameter of their stock or trunk (see Appendices II and III). The size is pretty uniform and small, probably because if larger they would provide a greater surface area to the currents and thus prone to displacement by the tidal currents.

The anemones appeared to be concentrated along specific ROV transects. Transects where these organisms were most prolific are 31S (140 counts, 183 if pp counted), 34N (99 counts, 142 if pp counted), 24S (120 counts, 160 if pp counted), and 36N continued (141 counts, 179 if pp counted).

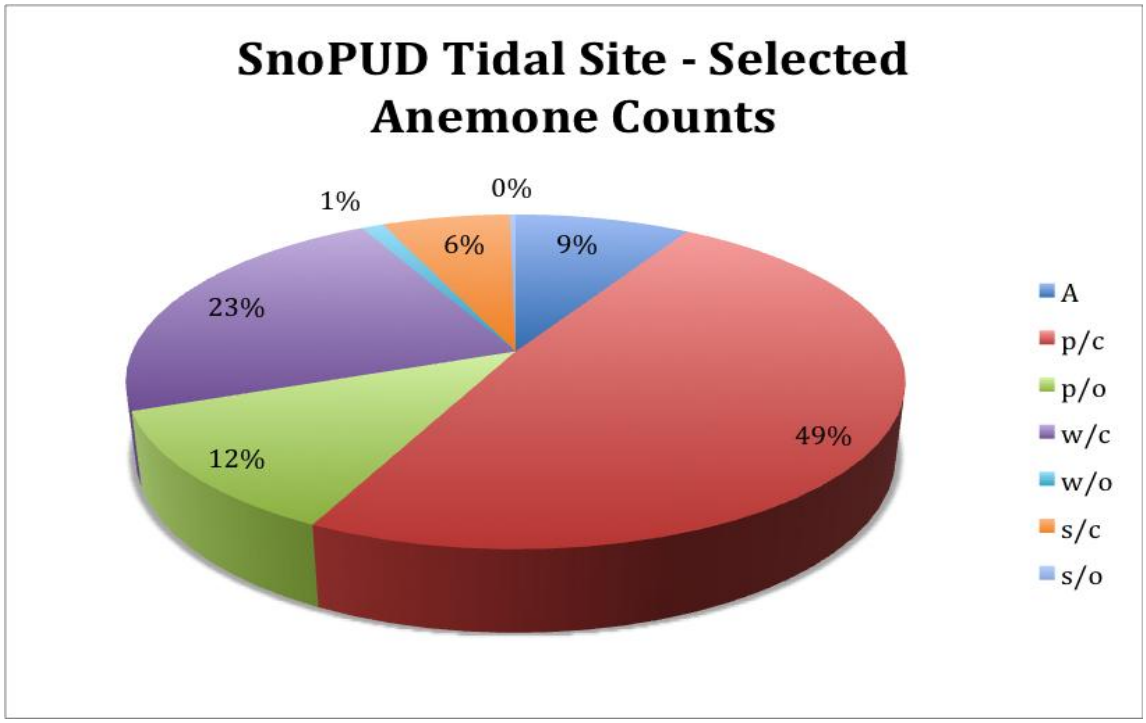

Figure 11. *Percentage of anemones counted from the ROV video. A = anemone, general, p/c = purple closed, p/o = purple open, w/c = white closed, w/o = white open, s/c = stripped closed, and s/o = stripped open anemones. The dominant type of nearly 50% is the purple closed anemone.*

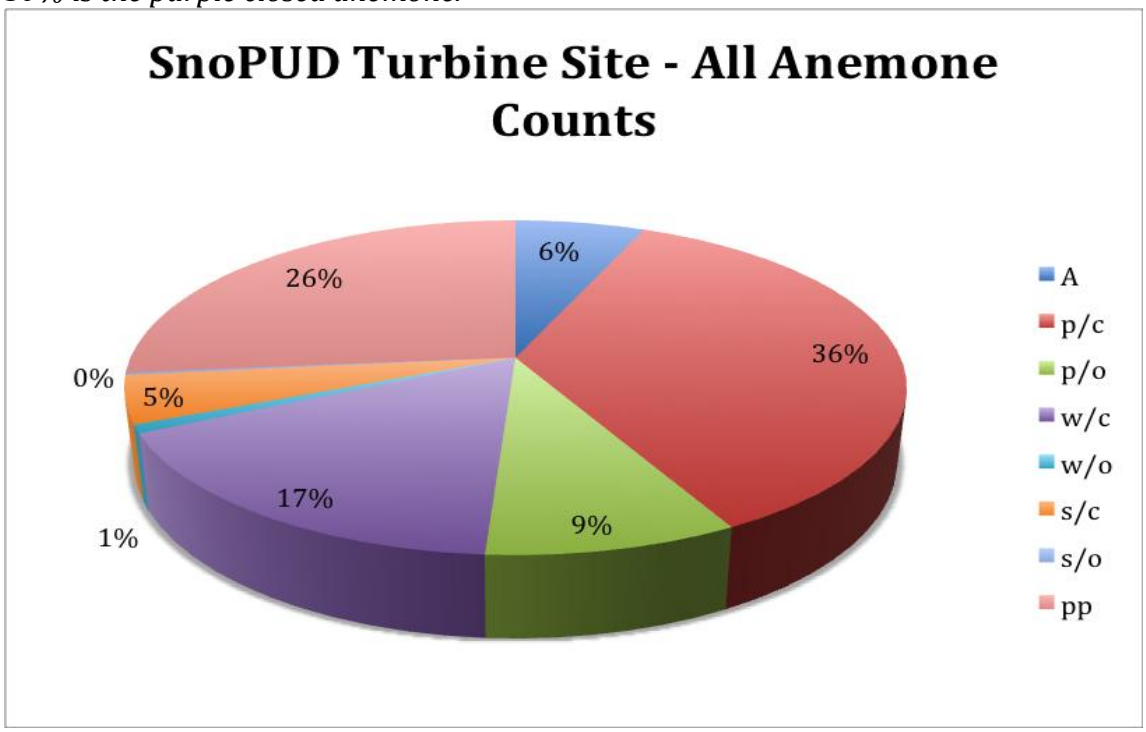

Figure 12. *Percentage of anemones counted in the ROV video including the pompom-like or nudibranch (pp) form. Purple closed anemone still out numbers all others.*

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

3.2.3 Sessile Organisms

Organisms included in this group are tunicate, chiton or limpid, and stemmed or basket sponge, as well as clams. Although observed in few numbers, these organisms were counted to obtain an estimate of their quantity. Chitons or limpids are the dominant organism of this group at 44% (7 counts) followed by tunicates at 37% (6 counts) and stemmed and basket sponges at 19% (3 counts) (Fig. 13).

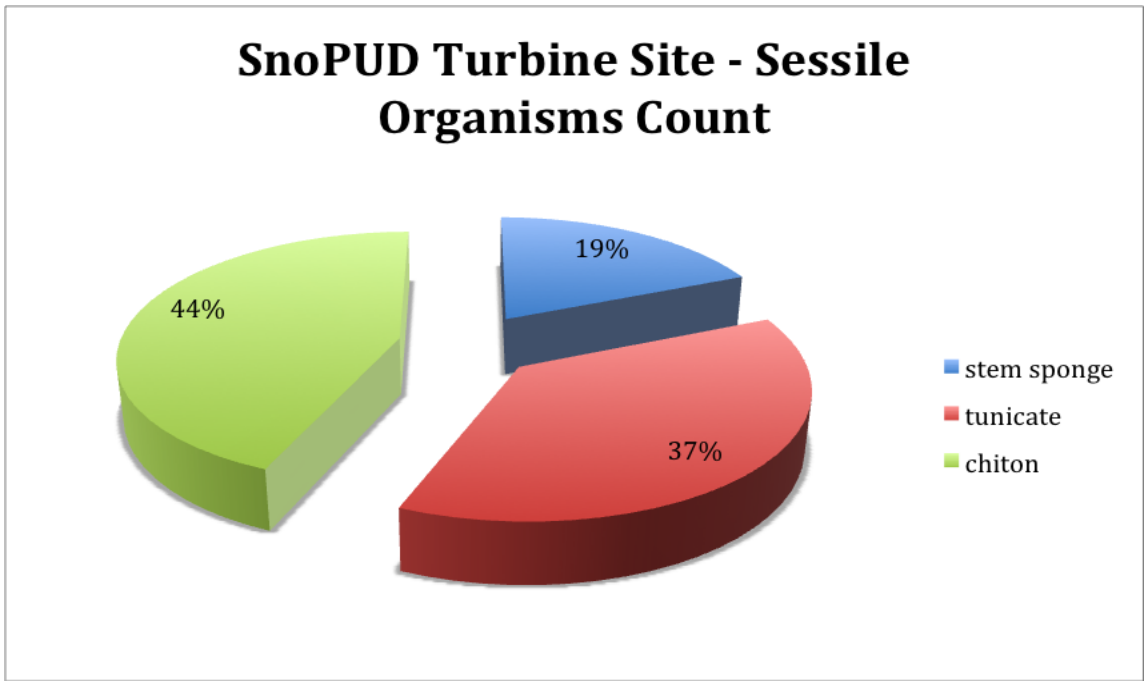

Figure 13. *Percentage of selected sessile organisms counted using the ROV video. Although small in numbers these sessile organisms provide an estimate of abundances based on what could be seen using the video.*

Clams observed in the ROV video were either partially open or closed, where 82% (23 counts) were open and 18% (5 counts) were closed (Fig. 14). If the clams are included with the other sessile organisms counted, closed clams dominate at 52%, chitons or limpids represent 16%, tunicates 14%, open clams 11%, and stemmed or basket sponges 7% of all sessile organisms counted (Fig. 15).

Open clams are the dominant species of the sessile organisms counted. These organisms were found to be most prolific along ROV transects 34N (3 counts), T-24S (4 counts), and 24S (6 counts).

For a complete run-down on the sessile organisms count see Appendices II and III.

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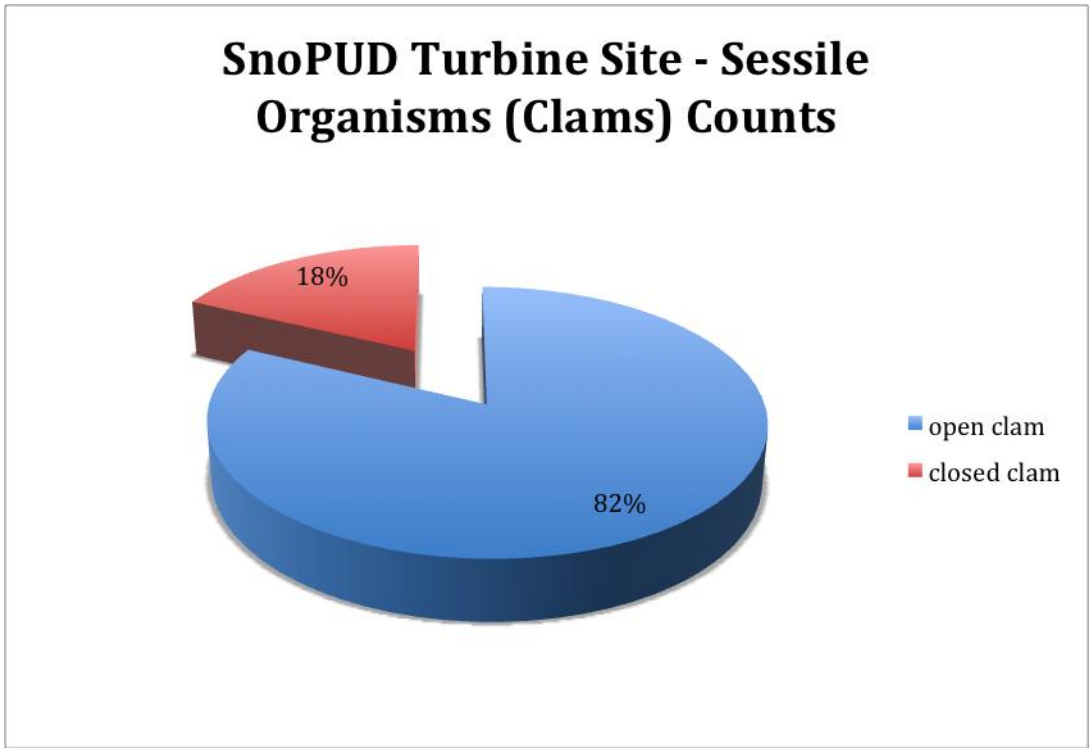

Figure 14. *Percentage of clams counted from the ROV video.*

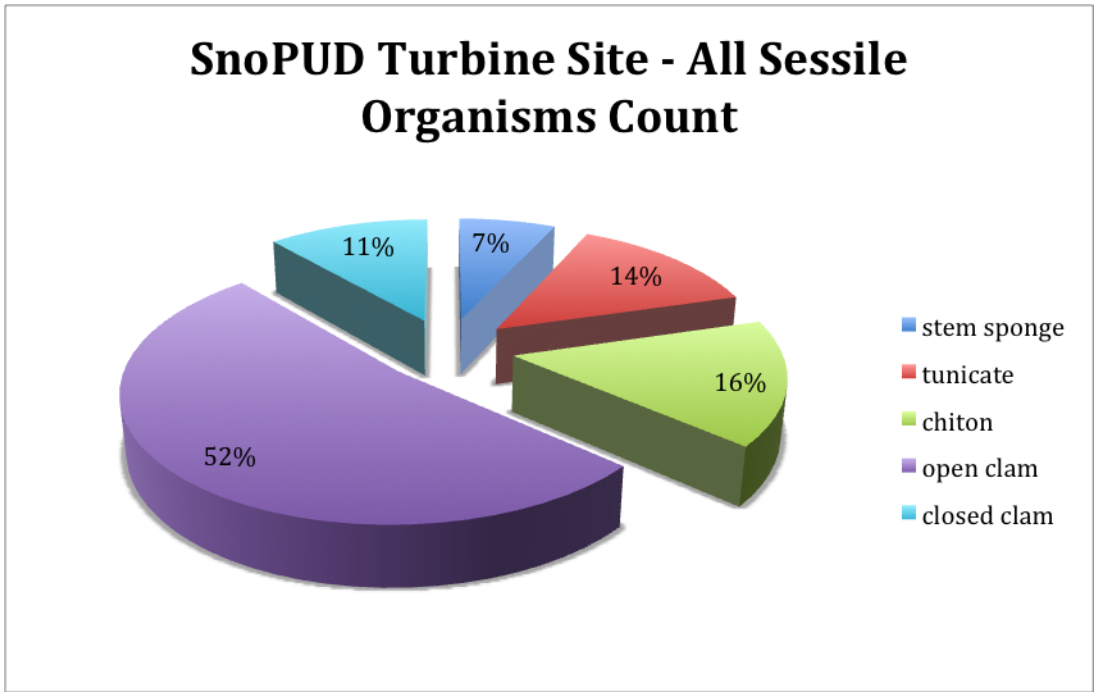

Figure 15. *Percentage of sessile organisms counted from the ROV video review including clams. Open clams dominate the group with 52%.*

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3.2.4. Epifauna

The epifauna selected for counting consist of two groups, starfish and urchins. The first group, starfish, consists of three different types, general five-legged, orange starfish, sun starfish, and leather starfish. Two types of urchins were counted including green(?) urchin and purple urchin. Each group was compared independently and then combined to determine the overall relative abundance of each species (see Plate 1 for spatial distrubution).

Of the 134 starfish counted 89% (119 counts) of them were of the common type, 9% (12 counts) were sun stars, and 2% (3 counts) were leather stars (Fig. 16).

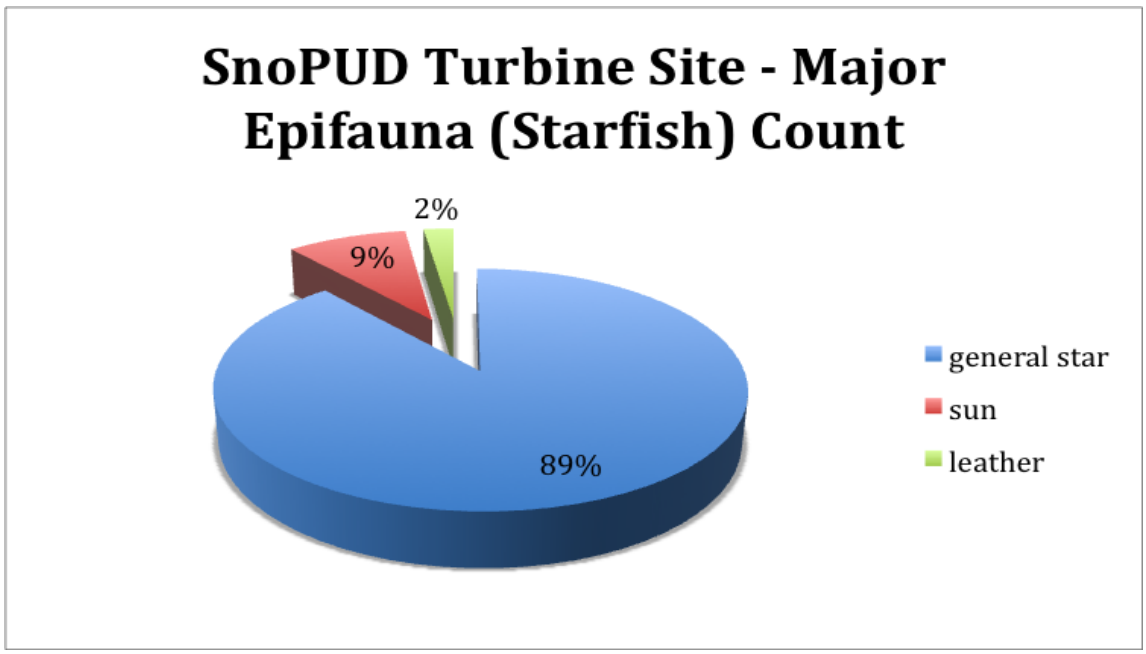

Figure 16*. Percentage of various starfish counted using the ROV video. The common general, five-legged orange starfish dominates the group with nearly 90% abundance.*

Urchins are the other epifauna group counted from the ROV video. The two types of urchins, green(?) and purple urchins, were compared to each other and it was found that the green urchin, U, represents 98% (239 counts) of the total compared to the purple urchin U(pur) or 2% (6 counts) of the total (Fig. 17).

The starfish and urchins were combined to be compared as a single group and it was found that out of a total of 242 counts the green(?) urchin comprised 63% of the group while the common starfish represents 31% with the sun star representing 3%, the purple urchin 2% and the leather star less than 1% (Fig. 18).

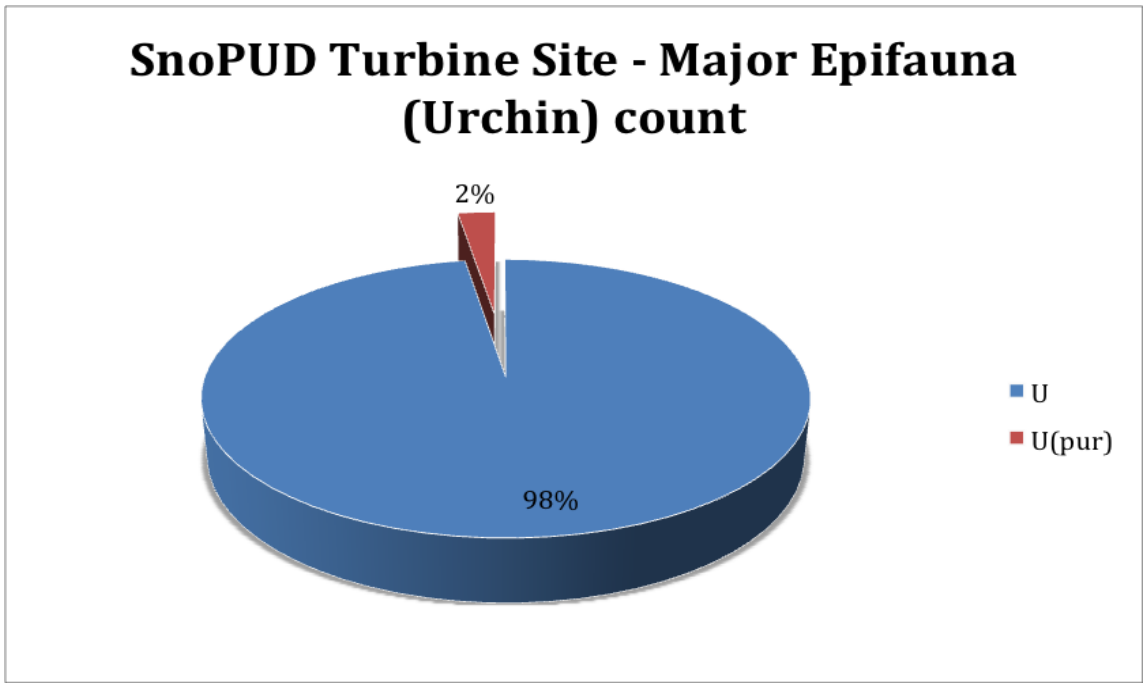

Figure 17. *Percentage of green(?), U, and purple, U(pur), urchins counted from the ROV video review.*

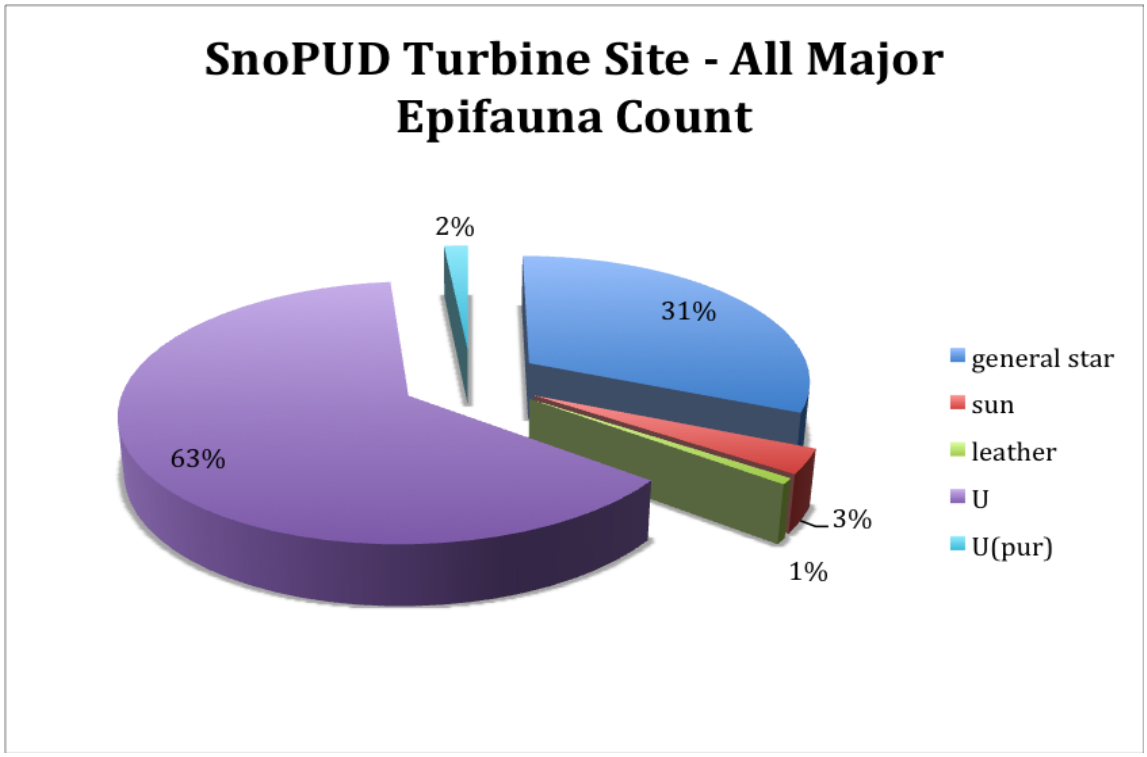

Figure 18. *Percentage of selected major epifauna counted from ROV video. The common (green?) urchin dominates the field at 63% followed by the common starfish at 31%.*

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

The ROV transects where this group of epifauna were found to be most concentrated in the investigation site are transects 31S (11 star, 14 urchin counts), 34N (13 star, 15 urchin counts), 24S (15 star, 24 urchin counts), 36N (11 star, 24 urchin counts), and 24S (6 star, 17 urchin counts).

Other epifauna counted, although rare, consist of turban snails (10) at 56%, shrimp (4) at 22%, hermit crab (2) at 11%, crab (1) at 5%, and an octopus (1) at 6% of the total this group (Fig. 19).

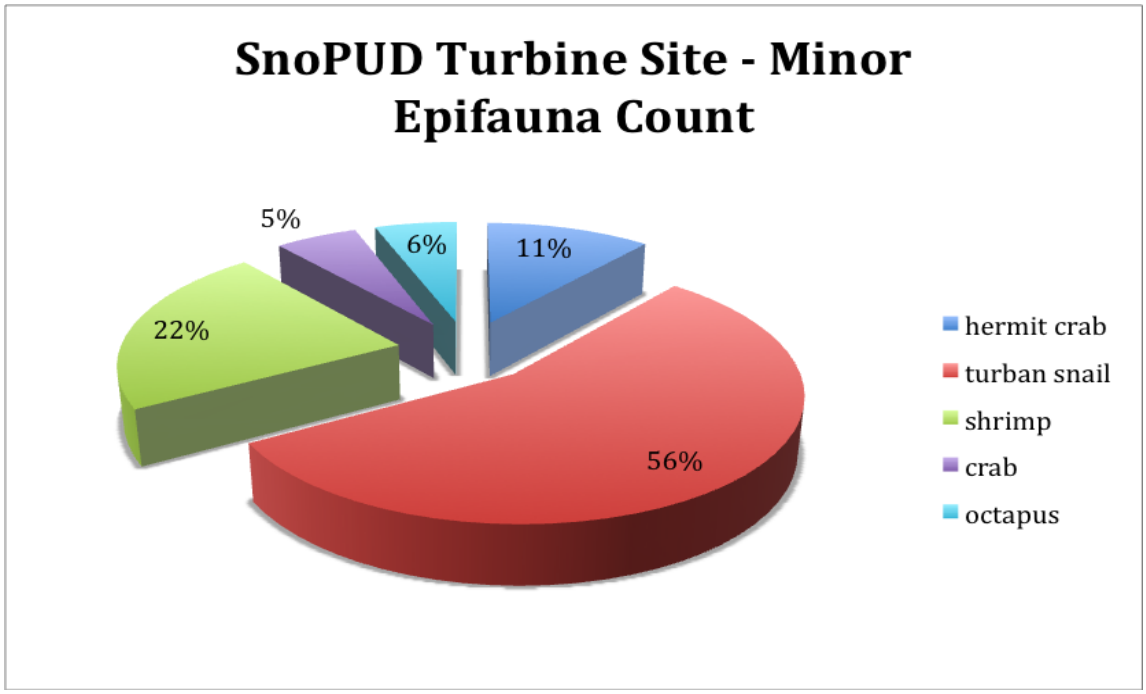

Figure 19. Percentage of rare (minor) epifauna counted in the review of the ROV video. The turban snail dominates this group at 56%.

When the major and minor epifauna are combined the common (green?) urchin dominates the field at 60%, while the general five-legged orange starfish represents 30%; these two species represent 90% of the total epifauna counted (Fig. 20). The remainder of the counted species makes up the final 10%.

Starfish were found to be most concentrated in numbers along ROV transects 31S (11), 34N (13), 24S (15), and 36N continued (11). Urchins were most concentrated in numbers along transects 27S? (14), 31S (14), 34N (15), 24S (24), 36N continued (24) and 24S continued (17). The minor epifauna were primarly concentrated along transects 16S-suspended (6), 34N (3), T-24S (4) and 24S (6). See Appendix III for complete counts (see Plate 1 for spatial distribution).

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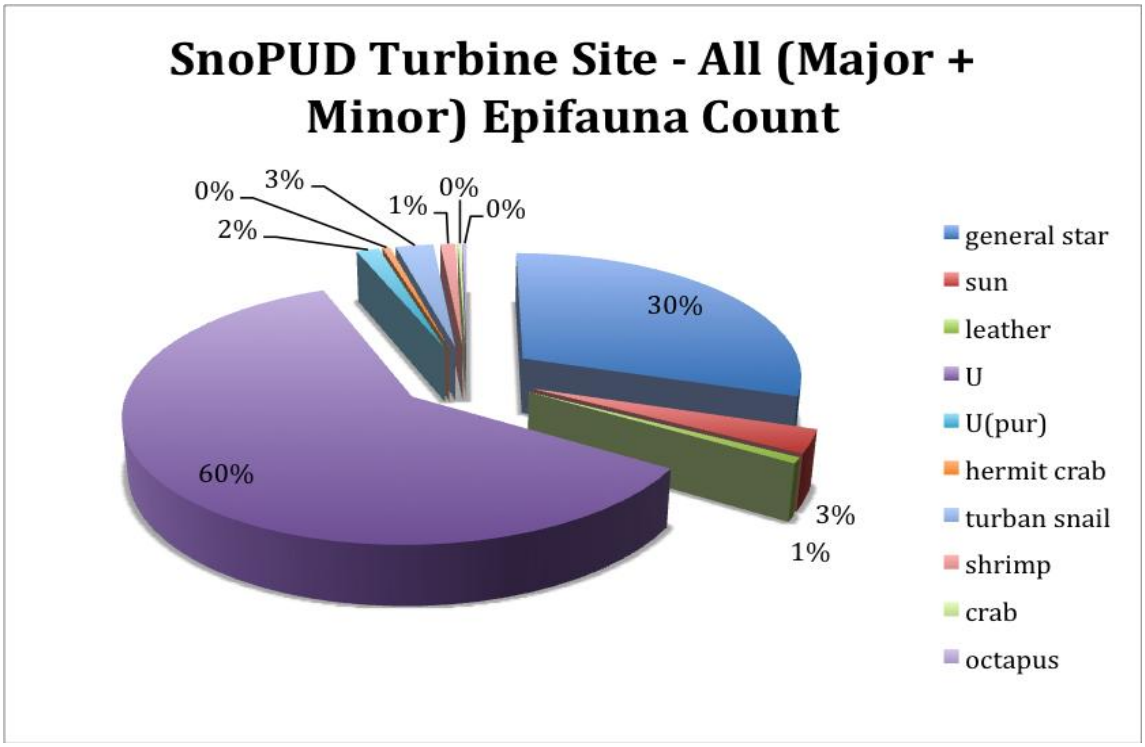

Figure 20. *Percentages of epifauna counted in the review of the ROV video. The common (green?) urchin and the common five-legged orange starfish comprise the majority of the group 90%.*

3.2.5. Fish

A total of 192 fish were counted in the ROV video review and represents a conservative estimate as many fish were seen several times but were not counted when thought to be a repeat. All fish including pelagic and benthic types were counted. Ratfish (rat) were conspicuously the most prominent representing 49% (98 counted) of the total and at times was a nuisance (some even entering the thrusters). Sculpin, ranging in size from ~5 cm to 30 cm, is the most prominent benthic fish counted at 38% (75 counted) followed by an unidentified fish (UnIDfish), generally a black and white stripped goby-like fish about 5-15 cm long, at 8% (16 counted), lingcod (ling) at 4% (7 counted), kelp cod or kelp greenling (kelp) at 1% (2 counted), and Pacific sand lance (PSL) at less than 1% (1 counted), although this identification is questionable (Fig. 21).

If ratfish is considered pelagic and not included in the count than the benthic fish would total 94, nearly half of all of the fish counted. Sculpin would then be the dominant species at 74% followed by the unidentified fish at 16%, kelp greenling at 7%, lingcod at 2%, and Pacific sand lance at 1% (Fig. 22). See Appendix II for video review log and Plate 1 for spatial distribution.

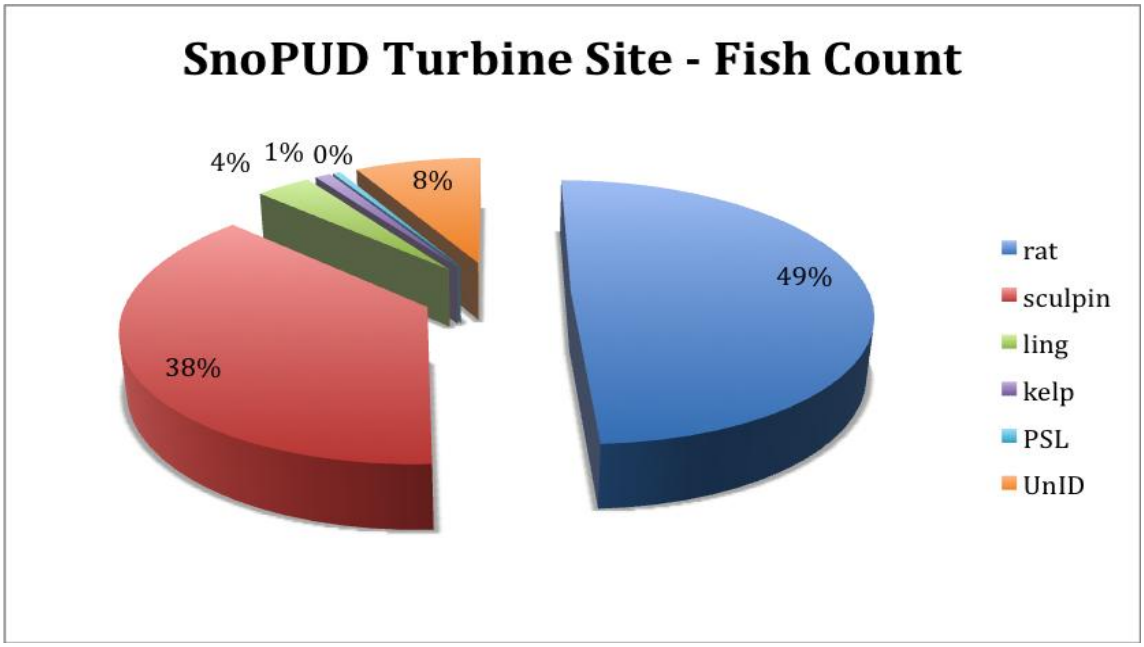

Figure 21. *Percentage of fish counted in the ROV video review. Ratfish dominate the field with almost 50% of the total.*

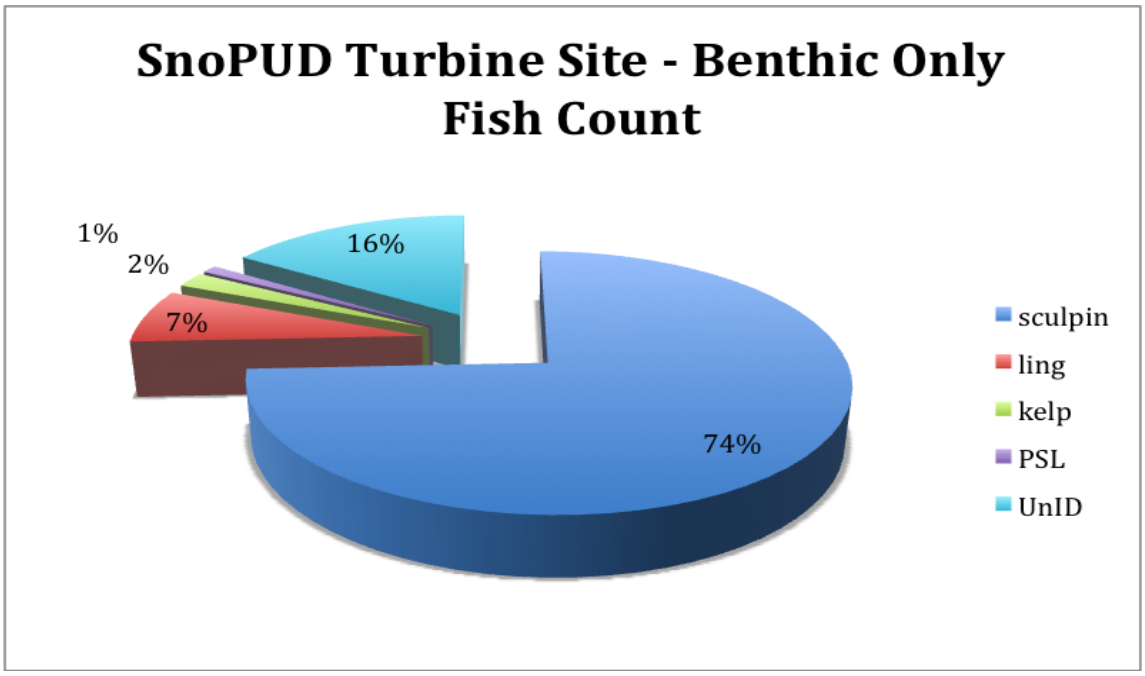

Figure 22. *Percentage of benthic fish counted in the ROV video review. Sculpin represent nearly two-thirds of all of the fish counted during the ROV survey.*

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Fish also appeared to be concentrated along certain ROV transects. Ratfish were highly concentrated along transects T-14N (12), T-14N-2 (10), and 36N continued-2 (10). The benthic fish were concentrated along transects 31S (13 fish, 9 Sculpin) and 24S (9 fish, 5 Sculpin). See Appendices III for complete call out of fish and Plate 1 for their spatial distribution.

4. Results and Recommendations

The SnoPUD turbine site is a dynamic and diverse geological and ecological area. Geomorphology and substrate types found at the site result from past glacial processes and present oceanographic conditions. Strong tidal currents winnowed the fine sediments leaving a cobble-pebble-small boulder lag pavement, heavily encrusted with sponge, bryozoans and tubeworms throughout the area. Locally, stringers of clean, fine grain sediment (gravel and sand) were observed and appear to be transiting through the site, transported by strong ebb tidal currents. A diverse and robust ecological community was observed during the ROV survey and some specific organisms were selected for counting in order to estimate abundances.

Due to strong tidal currents, marginal visibility and irregular bottom conditions consistent elevation above the bottom and continuous even speed for transiting the ROV was not possible. Consequently, not every meter of the turbine site was video imaged. However, due to the fairly consistent substrate type and biology a good characterization of the benthic habitat was possible. A robust and comprehensive statistical analysis of the data was not attempted, but an estimate of abundances as presented here should provide a good base line for, and facilitate, future monitoring efforts.

Few biological scientific names are used in this report primarily because the quality of the recorded video was not sufficient in most cases to identify organisms at the genius or species level. However, most of the organisms observed or counted are tagged to the video logs and can be easily studied in the future to determine their lowest taxonomic level.

Substrate, although fairly consistent throughout the turbine site, is patchy in places and ranges from primarily well-rounded cobble-pebble-small boulders to well-rounded cobble-pebble pavements. The larger clasts, cobbles and boulders, are generally encrusted with sponges, bryozoans, and tubeworms (Fig. 23). The substrate is loose or unconsolidated and clasts can be moved easily with the ROV. Encrustation occurs on the exposed surfaces of the clasts, while the buried, or under surfaces, remain clean, as indicated during times substrate was disturbed by the ROV and from samples collected by an anchor. This substrate appears to attract a diverse biological community consisting of barnacles, algae, anemones and various other attaching and sessile organisms, epifauna consisting of starfish and urchins, and fish, particularly Sculpin.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

There appears to be a relationship between substrate type and ecology. When comparing substrate types with biology along ROV transects it is apparent that most of the organisms observed and counted tend to be concentrated along those transects that appear to have the most diverse substrate types. For example, the most diverse substrate types were noted along transects 24S and 36N for coarse-grain clasts (cobble, pebble, and small boulder) and along 31S for the fine-grain constituents (gravel and pebble) and along these transects the substrate was heavily

Figure 23. *Small boulder and cobble recovered in flukes of anchor from barge used for the ROV operation at the turbine site. For scale pocketknife is approximately 10 cm long. Boulder and cobble are encrusted with sponge, bryozoans, and tubeworms. Note clean area on boulder where area was not exposed.*

encrusted and the largest concentrations of attached, sessile, epifaunal, and fish individuals were counted (Plate 1). Barnacles and algae appeared to be heavily concentrated along transects 27S(?), 31S, 24S, 36N continued and 31S continued. Most of the sessile organisms counted were found along transects 34N, T-24S, and 24S, while anemone counts were highest along transects 31S, 34N, 24S, and 36N continued (Plate 1). Starfish and urchins were more widespread being concentrated along transects 27S, 31S, 34N, 24S, 36N, and 24S-continued. Fish, primarily Sculpin, on the other hand, were restricted more to transects 31S, 24S, and T-34N continued.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Little derelict fishing gear or other anthropogenic debris with the exception of a short length of rope and crab pot rings seen on transect 26N were observed.

Most complex and diverse ecology is located in the SW corner and along the western hypotenuse of the mapped area, at sites where the substrate is coarse (e.g., large boulders). Closely spaced starfish, barnacle clusters and barnacle fields also concentrated in this corner, however the highest concentration of barnacles was found in the NE corner (Plate 1).

Based on these observations and organism counts it appears that the turbine site can be characterized as a coarse-grained, cobble, pebble, boulder habitat for encrusting organisms and Sculpin, although some rockfish appear to use the habitat as well. Epifauna such as sunfish and urchins also occupy the habitat. The proposed positions for the two tidal turbines appear to be well located in regard to the concentration of biological communities (Plate 1). The highest concentration and diversity of these communities lie in the NW and SE corner of the triangle survey area and just outside the northern and southern margin of the clean (no biological communities) dynamic substrate corridor (an active sediment migration corridor for material being transported by bottom currents) (see Plates 1 and 2).

The glacial cobble, pebble, small boulder lag is suspected to overlie a glacial clay layer as clay was observed underlying the coarse glacial lag deposit just outside of the north central boundary of the triangle turbine survey area along the cable route. The glacial lag is unconsolidated and easily moved so it is anticipated that foundation structures for the turbines can be installed with a minimum of disturbance to the substrate.

This ROV habitat characterization of the SnoPUD turbine site sets the foundation for monitoring the area during installation of the turbines and during the operational time of the units. Based on the experience from this study it appears that it is not feasible to collect substrate samples remotely, such as using sediment grab samples or dredges. Alternatively it is recommended that in situ observations using an ROV be undertaken to measure the substrate grain size and disturbance in the same manner as has been used for this study. Also, it is recommended that the same biological communities selected for observation and counting be used for future monitoring of the site. This will provide similar information that can be compared and contrasted with the results of this investigation.

References:

Anderson, T.J., and Yoklavich, M.M., 2006. Multiscale habitat associations of deepwater demersal fishes off central California. Fisheries Bulletin, 105, p. 168-179.

Gary, M., McAfee, Jr, R., and Wolf, C.L., (eds.), 1974. Glossary of Geology. American Geological Institute, Washington, D.C., 805 pp.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Lynch, T.P, Pinkard, D.R., and Bultler, J.L., 2004. Use of remotely operated vehicle as a fisheries survey tool. NOAA, ROV Operations, LaJolla, CA, 36 pp.

Pacunski, R.E., Palsson, W.A., Greene, H.G., and Gunderson, D., 2008. Conducting visual surveys with a small ROV in shallow water. In Marine Habitat Mapping Technology for Alaska, J.R. Reynolds and H. G. Greene (eds.), Alaska Sea Grant Program, University of Alaska Fairbanks, p. 109-128.

Plate 1. ROV track line map of the SnoPUD tidal turbine site showing location of individual and concentrations of biological organisms and substrate types as observed from the ROV video.

Plate 2. Multibeam echosounder bathymetric image with interpreted potential benthic habitat types in the vicinity of the SnoPUD tidal turbine site offshore Admiralty Head, Whidbey Island, Washington. Habitat types based on Greene (2007).

Explanation for Plate 2:

Ih(c/p/b)_p/u	Hard unconsolidated cobble/pebble/small boulder pavement in Inland sea, moderately to heavily encrusted
Ih(b/c)i_p/u	Hard unconsolidated boulder/cobble moraine pavement in Inland sea, moderately to heavily encrusted
Ihg_p/s	Hard scour gully with sedimentary pavement in Inland sea
Ih(c/b)w(w)_u	Hard unconsolidated cobble/boulder sediment waves in Inland sea
Ihm_c/u	Hard bedrock mounds of consolidated material locally covered with sediment in Inland sea
Ime_c/u	Mixed hard consolidated bedrock locally covered with soft unconsolidated sediment in Inland sea
Ime_c/u/h	Mixed hard consolidated bedrock locally covered with soft unconsolidated sediment, hummocky, in Inland sea
Imi_p/u	Mixed hard moraine pavement locally covered with soft unconsolidated sediment in Inland sea

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Imm/h_c/u/h	Mixed hard, consolidated mounds and depressions locally covered with soft unconsolidated sediment, hummocky, in Inland sea
Isb_u	Soft unconsolidated bimodal (pebble/gravel) sediment, clean or lightly encrusted, in Inland sea, dynamic, being transported

See Appendix IV for complete habitat code list (modified after Greene et al., 2007).

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Attachment 2

Greene, H.G. (2012) Review of ROV Video Collected Within the Tidal Turbine Box Offshore of Admiralty Head, Washington, Technical Report, October 2012.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

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Review of ROV Video Collected Within the Tidal Turbine Box Offshore of Admiralty Head, Washington

H. Gary GreeneCapRock Geology, Inc.
Final Report, October 2012

CapRock Geology, Inc. reviewed and examined nine DVD discs containing recorded seafloor video collected July 11-13, 2012 by Northwest Underwater Construction, LLC (their Job No. 112083) using a Remotely Operated Vehicle (ROV) to determine substrate type within the SnoPUD proposed tidal turbine site and cable route offshore of Admiralty Head, Whidbey Island, Washington.

Video quality ranged from very poor to marginal due to 1) the lack of a high-quality, high-resolution underwater color camera or recording system, 2) the medium-resolution black and white camera or recording system used as the primary observing system, 3) periods of high water column turbidity, 4) strong currents that interfered with ROV navigation, and (5) lack of audio on several recordings.

Notwithstanding the lack of color video and occasional turbid water conditions, a general determination of substrate could be made by logging video observations based on the deep-water habitat characterization scheme developed by Greene et al. (1999) and modified for use in mapping habitats offshore of California (Greene et al., 2005, 2007). A key to the overall Habitat Code is attached. While only periodic and general biological observations could be made, the video is useful in accessing the potential benthic habitat types of the seafloor.

Cable Route

From the audio descriptions in the video recordings it appears that the surveyed cable route runs from near the Coupeville ferry landing southward to a depth of over 71 m in a depression and then to shallow depths where the turbine installation sites are located. Without a navigation map of the cable route it is difficult to determine substrate distribution, however using the depth, heading and other information stamped on the video images a general substrate determination could be made.

Progressing from shallow to deep in an Inland sea the soft substrate coarsens from 1) cobbles, pebbles and sand, with occasional piles of cobbles producing a rugged bottom, to 2) sand and gravel and 3) gravel and pebbles. All clasts are well rounded and much of this substrate in shallow water is heavily covered with vegetation (algae). The potential habitat type codes for these substrates are 1) Is*(c/p/s)v[a], (Inland sea with soft sediment observed by video showing cobbles, pebbles and sand with sediment vegetated by algae) 2) Is*(s/g)v[a], (Inland sea with soft sediment observed by video showing sand and gravel with the sediment vegetated by algae),and 3) Is*(g/p)v[a], (Inland sea with soft sediment observed by video consisting of gravel and pebbles with the sediment vegetated by algae), much of it

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

being vegetated (Note that the clasts that comprise the substrate is listed in order of dominance, e.g., c/p/g indicates that cobbles are the dominant clast while pebbles are second and gravel third or the minor clast; see Appendix A). The deeper parts of the cable route are coarser grain consisting of 1) cobbles, pebbles and small boulders with 2) occasional concentrations of medium- to large-size boulders, possibly glacial dropstones. Many of the clasts are heavily encrusted with sponges, barnacles, algae and bryozoans. In one locality a 3) mud window was visible indicating a mud substrate overlain with coarser grain materials such as gravel, cobbles and pebbles. The deeper water potential habitat types range from 1) Is*(c/p/smb/y), (Inland sea with soft substrate observed by video consisting of cobbles, pebbles and small boulders and many barnacles), 2) Is*(b-d/y), (Island sea with soft substrate observed from video of dropstone boulders and barnacles, and 3) Im*(m/c/p)(Inland sea with mixed substrate of hard cobble and pebble pavement over mud) (see Appendix A).

Turbine Site

Substrate within the turbine site consists predominantly of cobbles, pebbles and small boulders (ROV Lines 4-12?). A cobble-pebble pavement with occasional small boulders exists at the site and results from a heavily winnowed glacial till. Fine-grain sediment of sand, silt and organic matter fill the interstices. A coarser grain substrate consisting of cobbles, small boulders, and pebbles with scattered medium- to large-size boulders are concentrated in the SE part of the ROV survey box (ROV Lines 1-3?). Finer grain substrate consisting of cobbles, pebbles and gravel with some scattered small boulders is located in the southern part of the ROV survey box (ROV lines 2 and 3?). Closely concentrated or piles of boulders were found to be located in the center of the box, primarily in the middle of ROV Lines 7 and 10. Much of the larger clasts within the survey box (boulders, cobbles and pebbles) are well rounded, heavily encrusted with sponges, barnacles, and bryozoans and vegetated with algae and crinoids.

Potential marine benthic habitats for the ROV survey box are classified as Is*(c/p/smb)v[a/b], (Inland sea with soft substrate observed by video consisting of cobbles, pebbles and small boulders with vegetated clasts of algae and bryozoans), Is*(c/smb/p)v[a/b], (Island sea of soft sediment observed by video consisting of cobbles, small boulders, and pebbles with clasts vegetated with algae and bryozoans), Ih*(b-d/y)[a/b], (Inland sea of hard substrate observed by video consisting of cobbles, pebbles and gravel vegetated with algae and bryozoans), and Ih*(c/p/g)v[a/b] (Inland sea of hard substrate observed by video consisting of cobbles, pebbles, and gravel with sediment vegetated with algae and bryozoans) (see Appendix A). These potential habitat types may be habitat for sculpin as quite a few sculpin fish were observed within the substrate along with ratfish and shark above the substrate. In addition to clams and shell hash, two scallops and an octopus were identified. Sea anemones, mostly closed, sea stars, urchins and a few other sessile and epifauna organisms were observed. Although occasional observations of these organisms were made, the survey data does not allow for the identification of

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

any fields of barnacles, anemones, or other organisms. Unfortunately, due to the lack of color and high-resolution video the ecosystem could not be characterized properly. However, the ecosystem appears to be composed of very robust encrusting and sessile organisms that can survive in a high current energy physical environment and a coarse-grain sustrate. Large size clasts such as boulders and cobbles appear to be static as many of the clasts are encrusted on their upper and side surfaces primarily by sponge, bryozoans, algae, and crinoids. If the clasts are dynamic and constantly in motion they would appear with fairly clean surfaces devoid of encrusting organisms and biota. The static conditions of clasts can be easily determined by turning them over to determine the amount of encrustation, if any, on the bottom surfaces. If encrustation is observed on the undersides of clasts, then this would indicate that it has moved recently. These conditions are consistent with those seen in the eastern quadrant of the 2010 survey area.

Estimated measurements of clast and organisms' sizes were facilitated with an 18.5 cm (7.3 in) parallel-spaced laser.

References:

Greene, H.G., Yoklavich, M.M., Starr, R., O'Connell, V.M., Wakefield, W.W., Sullivan, D.L. MacRea, J.E. and Cailliet, G.M., 1999. A classification scheme for deep-water seafloor habitats: *Oceanographica ACTA*, v. 22, n. 6, p. 663-678.

Greene, H.G., Bizzarro, J.J., Tilden, J.E., Lopez, H.L., and Erdey, M.D., 2005. The benefits and pitfalls of geographic information systems in marine benthic habitat mapping: *In* Wright, D.J. and Scholz, A.J., (Eds.), Place Matters. *Oregon State University Press*, Portland, OR, p. 34-46.

Greene, H.G., Bizzarro, J.J., O'Connell, V.M., and Brylinsky, C.K., 2007. Construction of digital potential marine benthic habitat maps using a coded classification scheme and its application: *In* Todd, B.J., and Greene, H.G. (Eds.), Mapping the Seafloor for Habitat Characterization, *Canadian Geological Association* Special Paper 47, p. 141-155.

Appendix A

Key to Habitat Code

System – Marine
Subsystem – Tropical

An attribute code was written to easily distinguish each habitat type and to facilitate ease of use and queries in GIS (e.g., ArcGIS). This code is based on the deep-water habitat characterization scheme developed by Greene et al. (1999) and modified for use in mapping habitats offshore of California (Greene et al., 2005, 2007a) and here

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

has been expanded to address habitats in a Tropical environment (0-1000 m water depth and 0-23° North and South Latitude). The code is designed so that the first character in the code, a capital letter, indicates one of nine Megahabitat types. These general Megahabitat types with suggested depth ranges in parentheses[1] are as follows:

A = Aprons, continental rise, deep fans and bajadas (3000-4000 m)
B = Basin floors, borderland types (floors at 1000-2500 m)
D = Demarcation, shelf edge or shelf break (100-200 m)
E = Estuary, (0-100 m)
F = Flanks, continental slope, basin/island flanks (200-3000 m)
I = Inland seas, fiords, and narrow inlets or passages (0-200 m)
M = Submarine mesa or plateau (200-1000 m)
P = Plains, abyssal (4000-6000+ m)
R = Ridges and seamounts (crests at 200-2500 m)
S = Shelf, continental and island shelves (0-200 m)
T = Trench, represents subduction, or paleo-subduction zones (3000-7000m)
Z= Zone of fractures (3000-5000 m) or fracture zones associated with spreading ridges

The second character in the code, a lower case letter, indicates bottom induration (hardness) and consists of the following:

h = hard bottom (e.g., rock outcrop or sediment pavement)
m = mixed hard and soft bottom (e.g., local sediment cover of bedrock)
s = soft bottom, sediment cover

<u>Sediment types</u> (for above indurations) - Use parentheses.
(b) = boulder
(c) = cobble
(p) = pebble
(g) = gravel
(s) = sand
(m) = mud, silt, clay
(h) = halimeda sediment, carbonate
(r) = rubble, coral
(f) = fragments, shell hash
(y) = barnacles and plates

When inferred, use question mark; i.e., (m?). This part of the code is not always used so is not considered as a character in the code.

[1] Depths found in parentheses are estimations and can be changed to fit depth ranges known to occur for the mapping project at hand.

The third character in the code, another lower case letter, not always used, indicates the Meso- or Macrohabitat type (based on scale). These types consist of the following:

a = atoll
b = beach, relic (submerged) or shoreline
c = canyon
  c(b) = bar within thalweg
  c(c) = curve or meander within the thalweg
  c(f) = fall or chute within the thalweg
  c(h) = canyon head
  c(m) = canyon mouth
  c(t) = thalweg
  c(w) = canyon wall
d = deformed, tilted and folded bedrock, overhangs
e = exposure, bedrock
f = flats, floors
g = gully, channel
  g(b) = bar or lobe within thalweg
  g(c) = curve or meander
  g(f) = fall or chute within the thalweg
  g(h) = gully head
  g(m) = gully mouth
  g(t) = thalweg
  g(w) = gully wall
h = hole, depression
i = ice-formed feature or deposit, moraine, drop-stone depression
j = platform
k = karst, solution pit, sink
l = landslide, mass movement, rubble
m = mound; includes linear ridges
n = enclosed waters, lagoon
o = overbank deposit (levee)
p = pinnacle, cone (Note: Pinnacles are often difficult to distinguish from boulders. Therefore, these features may be used in conjunction to designate the meso/macrohabitat [as (b)/p])
q = bay, embayment, bights, sounds
r = rill (subterranean winnowing of sediments forming linear depressions on surface
s = scarp, cliff, fault or slump scar
t = terrace
u = underwater tidal lands, tidepools
v = vegetative sediment or rock (grass or algae covered)
  v(a) = algae
  v(e) = eelgrass
  v(r) = rhodoliths

v(u) = ulva
w = dynamic bedforms
w(d) = sediment dunes (10s of m in amplitude, 100s m in period)
w(s) = sediment sheet
w(w) = sediment waves (10 cm to <m amplitude, 10s m in period) and dunes
x = seamount
x(b) = seamount base
x(c) = seamount crest, top
x/f = flat-topped seamount, guyot
y = delta, fan
z = zooxanthellae hosting structure, carbonate reef
z(br) = barrier reef
z(fr) = fringing reef
z(h/b) = head, bommie
z(pr) = patch reef
z(rr) = rear or back reef
z (rf) = reef flat
z(rc) = reef crest
z(fr) = fore reef

The fourth character in the code, preceded by an underline (i.e., _a), is a modifier that describes the texture, bedform, biology or rock type and consists of the following:

_a = anthropogenic (artificial reef/breakwall/shipwreck/disturbances)
(a-c) = cable
(a-dd) = dredge disturbances
(a-dg) = dredge grooves or channels
(a-dp) = dredge potholes
(a-dm) = dredge mounds (disposal)
(a-f) = ferry or other vessel prop wash scour or scar
(a-td) = trawl disturbances
(a-g) = groins, jetties, rip-rap
(a-m) = marina, harbor
(a-p) = pipelines
(a-s) = supports; dock pilings, dolphins, platform legs/pipes
(a-w)= wreck, ship, barge or plane
_b = bimodal (conglomeratic, mixed [includes gravel, cobbles and pebbles])
_c = consolidated sediment (includes claystone, mudstone, siltstone, sandstone, breccia, or conglomerate)
_d = differentially eroded
_e = effusive pit, pockmark
_f = fracture, joint; faulted
_g = granite, intrusive
_h = hummocky, irregular relief

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

_i = interface, lithologic contact
_k = kelp
_l = limestone or carbonate rock or structure
- _l(a) = alive reef
- _l(d) = dead reef
- _l(l) = linear reef
- _l(s-g) = spur and groove
- _l(p) = patch reef
- _l(pr-i) = individual patch reef
- _l(pr-a) = aggregated patch reef
- _l(r) = reef rubble

_m = massive sedimentary bedrock
_n = numerous
_o = outwash
_p = pavement
_r = ripples (>10 cm in amplitude)
_s = scour (current or ice, direction noted)
_t = tar flow or asphalt
_u = unconsolidated sediment
_v = volcanic rock, tuff
_w = wall

Seafloor Slope - Use category numbers, which is the fifth character in the code. Typically calculated for survey area from x-y-z multibeam data.

1	Flat (0-5º)[2]
2	Sloping (5-30º)
3	Steeply Sloping (30-45º)
4	Vertical (45-90º)
5	Overhang (>90º)
6	Unknown

Seafloor Rugosity - Use category letters (in caps), the sixth character in the code. Typically calculated for survey area from gridded x-y-z multibeam data using neighborhood statistics and reported as the ratio of surface area to planar (flat) area for a particular grid cell.

A	Very Low Rugosity (1.00 to 1.25)
B	Low Rugosity (1.25 to 1.50)
C	Moderate Rugosity (1.50 to 1.75)
D	High Rugosity (1.75 to 2.00)
E	Very High Rugosity (> 2.00)

[2] Numbers in parentheses are suggestions only and can be tailored to meet objectives of the habitat mapping exercise at hand.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

An example of how this code for remotely sensed data can be used is given below:

Ssc_u4 = Canyon head indenting shelf with smooth, soft, gentle-sloping sedimentary walls that locally crop out as steep (near vertical) scarps (10-100 m).

Ssf_u = Flat to gently sloping shelf with soft, unconsolidated sediment (10-150 m).

Fhe_m/cC = Continental slope with hard sedimentary (sandstone) bedrock that locally crops out and has smooth to moderately irregular relief (<1-3 m high): m means exposures often covered with sediment (200-2500 m).

Shz/t_l/h1D = Reef terrace at shelf depth, carbonate, flat with hummocky (high rugosity) surface

Geologic Unit – When possible, the associated geologic unit is identified for each habitat type and follows the habitat designation in parentheses. Examples given below:

Shp_d1D(Q/R) - Continental shelf megahabitat; flat, highly complex hard seafloor with pinnacles differentially eroded. Geologic unit = Quaternary/Recent.

Fhd_d2C (Tmm) - Continental slope megahabitat; sloping hard seafloor of deformed (tilted, faulted, folded), differentially eroded bedrock exposure forming overhangs and caves. Geologic unit = Tertiary Miocene Monterey Formation.

Determined from video, still photos, or direct observation. Macro/Microhabitat – preceded by an asterisk. Use parentheses for geologic attributes, brackets for biologic attributes. Based on observed large-scale seafloor features.

Geologic attributes (note percent grain sizes when possible)

(a) = anthropogenic (e.g., cables, pipelines, disturbances)
  (a-t) = trawl trails or grooves
  (a-d) = dredge tracks, pits or mounds
(b) = boulder (sm=small size, m=medium size, lg=large size)
  (b-d) = dropstone (kelp or ice)
(c) = cobble
(d) = deformed, faulted, or folded
(e) = exposure, bedrock (sedimentary, igneous, or metamorphic)
  (e-s) = smooth bedrock surface
  (e-r) = rough bedrock surface

(f) = fans or aprons
(g) = gravel
(h) = halimeda sediment, carbonate slabs or mound
(i) = interface
(j) = joints, cracks, crevices, and overhang (differentially eroded)
(k) = knob or ridge
(l) = limestone, carbonate deposit
(m) = mud, silt, or clay
(n) = notch, groove
(p) = pebble
(q) = coquina (shell hash)
(r) = rubble
(s) = sand
(t) = flat terrace-like seafloor including sedimentary pavements
(u) = Undulating surface, hummocky
    (u-r) = ripples
    (u-s) = scours
    (u-w) = sediment wave
(w) = wall, scarp, or cliff
(y) = barnacles or plates

Biologic attributes
[a] = algae
    [a-b] = red algae
    [a-c] = coralline algae
    [a-g] = green algae
    [a-m] = macroalgae
    [a-r] = rhodoliths
    [a-t] = turf algae
[b] = bryozoans
[c] = corals
    [ca-s/h] = alive hard coral (stony, hydrocorals)
    [ca-g/b] = alive soft coral (gorgonians, black)
    [c-d] = dead coral
[d] = detritus, drift algae
[e] = eelgrass and other seagrasses
[g] = gorgonians
[h] = holothorians
[k] = kelp
[n] = anemones
[o] = other sessile organisms
    [o-c] = crinoids, segmented worms, and cnidarians
[s] = sponges
[t] = tracks, trails, or trace fossils (bioturbation)
    [t-b] = burrows
    [t-m] = mounds

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

[u] = unusual organisms, or chemosynthetic communities
[w] = worm tubes
    [w-s] = spoon worms
[v] = vegetation
    [v-e] = emergent vegetation
[x] = uncolonized

Seafloor Slope - Use category numbers. Estimated from video, still photos, or direct observation.

1 Flat (0-5º)
2 Sloping (5-30º)
3 Steeply Sloping (30-45º)
4 Vertical (45 - 90°)
5 Overhang (90°+)

Seafloor Rugosity - Use category numbers. Estimated from video, still photos, or measured in situ. Numbers represent seafloor rugosity values calculated as the ratio of
surface area to linear area along a measured transect or patch.

A Very Low Rugosity (1.00 to 1.25)
B Low Rugosity (1.25 to 1.50)
C Moderate Rugosity (1.50 to 1.75)
D High Rugosity (1.75 to 2.00)
E Very High Rugosity (> 2.00)

Examples: *(m)[w]1C - Flat or nearly flat mud (100% cover) bottom with worm tubes; moderate rugosity.

*(s/c)1A - Sand bottom (>50% cover) with cobbles. Flat or nearly flat with very low rugosity.

*(h)[c]1E - Coral reef on flat bottom with halimeda sediment. Very high rugosity.

*(l/r)[ca-s/h] – limestone (carbonate) rubble with alive stony coral (<50% cover) and hydrocoral (>50% cover).

Shp$_{_d}$1D(Q/R)*(m)[w]1C - *Large-scale habitat type:* Continental shelf megahabitat; flat, highly complex hard seafloor with pinnacles, differentially eroded. Geologic unit = Quartenary/Recent. *Small-scale habitat type:* Flat or nearly flat mud (100% cover) bottom with worm tubes: moderate rugosity.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Attachment 3

McCallister, M.A. (2012) Northwest Underwater Construction, LLC ROV Survey, Memorandum, September26, 2012.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

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September 26, 2012

Eric Schneider, P.E.
Principal Engineer, Generation Division
Snohomish Public Utility District
PO Box 1107
Everett, WA 98206-1107

Re: Northwest Underwater Construction, LLC ROV Survey

Dear Mr. Schneider:

On August 11 - 13, 2012, Northwest Underwater Construction conducted a remotely-operated vehicle (ROV) video survey of the seabed in Admiralty Inlet and Admiralty Bay in support of the Snohomish Public Utilities District Tidal Energy Project. The principle product from this survey is the ROV video footage, hand-delivered to the District under separate cover on 27 August 2012. The enclosed NUC report and attached SST survey timeline are provided for your information.

Seafloor Conditions

Admiralty Bay: Cable Route

Within Admiralty Bay, the sea floor sediment of the eastern (shallow) half of the cable route appears to be predominantly coral- and algae-covered pebbles and cobblestones. Visibility in the inner Admiralty Bay section was hampered by abundant presence of organic debris in the water. The easternmost end of the cable route, in water depths from about 17 to 25 meters, is heavily vegetated by short, feathery algae. The bottom is too obscured to confirm the mix of sediment grain sizes without hands-on (diver) examination, but there is little evidence seen in the ROV footage of any fine sediment along this sector of the RPL. Large patches of algae attached to rocks cover much of the sea floor. It is reasonably level, but humpy.

As requested by the District, this shallow segment of the cable route was checked for evidence of geoduck clams; none was found, although there is no question there are other types of clams in the area. There is much organic litter between the cobbles and pebbles of the seabed, and a large portion of the fragments are butter or Manila clamshells. A request had been made to look for eelgrass; there was none (neither eelgrass nor evidence thereof). It appears that the habitat in the depth range surveyed is both too deep and too turbulent (there is a strong tidal surge present, even in the bay) for the eelgrass to take hold. Eelgrass also requires a sandy bottom. There does not appear to be any sand on the sea floor along the cable route. The seabed here is all cobbles with a few minor patches of pebbles. Everything is covered by organic growth.

The deeper western half of the cable route RPL (route position list) from about the 30-meter contour on the east side of a large depression just west of the Port Townsend/Coupeville Ferry harbor is paved

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e-mail: admin@soundandsea.com

with medium (10-15 cm) to very large (20-25 cm) cobblestones across the entire span, with small patches of pebbles and scattered boulders. A small but noteworthy boulder field, with probably a half-dozen 1 to 1-1.5 m rocks, and one 3 m by 1.5 m monster was encountered approximately due south of Admiralty Head. The boulders were marked on the navigation plot and a preliminary file was provided to the District by separate correspondence. There appears to be room for the cable route between the boulders, but the cable deployment through this sector (RPL nodes 12-14) will be a slow, careful process.

Turbine Deployment Site

Within the turbine deployment box, most of the survey lines appeared very uniform: large cobblestones predominate (12-16 cm), with scattered very large cobbles and small boulders (to 10-14 inches; few larger boulders were identified in the turbine box). Organic material obscures some of the sea floor; algae and barnacles primarily, but not as dense as in the bay.

The deployment site segment of the NUC survey is visually nearly identical to the video footage recorded during earlier Global Diving ROV surveys in the area. The surface is covered with a pavement of cobblestones across the entire span, with small patches of pebbles and scattered boulders, most in the ½ to 1 m range.

At the extreme north end of the deployment box on lines B12 and B13, there are patches of coarse sand and gravel (both in waves and flat shoals). The patches are relatively small – a few meters across, at least along the survey lines. Interestingly, the sand butts up against a zone of very large cobbles and relatively small (1/2 to 1 m) boulders. But as one moves closer into the box, the cobble size drops and few boulders of any size are seen inside the box. ***Note***: this area is immediately adjacent to the gravel wave zone downslope from Whidbey Island's coastline, and it may be that some of these boulders are not erratics deposited in situ but have rolled downslope from eroded coastal formations.

Summary of Seabed Conditions:

With very minor exceptions a fairly consistent cobblestone pavement is present throughout the deployment box and the entire cable route. At the extreme eastern end of the cable run into Admiralty Bay the cobbles are smaller and are interspersed with pebbles; and as noted above, there are sand patches and boulders in the north corner of the box, and a small boulder field (which includes large cobbles) just south of Admiralty Head. Other than those features, the entire area looks very uniform. Given the amount of side-to-side deviation of the ROV path during the survey, there is little reason to expect any significant variability in the seabed anywhere within the deployment box. There is more vegetation in the shallows of the bay, obscuring the bottom; more shell debris nearshore; and more barnacles out in the deeper water. But overall, it is a very predictable and consistent sedimentary environment.

Attachments

Sincerely,

Michael A. McCallister
CAPT USN/NOAA (Ret)
Sound & Sea Technology
425-293-2674

Enclosure (1) ROV SURVEY LOG
Enclosure (2) TIDAL ENERGY PROJECT: ROV INSPECTION REPORT dated July 25, 2012

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Sound and Sea

Tidal Energy Project: ROV Inspection Report

Report Date:
July 25, 2012

Prepared For:
Larry Armbruster
Sound and Sea

Prepared By:
Northwest Underwater Construction, LLC (NUC)
NUC Project No. 112083

Phone: (866) 270-1114; Visit us on the Web: www.nwuwconst.com

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July 25, 2012

Larry Armbruster
Mobile: 206 595-5781
Sound & Sea Technology, Inc.
3507 Shelby Road
Lynnwood, WA 98087
425 743-1282
Fax 425 742-5643

RE: Tidal Energy Project

Mr. Armbruster,
Attached is our report summarizing the findings of the ROV inspection Northwest Underwater Construction, LLC performed at Admiralty Inlet adjacent to Fort Casey on Whidbey Island, Washington on July 11, 2012. Underwater video was recorded during the course of the project and a DVD copy is included with this report.

Should you have any questions and/or comments please feel free to contact me at the numbers and/or emails listed below. Thank you for allowing us to provide these services for you and we look forward to working with you again in the near future.

Sincerely,

Ryan Berg

Special Projects Manager
Northwest Underwater Construction, LLC
800 NE Tenney Road, Suite 110-111
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(360)-695-5163 mobile
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rberg@nwuwconst.com

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Introduction

Northwest Underwater Construction, LLC (NUC) performed a Remote Operated Vehicle (ROV) underwater video inspection on June 21, 2012 at Admiralty Inlet, adjacent to Fort Casey on Whidbey Island, Washington. The work was performed in general accordance with the Association of Diving Contractors International, Inc. (ADCI) *Consensus Standards for Commercial Diving and Underwater Operations* (6th Ed.), and applicable regulations from U.S. and Washington 29 CFR; Dir. CPL 02-00-151; 2011. The following presents our Work Scope, Methods, Findings and any recommendations for further work based on our observations.

Facility and Project Location

The tidal project ROV survey is to support precise site and cable route selection and environmental permitting for demonstrating two Open Hydro tidal energy turbines to be deployed in Admiralty Inlet adjacent to Fort Casey on Whidbey Island, Washington

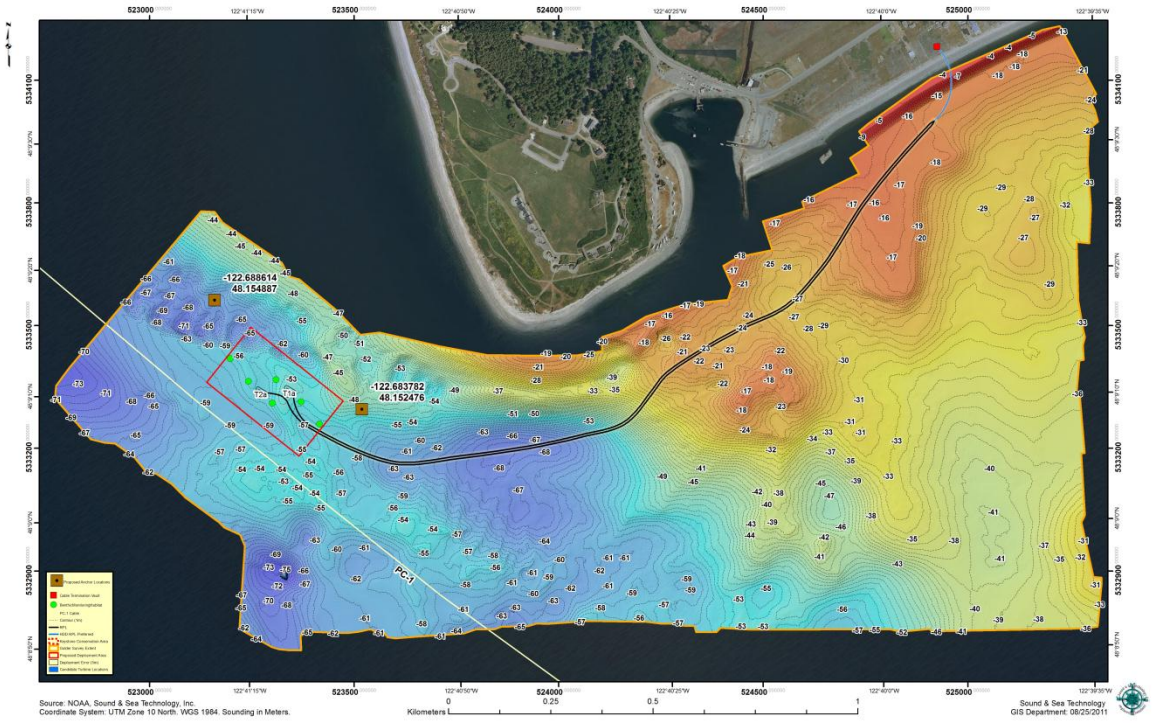

Figure 1: Proposed Turbine Site Locations and Cable Route (figure provided by Sound ad Sea)

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Work Scope

Our scope of work for this project consisted of providing a four-person ROV and survey crew (one captain, one pilot, one surveyor and one tender) to conduct a ROV visual inspection of specific client-defined areas of the proposed turbine site (Figure 1). NUC mobilized a support vessel and a *Sub Atlantic* ROV system capable of generating video footage in DVD or USB format to the project site.

Inspection Methods

NUC set-up and launched the ROV system during live boat operations on the M/V Salvager to conduct a general bottom survey and document visually observed conditions of the proposed turbine site using an DVD-recordable underwater video system for subsequent viewing by the project ROV Supervisor, Ryan Berg, and Sound and Sea's field representative Michael McCallister. Three roughly parallel ROV track lines were run from the strart of the cable route to the off shore turbine location. (Please reference survey data). During the course of the ROV inspection, sonar data was acquired to visually inspect approximately 10 meters 360 degrees while the ROV swam the track lines. During the survey no anomalies where noted. The survey crew noted large boulders larger than 1 meter with a GPS mark on the Hypack Navigation Suite. Due to the water clarity and visibility the black and white low-lux camera was utilized to observe bottom conditions.

Both the sonar and ROV data was displayed real-time on a laptop computer and stored for post-processing and incorporation into the report using the Hypack software program. Written field notes were also recorded during the course of the survey and are summarized below. To view all of the recorded video footage, please refer to the DVD included with the report.

Inspection Findings

The bottom conditions

Bottom conditions:
NUC observed approximately 8 to 10-inches of river rock and scattered boulders covering the bottom along the cable route inspection. This was also noted in the proposed turbine location. During the ROV inspection there was very little bottom sediment observed. (please reference the survey data as boulders were marked in hypack)

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

For review of the entire video footage, please refer to the DVD provided with this report. NUC thanks you for your business and please don't hesitate to contact me should you have any questions, comments or require follow-up work on the project.

Sincerely,

Ryan Berg

Special Projects Manager
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Reviewed by:
Brian Haug, Operations
brianh@nwuwconst.com

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Attachment (1)
ROV SURVEY LOG

11 July 2012

1030: Met aboard NUC survey vessel R/V ***SALVAGER*** in Port Townsend harbor. Conducted mission briefing (R. Berg), site briefing (M. McCallister), safety briefing (NUC vessel skipper).
1100:1200: Equipment checkout and navigation baseline tests
1210: Underway
1255: Arrive Admiralty Bay, Puget Sound
1325: Deploy ROV
1340: Commence survey of cable route (Line #1 – from HDD daylight site westbound to turbine deployment "box")
1635: End cable route Line #1 at turbine deployment box
1640: Commence cable route Line #2 (from turbine deployment box eastbound to HDD daylight site)
1850: End cable route line 2 at HDD daylight site
1900: Recover ROV
1910 RTB Port Townsend
1945 Arrive harborside Port Townsend

12 July 2012

1030: Met aboard R/V ***SALVAGER*** in Port Townsend harbor.
1040: Underway
1125: Arrive Admiralty Bay
1125: Coordinate operations with Keystone ferry; maneuver to deploy site
1209: Deploy ROV
1216: Commence survey of cable route (Line #3W – from ferry landing westbound to turbine deployment "box")
1153: End cable route Line #3W at turbine deployment box
1358: Recover ROV to check thruster problem (cleared up en route to surface)
1413: ROV deployed at southeast end of line B2 ("B" for "deployment Box")
1422: Recover ROV; unable to get ROV to sea floor (current still too strong, despite predicted window)
1513: Redeploy ROV
1522: ROV on bottom
1523: Commence survey line B07
1528: End Line B07 (partial)
1530: Begin Line B06
1542: Line B06 complete
1544: Begin Line B05
1554: Line B05 complete
1555: Begin Line B04
1610: Line B04 complete

1610: Begin Line B03
1613: line B03 complete
1614: Begin Line B02
1624: Line B02 complete; heading back to finish Line B07
1630: Loss of power on vessel. Recover ROV and troubleshoot
1636: Problem identified as tripped breaker on generator distribution panel; reset breaker and reset all electronics
1703: Redeploy ROV
1705: ROV on bottom
1715: Begin line B08
1724: End Line B08 (partial)
1725: Begin Line B09
1744: Line B09 complete
1745: Begin Line B08 partial
1755: Line B08 complete
1755: Begin Line B07 partial
1801: Line B07 complete
1803: Begin Line B10
1813: Line B10 complete
1814: Begin Line B11
1824: Line B11 complete
1825: Begin Line B12
1828: USBL pole bracket weld broke, causing USBL system failure (no way to correctly position ROV).
1831: Set ROV on bottom and strapped USBL pole to side of vessel
1833: Begin recovery of ROV
1852: Secure from survey, RTB Port Townsend
1910: Arrive harborside Port Townsend

13 July 2012

0830-1200: Aluminum welding on board NUC survey vessel to repair USBL pole
1230: Met aboard R/V ***SALVAGER*** in Port Townsend harbor; delayed for weather
1300: Underway
1330: Arrive Admiralty Bay
1335: Coordinate operations with Keystone ferry; maneuver to deploy site; check systems
1349: Deploy ROV
1355: ROV on the bottom
1359: Commence survey of cable route (Line #1- 50 m segment remaining from 11 July)
1406: End segment, Cable Route Line #1. Line 1 complete.
1408: Begin center line Cable Route Line 3E
1503: Cable Route Line 3E complete, joined up with Cable Route Line 3W
1505: Recover ROV and transit
1527: Redeploy ROV
1534: Commence survey of short segment on west end of Cable Route Center Line (Line 3W) heading westbound to turbine deployment “box”

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

1546: End segment of Cable Route Line 3W; transit to box, Line B12
1548: Commence survey line B12
1556: End Line B12
1600: Begin Line B13
1611: Line B13 complete
1613: line B03 complete
1616: Begin survey segment along Cable Route laydown loop, southeast end of deployment box
1623: Search for UW Sea Spider
1624: Line B02 complete; heading back to finish Line B07
1642: Located Sea Spider, bearing 257, 24 m from UW reported deployment location; collected video of instrument package
1650: Commence survey of Cable Route laydown loop outside NW end of box
1655: Loop survey complete. All lines complete; end survey
1700: ROV on board
1705: RTB Port Townsend
1742: Arrive harborside Port Townsend

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Appendix C

Derelict Gear Monitoring Plan

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

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ADMIRALTY INLET PILOT TIDAL PROJECT
FERC PROJECT NO. 12690

DERELICT GEAR MONITORING PLAN

(submitted with the Final Application for a New Pilot Project License)

Submitted by:
Public Utility District No. 1 of Snohomish County

February 29, 2012

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

TABLE OF CONTENTS

1.0 INTRODUCTION....1

2.0 PLAN GOAL AND OBJECTIVES....3

3.0 METHODS....3

3.1 Equipment....3

3.2 Monitoring Frequency and Protocols....3

3.3 Derelict Gear Removal Procedures....4

3.4 Notification Protocols....4

4.0 ADAPTIVE MANAGEMENT AND REPORTING....5

5.0 REFERENCES....6

Attachment 1 – Reporting Protocol for Injured or Stranded Mammals

LIST OF FIGURES

Figure 1. Known and removed derelict fishing gear in Puget Sound as of June 2010. 3

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

DERELICT GEAR MONITORING PLAN
for the Admiralty Inlet Pilot Tidal Project

1.0 INTRODUCTION

The Derelict Gear Monitoring Plan (DGM Plan) defines Public Utility District No. 1 of Snohomish County's (the District) pilot license obligations with respect to the monitoring for derelict gear that is snared or collected on any structure associated with the Admiralty Inlet Pilot Tidal Project, Project No. 12690 (the Project), and the subsequent removal of such derelict gear. This plan was developed in consultation with the Marine Aquatic Resource Committee (MARC) and Project stakeholders.

The Project involves installation of two 6-meter OpenHydro tidal energy conversion turbines in Admiralty Inlet, as well as placement of transmission cables to shore. The turbines will be installed in the northeastern portion of Admiralty Inlet, approximately 1 km west-southwest of Admiralty Head near latitude 48°09'03.24" N longitude 122°41'15.72" W latitude, in water depth of approximately 58 meters. The center-to-center separation distance between the two turbines will be approximately 70 meters. The 6-meter diameter turbines will extend 10.5 meters above the seabed. Each turbine will have its own transmission cable that will be connected to the grid at the Puget Sound Energy infrastructure on privately owned land east of Admiralty Head.

Any marine structure has the potential to trap or accumulate derelict fishing gear, which can pose a hazard to marine life. Derelict gear in Puget Sound is the subject of a concentrated mapping and removal effort by the Washington Department of Fish and Wildlife (WDFW) and the Northwest Straits Commission, with a total of 2,882 crab pots and 356 nets identified as of mid-2009. As of December 31, 2010, the Northwest Straits Marine Conservation Initiative has removed 2,493 derelict nets. An additional 1,366 nets have been removed through other Northwest Straits Marine Conservation Initiative projects (Northwest Straits Foundation [NWSF] 2011). Because of these efforts, it is expected that the risk of derelict fishing gear snagging on Project works has decreased substantially, and will decrease even more in the future. Figure 1 (source: NWSF 2011) shows the derelict nets removed and nets known to be remaining in Central and South Puget Sound and Hood Canal. There are two nets that remain in Admiralty Inlet.

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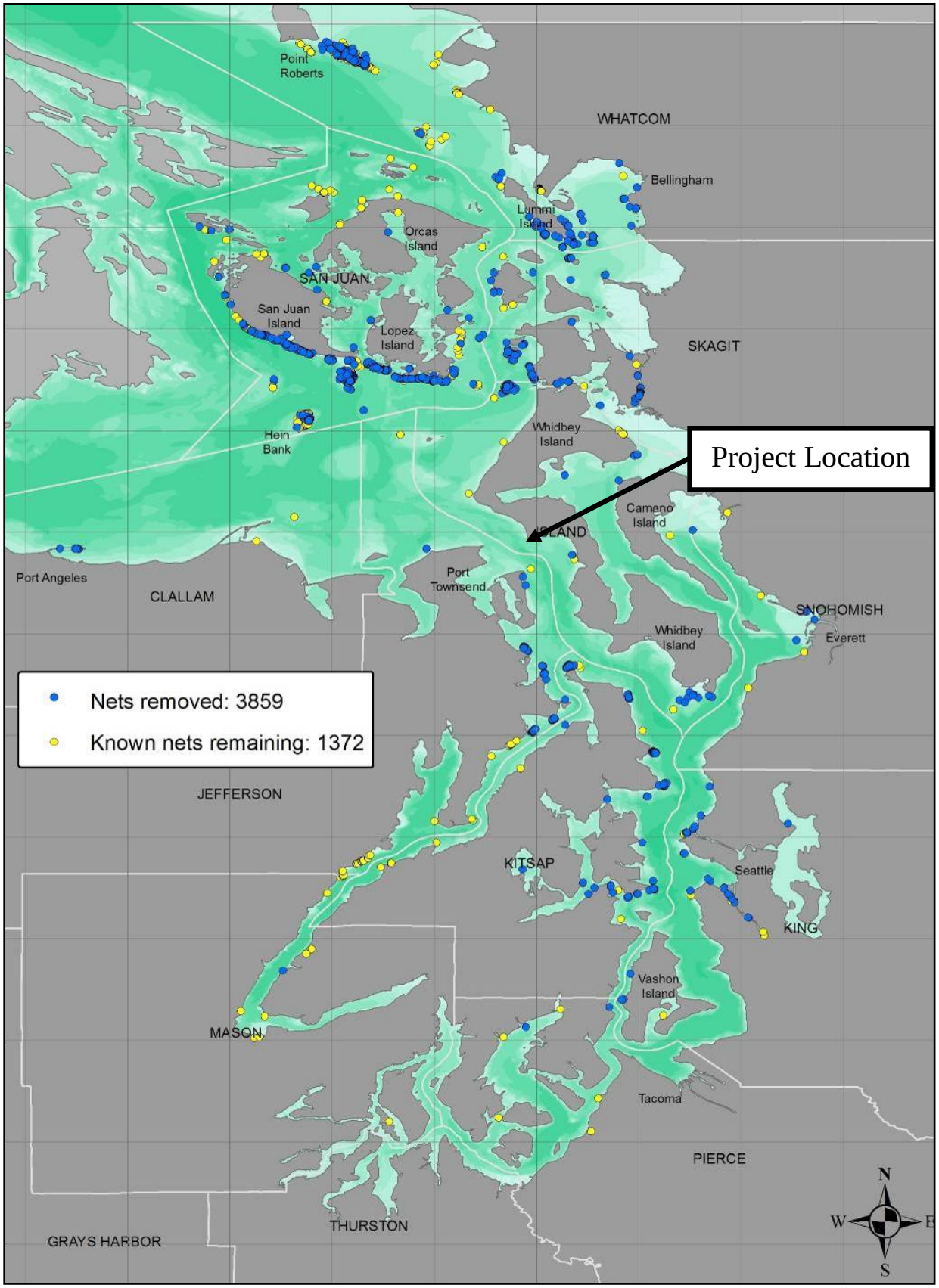

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Figure 1. Known and removed derelict fishing gear in Puget Sound as of June 2010.

2.0 PLAN GOAL AND OBJECTIVES

The DGM Plan Goal is to detect and remove any derelict gear that becomes snared or collected on any Project structure. To accomplish this, the District will (1) examine all Project structures during periodic ROV deployments; (2) remove any derelict gear located on Project structures; and (3) consult with the Admiralty Inlet Marine Aquatic Resources Committee (MARC) to consider modifications to this Plan, if needed, based on the results of derelict gear monitoring and removal efforts.

3.0 METHODS

3.1 Equipment

The District will use a remote operated vehicle (ROV) for the detection and removal of derelict gear from Project structures.[1] The ROV will be equipped with a video camera for all deployments, and also with a manipulator skid, grabber arm, and rotary disc cutter or other cutting device for gear removal deployments. Successful removal of deep-water fishing gear using ROVs has been demonstrated in Puget Sound (Natural Resource Consultants, Inc. (NRC) 2008). ROVs capable of detection and subsequent removal of derelict gear are available for deployment at the Project site within 48 hours (pers. comm., L. Armbruster, Sound and Sea Technology, July 2010).

In addition to ROV-based detection efforts, the District will rely upon other detection means to assist in the detection of derelict gear. If debris becomes entangled with the turbine, it is anticipated that the performance of the turbine would be reduced; such a reduction would be detected by Project electrical controls. In addition, the District's Near-Field Monitoring effort may also have the capability to detect entanglement.

3.2 Monitoring Frequency and Protocols

The District will monitor for derelict gear during ROV deployments required as part of standard operations and maintenance procedures. During the first year following Project installation, the District will deploy a ROV at a minimum of once every three months. Following the first year, the MARC will review the results of the DGM Plan to determine the degree to which derelict gear gets caught on the Project, if at all, and determine whether changing the frequency of subsequent underwater inspections is appropriate. The District will continue monitoring and removal after the first year, if necessary at a frequency developed with the MARC.

During each ROV deployment, the District will use the ROV to inspect Project structures for accumulation of derelict gear, with findings recorded by video camera. The District will review video data collected during each deployment for evidence of derelict gear. In the event that

[1] Safety considerations preclude the use of divers near Project turbines (pers. comm., N. Murphy, OpenHydro, 2009), and much of the Project is below depths at which diver removal of derelict gear is typically conducted (NRC 2008).

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

footage during the ROV inspections indicates derelict gear is found on the Project structures, the District will remove the derelict gear as soon as feasible. The District will notify the MARC as to the result of its review of video data within seven days following the deployment.

3.3 Derelict Gear Removal Procedures

If derelict gear is detected on a Project structure, the District will notify appropriate parties as outlined below. Following notification, the District will prepare, in consultation with the MARC, a derelict gear removal plan specifying the gear type detected and its location, the proposed ROV approach path, acceptable tidal conditions, local habitats, proposed disposal method, and other relevant information. In addition, the District will schedule the ROV staging and support vessel as well as commit the necessary personnel for the gear removal. The derelict gear removal plan will be submitted to WDFW and approved by WDFW and the MARC prior to removal work, and will include the District's notification obligations as outlined below.

The gear removal deployment will generally involve vessel anchoring, ROV anchoring, ROV approach and assessment of the derelict gear and any aquatic species trapped, ROV securing of the derelict gear using a manipulator arm and/or cutting tool, and winching up of the ROV, derelict gear, and ROV anchor by the support vessel. Upon removal, the derelict gear will be examined by a marine biologist. Species, size, and number of trapped or entangled marine life observed by video and from observations of gear brought to surface will be recorded and reported to the MARC. Disposal typically consists of removal of lead from nets for recycling, and landfill disposal for all remaining material (pers. comm., G. Ruggerone, NRC, August 2010).

3.4 Notification Protocols

In the event derelict gear is detected on a Project structure, the District will follow this notification approach:

- If there is evidence of entanglement of marine mammals, immediate notification of MARC and WDFW's Derelict Fishing Gear Hotline and activate National Marine Fisheries Service (NMFS) response plan (Attachment 1).
- If there is evidence of entanglement of other marine resources, notify MARC and WDFW's Derelict Fishing Gear Hotline within two business days or as otherwise specified through the Endangered Species Act consultations.
- If derelict gear is entangled, but no species are caught within it, notify MARC and WDFW's Derelict Fishing Gear Hotline within two weeks.
- If an injured, stranded, entangled, or dead marine mammal is observed during the any aspect of work described by this Plan, the District will follow NMFS protocols included in Attachment 1.

All detection notifications will be conducted via email and will include the following information: (1) location, (2) type of gear, (3) presence of aquatic organisms, and (4) the District's proposed removal and disposal process and timeline.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Following the development of a derelict gear removal plan, but prior to its implementation, the District will also conduct the following notifications, as required by WDFW (NWSF 2007):

- Three-day advance notice to the U.S. Coast Guard Notice to Mariners system;
- Three-day advance notice to local WDFW fisheries enforcement office;
- Three-day advance notice to local Tribes;
- Three-day advance notice to U.S. Navy;
- Three-day advance notice to local and county officials.

In addition to these pre-work notifications, the District will notify and confer with the MARC as described below.

4.0 ADAPTIVE MANAGEMENT AND REPORTING

In implementing this Plan, the District will consult with the MARC as appropriate on the technical issues described above and data interpretation associated with the monitoring. Such consultation will include consideration of results from monitoring efforts and subsequent adjustments to monitoring methods. In particular, the District will adopt the following triggers and subsequent actions:

- **Adaptive Management Trigger 1:** If monitoring shows that derelict gear has become ensnared or collected on any Project structure but no species are caught within it, the District will remove the derelict gear as soon as feasible, and notify the MARC within two weeks. The District will then, after consulting with the MARC in accordance with the Adaptive Management Committee Plan, modify the Project and/or monitoring plan if necessary.

- **Adaptive Management Trigger 2:** If monitoring shows non-listed species found entangled or otherwise impinged at the Project, the District will remove the derelict gear as soon as feasible, notify the MARC within two weeks, and provide a report to the MARC giving all available information on the case. The District will then, after consulting with the MARC in accordance with the Adaptive Management Committee Plan, modify the Project and/or monitoring plan if necessary.

- **Adaptive Management Trigger 3:** If monitoring shows marine mammals that are alive, but appearing debilitated, the District will record the sighting as part of their monitoring report as highlighted below in the Reporting Protocol for Injured or Stranded Marine Mammals. The District will then, after consulting with the MARC in accordance with the Adaptive Management Framework, modify the Project and/or monitoring plan if necessary.

- **Adaptive Management Trigger 4:** If monitoring shows live marine mammals observed entangled in fishing gear or marine debris, the District will immediately contact the marine mammal disentanglement network in Washington as highlighted below in the Reporting Protocol for Injured or Stranded Marine Mammals, and to NMFS giving all

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

available information on the case as highlighted below. The District will also immediately contact the MARC, and after consulting with the MARC in accordance with the Adaptive Management Framework, modify the Project and/or monitoring plan if necessary.

- **Adaptive Management Trigger 5:** If monitoring shows protected species found entangled in derelict gear on a Project structure, the District will notify the MARC within two business days or as otherwise specified in the ESA consultation, remove the derelict gear as soon as feasible, and will provide a report to NMFS giving all available information on the case as highlighted below in the Reporting Protocol for Injured or Stranded Marine Mammals. The District will then, after consulting with the MARC in accordance with the Adaptive Management Framework, modify the Project and/or monitoring plan if necessary.

The District will follow the procedures described in the Adaptive Management Framework when consulting with the MARC on implementation of the Plan. By June 30 of each year, the District will develop and file an annual report to the Commission fully describing its implementation of the Plan during the previous calendar year and a list of the proposed activities during the current calendar year. The MARC will have at least 30 days to review and comment on a draft report prior to the District finalizing and filing the report with FERC. The annual report will provide the following:

- A summary of the monitoring results.
- A summary of the results of any derelict gear removal effort.
- A summary of any issues or concerns identified by members of the MARC during the year regarding implementation of the Plan.
- A list of any changes to the Plan proposed by consensus of the MARC during the year.
- A list of Plan activities planned for the current year.

5.0 REFERENCES

Natural Resource Consultants, Inc. (NRC). 2008. Remote operated vehicle deepwater crab pot removal feasibility study. Seattle, Washington.

Northwest Straits Foundation (NWSF). 2011. Program Accomplishments 2002-Present. [Online] URL: http://www.derelictgear.org/Progress.aspx. Accessed February 2011.

Northwest Straits Foundation (NWSF). 2007. Derelict fishing gear priority ranking project. Seattle, Washington.

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Live Marine Mammals Observed at Sea

The Platform of Opportunity Program (POP) is administered by the National Marine Mammal Laboratory. If interested in training or to obtain standardized reporting forms for reporting sighting data contact Sally Mizroch at (206) 526-4030.

Live Marine Mammals Observed Swimming but Appearing Debilitated or Injured

Capability to respond to free swimming animals is very limited and relocation is a major issue. In addition, medical treatment facilities for marine mammals in Washington State are limited to pinnipeds. Therefore we recommend that monitors record the sighting as part of the monitoring report. The data should include: (1) species or common name or animal involved; (2) date of observation; (3) location (latitude/longitude in decimal degrees); and (4) description of injuries or unusual behavior observed.

Live Marine Mammals Observed Entangled in Fishing Gear or Marine Debris

The marine mammal disentanglement network in Washington is based at National Marine Fisheries Service (NMFS) Protected Resources Division and may be contacted via the Marine Mammal Stranding Network Program Office at (206) 526-4747 or Brent Norberg at (206) 909-3771 (cell). Contact should be made immediately if an entanglement is observed and, if possible the reporting vessel should remain on scene while contact is made. Report should include the following information: (1) Species or common name of animal involved; (2) location (latitude/longitude in decimal degrees); (3) whether the animal is anchored by the gear or swimming with the gear in tow; (4) a description of the entangling gear (line size, line color, size number and color of floats if attached, presence or absence of pots or webbing; (5) if towing gear give direction of travel and current speed; and (6) local weather conditions (sea state, wind speed and direction). The disentanglement network will determine whether or not a response can be mounted immediately and will advise the reporting vessel on next steps.

Dead Marine Mammals Observed Floating at Sea

Dead, floating marine mammals fall within the definition of "stranded" under the Marine Mammal Protection Act. To report strandings in the Puget Sound region contact the Marine Mammal Stranding Network Office at (206) 526-4747.

Dead Protected Species Found Entangled or Otherwise Impinged at the Project

These should be reported as part of the monitoring report to NMFS giving all available information on the case. The report should include the following information: (1) species or common name of animal involved; (2) location (latitude/longitude in decimal degrees); (3) whether the animal was found on the buoy or anchoring system; and (4) a description of injuries or entanglement observed; if derelict fishing gear or other debris was involved give a description of the gear (line size, line color, size number and color of floats if attached, presence or absence of pots or webbing; photographs if possible. In the event derelict gear is involved the presence of protected species entangled in the gear should be included in the report initiating

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

gear removal planning and coordination. *Note: If listed species are entangled, injured or killed at the Project the applicant should request re-initiation of consultation.*

20131203-5160 FERC PDF (Unofficial) 12/3/2013 4:21:53 PM

Document Content(s)

Admiralty Inlet Pilot Tidal Project FERC # P-12690.PDF.....1-422

Appendix S

TURBINE SUPPLY AND MAINTENANCE AGREEMENT

Snohomish County PUD No. 1
Resolution No. 5652

November 4, 2013

RESOLUTION NO. 5652

A RESOLUTION Authorizing the General Manager to Execute a Turbine Supply and Maintenance Agreement with OpenHydro for the Admiralty Inlet Pilot Tidal Project

WHEREAS, Public Utility District No. 1 of Snohomish County (the "District") is investigating the tidal energy resources of Puget Sound and the feasibility of utilizing those resources to generate clean, carbon-free, renewable electricity from tidal currents within Admiralty Inlet; and

WHEREAS, Resolution No. 5354 declared that "special market conditions" exist with respect to the selection of a supplier of tidal in-stream energy conversion devices and related services; and

WHEREAS, Resolution No. 5581 selected OpenHydro Technology Limited ("OpenHydro") as the supplier of tidal devices and related services for the Admiralty Inlet Pilot Tidal Project, and authorized and directed the General Manager to execute a Consulting Services Agreement with OpenHydro. The Resolution further authorized and directed the General Manager to negotiate one or more contracts with OpenHydro for the procurement of two turbines and necessary services for the Admiralty Inlet Pilot Tidal Project, to be presented to the Board for review and approval; and

WHEREAS, with the assistance from outside counsel and a team of consultants, District staff have negotiated a Turbine Supply and Maintenance Agreement designed to cover turbine procurement, installation, warranty, and maintenance for the term of the license that staff expects the Federal Energy Regulatory Commission ("FERC") to issue shortly; and

WHEREAS, District staff requests that the Board of Commissioners approve the Turbine Supply and Maintenance Agreement with OpenHydro, a copy of which is attached hereto as Exhibit "A" and incorporated herein as if set forth in full; and

WHEREAS, the Turbine Supply Maintenance Agreement is a two-phased contract. The first phase, identified as the "Initial Notice to Proceed," will occur immediately upon execution of the Agreement and will allow OpenHydro to proceed with work necessary to finalize all of the Turbine Supply and Maintenance Agreement terms, including: (a) development of a replacement power conversion and control solution for the Plant Control Conditioning Equipment, (b) defining the Minimum Level of Performance and the Warranty Period Performance Level, (c) finalizing terms for the installer barge needed for turbine delivery and recovery, as set forth in Exhibit "B" and incorporated herein as if set forth in full. Work authorized under the Initial Notice to Proceed shall not exceed $200,000; and

WHEREAS, the second phase, identified as the "Final Notice to Proceed," consists of the remainder of OpenHydro's performance under the Agreement, and will not be issued until the Board of Commissioners has formally approved the FERC license for the Admiralty Inlet Pilot Tidal Project, and has approved a modification to the Turbine Supply and Maintenance Agreement that supplies all the final terms, including appropriate insurance terms; the Disconnection/Reconnection Fixed-Price provided by the District's public works contractor; Minimum Level of Performance and Warranty Period Performance Level; the number of times the Turbine Unit brakes may be deployed before affecting the warranty terms; the terms of the installer barge; the preliminary draft production progress schedule; the name and location of OpenHydro and its Subcontractors' manufacturing facilities; the name of OpenHydro's manufacturing representative; and the terms for the Plant Control Conditioning Equipment, all as set forth in the Turbine Supply and Maintenance Agreement; and

WHEREAS, by authorizing this Agreement, the Board of Commissioners will only be approving the work identified as the Initial Notice to Proceed.

NOW, THEREFORE, BE IT RESOLVED by the Board of Commissioners of Public Utility District No. 1 of Snohomish County, Washington, as follows:

1. The General Manager or his designee is hereby authorized and directed to execute the Turbine Supply and Maintenance Agreement in substantially the form as that found in Exhibits "A" and "B" attached hereto.

2. The Board expressly limits its approval under the Turbine Supply and Maintenance Agreement to that work set forth in the Initial Notice to Proceed, Exhibit "B", and reserves authority to approve the Final Notice to Proceed under the terms and conditions of the Turbine Supply and Maintenance Agreement with OpenHydro.

PASSED AND APPROVED this 4th day of November, 2013.

President

Vice President

(absent)

Secretary

Exhibit A

Turbine Supply and Maintenance Contract

for

Admiralty Inlet Pilot Tidal Project

Contract No. _____

Turbine Supply and Maintenance Contract for
ADMIRALTY INLET PILOT TIDAL PROJECT
Contract No. _____

This agreement (hereinafter referred to as the "Contract") is made by and between Public Utility District No. 1 of Snohomish County, a municipal corporation duly organized and existing under the laws of the State of Washington, having its principal office at 2320 California Street, Everett, Washington 98206-1107, USA (hereinafter referred to as "the District"), and OpenHydro Technology Limited, a company duly organized and existing under the laws of Ireland, having its principal office at South Dock House, Hanover Quay, Dublin 2, Ireland (hereinafter referred to as "the Seller"). The District and the Seller may be hereinafter referred to collectively as the "Parties" and individually as a "Party."

This Contract consists of:

PART I – TERMS AND CONDITIONS OF CONTRACT

PART II – CONTRACT EXHIBITS

PART III – SPECIAL CONDITIONS

PART IV – SPECIFICATIONS

PART V – PLANS

PART VI – APPENDICES

Any change or modification of the Contract shall be binding on the Parties only if it is made in writing and signed by a duly authorized representative of each Party.

This Contract may be executed in two counterparts, each of which shall be deemed as an original, but both of which taken together shall constitute one and the same instrument. The District and the Seller shall each retain one counterpart.

This Contract is signed by duly authorized representatives of the Parties and is made as of this _____ day, November 2013.

THE DISTRICT:	**THE SELLER:**
PUBLIC UTILITY DISTRICT NO. 1 OF SNOHOMISH COUNTY	OPENHYDRO TECHNOLOGY LIMITED
_____	_____
Name: _____	Name: _____
Title: _____	Title: _____

TABLE OF CONTENTS

PART I – TERMS AND CONDITIONS OF CONTRACT

1. DEFINITIONS
2. SCOPE OF SELLER'S OBLIGATIONS
3. CONTRACT PRICE
4. TERMS OF PAYMENT AND MILESTONES
5. TAXES AND DUTIES
6. QUALITY CONTROL, FACTORY ACCEPTANCE TESTS AND INSPECTIONS
7. DISTRICT-FURNISHED EQUIPMENT AND SEPARATE CONTRACTORS
8. PERMITS AND TURBINE DEPLOYMENT SITE ACCESS
9. SITE CONDITIONS
10. TOW TRIALING AND DELIVERY OF TURBINE UNITS AND SPARE PARTS
11. PACKING AND MARKING
12. TRANSFER OF TITLE AND RISK OF LOSS
13. MINIMUM LEVEL OF PERFORMANCE
14. DELIVERY AND WATER WORK WINDOW
15. ACCEPTANCE AND REJECTION OF TURBINE UNITS
16. MAINTENANCE SERVICES
17. UNIT RECOVERY
18. SELLER'S WARRANTY
19. SELLER'S GUARANTEE
20. INDEMNITY
21. INSURANCE
22. INTELLECTUAL PROPERTY
23. CONFIDENTIALITY

24. PUBLICATIONS

25. AUDIT AND RECORD KEEPING

26. LAWS, CODES AND STANDARDS

27. OBLIGATIONS UNDER FEDERAL LAW

28. SAFETY, PUBLIC CONVENIENCE AND INTERFERENCE

29. MUTUAL WAIVER OF CONSEQUENTIAL DAMAGES

30. LIMITATION OF LIABILITY

31. SUSPENSION

32. FORCE MAJEURE

33. TERMINATION OF CONTRACT

34. CHANGES

35. CLAIMS AND NOTICE OF CLAIMS

36. DISPUTE RESOLUTION

37. LABOR – PREVAILING WAGES

38. SECURITY OF ELECTRONIC AND NATIONAL SECURITY INFORMATION

39. GRATUITIES

40. ASSIGNMENT

41. GOVERNING LAW

42. OTHER CONDITIONS

PART II – CONTRACT EXHIBITS

EXHIBIT A – CONDITIONS AND PROCUREMENT REQUIREMENTS FOR FEDERALLY FUNDED CONTRACTS

EXHIBIT B – STATEMENT OF INTENT TO PAY PREVAILING WAGES/DAVIS-BACON ACT

EXHIBIT C – SCHEDULE OF PREVAILING WAGES

EXHIBIT D – DIRECTIVE 99 – DISTRICT INFORMATION SECURITY

EXHIBIT E – GENERAL DATA REQUEST LIST, APPENDIX A TO FEDERAL REPORTING CHECKLIST

EXHIBIT F – FORM OF FINAL NOTICE TO PROCEED AMENDMENT

EXHIBIT G – FORM OF CHANGE ORDER

PART III – SPECIAL CONDITIONS

INSURANCE/OCIP

PART IV – SPECIFICATIONS

1. **DESIGN PREMISE REPORT**
   a. **TR 00179 Basis of Design Report Admiralty Inlet Inputs**
   b. **TR 00356 Basis of Design Report Admiralty Inlet Calculations and Results**
2. **TURBINE AND GENERATOR SPECIFICATION**
   a. **SD 00099 Turbine Specification Document**
   b. **SD 00121 Generator Specification Document**
3. **SUBSEA BASE ASSEMBLY**
   a. **TR 00288 Subsea Base Detailed Design Report**
4. **ELECTRICAL**
   a. **M06C0501 TCC Assembly Drawing**
   b. **SD 00090 Subsea Electrical System FDS**
   c. **SD 00111 TCC Single Line Diagram**
5. **POWER CONDITIONING & CONTROL EQUIPMENT**
6. **UW MONITORING INTEGRATION**
   a. **SD 00231 UW Integration Schematic**
7. **DEPLOYMENT**
   a. **PN 00173 Marine Operations Storyboard**
8. **ACCEPTANCE TEST CRITERIA**
   a. **PL 00224 Acceptance Test Protocol**
   b. **PL 00255 High Level Control Plan**
   c. **PL 00289 Performance Guarantee Schedule**
9. **DEPLOYMENT BARGE SPECIFICATIONS**
   a. **TR 00289 SnoPUD Turbine Installation Barge High Level Specification**
   b. **T-0003 5.2.0001 NUC Proposal**

c. T-0003 5.2.0002 NUC-OpenHydro Heads of Terms

10. O&M SPECIFICATION

a. PL 00226 Spare Parts List

b. TR 00195 Turbine Maintenance Study

c. T-0003 10.1 O&M Heads of Terms

11. DISTRICT FURNISHED EQUIPMENT

a. T-0003 10.7 Equipment Supply Matrix

12. DIVISION OF RESPONSIBILITY

a. T-0003 2.1 Division of Responsibility

13. WARRANTY PROVISIONS

14. PROJECT SCHEDULE

a. T-0003 2.2 SnoPUD Project Programme

15. SCHEDULE OF MILESTONE DOCUMENT DELIVERABLES

a. T-0003 2.3 Milestone document deliverables

b. OF11 Milestone Completion Certificate

c. Milestone Zero (No. 0) Description

16. DISTRICT PROVIDED INFORMATION

a. T-0003 10.1 District Provided Information

PART V – PLANS

1. TOTAL PROJECT SITE PLAN (C1)

2. ELECTRICAL SITE PLANS

PART VI – APPENDICES

APPENDIX A GEOPHYSICAL INVESTIGATION (OFFSHORE)

APPENDIX B GEOLOGICAL SETTING TECHNICAL MEMO (OFFSHORE)

APPENDIX C SUMMARY OF SITE CONDITIONS

APPENDIX D FERC LICENSE CONDITIONS

PART I – TERMS AND CONDITIONS OF CONTRACT

1. DEFINITIONS

The following words shall have the following meanings in this Contract unless the context otherwise requires:

"**Actual Delay Costs**" means the following types of reasonable costs payable by the Seller to the District as specified in the Contract as a result of delay in achieving Delivery or the Minimum Level of Performance: (a) District personnel costs, (b) costs actually paid by the District to third-parties (such as the public works contractor and consultants); and (c) extended permit and license fees. The following costs incurred as a result of delay in achieving Delivery or the Minimum Level of Performance are not included in Actual Delay Costs (i.e. Seller is responsible for these costs regardless of whether the Actual Delay Cost Cap is met): (a) disconnection/reconnection costs; (b) Turbine Unit Recovery costs; and (c) Turbine Unit redeployment costs.

"**Actual Delay Cost Cap**" means the maximum level of Actual Delay Costs for which the Seller is responsible. The Actual Delay Costs are capped at a total of $300,000 through October 14, 2016 and a total of $600,000 through October 14, 2017. If, however, the Seller is terminated for default, the Actual Delay Cost Cap will not operate as a cap on costs that may be due to the District as a result of the termination.

"**Affiliate**" means any other person or entity (including, without limitation, any officer, director, shareholder, partner, employee, agent or representative of such person or entity) that, directly or indirectly through one or more intermediaries, controls, is controlled by or is under common control with such first person or entity. For purposes of this definition, "control" (including with its correlative meanings, "controlled by" and "under common control with") shall mean the possession, directly or indirectly, of the power to direct or cause the direction of the management or policies of a person or entity, whether through the ownership of voting securities, partnership or other ownership interests, by contract, by law or otherwise.

"**Change of Law**" means a change of Law coming into effect after the date of this Contract that could not have been reasonably anticipated and that adversely and materially affect the District's or the Seller's performance under this Contract.

"**Claim**" means a demand or assertion by one of the Parties seeking, as a matter of right, adjustment or interpretation of the Contract terms, payment of money, and extension of time or other relief with respect to the terms of the Contract. The term "Claim" includes any and all disputes and matters in question between the District and the Seller arising out of or relating to the Contract.

"**Confidential Information**" means any information, whether printed, in machine readable form or otherwise, which is proprietary or confidential to the disclosing Party and disclosed to the receiving Party and which is disclosed by the disclosing Party in writing and marked as "Confidential" (or like designation) at, or reasonably soon after, the time of

disclosure, or in the case of non-tangible disclosures (discussions, briefings, etc.) identified as proprietary or confidential at the time of disclosure and summarized in writing by the disclosing Party within thirty (30) days of disclosure.

"**Connection Date**" means the date after Delivery and before Performance Testing on which the District connects each Turbine Unit to the subsea trunk cable as described in the Contract Specifications.

"**Contract**" shall have the meaning set forth above, and includes this PART I – "TERMS AND CONDITIONS OF CONTRACT," PART II – "CONTRACT EXHIBITS," PART III – "SPECIAL CONDITIONS," PART IV – "SPECIFICATIONS," PART V – "PLANS," and PART VI – "APPENDICES," as the same may be amended or otherwise modified from time to time as permitted herein.

"**Contract Specifications**" means the Contract Specifications set forth in Part IV of this Contract.

"**Contract Term**" means the time period commencing on (1) the date of this Contract and ending on (2) Final Turbine Unit Recovery and delivery of the Data Deliverables.

"**Data Deliverables**" means data of any form or format that the Contract requires the Seller to provide to the District, including but not limited to quarterly reports and operational data as more fully described in the Contract Specifications.

"**Delivery,**" "**Deliver**" or "**Delivered**" refers to the installation of a Turbine Unit in accordance with the Contract at the Turbine Deployment Site.

"**Delivery Date**" means the date that each Turbine Unit is Delivered to the Turbine Deployment Site. Each of the two Turbine Units shall have a separate Delivery Date.

"**Deployment Barge**" means a custom-made vehicle capable of being towed for the specific purpose of conducting the Tow Trialing and thereafter deploying and recovering of the Turbine Units at the Turbine Deployment Site, for interim Turbine Recovery, and for Final Turbine Unit Recovery, as more fully described in Contract Specifications Schedule 9.

"**District's Acceptance**" means the District's written acceptance of each of the Turbine Units, each acceptance independent of the other.

"**District-Furnished Equipment**" means items provided by the District to be incorporated into the Turbine Units by the Seller, including but not limited to equipment provided by Separate Contractors, including the Adaptive Monitoring Package (AMP) provided by the University of Washington and a Turbine Umbilical Storage Platform (TUSP) for deployment of a remote operated underwater vehicle (ROV) provided by a yet-to-be determined Separate Contractor, as more fully described in Contract Specifications Schedule 11.

"**District-Provided Information**" means the information set forth in Contract Specifications Schedule 16, copies of which have been provided to the Seller prior to the date of this Contract.

"**Document Deliverables**" means documents to be provided by the Seller, including drawings, specifications, quality assurance reports, and performance and commissioning reports as described in the Contract Specifications.

"**Factory Acceptance Tests**" ("**FAT**") means the test or tests of the Turbines conducted at the Seller's facilities in Ireland before shipment of the Turbines, as described in Contract Specifications Schedule 8.

"**Final Turbine Unit Recovery**" means removal of both Turbine Units from the Turbine Deployment Site and transport of the Turbine Units to a location in the Puget Sound area for salvage as mutually agreed to by the Parties.

"**Grid**" means Puget Sound Energy's single phase 7.2kV line near the Plant Control and Condition Building.

"**Law**" means any applicable law (including statutes, ordinances, rules, regulations and binding decisions by governing authorities, but excluding the District) to which the Parties (or either of them) are subject and/or which is applicable to the subject matter of this Contract.

"**Maintenance Services**" means services for the maintenance, recovery, monitoring or repair of the Turbine Units, and availability of the Deployment Barge, as specified in Contract Specifications Schedule 10.

"**Maintenance Services Fee**" means the fee to be paid to the Seller for providing Maintenance Services, in addition to the Contract Price, in accordance with this Contract. The Maintenance Services Fee will be adjustable annually as set forth in Contract Specifications Schedule 10.

"**Milestone Date**" means one of the dates identified in Article 4 (subject to any variation or extension of time granted or provided for in accordance with this Contract).

"**Milestone Events**" means the events identified in Article 4.

"**Minimum Level of Performance**" is a threshold electrical output to be measured at each Turbine Unit over an agreed period of time. Each Turbine Unit must meet the Minimum Level of Performance. After this Contract is executed, the Seller will provide a reasonable Minimum Level of Performance as set forth below.

"**Notice to Proceed**" means a written direction from the District to the Seller to commence performance under the Contract to the extent and in accordance with the terms specified in the notice. The "**Initial Notice to Proceed**" will occur immediately upon execution of the Contract and is generally expected to allow the Seller to proceed completely with work for (a) development of replacement power conversion and control solution for the Plant

Control Commissioning Equipment; (b) defining the Minimum Level of Performance and the Warranty Period Performance Level; (c) finalizing terms for the installer barge needed for turbine delivery and recovery; and (d) complying with Milestone Zero (No. 0). The **"Final Notice to Proceed"** with the complete remainder of the Seller's performance under the Contract will not be issued before the following have occurred:

a. The District's board has formally approved the conditions of the FERC license;

b. The District and the Seller have executed a modification to the Contract to account for any cost difference between the Disconnection/Reconnection Estimate provided by the District and the Disconnection/Reconnection Fixed-Price provided by the District's public works contractor;

c. The District has received a reasonable Minimum Level of Performance and Warranty Period Performance Level from the Seller;

d. The District and the Seller have agreed to the number of times the Turbine Unit brakes may be deployed before affecting the warranty terms;

e. The Seller has informed the District that it received a binding commitment from the installer barge and, if not, the District and the Seller have executed a modification to the Contract to account for any cost difference;

f. The Seller has provided its preliminary draft production progress schedule, the name and location of the manufacturing facilities of Seller and Seller's Subcontractors, and the name of the Seller's manufacturing representative;

g. Seller and the District have agreed on the technical proposal for the final proof of concept for the PCCE; and

h. No Party has notified the other Party that it elects to terminate the Contract for its convenience prior to issuance of the Final Notice to Proceed, all within such notifying Party's sole discretion.

"NUC" means Northwest Underwater Construction, Inc.

"Performance Test" or "Performance Testing" means the testing to be carried out at the Turbine Deployment Site by the Seller after the Delivery Date under the supervision of the District to determine whether the Turbine Units meet the Minimum Level of Performance as described in Contract Specifications Schedule 8.

"Plant Control Commissioning Building" (**"PCCB"**) is a shore structure designed and constructed by the District, or its Separate Contractors, that contains, among other things, **Plant Control Conditioning Equipment** (**"PCCE"**) supplied by **PCCE equipment supplier (**"**PCCE Equipment Supplier**"**)** and installed by the District or its Separate Contractor. A cable connection will connect the Turbine Units to the PCCE, and the PCCE will be connected to the Grid with a cable connection as necessary to allow for the export of electricity to the Grid.

"**Project**" means the Admiralty Inlet Pilot Tidal Project located in the State of Washington, United States of America.

"**Seller's Prime Subcontractors**" shall mean:

1. NUC
2. PCCE Equipment Supplier
3. Marine towing contractor
4. SSB contractor
5. Turbine Mobilization Facility

"**Seller's Subcontractors**" means contractors, subcontractors, suppliers and other persons engaged by the Seller in the execution or performance of this Contract or any part hereof, including but not limited to Seller's Prime Subcontractors. Although engaged by Seller in the execution or performance of this Contract, Special Contractors are not included within the definition of Seller's Subcontractors for purposes of this Agreement.

"**Seller's Subordinates**" means the officers, directors, employees, Affiliates, agents and representatives of Seller (and their respective successors and assigns), as well as the officers, directors, employees, agents and representatives of any and all of Seller's Subcontractors (and each and all of their respective successors and assigns). Neither the United States Department of Energy, nor Special Contractors, nor Seller's Subcontractors are Seller's Subordinates.

"**Separate Contractors**" means entities other than the Seller with which the District has contracted to supply services, material or equipment or to otherwise perform work on or near the Project.

"**Site Conditions**" means the physical conditions of the Turbine Deployment Site, including, without limitation, conditions relating to the environment, transportation, access, waste disposal, handling and storage of materials, the availability of electric power and other utilities, climatic conditions and seasons, topography, water conditions, geologic conditions, shore conditions, seafloor conditions, and all other local or other conditions that may be material to the Seller's obligations under this Contract.

"**Spare Parts**" means the spare parts to be delivered to the District in accordance with Contract Specifications Schedule 10.

"**Special Contractors**" shall mean PCCE Equipment Supplier and NUC or any replacement, as Seller may hire in its sole discretion.

"**Subsea Base**" means a gravity foundation structure, to be provided by the Seller in accordance with this Contract, which holds a Turbine and all ancillary equipment associated with the Turbine.

"**Tow Trialing**" means testing and verification of Turbine Unit functionality performed immediately prior to the Delivery Date. In Tow Trialing, a tug tows the Deployment Barge while the Turbine Unit is lowered into the flow stream, causing the blades to spin and informing the test results. Tow Trialing is more particularly described in Contract Specifications Schedule 8.

"**Turbines**" means the two open center turbines, each with approximately a six (6) meter diameter, that are described in the Contract Specifications.

"**Turbine Deployment Site**" means the two geographic locations on the seafloor where the Seller shall Deliver the Turbine Units, as more fully described in the Project Plans 'Total Project Site Plan.'

"**Turbine Mobilization Facility**" means the shore facility(ies) to which Turbines will be transported and at which Turbine Units will be assembled.

"**Turbine Unit**" means a Turbine, plus the Subsea Base to which the Turbine is attached, together with the related auxiliary equipment, accessories, components, and materials as specified in the Contract Specifications or as otherwise agreed in writing by the Parties. For the avoidance of doubt this will not include District-Furnished Equipment, on-shore transformers provided by Seller, the PCCB, PCCE or equipment supplied by a Separate Contractor for the PCCB.

"**Turbine Unit Recovery**" means removal at any time of one or both of the Turbine Units from the Turbine Deployment Site.

"**Warranty Period**" means the one-year period described in Article 18 for each of the Turbine Units.

"**Warranty Period Performance Level**" means an electrical output measured at each Turbine Unit over periods of time. After this Contract is executed, the Seller will provide a reasonable Warranty Period Performance Level prior to the District's issuance of the Final Notice to Proceed. The Parties anticipate that the Warranty Period Performance Level will be a less restrictive threshold than that set for the Minimum Level of Performance.

"**Water Work Window**" means the Washington Department of Fish and Wildlife-approved marine installation work window between July 16 to October 14, or as otherwise approved for specific installation activities by the governing agencies and tribes, established to avoid adverse effects on sensitive marine fish species.

2. SCOPE OF SELLER'S AND DISTRICT'S OBLIGATIONS

2.1 The Seller shall provide the District under the terms and conditions of this Contract items that include but are not limited to the following:

2.1.1 Two Turbine Units;

2.1.2 Document Deliverables;

2.1.3 Data Deliverables;

2.1.4 Maintenance Services;

2.1.5 Spare Parts; and

2.1.6 Final Turbine Unit Recovery.

2.2 The District shall provide the Seller under the terms and conditions of this Contract items that include but are not limited to the following:

2.2.1 The licenses, permits and approvals in accordance with Article 8.

2.2.2 A PCCB to allow installation of the PCCE supplied by Seller and installed by the District or the District's Separate Contractor.

2.2.3 The connection and disconnection of the Turbine Units (whether at installation or at any other time as more specifically set forth under this Contract) to the PCCE and the onward connection from the PCCE to the Grid as necessary to connect the Turbine Units to the Grid and the export of electricity to the Grid.

2.2.4 District-Furnished Equipment;

2.2.5 District-Provided Information; and

2.2.6 Ability to access, as specified in the Contract, the Turbine Units during the Warranty Period and for any Maintenance Services.

3. CONTRACT PRICE

3.1 The amount to be paid to the Seller for all services, materials and equipment under this Contract, excluding state and local sales taxes applied to the Contract Price and excluding the Maintenance Services Fee, (the "Contract Price") is the sum of the Milestone Payments in Section 4.1, and will be established in the Final Notice to Proceed Amendment. The Contract Price shall be subject to any increase or decrease as a result of a Change in the Contract as defined below.

3.2 The Maintenance Services Fee to be paid to the Seller for providing Maintenance Services in accordance with this Contract is not included in the Contract Price. The Maintenance Services Fee shall be determined and paid pursuant to the unit rates and payment terms set forth in Contract Specifications Schedule 10.

3.3 The total amount to be paid to the Seller for the supply and delivery of Spare Parts shall be included in the Contract Price.

4. TERMS OF PAYMENT

4.1 Payment Terms.

Payment on account of the Contract Price ("Milestone Payments") shall be made by the District on a "milestone" basis, with payments based on designated events in the fabrication, testing, performance, and delivery of the Turbine Units, Spare Parts and other deliverables. These events ("Milestone Events") are summarized in the table below and are more fully described in Contract Specifications Schedule 15. Milestone Zero (No. 0) requirements are described in Contract Specifications Schedule 15(c). The estimated date upon which the Milestone Events are to be achieved ("Milestone Date"), the Milestone Payments to be made by the District to the Seller separately for the Milestone Event, and the currency in which the Milestone Payment is to be made are set forth below. These amounts do not include state and local sales taxes on the Milestone Payment, which will be added to the payments set forth below.

No.	Milestone Event	Milestone Date	Amount (% of Contract Price)	Payment Amount *Euros*	Payment Amount *USD*
0.A	Power Conversion & Control Equipment	DATE TBD	TBD	-	$140,000
0.B	Deployment Barge Preliminary Design	DATE TBD	TBD	-	$20,000
0.C	Seller Planning and Project Development	DATE TBD	TBD	-	$40,000
1.	Delivery of initial set of Document Deliverables set forth in Contract Specifications Schedule 15	DATE TBD			
2.	Proof of procurement of major Turbine material components set forth in Contract Specifications Schedule 15	DATE TBD			
3.	Successful completion of the FAT for Oct 06 – 08 and Oct 06-09	DATE TBD			
4.	Turbine Shipment from Ireland	DATE TBD			
5.	Subsea Bases shipment from Manufacturing Facility	DATE TBD			
6.	Deployment Barge and Turbines ready to commence Tow Trials	DATE TBD			

No.	Milestone Event	Milestone Date	Amount (% of Contract Price)	Payment Amount *Euros*	Payment Amount *USD*
7.	Successful completion of the Tow Trial Acceptance Tests	DATE TBD			
8.	Successful Delivery of each of the Turbine Units at the Turbine Deployment Site	DATE TBD			
9.	Successful completion of Performance Tests (District's Acceptance)	DATE TBD			
Contract Price			100%		

4.2 Time is of the essence under this Contract except as provided otherwise under this Contract.

4.3 Each Milestone Payment will be reviewed separately. A partial Milestone Payment may be made if the identified Milestone Event has been substantially completed in accordance with the Contract, with the balance of the Milestone Payment paid when the Milestone Event is entirely completed. Any partial Milestone Payment shall be based pro rata on the reasonable value of the substantially completed Milestone Event work and/or deliveries.

4.4 The Seller shall submit separate invoices for each Milestone Payment in triplicate and shall include an itemization of any services rendered, or equipment shipped, in sufficient form and detail to permit review by the District. To the extent any such Milestone Payment relates to the procurement of (a) Subsea Base steel; (b) blades; (c) coils; (d) magnets; (e) Turbine inner ring, outer ring, and end caps; (f) flexi-floats; (g) winches; (h) batteries; (i) power conversion system; (j) transformers, or as otherwise required under Section 19.1 below, then the Seller shall provide the District with a UCC-1 or (at Seller's option) equivalent security interest within ten (10) days after the District's payment in the aforementioned materials/equipment, and shall clearly identify the related payment number and applicable Milestone Event.

4.5 Payment and acceptance of a Milestone Payment for a Milestone Event shall not constitute acceptance of the status or condition of a Turbine Unit, nor forfeit the District's right to inspect and accept the Seller's performance of a Milestone Event and its documentation, nor preclude the District or the

Seller from pursuing any other rights or remedies it may have under the Contract, in law or in equity.

4.6 The Milestone Payment for the final Milestone Event shall be equal to the Contract Price less the sum of all previous Milestone Payments paid by the District to the Seller, less any Actual Delay Costs alleged to be owed by Seller (if and only if the District provides reasonable prior written notification to Seller setting forth in detail the District's justification for the District's entitlement to Actual Delay Costs and the related detailed calculations), all of which shall be subject to final disposition under Article 36 (Dispute Resolution) below.

4.7 Twenty (20) days prior to submitting an invoice for a Milestone Event, the Seller shall issue a Milestone Completion Certificate ("MCC"). If the District disputes any MCC, the District shall, within twenty (20) days from its receipt of the MCC, give the Seller written notice of any aspect of the Milestone Completion Certificate with which it does not agree, including reasonable particulars of the District's basis and the actions required of the Seller to achieve completion ("MCC Dispute Notice"). Upon the Milestone Date, the Seller may issue an invoice in the undisputed amount.

4.8 The District shall pay amounts due and owing by wire transfer to the Seller's designated account net fifteen (15) days from receipt of a proper invoice. Payments due and unpaid shall bear interest as specified by Chapter 39.76 RCW, not to exceed the Bank of America prime rate plus two percent (2%) on an annual basis.

4.9 If the District disputes an MCC in accordance with Section 4.7, the Seller and District shall discuss in good faith any matters specified therein. If they are unable to resolve all matters specified in a MCC Dispute Notice within thirty (30) days of the District having given a MCC Dispute Notice, either Party shall be entitled to pursue resolution in accordance with Section 36 (Dispute Resolution). The District shall only be entitled to withhold payment of the portion of Milestone Payment in dispute.

4.10 No delay in achievement of any of the Milestone Events shall constitute a material breach of the Contract by Seller unless specifically set forth otherwise in this Contract.

5. TAXES AND DUTIES

5.1 The Seller shall, unless otherwise from time to time agreed in writing between the Parties, be responsible for the importation into the United States and clearance through customs of the Turbines and Seller-provided aspects of the Turbine Units and other equipment supplied by or through the Seller for the Project ("Imported Equipment"). The Seller shall include in the Contract Price all costs, expenses and duties, tariffs, governmental

charges, fees and import taxes paid in respect of importing the Imported Equipment into the United States and/or levied on the Imported Equipment, whether Federal, State or local government, as well as all business and occupation taxes, use taxes and sales and value-added taxes (but not sales taxes paid on the Milestone Payments).

5.2 The Seller shall include with applicable MCCs reasonable backup documentation or other vouching therefore to evidence payment of such costs, expenses and duties. The District shall be liable for state and local sales taxes on its payments to Seller.

6. QUALITY CONTROL, FACTORY ACCEPTANCE TESTS AND INSPECTIONS

6.1 The Seller shall manufacture and test the Turbines and the Turbine Units, including significant components utilized in the Turbines and Turbine Units, in accordance with the FAT and any generally recognized industry-standard practices and the Contract Specifications before Delivery of the Turbine Units to the Turbine Deployment Site. While the District may make suggestions of means and methods, techniques, sequences or procedures, the Seller alone is responsible for its means, methods, techniques, sequences and procedures as well as for its safety precautions and programs.

6.2 The District shall be entitled to review the Seller's quality control process as set forth in the Document Deliverables.

6.3 The Seller shall carry out FAT of the Turbines in accordance with Contract Specifications Schedule 8.

6.4 Prior to issuance of the Final Notice to Proceed, the Seller shall provide the District with its preliminary draft production progress schedule, the name and location of the manufacturing facilities of Seller and Seller's Subcontractors, and the name of the Seller's manufacturing representative. Within forty-five (45) days after the Final Notice to Proceed, Seller shall issue its proposed revised production progress schedule, the name and location of the manufacturing facilities of Seller and Seller's Subcontractors, and the name of the Seller's manufacturing representative, based on Seller's procurement activities since the Final Notice Proceed. Upon the District's request, the Seller shall provide the District with reasonable access to its manufacturing facilities during the manufacturing period so that the District may visit the Seller's and/or Seller's Prime Subcontractors' facilities to ascertain the state and progress of manufacture. The Seller shall be entitled to restrict access to its facilities to normal working hours on days when the relevant facilities are open for business and to those of the District's officers and employees who are engaged in the Project. The foregoing provisions of this Section 6.4 shall also apply to

access to the facilities of Seller's Prime Subcontractors and shall be included in the Seller's contracts with Seller's Prime Subcontractors. Where access is requested to facilities of other Seller's Subcontractors, the Seller shall use its commercially reasonable efforts to facilitate such access.

6.5 Notice of the expected date of a FAT shall be given to the District at least one (1) month in advance, and notice of the established date of such FAT shall be given to the District at least two (2) weeks in advance. The District shall be entitled to attend and observe the FAT at the time and place appointed. The Seller shall provide the District with a written report of the results of the FAT, which shall include, without limitation, a description of any Turbine deficiencies revealed thereby and the Seller's plan to remedy any such deficiencies.

6.6 The District shall bear all costs and expenses for attendance of the District at the FAT or for visits to the facilities. Provided always that in the event that the Seller reschedules a proposed FAT less than two weeks in advance of the scheduled test date (unless such rescheduling is caused by an event of Force Majeure or an act or omission of the District or any Separate Contractor or failure or deficiency of any District-Furnished Equipment), the Seller shall be responsible for any additional costs and expenses reasonably and properly incurred by the District as a result of such rescheduling. The District undertakes to use its reasonable endeavors to minimize or mitigate any additional costs and expenses so incurred by it as a result of such rescheduling and shall provide vouching in respect of such additional costs and expenses.

6.7 Nothing in this Article 6 shall relieve the Seller of its exclusive obligation for the design and supply of the Turbine Units and the Seller's exclusive obligation for the safety of its manufacturing facilities. Notwithstanding the foregoing the District undertakes that it shall ensure that its officers, employees and representatives shall, while they are on the Seller's and/or Seller's Subordinates' facilities, comply with all instructions and directions of the Seller and the Seller's Subordinates and shall indemnify, hold harmless and defend the Seller and the Seller's Subordinates in respect of all actions, costs, claims, damages, expenses and liabilities which the Seller and/or the Seller's Subordinates may suffer or incur in connection with any death of or injury to any of the District's officers, employees or representatives while they were on such facilities to the extent arising as a result of or caused by the negligence and/or failure of such officers, employees or representatives to comply with the instructions and/or directions of the Seller and/or the Seller's Subordinates.

7. DISTRICT-FURNISHED EQUIPMENT AND SEPARATE CONTRACTORS

7.1 District-Furnished Equipment.

7.1.1 The District shall provide the District-Furnished Equipment in accordance with Contract Specifications Schedule 11. The District will inspect each item of the District-Furnished Equipment prior to providing such equipment to the Seller and inform the Seller as soon as reasonably practicable if the District discovers any defect in the material or design or manufacture of District-Furnished Equipment. The Seller shall receive and promptly examine District-Furnished Equipment; such examination shall not be a representation that the Seller has made any exhaustive inspection(s) to check the quality or condition of the District-Furnished Equipment, and such examination shall not relieve the District of its responsibilities for the District-Furnished Equipment. The Seller shall inform the District as soon as reasonably practicable if the Seller discovers any defect in the material, design or manufacture of District-Furnished Equipment. Without limitation of any of Seller's other remedies at law and equity, the District shall endeavor to remedy any such defect as soon as possible. The Seller shall not be required to use District-Furnished Equipment in which the District or the Seller discovers such a defect.

7.1.2 To the extent of the negligence of the Seller, Seller's Subordinates, Seller's Subcontractors and/or Special Contractors, the Seller shall bear the risk of loss for District-Furnished Equipment after the District-Furnished Equipment has been delivered to Seller and is in its possession and control until Delivery of the Turbine Units to the Turbine Deployment Site, at which point all risk therein shall pass to the District. The Parties waive any and all claims against each other to the extent of any property insurance proceeds received with respect to any such loss.

7.1.3 The Seller shall be liable for any loss or damage to District-Furnished Equipment caused by a defect in the Turbine Units, Document Deliverables, Data Deliverables, Maintenance Services, or Turbine Unit Recovery. The Parties waive any and all claims against each other to the extent of any property insurance proceeds received with respect to any such loss or damage.

7.1.4 The District shall, save as expressly otherwise provided in this Contract, be responsible for the performance of all District-Furnished Equipment and shall warrant, and shall require its Separate Contractors to warrant, that all District-Furnished Equipment is fit for its intended purpose, of merchantable quality,

free from defects (latent and patent) and conforms in all respects to the Contract Documents.

7.1.5 To the extent not the fault of the Seller, and without limitation to any other of Seller's rights and remedies, in the event that any District-Furnished Equipment does not conform to the Contract Documents and/or contains or is subject to any defect in design, materials or manufacture, or suffers any breakdown or failure, and as a consequence thereof the Seller suffers any delay in performing its obligations under this Contract, then the District shall afford to the Seller such extension of time caused thereby as is reasonable in the circumstances for the performance of the Seller's obligations under this Contract and shall be liable to the Seller in respect of any reasonably and properly incurred additional costs and expenses which the Seller suffers or incurs as a result thereof.

7.2 Separate Contractors.

7.2.1 The District will conduct operations related to the Project with the District's own forces and will award separate contracts with Separate Contractors in connection with other portions of the Project or other construction or operations on or near the Turbine Deployment Site. The District shall notify Seller prior to hiring any Separate Contractors sufficiently in advance to reasonably implement the following clause. Upon request of Seller, the District and the Seller shall agree on appropriate reasonable contract provisions in the District's particular agreement with any such Separate Contractors to adequately protect Seller's proprietary information from disclosure to such Separate Contractor.

7.2.2 The District shall, subject to requiring that its Separate Contractors are bound by obligations of confidentiality no less onerous than those contained in this Contract, exchange information with Separate Contractors to the extent necessary for the purposes of and in connection with the proper implementation of the Project and provide for coordination with the Seller of the activities of the District's own forces and of each Separate Contractor, and the Seller shall coordinate and cooperate with them in a reasonable manner. The Seller shall participate reasonably with Separate Contractors and the District in their activities when reasonably requested by the District to do so.

7.2.3 The Seller shall, subject to its safety policies, procedures, and methods, afford the District and its Separate Contractors reasonable opportunity upon reasonable prior notice and during normal operational hours for access to Seller's manufacturing facilities and shore facilities, including the Turbine Mobilization Facility, and for

introduction, attachment, connection and storage of their materials and equipment and for performance of their activities, and Seller shall coordinate the Seller's operations with theirs as is reasonably required to facilitate Seller's performance of the Contract. Notwithstanding the foregoing, the District shall not delay the scheduled progress of Seller's work. The District shall, and shall require that the Separate Contractors shall, comply with all reasonable instructions and directions given by the Seller in relation to the terms of access to the Seller's manufacturing facilities, shore facilities, including the Turbine Mobilization Facility, and the Turbine Deployment Site and conduct of the District's personnel and operations thereon. If the Seller receives items from the District (whether from itself or from Separate Contractors) for storage, attachment, connection, erection or installation, the Seller shall acknowledge receipt for items delivered, and thereafter store such items in accordance with the reasonable written instructions to be provided by the District.

7.2.4 The Seller shall report material defects it actually discovers regarding the District's or Separate Contractor's completed or partially completed work product.

7.2.5 The District (on its behalf and on behalf of its Separate Contractors) shall be responsible for all losses and damage they cause to a Turbine Unit and/or to any of the Seller's plant, machinery and equipment.

7.2.6 The District shall reimburse the Seller for reasonable costs the Seller properly suffers or incurs to the extent caused by the District and/or any Separate Contractor's delays, improperly timed activities or defective performance.

7.3 Special Contractors

7.3.1 The Seller shall execute contracts with the Special Contractors for the Project. The Seller's contracts with Special Contractors shall include a one-year warranty reasonably acceptable to the District for the PCCE Equipment Supplier equipment. The Seller's contract with the PCCE Equipment Supplier shall include provisions requiring the PCCE Equipment Supplier to be on site for the duration of the commissioning activities for the PCCE and coordinating its activities with the District, the University of Washington and the Seller. The warranty shall provide that in the event of a material defect with Special-Contractor-furnished equipment, the Special Contractor will furnish replacement equipment and services to remedy any defect at no additional cost to

the Seller or the District and also provide that the Special Contractor's warranty will be assignable to the District.

7.3.2 The Seller shall manage the work of the Special Contractors. To the extent a warranty issue predominately relates to a Special Contractor, and the Seller has complied with Section 7.3.1, the warranty shall be assigned or considered to be issued directly to the District under terms agreed upon by the District and the Special Contractors. All other warranty issues, including those related in part to a Special Contractor, shall be addressed under the Contract through the Seller.

7.3.3 The District agrees to prosecute any such warranty claims predominately relating to a Special Contractor only directly against the Special Contractors and not against the Seller provided the Seller has complied with Section 7.3.1. The District shall not make any claims against the Seller relating to the Special Contractor warranties to the extent that such claims predominately relate to a Special Contractor, provided the Seller has complied with Section 7.3.1. The Seller shall provide resources and cooperate with the District's prosecution or defense of such warranty claims. In all cases, the Seller shall work with the District to develop a plan to address any warranty issue.

8. PERMITS AND TURBINE DEPLOYMENT SITE ACCESS

8.1 The District shall obtain and maintain, or cause to be obtained and maintained, all necessary licenses, permits and approvals for the use of Turbine Deployment Site and the PCCB, for connection of the Turbine Units to the PCCE, for connection between the PCCE and the Grid, for export of electricity generated by the Turbine Units, for any of the work of Separate Contractors, and for the operation of the Turbine Units at the Turbine Deployment Site, including, without limitation the following:

1. Pilot Tidal (Marine Hydrokinetic) License, FERC
2. Hydraulic Project Approval (HPA), WDFW
3. Section 401 Water Quality Cert., WA Dept. of Ecology
4. Coastal Zone Management Act (CZMA), WA Dept. of Ecology
5. Aquatic Resources Use Authorization (Aquatic Lands Lease), WA State DNR
6. Shoreline Conditional Use Permit, Island County
7. Building Permit, Island County
8. Flood Hazard Permit, Island County

The Seller shall obtain and maintain all other necessary licenses, permits and approvals, for the Seller's manufacturing facilities, shore facilities, including the Turbine Mobilization Facility, for the work of Seller's

Subcontractors and Special Contractors, and for conduct of Seller's own marine operations (including but not limited to the Tow Trials, Delivery and Turbine Unit Recovery). The District shall provide the Seller, and the Seller shall provide the District, with true and complete copies of all such necessary licenses, permits and approvals, and each shall promptly advise the other in writing of any amendment, alteration, variation or revocation of any of them. The Seller shall obtain all other licenses, permits, and permissions required for the Seller to carry out its business in the jurisdictions where the Turbines and Turbine Units are fabricated or assembled and through which they are transported.

8.2 The Seller and the District shall, so far as it is within its power and control, and subject to Changes under this Contract, comply with all licenses, permits and approval obtained by any Party.

8.3 The District shall furnish, as indicated in the Contract Specifications, the Turbine Deployment Site at which the Turbine Units are to be Delivered and all necessary licenses, permits, rights-of-way and easements for access thereto. If the Seller believes that any delay in the District's furnishing the Turbine Deployment Site, licenses, permits, rights-of-way, or easements entitles the Seller to an extension of one or more Milestone Dates, the Seller shall provide notice and make a Claim in accordance with Article 35.

9. SITE CONDITIONS

9.1 Site Conditions.

The District represents and warrants that (i) the Site Conditions as set out in Contract Specifications Schedule 16, and that (ii) the District-Provided Information are, to the best of its knowledge, complete and accurate in all material respects and acknowledges that in conducting its assessment of the Turbine Deployment Site the Seller is relying upon the District-Provided Information. The Seller acknowledges that it has received the District-Provided Information and has exercised reasonable care and diligence in using such District-Provided Information in the design and specification of the Turbines and of the Turbine Units and their installation in a manner which, based upon the District-Provided Information, the Seller considers appropriate for the Project. The Seller shall promptly notify the District of any discovered material variance between the actual Site Conditions and the anticipated Site Conditions indicated by this Contract or by the District-Provided Information and, without limitation, such variance shall be subject to Changes under this Contract.

9.2 Differing Site Conditions.

To the extent Site Conditions materially differ from the conditions described in the District-Provided Information (a "Differing Site

Condition"), the Seller shall be entitled to a Change in the Contract subject to the provisions of Article 34.

10. TOW TRIALING, DELIVERY OF TURBINE UNITS AND SPARE PARTS AND COMMISSIONING

10.1 The Project goal is Delivery of both Turbine Units by October 4, 2015. So long as the District has issued the Final Notice to Proceed by March 25, 2014, then if the Seller fails to Deliver both Turbine Units before October 4, 2015, the Seller shall not then be in default but shall be responsible for the District's Actual Delay Costs incurred after October 7, 2015, subject to an Actual Delay Cost Cap.

10.2 The Seller shall conduct Tow Trialing of the Turbine Units prior to the Delivery Date. The Turbine Units shall be required to have successfully passed the Tow Trialing in accordance with Contract Specifications Schedule 8 prior to Delivery to the Turbine Deployment Site.

10.3 The Seller, at its own risk and expense, shall be responsible for transporting and deploying the Turbine Units at the Turbine Deployment Site.

10.4 The Seller shall provide the District with forty (40) days' written notice of the projected date upon which each of the Turbine Units will be Delivered at the Turbine Deployment Site and shall Deliver the first of the Turbine Units on or after August 5, 2015. The Delivery Date of the second of the Turbine Units shall occur on or before October 7, 2015 (seven days prior to the expiration of the 2015 Water Work Window). If the Seller does not provide the 40-day notice under this Section for each Turbine Unit, the District will not notify its Separate Contractor to mobilize to connect the Turbine Unit, and the Seller shall be responsible for any delay thereby caused.

10.5 The District will be responsible for leading the commissioning of the PCCB and the PCCE. The Seller shall be on site for the duration of the commissioning activities and take the lead in commissioning its SCADA system and electrical equipment it furnished and in confirming that the Turbine Units are meeting the Minimum Level of Performance and Warranty Period Performance Level.

10.6 The Seller, at its own risk and expense, shall be responsible for transporting, unloading, and placing the Spare Parts at the Turbine Mobilization Facility.

10.7 Actual Delay Costs, subject to the Actual Delay Cost Cap, shall be the District's sole and exclusive remedy provided the Turbine Units are Delivered prior to October 4, 2017. Failure to timely Deliver a Turbine Unit prior to October 4, 2017, while susceptible to Actual Delay Costs, shall not constitute a material default by the Seller.

10.8 The Seller shall not be liable for the delay of the delivery of minor equipment or components so long as the delay does not cause a delay in the Performance Test.

11. PACKING AND MARKING

11.1 The Turbines, Turbine Units, and Spare Parts shall be properly packed in accordance with reasonable and prudent industry practices for overseas construction jobs sufficient to protect the contents from damage during ocean transportation.

12. TRANSFER OF TITLE AND RISK OF LOSS

12.1 The title and risk of loss to any Turbine Unit under this Contract shall pass to the District upon successful Delivery of the Turbine Unit at the Turbine Deployment Site in accordance with this Contract and the Seller's issuance of its second completion certificate for such Turbine Unit. The Seller shall continue to be responsible for (i) the quality and performance of such Turbine Units (until District's Acceptance as stipulated in Article 15 hereof) and (ii) compliance with all other terms and conditions of the Contract, including, but not limited to, the Warranty under Article 18.

12.2 The title and risk of loss to Spare Parts under this Contract shall pass to the District upon delivery to the District as defined in the Contract Specifications.

13. MINIMUM LEVEL OF PERFORMANCE

13.1 (a) The District shall connect each of the Turbine Units to the PCCB as described in the Contract Specifications and within seven (7) days of the Delivery Date. The Seller shall commence the Performance Testing on each Turbine Unit in accordance with the Performance Testing Procedure set forth in the Contract Specifications within two (2) business days of successful connection by the District. If the District fails to successfully connect a Turbine Unit within seven (7) days of the Delivery Date, then the time within which the Minimum Level of Performance is to be achieved by Seller shall be extended in accordance with the Contract.

(b) The District shall install the necessary undersea cables for connecting the Turbine Units and shall connect the undersea cable to the Turbine Units within the Water Work Window. The District shall prepare to connect the first Turbine Unit after its Delivery, potentially (and if so, coincidentally) while the second Turbine Unit is being prepared for deployment by Seller. The District shall prepare to connect the second Turbine Unit after its Delivery.

13.2 Provided that the Seller has Delivered the Turbine Units by October 7, 2015, and provided the District has connected the Turbine Units by October 14, 2015, the Seller shall successfully achieve and maintain the Minimum Level of Performance by no later than December 14, 2015. If the Seller Delivers the Turbine Units after the close of the 2015 Water Work Window, the Seller shall successfully achieve and maintain the Minimum Level of Performance within sixty (60) days after the District has initially connected the Turbine Units, and the District will provide the necessary cooperation for Seller to access the Project for Seller's activities.

13.3 If a Turbine Unit fails to achieve and maintain the Minimum Level of Performance by the date specified in Section 13.2, other than as a result of Differing Site Conditions, Force Majeure or other causes specified in Section 13.5 below, then the Seller shall promptly adjust, repair or replace the Turbine Unit and any deficient part or parts of the Turbine Units and promptly initiate further Performance Testing. If, however, the deficient part(s) are District-Furnished Equipment, the District shall be responsible for procuring such defective part(s) as soon as possible. If a Turbine Unit fails to achieve and maintain the Minimum Level of Performance due to any cause for which the Seller is responsible under the Contract, the Seller shall bear the Actual Delay Costs incurred as a result of the failure to achieve and maintain the Minimum Level of Performance as well as the Seller's other costs as follows: personnel and operating costs, costs for modification, improvement, testing, inspection, connection, repair or replacement of the Turbine Units, disconnection/reconnection costs, Turbine Unit Recovery costs and Turbine Unit redeployment costs. The Seller's responsibility for connection and disconnection costs shall be limited to the Disconnection/ Reconnection Fixed Price.

13.4 If a Turbine Unit fails to achieve and maintain the Minimum Level of Performance due to any defect or failure of the District-Furnished Equipment or by any cause for which the District is responsible under the Contract, the District shall bear all direct costs and expenses incurred by the Parties based on the failure to achieve the Minimum Level of Performance, including but not limited to costs for modification, improvement, testing, inspection, connection and disconnection, Turbine Unit Recovery costs and Turbine Unit redeployment costs, and repair or replacement of the Turbine Units.

13.5 The Seller is excused from Actual Delay Costs if the failure to achieve and maintain the Minimum Level of Performance is due to (i) the District's failure to comply with its obligations under this Contract, (ii) any act or omission of any Separate Contractor, (iii) the failure of or defect in any District-Furnished Equipment, or (iv) an event of Force Majeure.

14. CONNECTION, DISCONNECTION AND RECONNECTION

14.1 If a Turbine Unit needs to be disconnected and/or reconnected due to the Seller's fault in order to achieve either the Minimum Level of Performance or Warranty Period Level Performance, the Seller will be responsible for the disconnection/ reconnection costs as described below. The District shall be responsible for all disconnection/reconnection costs after the Warranty Period expires, including the disconnection for Final Turbine Unit Recovery.

14.2 The District has provided an estimate of the cost of the disconnection/ reconnection of a Turbine Unit ("Disconnection/Reconnection Estimate"), upon which the Seller has based its Contract Price. As part of the solicitation for the public works contract, the District will require bidders to provide a fixed-price cost, adjustable annually using the Price Index Fraction, for the disconnection/reconnection of a Turbine Unit ("Disconnection/ Reconnection Fixed-Price"). Once the Disconnection/Reconnection Fixed-Price is provided, the District and the Seller will negotiate a modification to this Contract to account for any difference between the Disconnection/Reconnection Estimate and the Disconnection/ Reconnection Fixed-Price.

14.3 The Seller shall be responsible to reimburse the District in the amount of the Disconnection/Reconnection Fixed-Price each time the Separate Contractor disconnects and reconnects a Turbine Unit after the initial connection and until the Warranty Period expires. The District will be responsible to pay the Separate Contractor any amount due in addition to the Disconnection/Reconnection Fixed-Price; the Seller shall reimburse the District for such additional costs reasonably incurred by and paid to the Separate Contractors during the Warranty Period only to the extent due to the Seller's fault.

15. ACCEPTANCE AND REJECTION OF TURBINE UNITS

15.1 The Turbine Units shall be Delivered by the Seller to the District at the Turbine Deployment Site on or before the contractual Delivery Date. Upon Delivery of each of the Turbine Unit at the Turbine Deployment Site, the Seller will issue its first of two completion certificates for each Turbine Unit (for a total of four completion certificates).

15.2 Upon successful completion of the Performance Testing, the Seller will issue its second completion certificate.

15.3 The District is not obligated to accept a Turbine Unit until its receipt of the two Turbine Unit completion certificates from the Seller for that Turbine Unit as specified in Article 15, at which time the Seller may request the

District to issue a certificate accepting the Turbine Unit. Each Turbine Unit shall be accepted separately.

15.4 If, because of the Seller's fault, one of the following events has occurred, the Seller will promptly (and in any case no more than thirty (30) days after the event) provide the District with a detailed, written plan describing how it intends to cure the deficiency in delivery or performance ("Cure Plan"):

(a) the District has rejected the Turbine Units in whole or in part by written notice to the Seller;

(b) both Turbine Units are not Delivered by October 4, 2015;

(c) both Turbine Units do not achieve Minimum Level of Performance by December 14, 2015;

(d) both Turbine Units are not Delivered by October 4, 2016;

(e) both Turbine Units do not achieve Minimum Level of Performance within sixty (60) days after the District has initially connected the Turbine Units; or

(f) both Turbine Units do not achieve the Warranty Period Performance Level for the duration of the warranty.

The Cure Plan will contain the Seller's proposal of its good-faith means and methods to cure the deficiency in delay or performance, including but not limited to a program, a schedule of milestone events and expected outcomes. Upon receipt of the Cure Plan, the District will establish a project management process and schedule, and the Seller shall work in good faith with the District in accordance with this process and pursue the objectives of the Cure Plan. Nothing herein shall be construed as a right for the District to approve or reject the Cure Plan. The Seller shall pursue the Cure Plan at its own expense, and Seller shall attend regular meetings with the District to facilitate implementation of the Cure Plan. The Cure Plan shall not constitute an amendment to the Contract.

15.5 The District shall not take any actions to repair any defects itself or by any third party provided the Seller is making a good-faith effort to pursue the Cure Plan. If the Seller fails to correct, and the District is obligated by a governmental entity to correct, the specified defects or nonconformities, the District may take action to correct the specified defects and nonconformities, but, without limitation to Seller's other rights and remedies, such actions by the District shall invalidate the warranties of Seller under this Contract. Furthermore, the District shall not violate Seller's sole and exclusive intellectual property rights in the Turbine Units as set forth in Article 22, which survive any termination of this agreement.

16. MAINTENANCE SERVICES

16.1 Commencing with the Delivery Date and throughout the Contract Term, the Seller shall, as necessary to maintain the Turbine Units and otherwise upon the District's request, dispatch appropriate equipment, information and personnel to the Turbine Deployment Site at any time to provide Maintenance Services at the Turbine Deployment Site. Maintenance Services shall be performed by the Seller in accordance with the terms and conditions set forth in Contract Specifications Schedule 10.

16.2 At the District's option, exercised on an annual basis beginning twelve (12) months prior to the initial Contract Term, the Seller shall provide extended Maintenance Services for up to twenty-four (24) months beyond the initial Contract Term ("Extended Maintenance Services"). The cost for Extended Maintenance Services and the period in which the District may exercise its right to Extended Maintenance Services is set forth in Contract Specifications Schedule 10.

17. TURBINE UNIT RECOVERY; SELLER RIGHT TO PURCHASE

17.1 The Seller shall provide for Turbine Unit Recovery in accordance with the Contract and the Contract Specifications during the one-year Warranty Period and during the period after expiration of the warranty.

17.2 Final Turbine Unit Recovery shall occur no earlier than one (1) year after the conclusion of the Warranty Period. The Seller shall provide for Final Turbine Unit Recovery in accordance with the Contract Specifications.

17.3 After Final Turbine Recovery, the District may retain, scrap, donate or sell the Turbine Units. If the District intends to sell a Turbine Unit, it shall notify the Seller in writing, and, for a period of thirty (30) days, the Seller shall have the right to purchase the Turbine Unit on the same terms as the proposed sale.

18. SELLER'S WARRANTY

18.1 Warranty Period. If the Seller achieves the Minimum Level of Performance of a Turbine Unit within sixty (60) days of the Delivery Date of that Turbine Unit, or if the District fails to connect a Turbine Unit within seven (7) days of Delivery, then, in either event, the Warranty Period for that Turbine Unit will be deemed to have commenced on the Date of Delivery of that Turbine Unit to the Turbine Unit Deployment Site. If connected by the District within seven (7) days of Delivery, and if a Turbine Unit does not achieve its Minimum Level of Performance within said sixty (60) days, however, the Warranty Period will commence for the Turbine Unit on the date when that Turbine Unit actually achieved the Minimum Level of Performance. The duration of the Warranty Period for each Turbine Unit shall be one year.

18.2 Warranty Period Performance Level. The Turbine Units must meet the Warranty Period Performance Level as set forth in the Contract Specifications. At the end of the one-year Warranty Period, the Parties will meet and determine the cumulative period of time during the Warranty Period that the Turbine Units met the Warranty Period Performance Level. The Warranty Period shall be tolled for any time period during which the Warranty Period Performance Level is not being met, less any intervening time period that Seller is delayed in remedying a problem because Seller cannot reasonably access the Turbine Unit(s) due to the Water Work Window or Force Majeure events. Seller shall not be responsible for further damage to the Turbine Units to the extent access to the Turbine Units is precluded by the Water Work Window or Force Majeure. Should Seller need to access the Turbine Units outside of the Water Work Window, Seller shall notify the District, and the District shall make a good-faith effort to obtain MARC approval within forty-five (45) days; if the District fails to obtain MARC approval with said period, the Warranty Period shall no longer be tolled after the expiration of said period until the time that the Water Work Window resumes.

18.3 Warranty Cap. The total expenditure and exposure that the Seller is obligated to incur in its endeavor to achieve the Warranty Period Performance Level shall not exceed $4,500,000 (four million five-hundred thousand dollars). This is a cap on the amount the Seller itself is obligated to spend on seeking to achieve the Warranty Period Performance Level and does not operate as a limitation of the Seller's potential liability to the District.

18.4 If the Seller provides maintenance (including recovery of the Turbine Units) prior to or during the Warranty Period in order to comply with terms of the warranty, these activities will be performed at no cost to the District but are applied and subject to the Warranty Cap.

19. SELLER'S SECURITY AND RETAINAGE

19.1 In addition to the Seller's obligations under Section 4.4, if requested by the District, the Seller shall provide a UCC-1 or (at Seller's option) equivalent security interests in the Turbines, the Subsea Base and the Turbine Units that apply through the Delivery Dates.

19.2 The District may retain five percent (5%) from each Milestone Payment made to Seller for the faithful performance of the Contract and payment of obligations arising under the Contract. When the Warranty Period Performance Level has been achieved for six months, the District shall pay to Seller fifty percent (50%) of the retained amount, provided the Seller submits releases and waivers through that date from its Special Contractors and Prime Contractors. Upon the completion of the Warranty Period, the District shall pay to Seller the entire outstanding balance of the retained

amount provided no Claims or liens have been filed by any Subcontractor and further provided that the Seller submits releases and waivers from its Special Contractors and Prime Subcontractors indicating that the Special Contractors and Prime Subcontractors waive and release liens or Claims against the Project real property or the retainage. Any balance withheld shall be paid upon mutual resolution or discharge of all such liens and Claims against the Project real property or the retainage. Nothing in this Section 19.2 shall authorize the District to withhold retainage from the Seller on the ground that Seller itself has filed liens or Claims against the District.

20. INDEMNITY

20.1 To the fullest extent permitted by law and subject to the conditions of this Article 20, the Seller shall defend, indemnify and hold harmless the District, its Affiliates, its Separate Contractors and consultants, and their respective board members, officers, managers, employees, successors and assigns (collectively, the "District Indemnified Parties"), from and against claims, damages, losses and reasonably and properly incurred direct expenses, including but not limited to costs, design professional and consultant fees, and attorneys' fees reasonably and properly incurred on such claims and in proving the right to indemnification, provided that such claim, damage, loss or expense is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property (other than the Work itself), but only to the extent caused by the negligent acts or omissions of the Seller, Seller's Subordinates, Seller's Subcontractors, Special Contractors, or anyone directly or indirectly employed by them or anyone for whose acts they may be liable ("Seller Indemnitors"). The Seller's defense and indemnity obligations hereunder shall be limited to, and shall not exceed, the amount of insurance proceeds actually paid for any such claims.

20.2 Where claims, damages, losses, or expenses arise from the concurrent negligence of (a) the District and/or any of the District Indemnified Parties and (b) the Seller Indemnitors, the Seller's obligations to indemnify and defend the Indemnified Parties under this Article shall be effective only to the extent of the Seller Indemnitors' negligence.

20.3 To the fullest extent permitted by law and subject to the conditions of this Article 20, the District shall defend, indemnify and hold harmless the Seller, its Affiliates, the Seller Subordinates, the Special Contractors, consultants, and their respective board members, officers, managers, employees, successors and assigns (collectively, the "Seller Indemnified Parties"), from and against claims, damages, losses and reasonably and properly incurred direct expenses, including but not limited to costs, design professional and consultant fees, and attorneys' fees reasonably and properly incurred on such claims and in proving the right to indemnification, provided that such

claim, damage, loss or expense is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property (other than the Work itself), but only to the extent caused by the negligent acts or omissions of the District, its Separate Contractors or anyone directly or indirectly employed by them or anyone for whose acts they may be liable ("District Indemnitors"). The District's defense and indemnity obligations hereunder shall be limited to, and shall not exceed, the amount of insurance proceeds actually paid for any such claim.

20.4 Where claims, damages, losses, or expenses arise from the concurrent negligence of (a) the Seller and/or any of the Seller Indemnified Parties and (b) the District Indemnitors, the District's obligations to indemnify and defend the Seller Indemnified Parties under this Article shall be effective to the extent of the District Indemnitors' negligence.

20.5 Each Party agrees to being added by the other Party as a party to any arbitration or litigation with third parties in which an Indemnified Party alleges indemnification or contribution from the Indemnitors.

20.6 To the extent that any portion of this Article 20 is stricken by a court or arbitrator for any reason, all remaining provisions shall retain their vitality and effect. The obligations under this Article 20 shall not be construed to negate, abridge, or otherwise reduce any other right or obligations of indemnity that would otherwise exist as to any party or person described in this Article 20. To the extent the wording of this Article 20 would reduce or eliminate an available insurance coverage, this Article 20 shall be considered modified to the extent that such insurance coverage is not negatively affected. This Article 20 shall survive completion, acceptance, final payment and any termination of the Contract.

20.7 In claims against any person or entity indemnified under this Article by an employee of any of the Indemnified Parties, the indemnification obligation under this Article shall not be limited by a limitation on amount or type of damages, compensation or benefits payable under workers' compensation acts, disability benefit acts or other employee benefit acts. AFTER MUTUAL NEGOTIATION OF THE PARTIES, THE SELLER AND THE DISTRICT WAIVE IMMUNITY AS TO THE INDEMNIFIED PARTIES UNDER TITLE 51 RCW, "INDUSTRIAL INSURANCE."

20.8 The District expects to secure an owner-controlled insurance program ("OCIP"), the details of which will be set forth in the Special Provisions to be provided prior to the Final Notice to Proceed. The Parties intend that an OCIP would cover the Parties' respective indemnification obligations in Article 20. In the event an OCIP is not obtained by the District, the Parties shall negotiate an appropriate amendment with respect to the terms of this Article 20 to address cost adjustments relating to resulting changes to

Seller's insurance costs, indemnity obligations, and any other terms and conditions for the program that the Parties agree are needed. The District shall afford Seller with a reasonable opportunity to review the OCIP, and the parties shall bargain in good faith if any changes to the Contract are necessary due to the OCIP terms.

21. INSURANCE

21.1 Before commencing the work under this Contract, the Seller shall procure and maintain at its own expense the following minimum insurance, and shall provide to the District certificates of insurance and additional insured endorsements evidencing such coverage:

(a) Workers' Compensation insurance for statutory obligations imposed by Workers' Compensation, Occupational Disease, or other similar laws and $1,000,000 Employers Liability;

(b) Products Liability, $1,000,000 per occurrence, $2,000,000 aggregate;

(c) Business Automobile Liability (for all owned, non-owned, hired, and leased vehicles): $1,000,000 combined single limit;

(d) Commercial General Liability, $1,000,000 per occurrence, $2,000,000 aggregate;

(f) Professional Liability (errors and omissions), $5,000,000 per occurrence, with a $5,000,000 aggregate.

The Seller shall have the District added as an additional insured under all such policies except Workers Compensation and Professional Liability.

22. INTELLECTUAL PROPERTY

22.1 The District's funding for the Project will be provided in part through a grant by the United States Department of Energy ("DOE"). Under the grant and 10 C.F.R. part 600, the District has certain obligations to provide Project data to DOE. The Seller shall provide the District with all data required by DOE or necessary for the District to comply with its obligations to DOE.

22.2 The Seller shall hold the District harmless from any liability or responsibility for, and shall indemnify the District against, loss and fine arising out of third party's claim for infringement on trademark, patent or copyright and/or related design used on or in connection with the Turbine Units, Document Deliverables or Data Deliverables. The Seller hereby grants the District a non-exclusive, non-revocable limited license to use the Document Deliverables and Data Deliverables for use on this Project.

22.3 The District shall hold the Seller harmless from any liability or responsibility for, and shall indemnify the Seller against, loss and fine arising out of a third party's claim for infringement on trademark, patent or copyright and/or related design of any District-Furnished Equipment or any other intellectual property under the control of the District or its Separate Contractors.

23. CONFIDENTIALITY

23.1 Any Confidential Information received by either Party (a "receiving Party") from the other Party (a "disclosing Party") pursuant to this Contract shall be used, disclosed, or copied, only for the purposes of, and only in accordance with, this Contract. The receiving Party shall use, as a minimum, the same degree of care as it uses to protect its own Confidential Information of a similar nature, but no less than reasonable care, to prevent the unauthorized use, disclosure or publication of Confidential Information. Without limiting the generality of the foregoing:

(i) the receiving Party shall only disclose Confidential Information to its bona fide employees, contractors or suppliers who need to obtain access thereto for purposes consistent with this Contract;

(ii) the receiving Party shall not make or have made any copies of Confidential Information except those copies which are necessary for the purposes of this Contract; and

(iii) the receiving Party shall retain on any copies it makes of the Confidential Information all proprietary notices or legends affixed to the Confidential Information as they appear on the copies of the Confidential Information originally received from the disclosing Party.

23.2 Confidential Information shall not include information that: (i) is or becomes publicly available without default hereunder by the receiving Party; (ii) is lawfully acquired by the receiving Party from a third party not under any obligation of confidentiality to the disclosing Party with respect to such information; (iii) is lawfully in the possession of the receiving Party in written or other recorded form at the time of its disclosure hereunder and not under any obligation of confidentiality to the disclosing Party with respect to such information; (iv) is disclosed to any third party by or with the written permission of the disclosing Party without restriction on further disclosure; or (v) is developed by the receiving Party independently. In addition, disclosure shall be permitted if and when required by law, provided that the disclosing Party gives (provided that it is lawful to do so) the other Party at least seven (7) days' advance notice before making such disclosure.

24. PUBLICATIONS

24.1 Except as required by law or as required in an official meeting with the District's governing Board of Commissioners, all communications made to the press and all publications relating to the Project or this Contract require the mutual consent of the Parties, which shall not be unreasonably withheld. The Parties shall work in good faith to coordinate communications relating to the Project or this Contract made to the public and the press, and shall endeavor to recognize the other Party's contribution to the Project in such communications.

24.2 The Seller shall provide the District with a portfolio of the Seller's images, branding, and trademarks for use in the District's public information and related activities in relation to the Project. The Parties shall work together in good faith to agree on the content and timing of all media and marketing releases relating to the Project or to the Seller. The Seller shall use its commercially reasonable efforts to provide other information required by the District to obtain necessary licenses, permits, and permissions.

25. AUDIT AND RECORD KEEPING

25.1 The Seller shall maintain, in accordance with generally accepted local accounting principles consistently applied, records and books of account of the calculation of the Contract Price and books, ledgers, records, documents, estimates, bids, correspondence, logs, schedules, emails, and other tangible and electronic data and evidence relating or pertaining to the costs and/or performance of the Contract ("records") to such extent and in such detail as will detail the performance by the Seller of its obligations under the Contract Documents and with all costs, charges and other amounts of whatever nature relating directly or indirectly to the Project. The Seller shall preserve such records for a period of six (6) years following the Contract Term and for such longer period as may be required by any other provision of the Contract or by law. Within fifteen (15) days of the District's written request, the Seller agrees to make available at the location of such records during normal business hours all such records for inspection, audit and reproduction (including electronic reproduction) by the District, its representatives. Provided always that the Seller shall be entitled to withhold (in whole or in part) any records and/or may redact any records which in its opinion (acting in good faith and reasonably) is held subject to obligations of confidentiality owed to any third party and/or contains professional and/or legally privileged advice from the Seller's professional advisers. Failure to comply fully with this requirement shall constitute a material breach of the Contract and a waiver of any pending Claim related to the records sought.

25.2 The Seller shall incorporate a provision substantially in the form of Section 25.1 in any of Seller's contracts with Seller's Prime Subcontractors by

which such Seller's Prime Subcontractors are obligated to maintain, preserve and make available records to the District to the same extent Seller is obligated to the District in Section 25.1.

26. LAWS, CODES AND STANDARDS

26.1 The Seller shall comply with and give notices required by all applicable laws and regulations, including but not limited to Federal, State, and Local laws, ordinances and regulations, governing or bearing upon the performance of the Contract, and shall promptly report to the District any nonconformity discovered by or made known to the Seller. If the Seller performs any work contrary to such laws, ordinances, rules or regulations, the Seller shall bear all related costs.

26.2 Where codes or standards are referred to in this Contract, they shall be the current and applicable approved editions of such code or standard. It shall be the duty of the Seller and Seller's Subcontractors and Special Contractors to submit evidence as requested that any materials or equipment provided under the Contract are in compliance with applicable codes and standards.

27. OBLIGATIONS UNDER FEDERAL LAW

27.1 Funding for the Project will be provided in part through federal funds. To the extent that the Seller has been made aware by the District, the Seller shall comply with the terms of Exhibit A – Special Conditions and Procurement Requirements for Federal Funded Contracts. The Seller shall incorporate Exhibit A to the extent required by law and this Article in all of the Seller's contracts with any of Seller's Prime Subcontractors.

27.2 The Seller shall not be debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participating in the Contract or the Project by any Federal department or agency. If requested, the Seller shall complete a certification form regarding debarment, suspension, ineligibility, and voluntary exclusion. Any such form completed by the Seller shall be incorporated into the Contract by reference. The Seller shall immediately provide written notice to the District if at any time the Seller learns that it has become debarred, suspended, proposed for debarment, declared ineligible or is voluntarily excluded from participating in the Contract or the Project by any Federal department or agency; or if at any time the Seller learns that its certification was or has become erroneous. The Seller shall not award any subcontract to a party that is debarred, suspended or otherwise excluded from or ineligible for participation in any federal assistance programs, except with the express written consent of the District. The Seller shall include all such provisions in any contracts with Seller's Subcontractors and Special Contractors.

27.3 As part of a Department of Energy (DOE) award, the DOE may request that the District provide the DOE with certain data as more fully described in Exhibit E, General Data Request List. In the event the DOE requests that the District provide such data, the District shall notify the Seller of the DOE's request, and the Seller shall provide the requested data to the District in the form and timeframe requested by the DOE. Should the District determine that Seller needs to comply with any DOE requirement other than by providing the type of data described in Exhibit E, the District shall make Seller aware of such requirement, and then the Parties will negotiate and execute an appropriate change order for any time and cost adjustment (if any) needed for Seller. Notwithstanding any provision of this Contract to the contrary, the Seller shall coordinate with the District for the reporting requirements of the DOE. The Seller shall include this provision in all its subcontracts with Seller's Subcontractors and Special Contractors.

28. SAFETY, PUBLIC CONVENIENCE AND INTERFERENCE

28.1 The Seller shall be solely responsible for insuring that its performance under the Contract, and the performance of Seller's Subordinates, Seller's Subcontractors and Special Contractors, is carried out in a safe manner and in accordance with the Washington Industrial Safety and Health Act (WISHA) and all other applicable safety laws, rules, and regulations.

28.2 All reasonable measures, notifications and scheduling considerations shall be required of the Seller to limit traffic disturbances and other disruptions when transporting the Turbines and Turbine Units to the Turbine Deployment Site. The Seller shall ensure that all Turbine Deployment Site work required under this Contract complies with all local standards or ordinances, Washington State and federal regulations, and safe working practice. The District reserves the right but is not obligated to stop work when in its judgment safety conditions are compromised or threaten the public or the District's property, workers or inspection personnel, and no extension of time of the Milestone Dates or increase in the Contract Price shall be due for any delays as a result of such work stoppages.

28.3 The Seller shall Deliver the Turbine Units to the Turbine Deployment Site in a manner that will maintain good public relations by minimizing so far as is reasonably practicable inconvenience and disturbance to the traveling and resident public affected thereby, and in such a manner to minimize so far as is reasonably practicable interference with the business operation of the District and others affected thereby. The Seller and the District shall cooperate with each other in all reasonable ways to prevent and/or minimize any such interference or disruption.

29. MUTUAL WAIVER OF CONSEQUENTIAL DAMAGES

29.1 In no event, and notwithstanding any other provision of this Contract, shall either Party be liable to the other Party, whether based in contract, tort (including negligence and strict liability) or otherwise, for any loss of profits or revenues, loss of use, economic loss, loss of profit or any other consequential loss or damage whatsoever and howsoever arising, whether or not such loss or damage could have been reasonably anticipated by a Party. This mutual waiver is applicable, without limitation, to all consequential damages due to either Party's termination in accordance with Article 33. Nothing contained in this Section 29.1, however, shall be deemed to preclude an award of Actual Delay Costs in accordance with the requirements of the Contract, or to preclude an obligation of one Party to indemnify another Party for direct, indirect or consequential damages due and payable by one Party to a third party.

29.2 The District's contracts with its Separate Contractors and the Seller's contracts with Seller's Subcontractors and Special Contractors shall include provisions waiving consequential damages substantially in the form of this Section 29.

30. LIMITATION OF LIABILITY

30.1 The overall direct liability of a Party to the other under this Contract, whether in contract, in tort (including negligence and strict liability) or otherwise, is capped in the aggregate of one hundred percent (100%) of the Contract Price.

30.2 The overall liability of a Party to other Party for third-party claims under Article 20 shall be limited to OCIP values.

31. SUSPENSION

31.1 The District may direct the Seller to suspend performance of this Contract in whole or in part at any time and from time to time, by giving seven (7) days' prior written notice of suspension to the Seller, and setting out, if appropriate, a description of the activities required in order to suspend performance. The Seller shall suspend performance as so instructed, and shall resume the suspended performance as promptly as practicable following the District's notice of resumption. In the event of suspension pursuant to this Article 31, the District shall reimburse the Seller for its actual out-of-pocket costs reasonably incurred plus reasonable overhead costs (not to exceed five percent (5%) of such out-of-pocket costs) incurred as a result of the suspension. Milestone Dates shall be revised to take into account any delay resulting from such suspension. If the suspension pursuant to this Article 31 exceeds two years, then the Seller shall, without prejudice to the District's obligations pursuant to the foregoing provisions

of this Section, be entitled to terminate this Contract, and such termination shall be deemed to be in accordance with Article 33.

31.2 The District shall give the Seller not less than sixty (60) days' prior written notice of resumption of the suspended performance. The Seller shall not resume the suspended performance unless and until both Parties mutually agree in accordance with Article 34 on the effect on the Milestone Dates, the Contract Price and any other provisions of this Contract affected by such resumption of suspended performance.

32. FORCE MAJEURE

32.1 "Force Majeure" shall mean event(s) beyond the reasonable control of the Party affected, including, but not limited to, acts of God or the public enemy, expropriation of facilities, war, terrorism, earthquake or volcanic activity or related undersea disturbance, rebellion or sabotage or damage resulting therefrom, flood, typhoon or other inclement weather more severe than that could have been reasonably anticipated, including the combined sea state conditions of significant wave height equal to or greater than one (1) meter and wind speed greater than or equal to seventeen (17) knots, for a total of five (5) consecutive slack-tide periods that would otherwise be suitable for Turbine Unit Deployment; explosion or other catastrophes; riot or strike (other than strike or industrial action by the employees of the Party affected); damage caused by any marine wildlife; water current speeds, after the Delivery of the second Turbine Unit, that are in excess of 5.64 m/s; acts of any government agency (including customs); or any other catastrophes; or any causes, whether or not of the same class or kind as those specifically named above, which are not within the control of the Party affected and which by the exercise of reasonable diligence, the Party is unable to prepare for or prevent.

32.2 If either Party is rendered wholly or partially unable to perform its obligations under this Contract due to the occurrence of a Force Majeure event, then subject to the following provisions of this Article 32, the affected Party shall be excused from the affected performance obligation for the duration of the Force Majeure event, including without limitation Seller's obligations to complete any Milestone Events, Delivery Date or Minimum Level of Performance.

32.3 Any Party affected by the Force Majeure event shall (a) notify the other Party of the occurrence of the event and the consequences in accordance with Article 35, (b) continue to perform its obligations to the extent the Party is not prevented from doing so, and (c) use commercially reasonable endeavors to remedy its inability to perform and to mitigate the effects of the Force Majeure event. The affected Party shall resume performing its contractual obligations affected by a Force Majeure event as soon as is reasonably and commercially practicable after the termination of the Force

Majeure event. Neither Party shall be liable to the other Party for any failure or delay in complying with its obligations to the extent that such failure or delay has been caused by one or more events of Force Majeure. The periods allowed for the performance by the Parties of its obligations under the Contract, including but not limited to the Delivery Date, shall be extended to the extent one or more Force Majeure events continues to materially and adversely affect the performance of a Party of its obligations under this Contract.

32.4 If the Force Majeure event continues for one year from the date that performance was first delayed, either Party may terminate this Contract, and the District's sole obligation shall be payment to the Seller of (i) all amounts due and not previously paid to the Seller for the Milestone Events completed in accordance with this Contract prior to notice of Force Majeure event; (ii) amounts due (including amounts which have been contractually and irreversibly committed to a third party but not yet incurred at the date of termination) to the extent of performance of Milestone Events in progress as of the date of the Force Majeure event; and (iii) reasonable costs incurred by the Seller, with reasonable prior written notice to the District, in settling and paying claims of Seller's Subordinates, Seller's Subcontractors and/or Special Contractors arising out of the cancelled orders, where such costs and cancellations were undertaken as a result of the Force Majeure event.

33. TERMINATION OF CONTRACT

33.1 Contract Termination for the District's Convenience.

33.1.1 The District may, for its own convenience and at its sole discretion, terminate this Contract by giving not less than thirty (30) days' prior written notice to the Seller. Upon the specified date of termination, the Seller shall discontinue performance as directed, mitigate ongoing costs, and, at the District's cost and expense, protect all completed work and take all reasonable measures after consultation with and approval of the District to terminate or assign to the District all contracts with Seller's Subordinates, Seller's Subcontractors and Special Contractors, purchase orders and similar commitments related to the Contract, as the District elects. The Seller shall deliver completed items with all applicable warranties and work-in-progress to the District, or dispose of such items and work-in-progress as the District may direct.

33.1.2 Should this Contract be terminated by the District pursuant to this Section 33.1 after the District has issued a Final Notice to Proceed, the District's sole obligation to the Seller shall be: (i) to indemnify, hold harmless and defend the Seller against and in respect of all liabilities to third parties, including actions, claims, damages, losses, costs, expenses, penalties and other liabilities, which the

Seller suffers or incurs as a consequence of the Seller exercising its right to terminate this Contract for convenience or as a consequence of any work the District procures or performs after the date of termination, and (ii) to pay to the Seller all amounts due and not previously paid to the Seller for Milestone Events satisfactorily completed in accordance with the Contract, for performance of those portions of Milestone Events pending as of the date of termination, and for the reasonable costs of settling and paying claims of Seller's Subordinates, Seller's Subcontractors or Special Contractors arising out of cancelled orders, and (c) five percent (5%) of the Contract Price.

33.1.3 If the District does not issue a Final Notice to Proceed, this Contract will terminate, and the District's sole obligation to the Seller shall be payment of the Milestone Zero payment, with no liability to the Seller for any of the other amounts set forth in Section 33.1.

33.1.4 The District shall notify Seller when the District obtains the FERC license required for this Project. In the event the District fails to obtain its FERC license required for the Project after using commercially reasonable efforts and through no fault of the District otherwise, the District shall notify Seller, and the District shall terminate this Contract for its convenience with no liability to Seller for any of the amounts set forth in Section 33.1 other than the Milestone Zero payment.

33.2 Contract Termination for the Seller's Default.

33.2.1 The District, upon thirty (30) days' written notice to the Seller and without prejudice to any other right or remedy, may terminate the Contract for cause if:

.1 the Seller is adjudged bankrupt, or makes a general assignment for the benefit of the Seller's creditors, or

.2 a receiver should be appointed on account of the Seller's insolvency, or

.3 the Seller is in material default under the Contract and fails to cure or commence to cure the default within thirty (30) days after receipt of written notice thereof, or

.4 after an event requiring the submission of a Cure Plan, the Seller fails to provide a Cure Plan and pursue the objectives of the Cure Plan and work with the District in good-faith.

33.2.2 Notwithstanding the above provisions of Section 33.2.1, the District shall not be entitled to terminate the Seller for cause:

.1 for failure to Deliver either or both Turbine Units (unless the Seller fails to establish a good-faith Cure Plan, fails to cooperate with the project management process and schedule established by the District, fails to work in good faith with the District in accordance with this process, or fails to Deliver both Turbine Units to the deployment site by October 4, 2017);

.2 for failure to achieve the Minimum Level of Performance (unless the Seller fails to pursue the objectives of the Cure Plan, fails to cooperate with the project management process and schedule established by the District, fails to work in good faith with the District in accordance with this process, or fails to achieve the Minimum Level of Performance by December 14, 2017);

.3 for failure to maintain the Warranty Period Performance Level for both Turbine Units (unless the Seller fails to pursue the objectives of the Cure Plan and fails to work in good faith with the District, or unless, despite having reasonable access to the Turbine Unit during the Water Work Window, the Seller fails to maintain the Warranty Period Performance Level for the duration of the Warranty Period within two (2) years of achieving the Minimum Level of Performance); or

.4 for failure to achieve a Milestone Event by the Milestone Date (except the Delivery, Minimum Level of Performance, or Warranty Period Performance Level Milestones).

33.2.3 Upon termination, the District may finish the Seller's performance under this Contract by whatever method the District may deem expedient. In addition, the District may exercise any rights, claims or demands that the Seller may have against Seller's Subordinates, Seller's Subcontractors and Special Contractors or third persons in connection with this Contract, and for this purpose the Seller hereby assigns, transfers and sets over to the District all such rights, claims and demands, including but not limited to the Seller's rights to the Deployment Barge (if any). If the District elects to finish the Seller's performance, the Seller shall not be entitled to receive any further payment until that performance under the Contract is complete. If the unpaid balance of the Contract Price exceeds the expense of finishing the Seller's performance under the Contract,

including compensation for additional reasonable managerial and administrative services, such excesses shall be paid to the Seller. If such expense exceeds such unpaid balance, the Seller shall pay the difference to the District.

33.2.4 Without limitation to Sections 33.2.1 and 33.2.2 above, and notwithstanding anything to the contrary in this Contract, delays or breaches to any Milestone Events other than those addressed in Sections 33.2.1 and 33.2.2 for which Seller is responsible under this Contract may not give rise to a material default of Seller under this Contract, and District may not terminate this Contract for cause for such Seller delays or breaches.

33.3 Contract Termination for the District's Default.

33.3.1 The Seller may terminate this Contract by giving written notice of termination to the District if (i) the District is in default of any material provision of this Contract, and fails to cure or commence to cure the default within thirty (30) days after receipt of written notice thereof, (ii) the District becomes insolvent or bankrupt, or an application shall be made to have the District declare insolvency or bankruptcy, or a receiver or trustee is appointed, or the District makes an assignment for the benefit of creditors or (iii) the suspension pursuant to Article 31 exceeds two (2) years.

33.3.2 Should this Contract be terminated by the Seller pursuant to Section 33.3, the District shall pay to the Seller as compensation (i) all amounts due and not previously paid to the Seller for Milestone Events completed in accordance with this Contract prior to notice of termination; (ii) amounts due to the extent of Milestone Events in production as of the date of termination; (iii) all reasonable costs of settling and paying claims arising out of canceled orders of Seller's Subordinates, Seller's Subcontractors or Special Contractors; and (iv) a reasonable profit not to exceed the percentage profit in the Contract Price for costs incurred in the performance of Milestone Events in production that have been terminated.

33.4 Contract Termination for the Seller's Convenience.

33.4.1 At any time prior to issuance of the Final Notice to Proceed, the Seller may, for its own convenience and at its sole discretion, terminate this Contract by giving not less than thirty (30) days' prior written notice to the District. Upon the specified date of termination, the Seller and the District shall discontinue performance, mitigate ongoing costs, and, at the District's cost and expense, protect all completed work and take all reasonable measures after consultation with and approval of the District to

terminate or assign to the District all contracts with Seller's Subordinates, Seller's Subcontractors and Special Contractors, purchase orders and similar commitments related to the Contract, as the District elects. The Seller shall deliver completed items with all applicable warranties and work-in-progress to the District, or dispose of such items and work-in-progress as the District may direct.

33.4.2 If the Seller terminates for convenience prior to issuance of a Final Notice to Proceed, the District's sole obligation to the Seller shall be payment of portion of the Milestone Zero payment earned to the date of such termination and shall have no liability to the Seller for any of the other amounts set forth in Section 33.1.

34. CHANGES

34.1 The term **"Change(s)"** or **"Change Order"** as used herein shall mean a written instrument signed by the District and Seller, substantially in the form attached hereto as Exhibit G, stating their mutual agreement to an amendment to this Contract, upon but not limited to any of the following: (i) a change in the Specifications or Seller's scope of performance; (ii) a change in the Project schedule or Delivery Date; and/or (iii) a change in the Site Conditions (collectively "**Changes**").

34.2 Either Party (a "requesting Party") may request Changes in good faith within the general scope of this Contract to the other Party (a "receiving Party") consisting of additions, deletions, or other revisions. The requesting Party shall submit a change request to the receiving Party in writing. As part of the request (if the Seller is the requesting Party) or within fifteen (15) business days after its receipt of any such request from District (if the District is the requesting Party), the Seller shall submit a detailed proposal to District stating, as applicable (a) the increase or decrease, if any, in the Contract Price which would result from such change, and (b) the effect, if any, upon the Project schedule by reason of such proposed change. The District shall have ten (10) business days from receipt of the Seller's detailed proposal to accept or reject in writing Seller's proposal in relation to the requested change. If the District agrees with the Seller's proposal, the District and Seller shall execute a Change Order reflecting the requested Changes and proposed adjustments. A Party disagreeing with the other Party's proposal shall promptly so notify the other Party, following which the Parties shall negotiate in good faith a solution which is satisfactory to both Parties. Should the requesting Party fail to respond to a receiving Party in writing within the foregoing ten (10) business day period, the requesting Party shall be deemed to have withdrawn its requested change.

34.3 The Seller shall not make any material changes without having received a Change Order executed by the District. If the Seller performs a material change without a Change Order executed by the District, the Seller will not be entitled to any additional payment.

34.4 Approved Changes, pursuant to a Change Order, will be implemented by the Seller without unreasonable delay.

34.5 Any disputes in respect of Change requests and Change Orders shall be resolved pursuant to the dispute resolution provisions of Articles 35 and 36.

35. CLAIMS AND NOTICE OF CLAIMS

35.1 In an effort to reduce the incidence and costs to all Parties of extended disputes, all Claims, direct or indirect, arising out of, or relating to, the Contract or the breach thereof, except those which have been waived under the terms of the Contract, shall be decided exclusively by the following alternative dispute resolution procedure unless the Parties mutually agree in writing otherwise. To the extent that the District and the Seller agree to a partnering process to help resolve disputes, that process shall be in addition to, and not in place of, the mandatory dispute resolution procedures set forth in Articles 35 and 36. Pending final resolution of a Claim, including the dispute resolution process set forth below, and except as otherwise agreed in writing, the Seller shall proceed diligently with performance of the Contract and maintain the Milestone Dates, and the District shall continue to make payments of undisputed amounts in accordance with the Contract.

35.2 The responsibility to substantiate Claims shall rest with the Party making the Claim. Claims must be initiated in writing and include the information and substantiation required by the Contract.

35.3 Except for Claims requiring notice before proceeding as otherwise described in the Contract, the Seller shall submit a written notice of a Claim to the District within seven (7) days after Seller becomes aware of such Claim and shall include a clear description of the event leading to or causing the Claim. For all Claims, the Seller shall submit a written Claim as provided herein within thirty (30) days of submitting the notice. Claims shall include a clear description of the Claim and any proposed change in the Contract Price (showing all components and calculations) and/or the Milestone Dates (showing cause and analysis of the resultant delay in the critical path) and shall provide all data supporting the Claim, including but not limited to a complete explanation as to why the relief sought is not within the scope of the Contract. The Seller may delay submitting data by an additional thirty (30) days if it notifies the District in its Claim that substantial data must be assembled. Failure to properly and timely submit a notice or a Claim shall waive the Claim. A Claim shall be deemed to include all changes, direct and indirect, in cost and in time to which the

Seller (and Seller's Subordinates, Seller's Subcontractors and Special Contractors) is entitled and may not contain reservations of rights without the District's written approval; any unapproved reservations of rights shall be without effect. Any claim by Seller's Subordinates, Seller's Subcontractors or Special Contractors may be brought only through, and after review by, the Seller.

35.4 All notices and Claims shall be made in writing and as required by the Contract. No act, omission, or knowledge, actual or constructive, of the District shall in any way be deemed to be a waiver of the requirement for timely written notice and a timely written Claim unless the District and the Seller sign an explicit, unequivocal written waiver. The fact that the District and the Seller may consider, discuss, or negotiate a Claim that has or may have been defective or untimely under the Contract shall not waive any provision of the Contract unless the District and the Seller sign an explicit, unequivocal waiver.

36. DISPUTE RESOLUTION

36.1 At any time following the receipt of a written Claim, a Party may require that an officer of the Seller and the District's designee (all with authority to settle) meet, confer, and attempt to resolve a Claim. If the Claim is not resolved during such meeting, neither Party may bring an action against the other Party unless the Claim is first subject to nonbinding mediation. This requirement cannot be waived except by an explicit written waiver signed by the District and the Seller.

36.2 Mediation. Claims not resolved through negotiation shall be subject to mandatory mediation. A request for mediation shall be filed in writing with the other Party to the Contract, and the Parties shall promptly attempt to mutually agree upon a mediator. If the Parties have not reached agreement on a mediator within thirty (30) days of the request, either Party may file the request with the American Arbitration Association or such other alternative dispute resolution service to which the Parties mutually agree, with a copy to the other Party, and the mediation shall be administered by the American Arbitration Association (or other agreed service) in accordance with its Construction Industry Mediation Procedures currently in effect. Mediation shall proceed in advance of binding dispute resolution proceedings, which shall be stayed pending mediation, unless stayed for a longer period by agreement of the Parties or court order. The Parties to the mediation shall share the mediator's fee and any filing fees equally. The mediation shall be held in Seattle, Washington, unless another location is mutually agreed upon. Agreements reached in mediation shall be enforceable as settlement agreements in any court having jurisdiction thereof.

36.3 Arbitration. All Claims between the Parties arising out of or in connection with this Contract that cannot be resolved through mediation shall be

exclusively and finally resolved by arbitration under the latest rules of the American Arbitration Association then in effect, unless the Parties mutually agree otherwise in writing.

36.3.1 Good faith participation in mediation in accordance with Section 36.2 is a condition precedent to the filing of a demand for arbitration. Accordingly, a demand for arbitration shall be made no earlier than the date written notification is received from one of the Parties stating that efforts at mediation have been unsuccessful, and in no event shall it be made after the date when the institution of legal or equitable proceedings based on the Claim would be barred by the applicable statute of limitations.

36.3.2 A demand for arbitration shall be made in writing, delivered to the other Party, and filed with the person or entity administering the arbitration.

36.3.3 The place of arbitration shall be Seattle, Washington.

36.3.4 The Parties shall have the right to production of documents, electronically stored information, and tangible things, or entering onto land, for inspection and other purposes as provided in Rule 34 of the Federal Rules of Civil Procedure. In addition, the Parties shall have the full rights to discovery provided for in Rules 26 through 36 of the Federal Rules of Civil Procedure without arbitrator approval. Any dispute concerning discovery will be resolved by the arbitrator(s).

36.3.5 Either Party may file, and the arbitrator(s) shall consider and rule on, pre-trial motions. The arbitrator(s) shall hear and determine any preliminary issue of law asserted by any Party to be dispositive of any claim or defense, in whole or in part, in the manner that a court would hear and dispose of a motion to dismiss for failure to state a claim, or for summary judgment, pursuant to such terms and procedures as the arbitrator(s) deem appropriate.

36.3.6 It is the intent of the Parties that, barring extraordinary circumstances, any arbitration shall be concluded within one (1) year of the date the arbitrator(s) are named, and, unless the Parties otherwise agree, the total time of the arbitration hearing (exclusive of any preliminary hearing time) shall not exceed twenty (20) hearing days, or one hundred sixty (160) hours, whichever is less, with the time to be equitably divided between the Parties by order of the arbitrator(s). The Parties may, upon mutual agreement, extend or modify these time limits. The arbitrator(s) shall issue their final award or ruling within a time period not to exceed thirty (30) days after closure of the hearings and evidence.

36.3.7 The Parties and the arbitrator(s) shall treat all aspects of the arbitration and other related proceedings, including, but not limited to, discovery, testimony, evidence, the record of the proceedings, briefs, and the decision or award, as strictly confidential and not subject to disclosure to any third party or entity, other than to the Parties, the arbitrator(s) and the AAA or other administering agency. The hearings shall be conducted privately, and in a private setting, with no persons permitted to participate or be present except the Parties, their designated counsel and representatives, the arbitrator(s), witnesses, a reporter of the proceedings (if requested and paid for by a Party) and a representative of the AAA or other administering agency.

36.3.8 Prior to the commencement of the hearing, either Party may request, and the arbitrator(s) shall issue, a written decision that includes a reasoned statement of decision or opinion stating or setting forth the essential facts and legal bases supporting the disposition. In the event a panel is used, the arbitrators' decision shall be signed by at least a majority of the arbitrators.

36.3.9 The Parties expressly intend, agree and acknowledge that the Parties knowingly, unequivocally and absolutely waive, and the arbitrators are not empowered to grant, any and all right to bring any demand, claim or action against the other for exemplary, consequential, treble or punitive damages in any forum, under any theory of recovery.

36.3.10 Within fifteen (15) days of receipt of the written decision, either Party will have the right to file with the arbitrator(s) and simultaneously serve on the other Party a written motion to reconsider. The arbitrator(s) may request the nonmoving or responding Party to file a written response within ten (10) days after receipt of that request. The arbitrator(s) thereupon will reconsider the issues raised by the motion and response (if any) and either confirm or alter their decision, which will then be final, binding and conclusive upon the Parties. The costs of such motion for reconsideration and written opinion of the arbitrator(s), including attorneys' fees, shall be awarded against the moving Party if its motion does not substantially prevail.

36.3.11 The decision and any award rendered by the arbitrator(s) shall then be final, and judgment may be entered in a court having jurisdiction thereof. Except for bases set forth in Section 7.04A of the Revised Code of Washington (the Uniform Arbitration Act), the Parties hereby waive any right to appeal the arbitration decision, which shall be conclusive and binding on the Parties.

36.3.12 The cost of the arbitrator(s) shall initially be borne equally by the Parties, subject to the arbitrator(s)' discretion to award and/or apportion reimbursement of such arbitrator fees as part of the "costs" included in any prevailing party determination.

36.3.13 The District may join the Seller as a party to any arbitration proceeding involving the alleged fault, responsibility, or breach of contract of the Seller, Seller's Subordinates, Seller's Subcontractors or Special Contractors.

36.3.14 If, and only if, no arbitration has been commenced under this Article 36, then the Parties agree to waive arbitration and submit to litigation in a court of competent jurisdiction if and only if litigation is required to join all parties necessary or beneficial to the full and final resolution of a claim, dispute or controversy.

36.3.15 The foregoing agreement to arbitrate and other agreements to arbitrate with an additional person or entity duly consented to by Parties to this Contract shall be specifically enforceable in accordance with applicable law in any court having jurisdiction thereof.

37. LABOR – PREVAILING WAGES

37.1 The Seller shall pay, and shall ensure that all of Seller's Subordinates, Seller's Subcontractors and Special Contractors pay, all prevailing wages and Davis-Bacon Act wages to the extent applicable to the Project. The Contract Specifications may specify additional or supplementary requirements.

37.2 To the extent applicable by law to this Contract, pursuant to RCW 39.12, "Prevailing Wages on Public Works," no worker, laborer, or mechanic employed in the performance of any part of the Contract shall be paid less than the "prevailing rate of wage" as determined by the Industrial Statistician of the Department of Labor and Industries. The schedule of the prevailing wage rates for the locality or localities where this Contract will be performed is attached to the executed Contract as Exhibit C and made a part of the Contract by reference as though fully set forth herein; if not attached, then the applicable prevailing wages under RCW 39.12 are determined as of the date of this Contract for the county in which the Project is located and are available at http://www.lni.wa.gov/TradesLicensing/PrevWage/WageRates/default.asp. A copy is also available for viewing at the District's office and will be mailed upon request. The Seller shall keep a paper copy available to workers. To the extent required by law, the Seller shall provide the Seller's Subordinates, Seller's Subcontractors and Special Contractors with a schedule of the applicable prevailing wage rates.

Questions relating to prevailing wage data should be addressed to the Industrial Statistician upon request.

Mailing Address:	Department of Labor and Industries Prevailing Wage Office P.O. Box 44540 Olympia, WA 98504
Telephone:	(360) 902-5335
Facsimile:	(360) 902-5300

37.3 The information in Exhibit C is offered for the convenience of the District. The District does not represent that the information is accurate or complete. To the extent that there is any discrepancy between the attached or provided schedule of prevailing wage rates and the published rates applicable under WAC 296-127-011, or if no schedule is attached, any applicable published rates shall apply with no increase in the Contract Price. It is the Seller's responsibility to ensure that the correct prevailing wage rates are paid.

37.4 Prior to the District making any payment under this Contract, the Seller and each of Seller's Subordinates, Seller's Subcontractors and Special Contractors shall file, to the extent required by law, a statement under oath with the District and certified by the Director of Labor and Industries indicating the hourly wage rate to be paid to each classification of workers entitled to prevailing wages, which shall not be less than the prevailing rate of wage. Such statement shall include the estimated number of workers in each classification employed on the Project by the Seller, Seller's Subordinates, Seller's Subcontractors and Special Contractors, as well as the Seller's contractor registration number and other information required by the Director of Labor and Industries. The statement, and any supplemental statements, shall be filed in accordance with the requirements of the Department of Labor and Industries. No payment shall be made until the District receives such certified statement.

37.5 The Seller shall also post, or caused to be posted, in a location readily visible to workers at all applicable sites:

(i) A copy of any required "Statement of Intent to Pay Prevailing Wages" approved by the Industrial Statistician of the Department of Labor and Industries; and

(ii) The address and telephone number of the Industrial Statistician of the Department of Labor and Industries where a complaint or inquiry concerning prevailing wages may be made.

37.6 Pursuant to RCW 39.12.060, in case any dispute arises as to the prevailing wage for work of a similar nature, and such dispute cannot be adjusted by

the parties in interest, including labor and management representatives, the matter shall be referred for arbitration to the Director of the Department of Labor and Industries, and his or her decision shall be final and conclusive and binding on all parties involved in the dispute.

37.7 The Seller shall defend, indemnify and hold the District harmless, including attorneys' fees, from any violation or alleged violation by the Seller, Seller's Subordinates, Seller's Subcontractors and/or Special Contractors of RCW 39.12 ("Prevailing Wages on Public Works") or Chapter 51 RCW ("Industrial Insurance"), including without limitation RCW 51.12.050.

37.8 Workers and Discipline.

The Seller shall at all times enforce strict discipline and good order among its employees, and shall not employ any unfit person or anyone not skilled in the work to which they are assigned. The Seller shall replace any employees or Seller's Subordinates, Seller's Subcontractors or Special Contractors whom the District considers objectionable.

37.9 Sanitation.

The Seller shall provide and maintain necessary sanitation conveniences for the use of workers for the Project, properly secluded from public observation.

38. SECURITY OF ELECTRONIC AND NATIONAL SECURITY INFORMATION

38.1 If the Seller requires access to the Internet while performing this Contract, the Seller may utilize the District's Internet access (the "Guest Network") for that purpose and when doing so may use equipment that is not owned by the District.

38.2 The Seller may arrange access to the Guest Network through the District's Information Technology Services (ITS) help desk within 48-hours' advance notice.

38.3 The Seller may have access to any Critical Infrastructure Information only if that access is required to satisfy the obligations of this Contract. If such access is required, Critical Infrastructure Information shall be identified in writing by the District and the Seller shall (i) comply with all associated requirements provided by a District's Critical Infrastructure Information Officer; (ii) treat all Critical Infrastructure Information as privileged and confidential, and release the information to any third party, or to any of Seller's Subordinates, Seller's Subcontractors and Special Contractors only upon the District's written consent; and (iii) if instructed by the District to file any Critical Infrastructure Information with any federal, state or local

government, prominently mark such information as Critical Electrical Infrastructure Information in accordance with 6 C.F.R. § 29.5(a)(3) and ensure that such information is protected in accordance with all applicable laws and regulations. For purposes of this Article, "Critical Infrastructure Information" means any and all information concerning any Critical Asset or Cyber Critical Asset, as identified pursuant to North American Electric Reliability Corporation ("NERC") Standard CIP-002 (including any revision or modification of that Standard adopted by NERC or the Western Electricity Coordinating council ("WECC")) and any information identified as Critical Energy Infrastructure Information by the Federal Energy Regulatory Commission in 18 C.F.R. § 388.113, including any revisions or modifications thereto. The protections described herein for protection of Critical Infrastructure Information supersede any prior non-disclosure agreement entered into between the Parties.

39. GRATUITIES

39.1 If the District finds that the Seller, or any of Seller's Affiliates, offered or gave gratuities (in the form of entertainment, gifts, or otherwise), to any official, employee, or agent of the District or State officials in an attempt to secure this Contract or favorable treatment in the awarding, amending, or making any determinations related to the performance of this Contract, the District may, by written notice to the Seller, terminate this Contract for cause. The District may also pursue other rights and remedies that the law or this Contract provides.

39.2 In the event the Seller is terminated as provided in Section 39.1, the District may pursue the same remedies against the Seller as it could pursue in the event of a breach of Contract by the Seller.

40. ASSIGNMENT

40.1 The Parties respectively bind themselves, their partners, successors, assigns and legal representatives to the other Party hereto and to partners, successors, assigns and legal representatives of such other Party in respect to covenants, agreements and obligations contained in the Contract. Except as provided in Section 40.2, neither Party shall assign the Contract as a whole without written consent of the other. If either Party attempts to make such an assignment without such consent, that Party shall nevertheless remain legally responsible for all obligations under the Contract.

40.2 If a majority of the ownership or the control of Seller is acquired by a third party, and such acquisition reasonably imperils performance or creates a conflict of interest that the District, in its sole discretion, cannot reasonably reconcile, then the District may terminate this Contract at any time pursuant to Section 33.2, except that the District shall give the Seller thirty (30) days'

written notice of termination and the opportunity for the Seller to cure prior to termination.

41. GOVERNING LAW

41.1 This Contract shall be construed in accordance with and governed by the internal laws of the State of Washington.

41.2 Since the District and the Seller have been represented by counsel who have materially participated in the authorship of this Contract, any ambiguities in the Agreement shall be neutrally construed, and not construed against the party drafting or preparing the agreement, but will be resolved by applying the most reasonable interpretation under the circumstances, giving full consideration to the intentions of the parties at the time of contracting.

42. OTHER CONDITIONS

42.1 Index – Heading.

Index and headings and subheadings of the Articles and Sections contained in this Contract are used only for convenience, and in no way define, limit or describe the scope or intent of this Contract or any of its provisions.

42.2 Notice.

All notices and other communications required or permitted by this Contract shall be in writing and delivered by hand (including by messenger or courier) or by airmail post or special courier or by email, telecopier or facsimile (receipt confirmed), at the addresses or numbers set forth below or at such other addresses or numbers as the Party receiving notice shall subsequently designate by way of replacement by giving ten (10) days' written notice to the other Party pursuant to this Section 42.2.

If to the District:

To: Eric Schneider
P.O. Box 1107
Everett, WA 98203
Fax: 425-267-6305
Email: easchneider@snopud.com

And To: Kim Moore
P.O. Box 1107
Everett, WA 98203
Fax: 425-783-8222
Email: kdmoore@snopud.com

If to the Seller:

OpenHydro Technology Limited
South Dock House,
Hanover Quay
Dublin 2, Ireland
Attention: Brendan Corr
Fax:
Email: brendan.corr@openhydro.com

Any notice sent by email, telecopier or facsimile transmission shall be confirmed within two (2) days after dispatch by notice sent by airmail or special courier. Any notice or confirmation of notice sent by airmail or special courier shall be deemed (in the absence of evidence of earlier receipt) to have been delivered ten (10) days after dispatch and in proving the fact of dispatch, it shall be sufficient to show that the envelope containing such notice was properly addressed, stamped and conveyed to the postal authorities or courier service for transmission by airmail or special courier. Any notice delivered by hand, email, facsimile, telecopier or telegram shall be deemed to have been delivered on the date of its dispatch.

42.3 Entire Agreement.

This Contract sets forth the full and complete understanding of the Parties relating to the subject matter hereof as of the date of this Contract and supersedes any and all negotiations, proposals, agreements, understandings and representations made or dated prior thereto with respect to such subject matter, including but not limited to the Consulting Services Agreement, which is subsumed by this Contract, and the Turbine Supply Term Sheet. This Contract has been negotiated on an arm's length basis by the Parties and shall be interpreted fairly in accordance with its terms and without any strict construction in favor of or against either Party. This Contract may be executed in separate counterparts, each of which shall be deemed an original, but all of which together shall constitute but one and the same instrument. This Contract does not create any agency, partnership, joint venture or other joint relationship between the District and the Seller. Nothing contained in this Contract shall be construed (a) to authorize either Party hereto to act as agent for the other Party or to permit a Party hereto to undertake any contract or other obligation for the other Party or (b) to create any agency, partnership, joint venture or other joint relationship between the Parties.

42.4 No Contractual Agreement With Third Parties.

The Contract shall not be construed to create a contractual relationship of any kind (1) between the District and either Seller's Subordinates, Seller's

Subcontractors or Special Contractors, (2) between the Seller and the District's consultants or Separate Contractors, or (3) between any persons or entities other than the Seller and the District.

42.5 Reports.

The Seller shall provide a report in accordance with the Contract Specifications. The report shall be provided via electronic transmittal prior to each Milestone Event, and to a list of recipients as supplied by the District, which may be modified by the District from time to time.

42.6 Severability.

In the event that any of the provisions or portions, or applications thereof, of this Contract become invalid, illegal or unenforceable in any respect under the law of any jurisdiction, the District and the Seller shall negotiate an equitable adjustment in the provisions of this Contract with a view toward effecting the purpose of this Contract, and the validity and enforceability of the remaining provisions or portions, or applications thereof, shall not be affected thereby.

42.7 Amendment and Waiver.

This Contract may not be changed or amended except through an explicit writing signed by both Parties, and no waiver hereunder may be oral or implied by conduct. Any Change or amendment or any waiver of any term or provision of, or consent granted under, this Contract shall only be effective if given in writing and signed by the waiving or consenting Party (or both Parties in the case of a Change or amendment). No relaxation, forbearance, delay, indulgence or failure by either Party to enforce any of the terms, covenants, conditions or other provisions of this Contract at any time shall in any way prejudice, affect, limit, modify or waive that Party's right thereafter to enforce or compel strict compliance with every term, covenant, condition or other provision hereof, any course of dealing or custom of the trade notwithstanding. No delay or omission on the part of a Party shall operate as a waiver thereof, nor shall any waiver by either Party of any breach of the Contract operate as a waiver of any subsequent or continuing breach of the Contract.

42.8 Survival.

Any covenants and agreements contained herein that must be performed following any termination of this Contract in order to give full force and effect to the intent of the Parties as set forth herein shall survive the termination of this Contract, regardless of whether such survival is expressly specified herein with respect to such covenants and agreements.

42.9 Order of Precedence

In the event of a conflict among the Contract Documents, the following order of precedence shall apply:

1. APPENDIX D – FERC LICENSE CONDITIONS
2. PART I – TERMS AND CONDITIONS OF CONTRACT
3. PART II – CONTRACT EXHIBITS
4. PART III – SPECIAL CONDITIONS
5. PART IV – SPECIFICATIONS
6. PART V – PLANS
7. PART VI – APPENDICES

PART II – CONTRACT EXHIBITS

PART III – SPECIAL CONDITIONS

PART IV – SPECIFICATIONS

PART V – PLANS

PART VI – APPENDICES

Exhibit B

Scope of Supply

Milestone 0.A – Power Conversion & Control Equipment

1. Development of replacement power conversion, and control solution for Demand Energy Network.

Milestone 0.B – Barge Preliminary Design to be completed by NUC including:

1. Perform initial feasibility design to validate alternative turbine deployment barge using flexi-floats for pontoons.
2. Incorporating flexi-float standard sizes perform buoyancy and stability calculations to determine quality and configuration.
3. Gather and assemble all loading information required to perform calculations.
4. Incorporate placement of all required HPU and hoisting equipment in the design.
5. Provide adequate quantities and weights from which revised budget can be developed.

Milestone 0.C – OpenHydro Planning, and Project Development

1. **Supplier Control Plan** – List the sequence of the assembly, quality inspections according to engineering requirements and required outgoing inspection criteria, etc.
2. **Incoming Inspection Plans** – Secondary inspections by third parties on supplied samples to ensure conformance and cross-check against supplier outgoing inspection. Certification documents for selected items will be made available to the District. Each component will be subject to detailed inspection upon manufacture by either Site Acceptance Test (SAT), or Factory Acceptance Test (FAT), by the QC functions. The manufactured product will be compared to what was specified by OpenHydro, and also examined for any manufacturing/transportation defects. Critical dimensions will be highlighted on drawings by the Engineering Team to inspection upon delivery of the part.

3. **Manufacturing Control Plan** – (same process as with the suppliers) List the sequence of assembly and quality inspections according to engineering requirements for the production of the Rotor, Stator, and the Rotor/Stator assembly. All supporting test plans, record sheets and personnel responsible, are listed as part of this process. This control plan is drafted by Engineering /Quality /Manufacturing departments and approved by the Chief Engineer, Mr. Paul Dunne and as accepted by the District.

4. **Mobilization & Deployment Control Plan** – (same process as Manufacturing) List the sequence of assembly and quality inspections during the mobilization phase according to engineering requirements. All supporting test plans, record sheets and personnel responsible are listed as part of this process. This control plan is drafted by the Project Engineer, approved by the Chief Engineer and as accepted by the District.

5. **Completion of FERC Project Plans** – The District will generate FERC plans for OpenHydro review/input. OpenHydro will provide all reasonable resource, and project support during the development of these project plans.

Not To Exceed Price

Milestone Zero (No. 0)	
A) Power Conversion & Control Equipment	$140,000
B) Barge Preliminary Design	$20,000
C) OpenHydro Labour for completion of Submittal 1: Incoming Inspection Plan Manufacturing Control Plan Mobilization & Deployment Control Plan Review & input District generated FERC Plans	$40,000
Total Costs for Preliminary Notice to Proceed	**$200,000**

*Power Conversion & Control Equipment cost is a current best estimate based on DEN proposal.

Appendix T

OWNER CONTROLLED INSURANCE PROGRAM (OCIP)

OCIP information and Project Insurance Manual can be found in the Special Conditions section of the Contract Documents.

Appendix U

DEPARTMENT OF ENERGY GRANT TERMS
DE-EE0003648.0001

SPECIAL TERMS AND CONDITIONS

Table of Contents

Number	Subject	Page
1.	RESOLUTION OF CONFLICTING CONDITIONS	2
2.	AWARD AGREEMENT TERMS AND CONDITIONS	2
3.	ELECTRONIC AUTHORIZATION OF AWARD DOCUMENTS	2
4.	PAYMENT PROCEDURES - REIMBURSEMENT THROUGH THE AUTOMATED CLEARING HOUSE (ACH) VENDOR INQUIRY PAYMENT ELECTRONIC REPORTING SYSTEM (VIPERS)	2
5.	INCREMENTAL FUNDING AND MAXIMUM OBLIGATION - DIFFERENT BUDGET PERIOD AND PROJECT PERIOD	3
6.	COST SHARING FFRDC NOT INVOLVED	3
7.	REBUDGETING AND RECOVERY OF INDIRECT COSTS	4
8.	USE OF PROGRAM INCOME - ADDITION	4
9.	FINAL INCURRED COST AUDIT	4
10.	STATEMENT OF FEDERAL STEWARDSHIP	5
11.	SITE VISITS	5
12.	REPORTING REQUIREMENTS	5
13.	PUBLICATIONS	6
14.	FEDERAL, STATE, AND MUNICIPAL REQUIREMENTS	6
15.	INTELLECTUAL PROPERTY PROVISIONS AND CONTACT INFORMATION	6
16.	CONTINUATION APPLICATION AND FUNDING – AWARDS UNDER 10 CFR 600	7
17.	LOBBYING RESTRICTIONS	7
18.	NOTICE REGARDING THE PURCHASE OF AMERICAN-MADE EQUIPMENT AND PRODUCTS	8
19.	DECONTAMINATION AND/OR DECOMMISSIONING (D&D) COSTS	8
20.	REPORTING SUBAWARDS AND EXECUTIVE COMPENSATION	8
21.	SYSTEM FOR AWARD MANAGEMENT AND UNIVERSAL IDENTIFIER REQUIREMENTS	12
22.	NATIONAL ENVIRONMENTAL POLICY ACT (NEPA) REQUIREMENTS	13
23.	SUBCONTRACT APPROVALS	15

1. RESOLUTION OF CONFLICTING CONDITIONS

Any apparent inconsistency between Federal statutes and regulations and the terms and conditions contained in this award must be referred to the DOE Award Administrator for guidance.

2. AWARD AGREEMENT TERMS AND CONDITIONS

This award/agreement consists of the Assistance Agreement, plus the following:

a. Special Terms and Conditions.
b. Attachments:

Attachment Number	Title
1.	Statement of Project Objectives
2.	Federal Assistance Reporting Checklist and Instructions
3.	Budget Pages (SF 424A)
4.	Intellectual Property Provisions

c. DOE Assistance Regulations, 10 CFR Part 600 at http://www.eCFR.gov.
d. Application/proposal as approved by DOE.
e. National Policy Assurances to Be Incorporated as Award Terms in effect on date of award at http://energy.gov/management/office-management/operational-management/financial-assistance/financial-assistance-forms under Award Terms.

3. ELECTRONIC AUTHORIZATION OF AWARD DOCUMENTS

Acknowledgement of award documents by the Recipient's authorized representative through electronic systems used by the Department of Energy, specifically FedConnect, constitutes the Recipient's acceptance of the terms and conditions of the award. Acknowledgement via FedConnect by the Recipient's authorized representative constitutes the Recipient's electronic signature.

4. PAYMENT PROCEDURES - REIMBURSEMENT THROUGH THE AUTOMATED CLEARING HOUSE (ACH) VENDOR INQUIRY PAYMENT ELECTRONIC REPORTING SYSTEM (VIPERS)

a. Method of Payment. Payment will be made by reimbursement through ACH.

b. Requesting Reimbursement. Requests for reimbursements must be made electronically through Department of Energy's Oak Ridge Financial Service Center (ORFSC) VIPERS. To access and use VIPERS, you must enroll at https://vipers.oro.doe.gov. Detailed instructions on how to enroll are provided on the web site.

For non-construction awards, you must submit a Standard Form (SF) 270, "Request for Advance or Reimbursement," at https://vipers.oro.doe.gov and attach a file containing appropriate supporting documentation. The file attachment must show the total Federal

share claimed on the SF 270, the non-Federal share claimed for the billing period if cost sharing is required, and cumulative expenditures to date (both Federal and non-Federal) for each of the following categories: salaries/wages and fringe benefits; equipment; travel; participant/training support costs, if any; other direct costs, including subawards/contracts; and indirect costs. For construction awards, you must submit a SF 271, "Outlay Report and Request for Reimbursement for Construction Programs," through VIPERS.

c. Timing of submittals. Submittal of the SF 270 or SF 271 should coincide with your normal billing pattern, but not more frequently than every two weeks. Requests for reimbursement must be limited to the amount of disbursements made during the billing period for the Federal share of direct project costs and the proportionate share of any allowable indirect costs incurred during that billing period.

d. Adjusting payment requests for available cash. You must disburse any funds that are available from repayments to and interest earned on a revolving fund, program income, rebates, refunds, contract settlements, audit recoveries, credits, discounts, and interest earned on any of those funds before requesting additional cash payments from DOE.

e. Payments. The DOE approving official will approve the invoice as soon as practical, but not later than 30 days after your request is received, unless the billing is improper. Upon receipt of an invoice payment authorization from the DOE approving official, the ORFSC will disburse payment to you. You may check the status of payments at the VIPERS web site. All payments are made by electronic funds transfer to the bank account specified in the information entered in the System for Award Management (SAM) website (https://www.sam.gov).

5. INCREMENTAL FUNDING AND MAXIMUM OBLIGATION - DIFFERENT BUDGET PERIOD AND PROJECT PERIOD

If at any time during the award a budget period is funded on an incremental basis, the maximum obligation of DOE is limited to the total amount shown in Block 13 of the Assistance Agreement. You are not obligated to continue performance of the project beyond the total amount obligated and your pro rata share of the project costs, if cost sharing is required. Subject to the availability of additional funds, DOE anticipates obligating the total estimated amount for the current budget period. Funding for all awards and future budget periods is contingent upon the availability of funds appropriated by Congress for the purpose of this program and the availability of future-year budget authority.

6. COST SHARING FFRDC NOT INVOLVED

a. Total Estimated Project Cost is the sum of the Federal Government share and Recipient share of the estimated project costs. The Recipient's cost share must come from non-Federal sources unless otherwise allowed by law. By accepting Federal funds under this award, you agree that you are liable for your percentage share of total allowable project

costs, on a budget period basis, even if the project is terminated early or is not funded to its completion. This cost is shared as follows:

Budget Period	DOE Cost Share $ / %	Recipient Cost Share $ / %	Total Estimated Costs
1	$6,574,258 / 35%	$12,055,542 / 65%	$18,629,800
2	$3,425,742 / 35%	$6,281,953 / 65%	$9,707,695
Total Project	$10,000,000 /35%	$18,337,495 / 65%	$28,337,495

b. If you discover that you may be unable to provide cost sharing of at least the amount identified in paragraph a. of this term, you should immediately provide written notification to the DOE Award Administrator, indicating whether you will continue or phase out the project. If you plan to continue the project, the notification must describe how replacement cost sharing will be secured.

c. You must maintain records of all project costs that you claim as cost sharing, including in-kind costs, as well as records of costs to be paid by DOE. Such records are subject to audit.

d. Failure to provide the cost sharing required by this term may result in the subsequent recovery by DOE of some or all the funds provided under the award.

7. REBUDGETING AND RECOVERY OF INDIRECT COSTS REIMBURSABLE INDIRECT COSTS AND FRINGE BENEFITS

a. If actual allowable indirect costs are less than those budgeted and funded under the award, you may use the difference to pay additional allowable direct costs during the project period. If at the completion of the award the Government's share of total allowable costs (*i.e.*, direct and indirect), is less than the total costs reimbursed, you must refund the difference.

b. Recipients are expected to manage their indirect costs. DOE will not amend an award solely to provide additional funds for changes in indirect cost rates. DOE recognizes that the inability to obtain full reimbursement for indirect costs means the Recipient must absorb the underrecovery. Such underrecovery may be allocated as part of the organization's required cost sharing**.**

8. USE OF PROGRAM INCOME - ADDITION

If you earn program income during the project period as a result of this award, you may add the program income to the funds committed to the award and used to further eligible project objectives.

9. FINAL INCURRED COST AUDIT

In accordance with 10 CFR 600, DOE reserves the right to initiate a final incurred cost audit

on this award. If the audit has not been performed or completed prior to the closeout of the award, DOE retains the right to recover an appropriate amount after fully considering the recommendations on disallowed costs resulting from the final audit.

10. STATEMENT OF FEDERAL STEWARDSHIP

DOE will exercise normal Federal stewardship in overseeing the project activities performed under this award. Stewardship activities include, but are not limited to, conducting site visits; reviewing performance and financial reports; providing technical assistance and/or temporary intervention in unusual circumstances to correct deficiencies which develop during the project; assuring compliance with terms and conditions; and reviewing technical performance after project completion to ensure that the award objectives have been accomplished.

11. SITE VISITS

DOE's authorized representatives have the right to make site visits at reasonable times to review project accomplishments and management control systems and to provide technical assistance, if required. You must provide, and must require your subrecipients to provide, reasonable access to facilities, office space, resources, and assistance for the safety and convenience of the government representatives in the performance of their duties. All site visits and evaluations must be performed in a manner that does not unduly interfere with or delay the work.

12. REPORTING REQUIREMENTS

a. Requirements. The reporting requirements for this award are identified on the Federal Assistance Reporting Checklist, DOE F 4600.2, attached to this award. Failure to comply with these reporting requirements is considered a material noncompliance with the terms of the award. Noncompliance may result in withholding of future payments, suspension or termination of the current award, and withholding of future awards. A willful failure to perform, a history of failure to perform, or unsatisfactory performance of this and/or other financial assistance awards, may also result in a debarment action to preclude future awards by Federal agencies.

b. Dissemination of scientific/technical reports. Scientific/technical reports submitted under this award will be disseminated on the Internet via the DOE Information Bridge (www.osti.gov/bridge), unless the report contains patentable material, protected data or SBIR/STTR data. Citations for journal articles produced under the award will appear on the DOE Energy Citations Database (www.osti.gov/energycitations).

c. Restrictions. Reports submitted to the DOE Information Bridge must not contain any Protected Personal Identifiable Information (PII), limited rights data (proprietary data), classified information, information subject to export control classification, or other information not subject to release.

13. PUBLICATIONS

a. You are encouraged to publish or otherwise make publicly available the results of the work conducted under the award.

b. An acknowledgment of DOE support and a disclaimer must appear in the publication of any material, whether copyrighted or not, based on or developed under this project, as follows:

> *Acknowledgment*: "This material is based upon work supported by the Department of Energy [add name(s) of other agencies, if applicable] under Award Number(s) [enter the award number(s)]."
>
> *Disclaimer*: "This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof."

14. FEDERAL, STATE, AND MUNICIPAL REQUIREMENTS

You must obtain any required permits and comply with applicable federal, state, and municipal laws, codes, and regulations for work performed under this award.

15. INTELLECTUAL PROPERTY PROVISIONS AND CONTACT INFORMATION

a. The intellectual property provisions applicable to this award are provided as an attachment to this award or are referenced in the Assistance Agreement. A list of all intellectual property provisions may be found at: http://energy.gov/gc/standard-intellectual-property-ip-provisions-financial-assistance-awards

b. Questions regarding intellectual property matters should be referred to the DOE Award Administrator identified and the Patent Counsel designated as the service provider for the DOE office that issued the award. The Patent Counsel for the Golden Service Center is Julia Moody who may be reached at julia.moody@go.doe.gov or 720-356-1699.

16. CONTINUATION APPLICATION AND FUNDING – AWARDS UNDER 10 CFR 600

a. Continuation Application. A continuation application is a non-competitive application for an additional budget period within a previously approved project period. At least 90 days before the end of each budget period, you must submit to the DOE Project Officer and the DOE Award Administrator your continuation application, which includes the following information:

1. A report on your progress towards meeting the objectives of the project, including any significant findings, conclusions, or developments, and an estimate of any unobligated balances remaining at the end of the budget period. If the remaining unobligated balance is estimated to exceed 20 percent of the funds available for the budget period, explain why the excess funds have not been obligated and how they will be used in the next budget period.

2. A detailed budget and supporting justification for the upcoming budget period if additional funds are requested, a reduction of funds is anticipated, or a budget for the upcoming budget period was not approved at the time of award.

3. A description of your plans for the conduct of the project during the upcoming budget period, if there are changes from the DOE approved application.

b. Continuation Funding. Continuation funding is contingent on (1) availability of funds; (2) meeting the objectives, milestones, deliverables, decision point criteria, and stage gates of your approved project and obtaining approval from DOE to continue work on the project; (3) submittal of required reports; and/or (4) compliance with the terms and conditions of the award.

c. Continuation funding is specifically contingent on DOE approval of Critical Go/No Go or stage gate reviews decision points, as set forth in the Statement of Project Objectives.

d. As a result of the go/no go or stage gate reviews, DOE may, at its discretion, authorize the following actions by the Recipient: (1) continue to fund the project, depending on appropriations; (2) recommend redirection of work under the project; (3) place a hold on the project, pending further supporting data or funding; or (4) cancel the project because of insufficient progress, change in strategic direction, or lack of funding.

17. LOBBYING RESTRICTIONS

By accepting funds under this award, you agree that none of the funds obligated on the award shall be expended, directly or indirectly, to influence congressional action on any legislation or appropriation matters pending before Congress, other than to communicate to Members of Congress as described in 18 U.S.C. 1913. This restriction is in addition to those prescribed elsewhere in statute and regulation.

18. NOTICE REGARDING THE PURCHASE OF AMERICAN-MADE EQUIPMENT AND PRODUCTS

To the greatest extent practicable, all equipment and products purchased with funds made available under this award should be American-made.

19. DECONTAMINATION AND/OR DECOMMISSIONING (D&D) COSTS

Notwithstanding any other provisions of this Agreement, the Government shall not be responsible for or have any obligation to the Recipient for (i) Decontamination and/or Decommissioning (D&D) of any of the Recipient's facilities, or (ii) any costs which may be incurred by the Recipient in connection with the D&D of any of its facilities due to the performance of the work under this Agreement, whether said work was performed prior to or subsequent to the effective date of the Agreement.

20. REPORTING SUBAWARDS AND EXECUTIVE COMPENSATION

a. Reporting of first-tier subawards.

1. Applicability. Unless you are exempt as provided in paragraph d. of this award term, you must report each action that obligates $25,000 or more in Federal funds that does not include Recovery funds (as defined in section 1512(a)(2) of the American Recovery and Reinvestment Act of 2009, Pub. L. 111-5) for a subaward to an entity (see definitions in paragraph e. of this award term).

2. Where and when to report.

i. You must report each obligating action described in paragraph a.1. of this award term to https://www.fsrs.gov .

ii. For subaward information, report no later than the end of the month following the month in which the obligation was made. (For example, if the obligation was made on November 7, 2010, the obligation must be reported by no later than December 31, 2010.)

3. What to report. You must report the information about each obligating action that the submission instructions posted at https://www.fsrs.gov specify.

b. Reporting Total Compensation of Recipient Executives.

1. Applicability and what to report. You must report total compensation for each of your five most highly compensated executives for the preceding completed fiscal year, if

i. The total Federal funding authorized to date under this award is $25,000 or more;

ii. In the preceding fiscal year, you received;

(A) 80 percent or more of your annual gross revenues from Federal procurement contracts (and subcontracts) and Federal financial assistance subject to the Transparency Act, as defined at 2 CFR 170.320 (and subawards); and

(B) $25,000,000 or more in annual gross revenues from Federal procurement contracts (and subcontracts) and Federal financial assistance subject to the Transparency Act, as defined at 2 CFR 170.320 (and subawards); and

iii. The public does not have access to information about the compensation of the executives through periodic reports filed under section 13(a) or 15(d) of the Securities Exchange Act of 1934 (15 U.S.C. 78m(a), 78o(d)) or section 6104 of the Internal Revenue Code of 1986. (To determine if the public has access to the compensation information, see the U.S. Security and Exchange Commission total compensation filings at http://www.sec.gov/answers/execomp.htm)

2. Where and when to report. You must report executive total compensation described in paragraph b.1. of this award term:

i. As part of your registration profile at https://www.sam.gov.

ii. By the end of the month following the month in which this award is made, and annually thereafter.

c. Reporting of Total Compensation of Subrecipient Executives.

1. Applicability and what to report. Unless you are exempt as provided in paragraph d. of this award term, for each first-tier subrecipient under this award, you shall report the names and total compensation of each of the subrecipient's five most highly compensated executives for the subrecipient's preceding completed fiscal year, if;

i. In the subrecipient's preceding fiscal year, the subrecipient received;

(A) 80 percent or more of its annual gross revenues from Federal procurement contracts (and subcontracts) and Federal financial assistance subject to the Transparency Act, as defined at 2 CFR 170.320 (and subawards); and

(B) $25,000,000 or more in annual gross revenues from Federal procurement contracts (and subcontracts), and Federal financial assistance subject to the Transparency Act (and subawards); and

ii. The public does not have access to information about the compensation of the

executives through periodic reports filed under section 13(a) or 15(d) of the Securities Exchange Act of 1934 (15 U.S.C. 78m(a), 78o(d)) or section 6104 of the Internal Revenue Code of 1986. (To determine if the public has access to the compensation information, see the U.S. Security and Exchange Commission total compensation filings at http://www.sec.gov/answers/execomp.htm)

2. Where and when to report. You must report subrecipient executive total compensation described in paragraph c.1. of this award term:

i. To the recipient.

ii. By the end of the month following the month during which you make the subaward. For example, if a subaward is obligated on any date during the month of October of a given year (*i.e.*, between October 1 and 31), you must report any required compensation information of the subrecipient by November 30 of that year.

d. Exemptions

If, in the previous tax year, you had gross income, from all sources, under $300,000, you are exempt from the requirements to report:

i. Subawards and;

ii. The total compensation of the five most highly compensated executives of any subrecipient.

e. Definitions. For purposes of this award term:

1. Entity means all of the following, as defined in 2 CFR Part 25:

i. A Governmental organization, which is a State, local government, or Indian tribe;

ii. A foreign public entity;

iii. A domestic or foreign nonprofit organization;

iv. A domestic or foreign for-profit organization;

v. A Federal agency, but only as a subrecipient under an award or subaward to a non-Federal entity.

2. Executive means officers, managing partners, or any other employees in management positions.

3. Subaward:

i. This term means a legal instrument to provide support for the performance of any portion of the substantive project or program for which you received this award and that you as the recipient award to an eligible subrecipient.

ii. The term does not include your procurement of property and services needed to carry out the project or program (for further explanation, see Sec. __ .210 of the attachment to OMB Circular A-133, Audits of States, Local Governments, and Non-Profit Organizations).

iii. A subaward may be provided through any legal agreement, including an agreement that you or a subrecipient considers a contract.

4. Subrecipient means an entity that:

i. Receives a subaward from you (the recipient) under this award; and

ii. Is accountable to you for the use of the Federal funds provided by the subaward.

5. Total compensation means the cash and noncash dollar value earned by the executive during the recipient's or subrecipient's preceding fiscal year and includes the following (for more information see 17 CFR 229.402(c)(2)):

i. Salary and bonus.

ii. Awards of stock, stock options, and stock appreciation rights. Use the dollar amount recognized for financial statement reporting purposes with respect to the fiscal year in accordance with the Statement of Financial Accounting Standards No. 123 (Revised 2004) (FAS 123R), Shared Based Payments.

iii. Earnings for services under non-equity incentive plans. This does not include group life, health, hospitalization or medical reimbursement plans that do not discriminate in favor of executives, and are available generally to all salaried employees.

iv. Change in pension value. This is the change in present value of defined benefit and actuarial pension plans.

v. Above-market earnings on deferred compensation which is not tax-qualified.

vi. Other compensation, if the aggregate value of all such other compensation (*e.g.* severance, termination payments, value of life insurance paid on behalf of the employee, perquisites or property) for the executive exceeds $10,000.

21. SYSTEM FOR AWARD MANAGEMENT AND UNIVERSAL IDENTIFIER REQUIREMENTS

A. Requirement for Registration in the System for Award Management (SAM)

Unless you are exempted from this requirement under 2 CFR 25.110, you as the recipient must maintain the currency of your information in SAM until you submit the final financial report required under this award or receive the final payment, whichever is later. This requires that you review and update the information at least annually after the initial registration, and more frequently if required by changes in your information or another award term.

If you had an active registration in the CCR, you have an active registration in SAM.

B. Requirement for Data Universal Numbering System (DUNS) Numbers

If you are authorized to make subawards under this award, you:

1. Must notify potential subrecipients that no entity (see definition in paragraph C of this award term) may receive a subaward from you unless the entity has provided its DUNS number to you.

2. May not make a subaward to an entity unless the entity has provided its DUNS number to you.

C. Definitions

For purposes of this award term:

1. System for Award Management (SAM) means the Federal repository into which an entity must provide information required for the conduct of business as a recipient. Additional information about registration procedures may be found at the SAM Internet site (currently at https://www.sam.gov).

2. Data Universal Numbering System (DUNS) number means the nine-digit number established and assigned by Dun and Bradstreet, Inc. (D&B) to uniquely identify business entities. A DUNS number may be obtained from D&B by telephone (currently 866-705-5711) or the Internet (currently at http://fedgov.dnb.com/webform).

3. Entity, as it is used in this award term, means all of the following, as defined at 2 CFR Part 25, subpart C:

a. A Governmental organization, which is a State, local government, or Indian Tribe;

b. A foreign public entity;

c. A domestic or foreign nonprofit organization;

d. A domestic or foreign for-profit organization; and

e. A Federal agency, but only as a subrecipient under an award or subaward to a non-Federal entity.

4. Subaward:

a. This term means a legal instrument to provide support for the performance of any portion of the substantive project or program for which you received this award and that you as the recipient award to an eligible subrecipient.

b. The term does not include your procurement of property and services needed to carry out the project or program (for further explanation, see Sec. __.210 of the attachment to OMB Circular A-133, Audits of States, Local Governments, and Non-Profit Organizations).

c. A subaward may be provided through any legal agreement, including an agreement that you consider a contract.

5. Subrecipient means an entity that:

a. Receives a subaward from you under this award; and

b. Is accountable to you for the use of the Federal funds provided by the subaward.

22. NATIONAL ENVIRONMENTAL POLICY ACT (NEPA) REQUIREMENTS

DOE must comply with the National Environmental Policy Act (NEPA) prior to authorizing the use of Federal funds. The Recipient is restricted from taking any action using Federal funds that would have an adverse effect on the environment or limit the choice of reasonable alternatives prior to DOE completing the NEPA review for this project.

DOE has completed its NEPA review for certain activities; however, Federal funding for certain other tasks is contingent upon DOE completing the NEPA review for all activities under this Award.

Recipient is restricted from taking any action using federal funds, which would have an adverse effect on the environment or limit the choice of reasonable alternatives, prior to DOE/National Nuclear Security Administration (NNSA) completing its NEPA review for all activities under this Award.

Prohibited actions include:

- Final Design, Equipment Procurement, Assembly, and Construction
- Sea Trialing, Deployment, Subsea Connection, Testing

• Operation, Evaluation, and Removal

This restriction does not preclude you from completing the following proposed preliminary activities:

• Engage stakeholders and all necessary regulatory agencies to ensure that all required documentation has been submitted for the necessary project permits or authorizations. This work does not include any preliminary studies for the Environmental Assessment; it is comprised of paperwork completion and meeting participation only.

• Complete the preliminary engineering designs for the entire project. This includes the project site, power cables, monitoring infrastructure, data acquisition system, and on-shore power station. Upon completion of this subtask, all designs will be in a near-final design stage, but will not be finalized.

• Develop and post requests for proposals (RFPs) for all subcontractor work under the grant. The proposals will be reviewed and top bidders selected for further negotiations. No final contracts will be executed under this subtask.

• Develop the construction management plan in order to ensure proper communication during the project period. This subtask involves research and planning activities and not the execution of any construction.

If you move forward with activities that are not authorized for federal funding by the DOE Contracting Officer in advance of the final NEPA decision, you are doing so at risk of not receiving federal funding and such costs may not be recognized as allowable cost share.

Questions about the permissibility of Federal cost sharing on activities prior to DOE's issuance of a final NEPA determination shall be directed to the DOE Contracting Officer. The Recipient must receive written approval from the DOE Contracting Officer before incurring costs for Federal cost sharing. After receiving approval from the DOE Contracting Officer, if the Recipient chooses to incur costs eligible for Federal cost sharing for the approved activities, the Recipient agrees to abide by the conditions, limitations, mitigation measures, monitoring requirements, and reporting responsibilities specified in writing from the Contracting Officer and to undertake these activities in accordance with necessary landowner approvals, required permits, and any additional approvals and mitigation requirements of other Federal, state and local governmental agencies with jurisdiction by law.

If the Recipient later intends to add to or modify the activities in the approved SOPO, those new activities or modified activities are subject to additional NEPA review and are not authorized for federal funding until the Contracting Officer provides approval on those additions or modifications. Recipients are restricted from taking any action using federal funds, which would have an adverse effect on the environment or limit the choice of reasonable alternatives prior to authorization from the Contracting Officer. Should the Recipient elect to undertake activities prior to authorization from the Contracting Officer, the

Recipient does so at risk of not receiving federal funding and such costs may not be recognized as allowable cost share.

23. SUBCONTRACT APPROVALS

a. At Risk Notice: The Recipient must obtain written approval by the Contracting Officer for reimbursement of costs associated with subcontractors/activities listed in paragraph b. below. If the subcontract is under $100,000, the Recipient must submit a Statement of Project Objectives, and basis of cost estimate. If the subcontract is for $100,000 or more, the Recipient must submit a Statement of Objectives, and PMC 123.1 Budget Justification. No funds shall be expended on the subcontracts supporting the tasks identified in paragraph b. below unless DOE approval is provided. DOE does not guarantee or assume any obligation to reimburse costs incurred by the Recipient or subcontractor for these tasks, until approval is provided in writing by the Contracting Officer.

b. Contracting Officer approval as set out above is requested for the following:

Task #	Subcontractor	Total Amount ($)
2, 4	OpenHydro Technology	$13,906,328
2, 4, 5	TBD General Contractor	$6,201,275
1, 2, 4	Sound and Sea Technology	$235,651
2, 4	Lawhead Architects	$150,000
2, 4, 5	TBD Insurance Company	$400,000
Total:		**$20,893,254**

The DOE Contracting Officer may require additional information concerning these tasks prior to providing written approval.

c. Upon written approval by the Contracting Officer, the Recipient may then receive payment for the tasks identified in paragraph b. above for allowable costs incurred, or DOE will recognize costs incurred toward cost share requirements, if any, in accordance with the payment provisions contained in the Special Terms and Conditions of this agreement.

Attachment 1

Statement of Project Objectives

STATEMENT OF PROJECT OBJECTIVES

Snohomish County Public Utility District No. 1
Puget Sound Pilot Tidal Energy Project: DE-EE0003648

A. PROJECT OBJECTIVES

Snohomish County Public Utility District (the District) and its partners propose to deploy two utility-scale tidal energy turbines in Admiralty Inlet, Puget Sound, Washington. This site has been identified as one of the largest tidal hydrokinetic resources in the United States, but is also a unique environment within the range of several endangered species and under existing anthropogenic stress.

The Project will involve the deployment, operation, monitoring, and evaluation of two 6-meter diameter Open-Center turbines developed and manufactured by OpenHydro Group Ltd. The Project is expected to generate 300 kilowatts of electrical energy during periods of peak tidal currents with an average energy output of approximately 30 – 40 kilowatts. While the Project will be connected to the grid and produce a modest amount of energy, its primary purpose is to gather data to better inform the viability of commercial tidal energy generation from technical, economic, social, and environmental standpoints. This data is critical to the responsible advancement of commercial scale tidal energy in the United States.

The installation is proposed in the summer of 2015 with an operational duration planned from three to five years. Once the system is installed it will spend roughly 70% of the time generating and 30% of the time in between tides during slack water. The current schedule allows for up to 9-months of operational data prior to the award expiration; however the District is committed to providing the same data throughout the entire project duration.

B. PROJECT SCOPE

This project will enable the deployment, demonstration, and testing of tidal hydrokinetic technology in Puget Sound, Washington. The District believes there is potential to generate renewable, emission free, environmentally benign, and cost-effective energy from tidal flows at selected sites in the Puget Sound, and that successful tidal energy demonstration in the Sound may enable significant commercial development in the United States resulting in important benefits for both the northwest region and the country. This Project promotes the Wind and Water Power Technologies Office goals of advancing the commercial viability, cost-competitiveness, and market acceptance of marine hydropower systems. This proposal includes portions of the environmental monitoring plan design, together with system supply, integration and initial monitoring. The scope of this award includes only limited environmental monitoring for the project duration.

C. TASKS TO BE PERFORMED

Reports and other deliverables will be provided in accordance with the Federal Assistance Reporting Checklist following the instructions included therein.

Budget Period 1

Task 1: Project Design, Planning and Vendor Selection

This task includes permit and regulatory tracking activities, the completion of plant design and construction planning, and competitive contractor selection. The objectives of task 1 will bring the Project through planning and near-final engineering design to the pre-construction stage. The necessary work includes the following sub-tasks:

Task 1.1, Regulatory Tracking: Working with regulatory agencies and stakeholders to track final permit progress and regulatory authorizations;

Task 1.2, Systems Engineering Design: Design and integration for all plant components (e.g. power conditioning, grid connection, monitoring infrastructure, supervisory control and data acquisition) to a near-final design stage;

Task 1.3, Contractor Selection: Preparation of bid documents, competitive bidding and bid evaluation and award of key construction contractors (e.g. horizontal directional drilling, on-shore civil works, turbine/foundation deployment, subsea cable installation, grid interconnection); and

Task 1.4, Construction Management Plan: Development of a construction management plan.

Task 1 Deliverables / Milestones:

- DRAFT bid documents for the public works contract:
    - Plans and Specifications
    - Special and General Conditions
    - Appendices
- DRAFT Turbine Supply and Maintenance Agreement
    - Agreement Terms and Conditions
    - Contract Exhibits
    - Special Conditions
    - Specifications
    - Plans
    - Appendices
    - Commercial Attachments

Task 2: Final Design, Equipment Procurement, Assembly, and Construction

The overall objectives of Task 2 are to finalize system design, procure, fabricate, ship, and assemble all materials, and complete equipment construction and site preparation activities. This task will complete all activities required prior to deployment and commissioning of the turbines through the following sub-tasks:

Task 2.1, Final Engineering Design: Finalize systems design including all plant components and connections;

Task 2.2, Equipment Procurement: Procurement of turbines and foundations, transmission cables, power conditioning equipment, turbine/foundation installer barge services, and monitoring infrastructure in collaboration with vendors;

Task 2.3, Test Plans: Finalization of the technical and environmental test plan, building on data and analysis from the European Marine Energy Centre (EMEC) and the Bay of Fundy;
Task 2.4, Turbine Fabrication and Shipment: Fabrication and assembly of the turbines, shipment and delivery to Project site;
Task 2.5, Construct Turbine Foundations: Completion of turbine foundation construction activities, assembly of turbines to foundations; and
Task 2.6, Site Preparation: Complete Horizontal Directional Drilling (HDD) activities and prepare site for deployment and connections to grid.

Task 2 Deliverables / Milestones:

- Designs
- Test Plan review presentation to DOE
- List of materials and associated costs
- FINAL bid documents for the public works contract:
    - Plans and Specifications
    - Special and General Conditions
    - Appendices
- FINAL Turbine Supply and Maintenance Agreement
    - Agreement Terms and Conditions
    - Contract Exhibits
    - Special Conditions
    - Specifications
    - Plans
    - Appendices
    - Commercial Attachments

Task 3: Go/No-Go

Upon completion of Budget Period 1, DOE will perform a go/no-go evaluation of the project. In order to obtain approval to proceed into Budget Period 2, the District must provide DOE with documentation confirming that it has met the objectives, milestones, deliverables, and all go/no-go decision point criteria of the approved project.

Task 3 Deliverables / Milestones

- Board resolution authorizing the District to enter into the several contracts associated with the Project, together with the acceptance of the terms outlined in the final FERC license articles.
- DOE Go/No-go presentation to DOE staff.

Budget Period 2

Task 4: Sea Trialing, Deployment, Subsea Connection, Testing

Task 4 includes deployment and commissioning of the tidal array. In addition to successful deployment in Admiralty Inlet, the objectives of this task are to begin all technical and environmental testing necessary to qualify the tidal energy system at Technology Readiness Level (TRL) 8 and demonstrate readiness for the first phase of a commercial plant build out. The Admiralty Inlet site will expose the project to a wide breadth of conditions including both benign and extreme environments. The necessary work includes, but is not limited to, the following sub-tasks:
Task 4.1, Sea Trials Testing: Ensuring all turbine components are prepared for deployment by towing turbine and foundation assembly near deployment site using the installer barge;
Task 4.2, Deployment and Subsea Connection: Turbine, environmental monitoring integration equipment, and foundation deployment in Admiralty Inlet and subsea connection of turbines to power conditioning equipment;
Note: the environmental monitoring integration equipment is being developed through a collaborative effort between OpenHydro and the University of Washington. The environmental monitoring equipment connected to this project is being developed by the University of Washington and is funded separately under EE0000301.
Task 4.3, Shore Connection: Connection to on-shore electrical grid; and
Task 4.4, Commissioning: Plant startup, checkout, and commissioning.

Task 4 Deliverables / Milestones:

- Construction Completion and Operational Status Report

Task 5: Operation, Evaluation, and Removal
The overall objectives of Task 5 are to evaluate a fully functioning, monitored and grid-connected tidal energy array, and to gather and analyze data to meaningfully inform the viability of commercial tidal energy generation from technical, economic, social, and environmental standpoints. Operational experience and testing will include analysis of kWh produced, capacity factor, reliability, maintainability and availability. Evaluation of results will include assessments of plant efficiency as a function of plant rating, turbine efficiency as a function of tidal regime, and O&M costs as a function of O&M processes. These objectives will be completed through the following sub-tasks:
Task 5.1, Operation: Turbine operation plan implementation, including analysis and reporting;
Task 5.2, Performance Evaluation: Technical and economic performance evaluation of the Project; and

Technical Performance Data: For the purposes of collecting power quality data, the District will perform monitoring and analysis via on-site measurements with a focus on harmonics, flicker and voltage fluctuations due to flow turbulence and turbine vibrations. Data collected to assess power take-off and efficiency will be gathered from the turbine mounted Acoustic Doppler Current Profilers together with the turbines' specific power output data. Foundation stability data will be collected via strain gauges, heading pitch and roll sensors, and accelerometers may be attached to the structure.

Economic Performance Data: Throughout capital construction and operations the District will be collecting cost data for the basis for a levelized cost of energy analysis. Operational cost data for marine operations, both for capital and O&M requirements of the project shall be recorded.

Note: The District has a robust environmental monitoring program associated with this project. Funding sources outside this award are proposed; therefore no scope for environmental data collection is included herein.

Task 5.3, Removal: Final turbine removal and salvage at project completion

After completion of all tasks under this award, turbines will remain in operation for a period to be determined by the FERC license, then will be removed. System performance and other operational or environmental data gathered after the award period is complete will be provided in accordance with the award contract.

Task 5 Deliverables/Milestones:

- Measured resource characteristics upstream and downstream of the turbine
- Turbine Rotational Speed
- Generator Current
- Generator Voltage
- Generator Frequency
- Total Running Time
- Number of revolutions of the rotor
- Quarterly Summary Turbine Operating Characteristics
- Turbine and system sensors list, statistics on fault type and frequency of faults
- Energy conversion efficiencies / losses along the water-to-wire path
- LCOE with cost breakdown structure and calculations
- Environmental Data associated with the overall project objectives. District is committed to sharing the data it collects in collaboration with the University of Washington and the NNMREC.

Attachment 2

Federal Reporting Checklist and Instructions

DOE F 4600.2
(3/11)
All Other Editions Are Obsolete

Attachment 2

U.S. Department of Energy
FEDERAL ASSISTANCE REPORTING CHECKLIST
AND INSTRUCTIONS FOR RD&D PROJECTS

1. Identification Number:	2. Program/Project Title:
DE -EE0003648.0001	Puget Sound Pilot Tidal Energy Project

3. Recipient:

Public Utility District No.1 of Snohomish County

4. ReportingRequirements:		Frequency	Addresses
A. MANAGEMENT REPORTING			
☑ Research Performance Progress Report (RPPR)		Q	https://www.eere-pmc.energy.gov/SubmitReports.aspx
☑ Special Status Report		A	https://www.eere-pmc.energy.gov/SubmitReports.aspx
B. SCIENTIFIC/TECHNICAL REPORTING (Reports/Products must be submitted with appropriate DOE F 241. The 241 forms are available at www.osti.gov/elink)			
Report/Product	Form		
☑ Final Scientific Report	DOE F 241.3	F	http://www.osti.gov/elink-2413
☐ Conference papers/proceedings*	DOE F 241.3		http://www.osti.gov/elink-2413
☐ Software/Manual	DOE F 241.4		http://www.osti.gov/estsc/241-4pre.jsp
☐ Other (see special instructions)	DOE F 241.3		http://www.osti.gov/elink-2413
** Scientific and technical conferences only*			
C. FINANCIAL REPORTING			
☑ SF-425, Federal Financial Report		FQ	https://www.eere-pmc.energy.gov/SubmitReports.aspx
D. CLOSEOUT REPORTING			
☑ Patent Certification		F	https://www.eere-pmc.energy.gov/SubmitReports.aspx
☑ SF-428 & 428B Final Property Report		F	https://www.eere-pmc.energy.gov/SubmitReports.aspx
☐ Other			https://www.eere-pmc.energy.gov/SubmitReports.aspx
E. OTHER REPORTING			
☑ Annual Indirect Cost Proposal		Y180	See block 5 below for instructions.
☐ Audit of For-Profit Recipients			See block 5 below for addresses.
☐ SF-428 Tangible Personal Property Report Forms Family			https://www.eere-pmc.energy.gov/SubmitReports.aspx
☑ Other		A	See block 5 below for instructions

FREQUENCY CODES AND DUE DATES:

A - Within 5 calendar days after events or as specified.

F - Final; 90 calendar days after expiration or termination of the award.

Y - Yearly; 90 days after the end of the reporting period.

S - Semiannually; within 30 days after end of the reporting period.

Q - Quarterly; within 30 days after end of the reporting period.

O - Other: See instructions for further details

Y180 - Yearly; 180 days after end of the recipient's fiscal year.

5. Special Instructions:

Annual Indirect Cost Proposal - If DOE is the Cognizant Federal Agency, then the proposal should be sent to https://www.eere-pmc.energy.gov/SubmitReports.aspx. Otherwise, it should be sent to the Cognizant Federal Agency.

If required, Audit of For-Profit Recipients must be sent to 2 different addresses in accordance with the final audit guidance. A copy for the Contracting Officer shall be submitted via https://www.eere-pmc.energy.gov/SubmitReports.aspx; a copy must also be e-mailed to the CFO at DOE-Audit-Submission@hq.doe.gov

MANAGEMENT REPORTING

A Go/No-Go meeting will be required in order to gain approval to move into Budget Period 2. The agenda and expectations for this meeting will be provided prior to the end of Budget Period 1. A Design Review meeting will be required prior to completion of the project. The Design Review agenda and expectations will be provided in advance of the meeting.

OTHER REPORTING

This program is covered by a special protected data statute. The provisions of the statute provide for the protection from public disclosure, for a period of up to five years from the date of its development, of first-produced data that would be trade secret, or commercial or financial information that is privileged or confidential, if the information had been obtained from a non-Federal party. Generally, the provision entitled, Rights in Data Programs Covered Under Special Protected Data Statutes, (10 CFR 600 Appendix A to Subpart D), will apply to this award. DOE may request data during the award to distribute solely among DOE and DOE National Labs. For example, performance data may be requested to better inform National Lab development of performance models. Also, DOE may request data during the award to disseminate to the public. Please see Appendix A for example data produced under an award which DOE may request. Please see Appendix B for LCOE calculation guidance.

Federal Assistance Reporting Instructions (3/11)

A. MANAGEMENT REPORTING

Research Performance Progress Report (RPPR)

See attached document entitled "Research Performance Progress Report".

Special Status Report

The recipient must report the following events by e-mail as soon as possible after they occur:

1. Developments that have a significant favorable impact on the project.

2. Problems, delays, or adverse conditions which materially impair the recipient's ability to meet the objectives of the award or which may require DOE to respond to questions relating to such events from the public. The recipient must report any of the following incidents and include the anticipated impact and remedial action to be taken to correct or resolve the problem/condition:

    a. Any single fatality or injuries requiring hospitalization of five or more individuals.

    b. Any significant environmental permit violation.

    c. Any verbal or written Notice of Violation of any Environmental, Safety, and Health statutes.

    d. Any incident which causes a significant process or hazard control system failure.

    e. Any event which is anticipated to cause a significant schedule slippage or cost increase.

    f. Any damage to Government-owned equipment in excess of $50,000.

    g. Any other incident that has the potential for high visibility in the media.

B. SCIENTIFIC/TECHNICAL REPORTS

Final Scientific/Technical Report

Content. The final scientific/technical report must include the following information and any other information identified under Special Instructions on the Federal Assistance Reporting Checklist:

1. Identify the DOE award number; name of recipient; project title; name of project director/principal investigator; and consortium/teaming members.

2. Display prominently on the cover of the report any authorized distribution limitation notices, such as patentable material or protected data. Reports delivered without such notices may be deemed to have been furnished with unlimited rights, and the Government assumes no liability for the disclosure, use or reproduction of such reports.

3. Provide an executive summary, which includes a discussion of: (1) how the research adds to the understanding of the area investigated; (2) the technical effectiveness and economic feasibility of the methods or techniques investigated or demonstrated; or (3) how the project is otherwise of benefit to the public. The discussion should be a minimum of one paragraph and written in terms understandable by an educated layman.

4. Provide a comparison of the actual accomplishments with the goals and objectives of the project.

5. Summarize project activities for the entire period of funding, including original hypotheses, approaches used, problems encountered and departure from planned methodology, and an assessment of their impact on the project results. Include, if applicable, facts, figures, analyses, and assumptions used during the life of the project to support the conclusions.

6. Identify products developed under the award and technology transfer activities, such as:

    a. Publications (list journal name, volume, issue), conference papers, or other public releases of results. If not provided previously, attach or send copies of any public releases to the DOE Program Manager identified in Block 15 of the Assistance Agreement Cover page;

    b. Web site or other Internet sites that reflect the results of this project;

    c. Networks or collaborations fostered;

    d. Technologies/Techniques;

    e. Inventions/Patent Applications, licensing agreements; and

    f. Other products, such as data or databases, physical collections, audio or video, software or netware, models, educational aid or curricula, instruments or equipment.

7. For projects involving computer modeling, provide the following information with the final report:

    a. Model description, key assumptions, version, source and intended use;

    b. Performance criteria for the model related to the intended use;

    c. Test results to demonstrate the model performance criteria were met (e.g., code verification/validation, sensitivity analyses, history matching with lab or field data, as appropriate);

    d. Theory behind the model, expressed in non-mathematical terms;

    e. Mathematics to be used, including formulas and calculation methods;

f. Whether or not the theory and mathematical algorithms were peer reviewed, and, if so, include a summary of theoretical strengths and weaknesses;

g. Hardware requirements; and

h. Documentation (e.g., users guide, model code).

Electronic Submission. The final scientific/technical report must be submitted electronically via the DOE Energy Link System (E-Link) accessed at http://www.osti.gov/elink-2413.

Electronic Format. Reports must be submitted in the ADOBE PORTABLE DOCUMENT FORMAT (PDF) and be one integrated PDF file that contains all text, tables, diagrams, photographs, schematic, graphs, and charts. Materials, such as prints, videos, and books, that are essential to the report but cannot be submitted electronically, should be sent to the DOE Administrator at the address listed in Block 16 of the Assistance Agreement Cover Page.

Submittal Form. The report must be accompanied by a completed electronic version of DOE Form 241.3, "U.S. Department of Energy (DOE), Announcement of Scientific and Technical Information (STI)." You can complete, upload, and submit the DOE F 241.3 online via E-Link. You are encouraged not to submit patentable material or protected data in these reports, but if there is such material or data in the report, you must: (1) clearly identify patentable or protected data on each page of the report; (2) identify such material on the cover of the report; and (3) mark the appropriate block in Section K of the DOE F 241 3. Reports must not contain any limited rights data (proprietary data), classified information, information subject to export control classification, or other information not subject to release. Protected data is specific technical data, first produced in the performance of the award that is protected from public release for a period of time by the terms of the award agreement.

Conference Papers/Proceedings

Content. The recipient must submit a copy of any conference papers/proceedings, with the following information: (1) Name of conference; (2) Location of conference; (3) Date of conference; and (4) Conference sponsor.

Electronic Submission. Scientific/technical conference paper/proceedings must be submitted electronically via the DOE Energy Link System (E-Link) at http://www.osti.gov/elink-2413. Non-scientific/technical conference papers/proceedings must be sent to the URL listed on the Reporting Checklist.

Electronic Format. Conference papers/proceedings must be submitted in the ADOBE PORTABLE DOCUMENT FORMAT (PDF) and be one integrated PDF file that contains all text, tables, diagrams, photographs, schematic, graphs, and charts. If the proceedings cannot be submitted electronically, they should be sent to the DOE Administrator at the address listed in Block 16 of the Assistance Agreement Cover Page.

Submittal Form. Scientific/technical conference papers/proceedings must be accompanied by a completed DOE Form 241.3. The form and instructions are available on E-Link at http://www.osti.gov/elink-2413. This form is not required for non-scientific or non-technical conference papers or proceedings.

Software/Manual

Content. Unless otherwise specified in the award, the following must be delivered: source code, the executable object code and the minimum support documentation needed by a competent user to understand and use the software and to be able to modify the software in subsequent development efforts.

Electronic Submission. Submissions may be submitted electronically via the DOE Energy Link System (E-Link) at http://www.osti.gov/estsc/241-4pre.jsp. They may also be submitted via regular mail to:

Energy Science and Technology Software Center
P.O. Box 1020
Oak Ridge, TN 37831

Submittal Form. Each software deliverable and its manual must be accompanied by a completed DOE Form 241.4, "Announcement of U.S. Department of Energy Computer Software." The form and instructions are available on E-Link at http://www.osti.gov/estsc/241-4pre.jsp.

Protected Personally Identifiable Information (PII). Management Reports or Scientific/Technical Reports must not contain any *Protected* PII. PII is any information about an individual which can be used to distinguish or trace an individual's identity. Some information that is considered to be PII is available in public sources such as telephone books, public websites, university listings, etc. This type of information is considered to be Public PII and includes, for example, first and last name, address, work telephone number, e-mail address, home telephone number, and general educational credentials. In contrast, *Protected* PII is defined as an individual's first name or first initial and last name in combination with any one or more of types of information, including, but not limited to, social security number, passport number, credit card numbers, clearances, bank numbers, biometrics, date and place of birth, mother's maiden name, criminal, medical and financial records, educational transcripts, etc.

C. FINANCIAL REPORTING

Recipients must complete the SF-425 as identified on the Reporting Checklist in accordance with the report instructions. A fillable version of the form is available at http://www.whitehouse.gov/omb/grants/grants_forms.aspx.

D. CLOSEOUT REPORTS

Final Invention and Patent Report

The recipient must provide a DOE Form 2050.11 , "PATENT CERTIFICATION." This form is available at http://energy.gov/management/downloads/patent-certification.

Final Property Report

See instructions under **SF-428 Tangible Personal Property Report Forms Family** below.

E. OTHER REPORTING

Annual Indirect Cost Proposal and Reconciliation

Requirement. In accordance with the applicable cost principles, the recipient must submit an annual indirect cost proposal, reconciled to its financial statements, within six months after the close of the recipient's fiscal year, unless the award is based on a predetermined or fixed indirect rate(s), or a fixed amount for indirect or facilities and administration (F&A) costs.

Cognizant Agency. The recipient must submit its annual indirect cost proposal directly to the cognizant agency for negotiating and approving indirect costs. If the DOE awarding office is the cognizant agency, submit the annual indirect cost proposal to https://www.eere-pmc.energy.gov/SubmitReports.aspx.

Audit of For-Profit Recipients

As required by 10 CFR 600.316, as supplemented by For-Profit Audit Guidance Parts I through IV, audits must be performed of For-Profit Recipients of financial assistance awards (prime awards) and sub-awards.

For-Profit Audit Guidance Parts I through IV to assist for-profit recipients in complying with the audit requirements of 10 CFR 600.316 are posted on the Financial Assistance Forms page of the MA home page under the 'Coverage of Independent Audits' subheading, http://energy.gov/management/downloads/profit-audit-guidance.
Submission: For recipients, financial statement and compliance audit submissions are due to DOE within six months of the recipients' fiscal year-end dates. For sub-awardees, financial statement and compliance audit submissions are due to the pass-through entity within six months of the sub-awardees' fiscal year-end dates. For recipients, the compliance audits must be submitted, along with audited financial statements, to the appropriate DOE Contracting Officer at https://www.eere-pmc.energy.gov/SubmitReports.aspx as well as to the DOE Office of the Chief Financial Officer at DOE-Audit-Submission@hq.doe.gov

SF-428 Tangible Personal Property Report Forms Family

Requirement. The SF-428 is a forms family consisting of 5 forms: the SF-428, SF-428-A, SF-428-B, SF-428-C, and SF-428S. Fillable versions of the SF-428 forms are available at http://energy.gov/management/office-management/operational-management/financial-assistance/financial-assistance-forms.

- The SF-428 is the cover page and the submitter attaches the appropriate form or forms as listed on the SF-428.
- The SF-428-A is the Annual report, due Oct. 30th of each calendar year.
- The SF-428-B is the Final Award Closeout Report, due at award completion.
- The SF-428-C is the Disposition Report/Request.

- The SF-428S is the supplemental form for the SF-428-A, SF-428-B and SF-428-C.

If at any time during the award the recipient is provided Government-furnished property or acquires property with project funds and the award specifies that the property vests in the Federal Government (i.e. federally owned property), the recipient must submit an annual inventory of this property to the DOE Administrator using the SF-428 and SF-428-A forms at the address on page 1 of this checklist no later than October 30th of each calendar year, to cover an annual reporting period ending on the preceding September 30th. The SF-428 and SF-428-B reports are required during closeout.

Content of Inventory. As required on the SF-428-A form, the inventory must include a description of the property, tag number, acquisition date, and acquisition cost, if purchased with project funds. The location of property should be listed under the Comments section. The report must list all federally owned property, including property located at subcontractor's facilities or other locations.

RESEARCH PERFORMANCE PROGRESS REPORT

Standard Cover Page Data Elements and Reporting Categories

The standard cover page data elements shown below, as well as mandatory and optional components comprise the complete research performance progress report format.

Each category in the RPPR is a separate reporting component. Each component is marked to indicate if it is optional or mandatory. Mandatory components must be addressed in each report, optional are at your discretion.

If you have nothing significant to report during the reporting period on a question or item, state "Nothing To Report".

1. COVER PAGE DATA ELEMENTS: Mandatory

- Federal Agency and Organization Element to Which Report is Submitted
- Federal Grant or Other Identifying Number Assigned by Agency
- Project Title
- PD/PI Name, Title and Contact Information (e-mail address and phone number)
- Name of Submitting Official, Title, and Contact Information (e-mail address and phone number), if other than PD/PI
- Submission Date
- DUNS Number
- Recipient Organization (Name and Address)
- Project/Grant Period (Start Date, End Date)
- Reporting Period End Date
- Report Term or Frequency (annual, semi-annual, quarterly, other)
- Signature of Submitting Official (electronic signatures (i.e., Adobe Acrobat) are acceptable)

2. ACCOMPLISHMENTS: Mandatory

What was done? What was learned?

The information provided in this section allows the agency to assess whether satisfactory progress has been made during the reporting period.

INSTRUCTIONS – Accomplishments

The PI is reminded that the grantee is required to obtain prior written approval from the Contracting Officer whenever there are significant changes in the project or its

direction. Requests for prior written approval must be submitted to the Contracting Officer (submission via Fedconnect is acceptable).

- What are the major goals and objectives of the project?
- What was accomplished under these goals?
- What opportunities for training and professional development has the project provided?
- How have the results been disseminated to communities of interest?
- What do you plan to do during the next reporting period to accomplish the goals and objectives?

What are the major goals of the project?

List the major goals of the project as stated in the approved application or as approved by the agency. If the application lists milestones/target dates for important activities or phases of the project, identify these dates and show actual completion dates or the percentage of completion.

Generally, the goals will not change from one reporting period to the next. However, if the awarding agency approved changes to the goals during the reporting period, list the revised goals and objectives. Also explain any significant changes in approach or methods from the agency approved application or plan.

What was accomplished under these goals?

For this reporting period describe: (1) major activities; (2) specific objectives; (3) significant results, including major findings, developments, or conclusions (both positive and negative); and (4) key outcomes or other achievements. Include a discussion of stated goals not met. As the project progresses, the emphasis in reporting in this section should shift from reporting activities to reporting accomplishments.

What opportunities for training and professional development has the project provided?

Describe opportunities for training and professional development provided to anyone who worked on the project or anyone who was involved in the activities supported by the project.

“Training” activities are those in which individuals with advanced professional skills and experience assist others in attaining greater proficiency. Training activities may include, for example, courses or one-on-one work with a mentor. “Professional development” activities result in increased knowledge or skill in one’s area of expertise and may include workshops, conferences, seminars, study groups, and individual study. Include participation in conferences, workshops, and seminars not listed under major activities.

How have the results been disseminated to communities of interest?

Describe how the results have been disseminated to communities of interest. Include any outreach activities that have been undertaken to reach members of communities who are not

usually aware of these research activities, for the purpose of enhancing public understanding and increasing interest in learning and careers in science, technology, and the humanities.

What do you plan to do during the next reporting period to accomplish the goals?

Describe briefly what you plan to do during the next reporting period to accomplish the goals and objectives.

3. PRODUCTS: [Optional/Mandatory]

What has the project produced?

Publications are the characteristic product of research. Agencies evaluate what the publications demonstrate about the excellence and significance of the research and the efficacy with which the results are being communicated to colleagues, potential users, and the public, not the number of publications.

Many projects (though not all) develop significant products other than publications. Agencies assess and report both publications and other products to Congress, communities of interest, and the public.

INSTRUCTIONS – Products

List any products resulting from the project during the reporting period. Examples of products include:

- Publications, conference papers, and presentations;
- Website(s) or other Internet site(s);
- Technologies or techniques;
- Inventions, patent applications, and/or licenses;
- Other products, such as data or databases, physical collections, audio or video products, software or NetWare, models, educational aids or curricula, instruments, or equipment; and

- Any other public release of information related to the project.

Publications, conference papers, and presentations

Report only the major publication(s) resulting from the work under this award. There is no restriction on the number. However, agencies are interested in only those publications that most reflect the work under this award in the following categories:

- **Journal publications.** List peer-reviewed articles or papers appearing in scientific, technical, or professional journals. Include any peer-reviewed publication in the periodically published proceedings of a scientific society, a conference, or the like. A publication in the proceedings of a one-time conference, not part of a series, should be reported under "Books or other non-periodical, one-time publications."

Identify for each publication: Author(s); title; journal; volume: year; page numbers; status of publication (published; accepted, awaiting publication; submitted, under review; other); acknowledgement of federal support (yes/no).

- **Books or other non-periodical, one-time publications.** Report any book, monograph, dissertation, abstract, or the like published as or in a separate publication, rather than a periodical or series. Include any significant publication in the proceedings of a one-time conference or in the report of a one-time study, commission, or the like.

  Identify for each one-time publication: author(s); title; editor; title of collection, if applicable; bibliographic information; year; type of publication (book, thesis or dissertation, other); status of publication (published; accepted, awaiting publication; submitted, under review; other); acknowledgement of federal support (yes/no).

- **Other publications, conference papers and presentations.** Identify any other publications, conference papers and/or presentations not reported above. Specify the status of the publication as noted above.

Website(s) or other Internet site(s)

List the URL for any Internet site(s) that disseminates the results of the research activities. A short description of each site should be provided. It is not necessary to include the publications already specified above in this section.

Technologies or techniques

Identify technologies or techniques that have resulted from the research activities. Describe the technologies or techniques and how they are being shared.

Inventions, patent applications, and/or licenses

Identify inventions, patent applications with date, and/or licenses that have resulted from the research. Submission of this information as part of an interim research performance progress report is not a substitute for any other invention reporting required under the terms and conditions of an award.

Other products

Identify any other significant products that were developed under this project. Describe the product and how it is being shared. Examples of other products are:

- Databases;
- Physical collections;
- Audio or video products;
- Software or NetWare;
- Models;

- Educational aids or curricula;
- Instruments or equipment;
- Data & Research Material (e.g., cell lines, DNA probes, animal models); and
- Other.

4. PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS:
[Optional/Mandatory]

Who has been involved?

Agencies need to know who has worked on the project to gauge and report performance in promoting partnerships and collaborations.

INSTRUCTIONS - Participants & Other Collaborating Organizations

Provide the following information on participants:

- What individuals have worked on the project?
- What other organizations have been involved as partners?
- Have other collaborators or contacts been involved?

What individuals have worked on the project?

Provide the following information for: (1) principal investigator(s)/project director(s) (PIs/PDs); and (2) each person who has worked at least one person month per year on the project during the reporting period, regardless of the source of compensation (a person month equals approximately 160 hours of effort).

- Provide the name and identify the role the person played in the project. Do NOT include any other identifying information on individuals. Indicate the nearest whole person month (Calendar, Academic, Summer) that the individual worked on the project. Show the most senior role in which the person has worked on the project for any significant length of time. For example, if an undergraduate student graduates, enters graduate school, and continues to work on the project, show that person as a graduate student, preferably explaining the change in involvement.

- Describe how this person contributed to the project and with what funding support. If information is unchanged from a previous submission, provide the name only and indicate “no change”.

- Identify whether this person is collaborating internationally. Specifically is the person collaborating with an individual located in a foreign country and whether the person had traveled to the foreign country as part of that collaboration and duration of stay. The foreign country(ies) should be identified.

Example:

Name:	Mary Smith
Project Role:	Graduate Student
Nearest person month worked:	5
Contribution to Project:	Ms. Smith has performed work in the area of combined error-control and constrained coding.
Funding Support:	The Ford Foundation (Complete only if the funding provided from other than this award.)
Collaborated with individual in foreign country:	Yes
Country(ies) of foreign collaborator:	China
Traveled to foreign country:	Yes
If traveled to foreign country(ies), duration of stay:	5 months

What other organizations have been involved as partners?

Describe partner organizations – academic institutions, other nonprofits, industrial or commercial firms, state or local governments, schools or school systems, or other organizations (foreign or domestic) – that have been involved with the project. Partner organizations may provide financial or in-kind support, supply facilities or equipment, collaborate in the research, exchange personnel, or otherwise contribute.

Provide the following information for each partnership:

Organization Name:
Location of Organization: (if foreign location list country)
Partner's contribution to the project: (identify one or more)

- Financial support;
- In-kind support (e.g., partner makes software, computers, equipment, etc., available to project staff);
- Facilities (e.g., project staff use the partner's facilities for project activities);
- Collaborative research (e.g., partner's staff work with project staff on the project); and
- Personnel exchanges (e.g., project staff and/or partner's staff use each other's facilities, work at each other's site).

More detail on partner and contribution (foreign or domestic).

Have other collaborators or contacts been involved?

Some significant collaborators or contacts within the recipient's organization may not be covered by "What people have worked on the project?" Likewise, some significant collaborators or contacts outside the recipient's organization may not be covered under "What other organizations have been involved as partners?" For example, describe any significant:

- collaborations with others within the recipient's organization; especially interdepartmental or interdisciplinary collaborations;
- collaborations or contact with others outside the organization; and
- collaborations or contacts with others outside the United States or with an international organization.
- country(ies) of collaborations or contacts.

It is likely that many recipients will have no other collaborators or contacts to report.

5. IMPACT: [Optional/Mandatory]

What is the impact of the project? How has it contributed?

Over the years, this base of knowledge, techniques, people, and infrastructure is drawn upon again and again for application to commercial technology and the economy, to health and safety, to cost-efficient environmental protection, to the solution of social problems, to numerous other aspects of the public welfare, and to other fields of endeavor.

The taxpaying public and its representatives deserve a periodic assessment to show them how the investments they make benefit the nation. Through this reporting format, and especially this section, recipients provide that assessment and make the case for Federal funding of research and education.

Agencies use this information to assess how their research programs:
- increase the body of knowledge and techniques;
- enlarge the pool of people trained to develop that knowledge and techniques or put it to use; and
- improve the physical, institutional, and information resources that enable those people to get their training and perform their functions.

INSTRUCTIONS - Impact

This component will be used to describe ways in which the work, findings, and specific products of the project have had an impact during this reporting period. Describe distinctive contributions, major accomplishments, innovations, successes, or any change in practice or behavior that has come about as a result of the project relative to:

- the development of the principal discipline(s) of the project;
- other disciplines;
- the development of human resources;
- physical, institutional, and information resources that form infrastructure;
- technology transfer (include transfer of results to entities in government or industry, adoption of new practices, or instances where research has led to the initiation of a startup company); or
- society beyond science and technology.

What is the impact on the development of the principal discipline(s) of the project?

Describe how findings, results, techniques that were developed or extended, or other products from the project made an impact or are likely to make an impact on the base of knowledge, theory, and research and/or pedagogical methods in the principal disciplinary field(s) of the project. Summarize using language that an intelligent lay audience can understand (*Scientific American* style).

How the field or discipline is defined is not as important as covering the impact the work has had on knowledge and technique. Make the best distinction possible, for example, by using a "field" or "discipline", if appropriate, that corresponds with a single academic department (i.e., physics rather than nuclear physics).

What is the impact on other disciplines?

Describe how the findings, results, or techniques that were developed or improved, or other products from the project made an impact or are likely to make an impact on other disciplines.

What is the impact on the development of human resources?

Describe how the project made an impact or is likely to make an impact on human resource development in science, engineering, and technology. For example, how has the project:

- provided opportunities for research and teaching in the relevant fields;
- improved the performance, skills, or attitudes of members of underrepresented groups that will improve their access to or retention in research, teaching, or other related professions;
- developed and disseminated new educational materials or provided scholarships; or
- provided exposure to science and technology for practitioners, teachers, young people, or other members of the public?

What is the impact on physical, institutional, and information resources that form infrastructure?

Describe ways, if any, in which the project made an impact, or is likely to make an impact, on physical, institutional, and information resources that form infrastructure, including:

- physical resources such as facilities, laboratories, or instruments;
- institutional resources (such as establishment or sustenance of societies or organizations); or
- information resources, electronic means for accessing such resources or for scientific communication, or the like.

What is the impact on technology transfer?

Describe ways in which the project made an impact, or is likely to make an impact, on

commercial technology or public use, including:

- transfer of results to entities in government or industry;
- instances where the research has led to the initiation of a start-up company; or
- adoption of new practices.

What is the impact on society beyond science and technology?

Describe how results from the project made an impact, or are likely to make an impact, beyond the bounds of science, engineering, and the academic world on areas such as:

- improving public knowledge, attitudes, skills, and abilities;
- changing behavior, practices, decision making, policies (including regulatory policies), or social actions; or
- improving social, economic, civic, or environmental conditions.

What dollar amount of the award's budget is being spent in foreign country(ies)?

Describe what percentage of the award's budget is being spent in foreign country(ies). If more than one foreign country, identify the distribution between the foreign countries.

6. CHANGES/PROBLEMS: [Optional/Mandatory]

The PI is reminded that the grantee is required to obtain prior written approval from the Contracting Officer whenever there are significant changes in the project or its direction. Requests for prior written approval must be submitted to the Contracting Officer (submission via Fedconnect is acceptable). If not previously reported in writing, provide the following additional information, if applicable:

- Changes in approach and reasons for change.
- Actual or anticipated problems or delays and actions or plans to resolve them.
- Changes that have a significant impact on expenditures.
- Significant changes in use or care of animals, human subjects, and/or biohazards.

INSTRUCTIONS - Changes/Problems

Changes in approach and reasons for change

Describe any changes in approach during the reporting period and reasons for these changes. Remember that significant changes in objectives and scope require prior approval of the agency.

Actual or anticipated problems or delays and actions or plans to resolve them

Describe problems or delays encountered during the reporting period and actions or plans to resolve them.

Changes that have a significant impact on expenditures

Describe changes during the reporting period that may have a significant impact on expenditures, for example, delays in hiring staff or favorable developments that enable meeting objectives at less cost than anticipated.

Significant changes in use or care of human subjects, vertebrate animals, and/or Biohazards

Describe significant deviations, unexpected outcomes, or changes in approved protocols for the use or care of human subjects, vertebrate animals, and/or biohazards during the reporting period. If required, were these changes approved by the applicable institution committee and reported to the agency? Also specify the applicable Institutional Review Board/Institutional Animal Care and Use Committee approval dates.

Change of primary performance site location from that originally proposed

Identify any change to the primary performance site location identified in the proposal, as originally submitted.

7. SPECIAL REPORTING REQUIREMENTS: [Optional/Mandatory]

Respond to any special reporting requirements specified in the award terms and conditions, as well as any award specific reporting requirements.

8. BUDGETARY INFORMATION: [Optional/Mandatory]

This component will be used to collect budgetary data from the recipient organization. The information will be used in conducting periodic administrative/budgetary reviews. Budgetary data should be submitted in an Excel spreadsheet format.

Appendix A – General Data Request List

Device General Specifications

- Description of energy capture technology, including major hardware and electrical components, depth below the surface and above the sea/river bed of the energy capture axis and principle of operation
- Normal range of operating parameters
- Extreme event operating parameters
- Standard dimensions
- Device weight and displacement
- Power production
    - Electrical - Rated power output
    - Average (over one year) power output
    - Efficiency
    - Availability
- Hydrodynamic Design Codes and Results
- Predicted resource mean and turbulent turbine inflow field
- Blade steady and unsteady load predictions
- Shaft steady and unsteady load predictions
- Cowling and tower steady and unsteady load predictions
- Blade cavitation inception predictions
- Rotor power and efficiency predictions
- Structural Design Codes and Results
- Blade steady stress/strain predictions
- Blade vibration natural frequencies and mode shapes predictions
- Blade vibration response to unsteady loads predictions
- Blade fatigue and radiated noise predictions
- Cowling and tower stress/ strain predictions
- Tower vibration response to unsteady loads predictions
- CAD drawing of the device
- List of components with weights and materials
- Mooring Design, if applicable
    - Geometry
    - Anchor type and weight
    - CAD drawing of anchors
    - Arrangement drawing with dimensions
    - Mooring line, type, arrangement (slack and taught), thickness and weight
- Power Conversion Chain Codes and Results
    - Breakdown schematic of power conversion components
    - Steady and unsteady loads predictions and predictions of the response to those loads
    - Technical specifications of components (dimensions, weight)
    - Control algorithm, if applicable
    - Failure rate distribution of each component (by cycles or time)
    - Scheduled Maintenance requirements (i.e. Gearbox needs oil replacement every 2-years)
- Electrical System
    - Electrical topology

  - Subsystems/components: size, weight
  - EMF output (device and cables)
- Biofouling Effects
  - On blade steady loads and power output
  - On system unsteady loads and response
- Cost
- Cost basis rationale and itemized list of components with cost estimates at time of design

Device Measurements

- Resource Assessment Sensors and Results
  - Turbine rotor inflow mean and turbulent velocities
- Model and Full Scale Hydrodynamic Sensors and Results
- Mean and turbulent velocities into, through and downstream of the rotor
- Mean and turbulent velocities into, over and downstream of the cowling and tower
- Blade, cowling and tower steady and unsteady loads
- Cavitation types and inception
- All measured results should have uncertainties quantified and presented
- Compare all measured results with those from design predictions for code verification
- Model and Full Scale Structural Response Sensors and Results
  - Blade, cowling and tower steady stresses/strains
  - Blade vibration natural frequencies and mode shapes
  - Blade and tower vibration response and fatigue
  - All measured results should have uncertainties quantified and presented
  - Compare all measured results with those from design predictions for code verification
- Power Conversion Chain
  - Internal temperature
  - Generator temperature
  - Rotational velocity
  - Generator rotor or shaft stress/strain (as applicable)
  - Major component vibrations
- Mooring, if applicable
  - Line tension
  - Line angle
  - Line vibrations
- Power (power quality, min sampling rate of 50 kHz (1 minute avg))
  - Device voltage
  - Device current
  - Grid voltage - if applicable
  - Grid current - if applicable
- System Health
  - Water intrusion
  - Internal humidity
  - Internal temperature

  - Fault status
  - Vibrations and internal noise
- Acoustic
  - Radiated noise levels
- Video
  - Subsurface video of device and surroundings to monitor environmental impact

Installation and Operations and Maintenance

- Final assembly procedure at port (cranes, cost, etc)
- Installation procedure, schedule and cost
- Required dedicated O&M Vessel(s)/support personnel
- Required onshore O&M facilities/support personnel
- O&M equipment purchases and cost

Grid Connection

- Overview map showing: (1) deployment location, (2) grid interconnection point, (3) distances
- Cable design details - dimensions, rated capacity, frequency, # of conductors, etc
- Device or array connection to power transmission cable
- Packing density (Array layouts for: 1, 10, 100 devices)
- Voltage frequency and the permitted tolerances
- Prevailing grid conditions that may have limited the power output during the test period
- Grid connection voltage, current, frequency including measures of voltage flicker and fluctuations, harmonic distortion (including existing grid harmonics and harmonic emission from device), power factor, and voltage unbalance.

Environmental Measurements

Metocean Measurements:

- In-Flow
  - Detailed overall current velocity profile
- Water Properties
  - Temperature (profile with depth if applicable)
  - Salinity
  - pH
  - Conductivity
  - Dissolved oxygen
  - Suspended sediment (concentration, particle size)
  - Turbidity
  - Dissolved nutrients (nitrate, phosphate, silicate, etc.)
- Acoustic
  - Ambient noise spectra and seasonal variations
- Electromagnetic Field (EMF)
  - Strength

- Spectra

Bathymetry

- Bathymetry & topology of sea/river bed (could have potential effect on performance of devices/mooring system, quality of tidal currents). Specify measurement method (i.e., multi-beam and/or single-beam, side scan, video, etc.)
- Sub-bottom/sediment core samples with soil characteristics (geotechnical data for designing foundations and anchoring systems)
  - Bulk Density with depth
  - Particle size distribution with depth
  - Total organic carbon (to help characterize benthic habitat)

Biological Characteristics and Effects

- All baseline pre-installation biological survey data
- All biological monitoring for effects during construction, operation and decommissioning
- Baseline assessments of marine animals in area, particularly threatened or endangered species (i.e. marine mammals, seabirds, resident and migratory fish, commercially important invertebrates like crab)
- Monitoring data (post installation) of direct and indirect interactions of marine animals with devices
- Benthic substrate characteristics, before and after installation
- Measures of productivity of systems, such as chlorophyll
- Animals affected by acoustics (noise) and acceptable noise level thresholds for each
- Animals affected by EMF from devices or cables and acceptable EMF level thresholds
- Near shore habitat that will be affected by cable crossings, grid connection
- Benthic habitat surveys before and after deployment
- Surveys of macrofauna before and after deployment
- ROV survey results
- Type of monitoring equipment & methodology
- Season and duration of monitoring

Siting and Acceptance

- Fishing - Commercial/recreational/subsistence
- Key recreational uses
- Navigation, commercial shipping, etc
- Outreach activities
- Demographic studies
- Other marine industries
- Nearby port/landing facility
- Outline of required studies
- Study cost estimates
- Permitting process cost and timelines

Standardized Cost and Performance Reporting for Marine and Hydrokinetic Technologies

Overview and Introduction

As a research and development (R&D) organization, the U.S. Department of Energy's (DOE's) Wind and Water Power Technologies Office (WWPTO) assesses, evaluates, and funds technologies that vary significantly on issues of maturity, scale, design, and resource. Targeting high-impact R&D, as well as communicating the state of the marine and hydrokinetic (MHK) industry and the subsequent rationale for program investments to internal and external stakeholders requires a uniform assessment of the diverse set of MHK technologies. To this end, DOE uses the Levelized Cost of Energy (LCOE) as an integrated metric, combining cost and performance. LCOE is the level of sales revenue per megawatt-hour (MWh) of grid-tied electricity production needed for an electricity-generating venture to "break even" in the sense that the project covers all capital and operating expenses and satisfies a minimum rate of return for investors.

However, the assumptions embedded within the LCOE equation can vary significantly, and without adequate transparency it is difficult to conduct meaningful analysis of the techno-economic viability of wave and current (tidal, river, and ocean) energy resources using real industry data—let alone understand differences in cost and performance across devices of the same type. Facilitating an "apples-to-apples" comparison is inherently difficult between MHK technologies, as each developer conducts his/her own analyses, marketing, and R&D decision-making based on unique cost, financial, and resource assumptions. Owing to the nascent stage of the industry, varying levels of technological maturity and numerical model validation introduce an additional layer of uncertainty to MHK LCOE estimates. In order to build DOE and investor confidence in estimates developed by the sector, the lack of uniform and transparent calculation of LCOE must be addressed. Armed with a set of transparent and defensible LCOE estimates, and a unique ability to continue to gather broad and representative data, DOE may demonstrate quantitatively the position of the MHK industry along the technological "learning curve," and key areas for technology advancement that will lead to reduced LCOE and a substantial potential of MHK to contribute to the nation's energy system.

To normalize competing claims of LCOE**,** DOE has developed—for its own use—a standardized cost and performance data reporting process to facilitate uniform calculation of LCOE from MHK device developers. DOE is initially targeting two specific audiences to follow the

standardized cost calculation and performance reporting: (1) recipients of Water Power Program technology development financial assistance awards to provide initial feedback, and after refining based on this feedback (2) applicants to future DOE funding announcements . In the former case, uniform data collection allows DOE to make thorough estimates of the current state of the MHK industry. In the latter case, by collecting cost and performance data as part of the award process, DOE is able to make informed judgments on the funding of high-impact technologies.

It is important to note that this standardization framework is only the first version in what is anticipated to be an iterative process that involves industry and the broader DOE stakeholder community. Feedback from DOE's current awardees will produce significant refinements and improvements to the framework, and the goal of this submission is to both raise awareness among potential applicants for future funding opportunities and solicit initial comments from industry. The procedure for comment on this document can be found in the "Comment Process and Contact Information" section at the end of the document.

The standardized data reporting and LCOE calculation includes three different elements:

1. **A standardized cost-reporting framework** that specifies the scale, scope, and categories of the cost estimate. The intent of this framework is to: (a) normalize deployment scale—developers will be asked to report costs at both the single device and a specified array scale to capture infrastructure, operational, and manufacturing economies of scale; (b) ensure that costs encompass all project development activities, are current, and *do not* include forecasted components of future technological learning; and (c) provide uniform categories and definitions for cost elements to ensure reported costs are comparable.

   These costs will be reported in a "Cost Breakdown Structure" (CBS) workbook to provide a uniform platform to estimate or track capital and operational costs that accrue during the entire project lifetime. The CBS is structured to be product-oriented in a hierarchical fashion, and includes both technology-specific elements (e.g., a float or rotor) and soft costs (e.g., warranty, siting, and scoping).

   DOE's WWPTO is itself transitioning to a similar CBS format for all of its technology market segments (MHK, hydropower, land-based wind, and offshore wind).

2. **DOE-provided reference resources** to normalize assumptions related to deployment location and resource intensity to produce comparable energy generation calculations. Developers are expected to calculate specified energy production metrics based on the reference resource and their performance simulation models. A standard array scale (in

terms of annual generation) is dictated for each of the reference resources. For additional context, DOE is also seeking a narrative description of the model software used in estimating device performance, including assumptions and simplifications, and the validation approach. A separate document will detail reporting parameters for validation data.

For wave technologies, the reference resource is given by a scatter diagram (for details see the Wave Performance Reporting section below) representing the wave climate off the coast of northern California. For near-shore technologies, the matrix will be modified to reflect the reduced energy content in the waves. The array scale that corresponds to the wave reference resource is a deployment that delivers 260,000 MWh of energy per year to the grid.

The tidal reference resource is representative of current speeds in Puget Sound's Admiralty Inlet and is provided in bins with a granularity of 0.1 meters per second. Flow speed variation within the water column is accounted for through the use of a 1/7 power-law relationship. The array scale that corresponds to the tidal reference resource is a deployment that delivers 136,000 MWh of energy per year to the grid.

In addition to the reference resource, developers are also welcome to provide an a set of performance and cost estimates in their own "design" resource.

3. **Uniform financial parameters** (such as tax, inflation, and project financial structure) to remove outstanding financial variables from what is intended to be a technology question. The standardized financial parameters explicitly remove incentives from the calculation of LCOE to isolate technology cost drivers and inform R&D programming.

Where possible, DOE is attempting to maintain consistency with the emerging set of power performance and resource assessment standards under development by the International Electrotechnical Commission's (IEC's) Technical Committee (TC) 114: Marine Energy – Wave, tidal, and other water current converters[1]. As currently written, the standardized reporting framework relies on the existing published technical specifications [1,2,3] and some of the initial work completed on unpublished drafts. The TC 114 documents have not formally reached the level of "Standard" and are subject to change as they undergo broader industry review and acceptance. As these standards evolve, so too might DOE's reporting standards.

[1] http://www.iec.ch/dyn/www/f?p=103:7:0::::FSP_ORG_ID:1316

Appendix B – LCOE Reporting Guidance

An Introduction to Levelized Cost of Energy

Levelized Cost of Electricity (LCOE) is the level sales revenue per unit of grid-tied electricity production (this document uses megawatt-hours [MWh]) needed for an electricity-generating venture to "break-even" in the sense that the project covers all capital and operating expenses and satisfies a minimum rate of return for investors. A simplified equation for LCOE is presented below:

$$LCOE = \frac{ICC * FCR + O\&M}{AEP}$$

Where:

- **ICC**, installed capital costs, represents all capital expenditures associated with the planning, design, manufacturing, deployment, and project management of a WEC array ("wet capex");

- **FCR**, fixed charge rate, is the annual return, represented as a fraction of installed capital costs, needed to meet investor revenue requirements;

- **O&M**, operations and maintenance costs, includes all routine maintenance, operations, and monitoring activity (i.e. non-depreciable);

- and **AEP**, annual energy production, describing the average annual energy generated (after accounting for device or array availability) and delivered to the point of AC grid interconnection (i.e. the measurable basis for power purchase contracts).

Reporting Power Performance

This section details the process and reporting transparency necessary for DOE to have full context and confidence in a reported estimate of power performance. Guidelines for both Wave and Tidal energy converters are discussed, including the description of a "reference resource" chosen by DOE for each technology class. This document will only contain a summary of the reference resource details; more granular datasets than those provided here will be necessary to adhere to the reporting standards. These datasets along with the MHK LCOE Reporting Guidance Document and Device Performance Validation Data Request are hosted on the Open Energy Information ("OpenEI") Water Power Forum:

http://en.openei.org/community/discussion/mhk-lcoe-reporting-guidance-draft.

Terminology and standards are adapted—with effort to maintain consistency where possible—from three standards: the 62600-1: "Terminology" Technical Specification [1], the 62600-100: "Electricity producing wave energy converters—Power performance assessment" Technical

Specification [2], and the 62600-200: "Power performance assessment of electricity producing tidal energy converters" Draft Technical Specification [3].

Only one major term is substantially redefined from the TC 114 publications: Annual Energy Production. In the wave and tidal "Power Performance" standards, AEP is typically defined as the power measured at the output terminals of an energy generating device at 100% availability. AEP is redefined here to match internal DOE convention across multiple R&D programs. For the purposes of this document, Annual Energy Production is the annual energy delivered to the point of transmission interconnection when accounting for both transmission losses and device/array availability (see the Wave and Tidal Performance Reporting sections for more detail).

Wave Energy Converter (WEC) Guidance

This section details the methodology for calculating and communicating WEC and WEC array performance, and describes the major characteristics of the wave reference resource. Reporting requirements are summarized at the end of the section.

Wave Performance Reporting

The following terms are defined for clarity and consistency in the calculation of power production:

- **Deep-water depth** is the spatial location where water depth is greater than or equal to half of the wavelength. **Intermediate depth** is less than half the wavelength but greater or equal to a twentieth. **Shallow water depth** is less than a twentieth of wavelength.

- **Wave power** is the terminology used to describe the time-averaged power of a given sea state, expressed in terms of kW/m. In literature, this is also referred to as "wave energy flux per unit width" (IEC, 2011) and "wave power density" (EPRI, 2011), among other terms; depending on source, the distinction between terminologies can be contradictory.

- **Significant wave height (H_s)** is traditionally defined in physical oceanography as the statistical measurement of the average of the largest one-third of wave heights in an irregular sea state[2], expressed in meters. **Peak period** (T_p) is the wave period corresponding to the maximum value of the wave spectrum[3], expressed in seconds.

[2] The significant wave height can be calculated based on zero down crossing analysis from time history data or four times the square root of the zeroth-order spectral moment of the wave energy spectrum (IEC TC114). The symbol $H_{1/3}$ is often used for the first definition, and H_{m0} is often used for that latter definition.

[3] We use peak period, as it is more practical for industry. Alternatively, one can use the energy period T_e. Theoretically, they will be converge to nearly the same value when the data sample is large enough, i.e., sufficient time. For example, Beels et al (2007) demonstrate a scenarios where $T_e=T_p\times1.162$.

- The **mechanical power extraction** of a WEC is the physical power extracted from an incident wave prior to any mechanical or electrical processes that converts this extracted power to electrical power.

- The **electrical power capture** of a WEC is power production at the point nearest where mechanical power is converted to smoothed and of grid-quality electrical power, net of power drawn by onboard electrical systems. This "nearest point" (point of power capture) would typically be the output terminal (per TC 114, the point of A/C export) of a WEC or post-generation smoothing/aggregation mechanism (e.g. storage batteries, super capacitors). This should necessarily include all mechanical and electrical losses in the conversion system prior to transmission system interconnection.
- As a technology performance measure, the estimate of total energy production at the point of power capture of a WEC or array across a year and assuming 100% availability is **theoretical annual energy production (TAEP)**[4].

- As practical performance measure, when TAEP is modified by availability it becomes **actual energy capture (AEC)**, when AEC is further modified by transmission losses to the point of grid interconnection (i.e. delivered power) it becomes **Annual Energy Production (AEP)**. Availability losses can either be **forced** (unplanned) or **unforced** (planned).

Note: **Rated capacity** would be expected to closely match a WEC/array's peak power capture, which should dictate requirements for power transmission infrastructure and grid interconnection. However, in the absence of a rating standard with respect to aggregation and smoothing, rated capacity may currently be inconsistently defined between WEC technologies. Insofar as device and array power production limitations are embodied in power capture, and subsequently constrain energy production, rated capacity is unnecessary for calculating LCOE.

Calculating and Documenting Annual Energy Production (AEP)

Developers will need to calculate their device and array performance using a **time-domain numerical model**. The simulation needs to be performed based on the wave statistical dataset provided by DOE. More details and the general process for calculating AEP are described as follow:

1. DOE will provide a standard wave statistical dataset, which represents the typical sea states of Northern California coast. The wave statistics data are often presented in terms of their joint probability distribution (JPD), which is defined based on given significant

[4] TAEP is the direct analogue of Mean Annual Energy Production (MAEP) as defined in IEC 2012a.

wave heights and peak wave periods. We refer this type of dataset as a scatter diagram according to IEC TC114.

2. Developers should calculate performance in the reference resource (see the following section on the Wave Reference Resource) and supply 1) a mechanical power matrix, and 2) an electrical power capture matrix, mapping mechanical power extraction and electrical power capture respectively, to the scatter diagram bins defined by significant wave height, H_s, and peak period, T_p. The two power matrices should be developed as follows. Please also include an itemized description of mechanical and electrical losses in the conversion system.
    a. A time-domain numerical simulation must be performed to calculate the device power matrices. First, the technology developer shall produce a time series using the Bretschneider spectrum combinations of H_s and T_p corresponding to the reference site scatter diagram (see wave reference resource section for more details on the next page). The length of time series must be at least $200T_p$ and it is recommended that time step be $0.01T_p$[5]. For consistency, the time series should be generated using the standard Bretschneider spectrum. This time series serves as the input to device performance codes to produce power output at the specified combination of H_s and T_p. By repeating this procedure for all combinations of H_s and T_p within the scatter diagram, one can produce the complete power matrix.
    b. Bin sizes should follow the bin size of the scatter diagram and be a maximum of 0.5 meters (significant wave height) by 1 second (peak period).
    c. Because the device performance analysis was conducted using numerical simulations, additional modeling and design parameters (e.g., the selection of viscous damping coefficient and the configuration of the mooring design) will need to be addressed and documented.
    d. Depending on device design and capture mechanism, additional variables may need to be taken in to account, such as mean wave direction. Specifically for those devices that are directionally sensitive, DOE plans to include a directional dataset in future iterations of this document. However, for the sake of simplicity, developers with a directionally sensitive device should take a standardized 10% loss in AEP (Babarit et al., 2012)[6].
    e. Matrix entries should be equal to zero for sea states in which the WEC technology is in survival mode.
    f. For WECs that are installed in shallow water, assuming that the wave statistics in shallow water are the same as in deep water would overestimate the device AEP. Therefore, developers should to include their own estimate of the shallow water

[5] The technology developers can use their own simulation duration or time step size, but we do recommend the length should be at least $200T_p$ seconds. Note that the simulation duration used by Babarit et al. (2011) is $15T_p$+1200s with a time step size between 0.01s and 0.05s.

[6] At this stage, we do not include the further directionality calculation here, although we understand its importance and would include it in the future.

reduction in energy with supporting documentation, or take an averaged 10% loss in AEP (Folley and Whittaker, 2009). In future iterations of this guidance DOE will provide a more detailed shallow water representation of the reference site.

g. In the cases where developers elect to include an additional "design resource", the same procedure described in steps a. through g. above should be followed. **Regardless of the choice to include performance estimates for the design resource, developers must evaluate device and array performance in the reference resource.**

3. Array losses (for the reporting cases at array scale) should also be estimated and reported. Developers should either consider a 10% loss on AEP (Babarit, 2012; Babarit, 2013) for device spacing equal to or greater than 10 device sizes, or provide their own analysis on the array lost. If array power output is estimated through numerical simulations or experimental wave tank tests, please report additional array-level mechanical power and power capture matrices. If other non-modeled estimates are used (e.g. rules of thumb, results in literature, and prior experience), please list of assumptions and description of the process and rationale for the selection of the array loss value.

4. AEP is estimated after averaging annually, accounting for availability, and adjusting for transmission losses. AEP should be reported in MWh.

Please provide the results with a narrative description of the numerical model and the current extent and results of numerical model validation. If a device performance analysis was developed through experimental wave tank tests, these results should be used for comparison and verification of the numerical simulations. Any additional test settings and parameters (e.g., the instrument settings and the configuration of the mooring design) should be described and documented. For more information on providing test data refer to the standalone Device Performance Validation Data Request on OpenEI.

Wave Reference Resource

The wave reference resource is adapted from DOE's Reference Model projects. The reference site is in Northern California near Humboldt Bay. The resource data is determined based on the nearby National Data Buoy Center measurements, and the data is represented in an annual scatter diagram[7]. In addition, DOE request the time-series be based on a Bretschneider spectrum, to replicate the wave elevation at the site. The developers can import the wave elevation time history data directly into their time-domain numerical simulations for the power performance calculation if needed. A MATLAB script for generating the time series data is provided in the Appendix.

[7] At this stage, we do not include detailed monthly or seasonal data, although we understand their importance and will include them in the future.

Appendix B – LCOE Reporting Guidance

The scatter diagram for the Northern California Site is shown below in Figure 1. An excel representation of the scatter diagram will be available on the OpenEI website. The site is assumed have a water depth of 70m and sit approximately 5km from shore.

		Peak Period (s)												
		5.7	6.7	7.7	8.7	9.7	10.7	11.7	12.7	13.7	14.7	15.7	16.7	17.7
Hs (m)	0.25	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	0.75	0.4%	1.1%	1.1%	1.3%	0.4%	0.6%	0.3%	0.2%	0.2%	0.3%	0.4%	0.5%	0.2%
	1.25	1.0%	2.8%	2.4%	4.6%	1.8%	2.2%	1.1%	0.9%	0.7%	0.5%	0.4%	0.4%	0.2%
	1.75	0.2%	2.5%	2.7%	3.6%	2.1%	3.5%	1.9%	1.4%	1.2%	1.0%	0.5%	0.5%	0.3%
	2.25	0.0%	0.6%	2.3%	3.6%	1.7%	3.3%	2.4%	1.9%	1.5%	1.0%	0.6%	0.5%	0.3%
	2.75	0.0%	0.2%	0.9%	2.7%	1.0%	2.2%	2.0%	1.5%	1.3%	0.9%	0.5%	0.5%	0.3%
	3.25	0.0%	0.0%	0.2%	1.1%	0.7%	1.2%	1.3%	1.2%	1.1%	0.8%	0.5%	0.4%	0.2%
	3.75	0.0%	0.0%	0.0%	0.3%	0.3%	0.5%	0.7%	0.7%	0.7%	0.6%	0.3%	0.3%	0.1%
	4.25	0.0%	0.0%	0.0%	0.1%	0.1%	0.2%	0.3%	0.3%	0.4%	0.4%	0.2%	0.2%	0.1%
	4.75	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%	0.2%	0.2%	0.1%	0.2%	0.1%
	5.25	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%	0.1%	0.1%

Figure 1 - Humboldt Bay Scatter Diagram

Future iterations of this guidance will make at least two significant refinements to this reference resource. First, the data will be presented in the form of 12 monthly scatter diagrams to facilitate more accurate energy estimates for those developers with advanced control and O&M strategies with significant seasonal variation. Second, directionality will be added to better estimate energy production from devices with significant directional sensitivity. Both of these changes have been withheld from this original version of the LCOE reporting guidance to simplify the initial analytical needs and reduce the burden on the developers providing the first results and feedback.

Summary Reporting Requirements

Overall, DOE is requesting that power performance be estimated at both the single device and array scales in the DOE reference resource, resulting in two estimates of AEP. If a developer disagrees with, or finds the use of the reference resource unfavorable to their device, they are free to provide an additional set of single device and array performance estimates as well. The following documentation must accompany the calculation of AEP in each resource (the DOE reference resource and the developer design resource):

1. Device Mechanical Power Matrix
2. Device Power Capture Matrix
3. Itemized Losses between Mechanical Power and Power Capture Matrices, in matrix form if available
4. Description of Wave Power Production Model
5. Array Loss Factor
6. (If Available) Array Power Capture Matrix

7. Description and Justification of Array Calculations
8. Availability Losses
9. Description and Justification of Availability Loss Calculations
10. Device and Array TAEP
11. AEC and AEP at device and array scales
12. (Optional) Additional Resource Location and Deployment Depth
13. (Optional) Additional Resource Scatter Matrix
14. (Optional) Additional Resource Array Scale
15. (Optional) Additional Resource Description and Justification

Tidal Energy Converter (TEC) Guidance

Tidal Performance Reporting

For tidal energy converters, **Net Electrical Power Output** ("*power output*") is power exported from a TEC as measured at device output terminals and net of power drawn by onboard electrical systems. It is represented graphically and in tabular form as a "**Power Curve**" relationship between power output and average current speed at the hub-height of the TEC. The power curve should account for **cut-in** and **cut-out water velocities**.

Power output (and delivered power) should necessarily include all losses in the conversion system prior to transmission to shore. The physical power transferred to the device from the current flow is mechanical power—the fraction of physical power vs. extracted power is represented dimensionless form as the coefficient of performance (C_P). Prior to conversion to electrical power, some power is lost within the mechanical conversion system (e.g. friction) these are mechanical losses. Losses experienced during electrical conversion (e.g. generator efficiencies) are considered electrical losses. Both mechanical and electrical losses should be itemized in describing the development of the power curve.

As a technology performance measure, the estimate of total energy production at the point of power output of a TEC or array across a year and assuming 100% availability is **theoretical annual energy production (TAEP)**. TAEP is meant only to represent technology performance and subsequently does not account for device availability or transmission losses.

As practical performance measures, when AEP is modified by availability and array losses it becomes **actual energy capture (AEC),** when AEC is further modified by transmission losses to the point of grid interconnection (i.e. power output to delivered power) it becomes **annual energy production (AEP)**. Availability losses can either be forced (unplanned) or unforced (planned).

Note: **Rated capacity** would be expected to closely match a TEC/array's peak power output, which should dictate requirements for power transmission infrastructure and grid interconnection. However, in the absence of formal industry standards rated capacity may be inconsistently defined between TEC technologies. Insofar as device and array power production limitations are embodied in power capture, and subsequently constrain energy production, rated capacity is unnecessary for calculating LCOE.

Calculating AEP

The general process for calculating AEP is as follows:

1. Developers should prepare a representation of device performance in the form of the power curve as described above (as average kW within .1 m/s bins). A representation of a similar curve depicting C_p vs. flow should also be prepared.

2. Multiplying a velocity distribution by the device power curve, and this result by 8,766 hours yields theoretical annual energy production (TAEP).

3. AEP is estimated after averaging annually, accounting for availability, and adjusting for transmission losses. AEP should be reported in MWh.
    a. Averaging the results from step 2 on an annual basis will produce TAEP. Applying an availability factor will reduce TAEP to AEC.

Ideally, the power curve will be produced from full-scale in-water deployment data in accordance with (IEC 2012b). If full-scale deployment data is unavailable (i.e. for lower TRL projects), please provide a narrative description of the model architecture used to estimate power output and $C_{P,}$ accompanied by the extent and results of model validation with physical tests**.**

Tidal Reference Resource

The reference tidal resource is presented as a probability distribution function derived from a composite of the Tacoma Narrows and Admiralty Inlet portions of the Puget Sound in Washington State. The tidal regime is mixed but mainly semidiurnal, and surface tidal currents are assumed to experience maximum flows of 3.3 m/s.

For the purposes of this standardized but simplified LCOE evaluation DOE is making a number of simplifying assumptions. Specifically, it is assumed that the extraction plane of the tidal energy converter is always oriented normal to incoming flows, and power law velocity distributions provide an adequate approximation of flow speed variation with water column depth. A power law of 1/7 is assumed for the reference resource and the water depth is assumed to be 60 meters. While this is accurate in a general sense, important context and caveats can be

found in the technical report (Polagye, 2012) describing the development of these resource characteristics for DOE's Tidal Turbine Reference Model Project. The distribution of surface current velocity for the Puget Sound resource is displayed below in Figure 2.

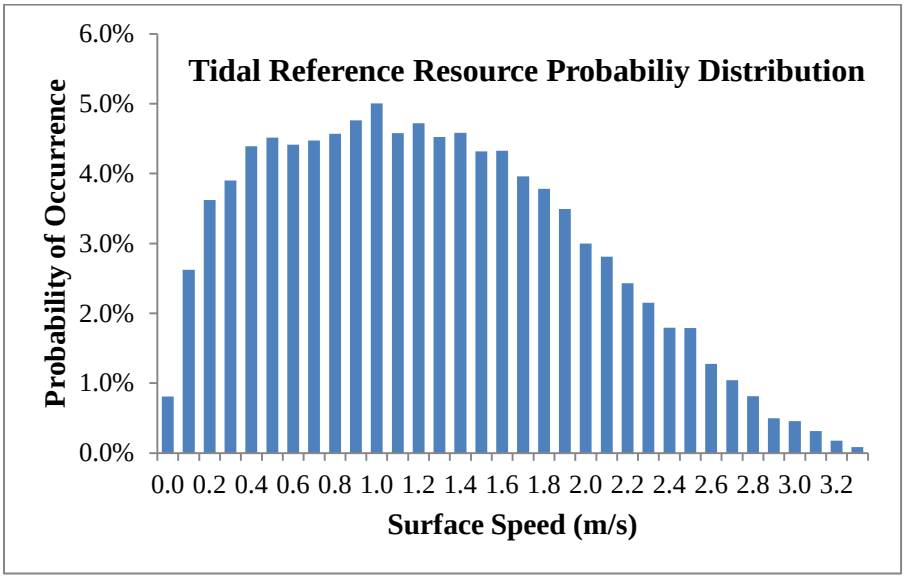

Figure 2 - Tidal Reference Resource

Summary Reporting Requirements

Overall, DOE is requesting that power performance be estimated at both the single device and array scales in the DOE reference resource, resulting in two estimates of AEP. If an awardee disagrees with, or finds the use of the reference resource unfavorable to their device, they are free to provide an additional set of single device and array performance estimates. The following documentation must accompany the calculation of AEP in each resource (the DOE reference resource and the optional additional resource):

1. Device C_P Curve
2. Device Power Curve
3. Itemized Losses between Device Mechanical Power and Power Capture Matrices, preferably in "curve" form
4. Description of Device Losses Estimation (i.e. field test data or modeled performance)
5. Array Loss Factor
6. Description and Justification of Array Calculations
7. Availability Losses
8. Description and Justification of Availability Loss Calculations
9. TAEP
10. AEC and AEP at device and array scales

11. (Optional) Additional Resource Location and Deployment Depth
12. (Optional) Additional Resource Velocity Distribution
13. (Optional) Additional Resource Array Scale
14. (Optional) Additional Resource Description and Justification

Cost Reporting Guidance

To enable apples to apples comparisons of cost, DOE asks that all device and project costs be reported within the framework of the DOE MHK Cost Breakdown Structure (CBS). The CBS is a hierarchical system for categorizing and itemizing the costs associated MHK project development. The scope of the CBS covers all lifecycle expenditures from the costs associated with project planning and permitting to generating equipment and supporting infrastructure to operations and maintenance. The hierarchy in the CBS consists of 5 levels; level 1 is very general (capital expenditures and operating expenditures) and each subsequent level in the hierarchy is increasingly specific. The CBS was developed to be general and able to accommodate cost data from a variety of technologies. As a result, the detailed levels of the CBS (particularly levels 4 and 5) contain cost elements that are only applicable to some technologies. Figure 2 below shows the full CBS down to the third level, and Figure 3 provides an example of the fifth level of detail for the subsea cable system.

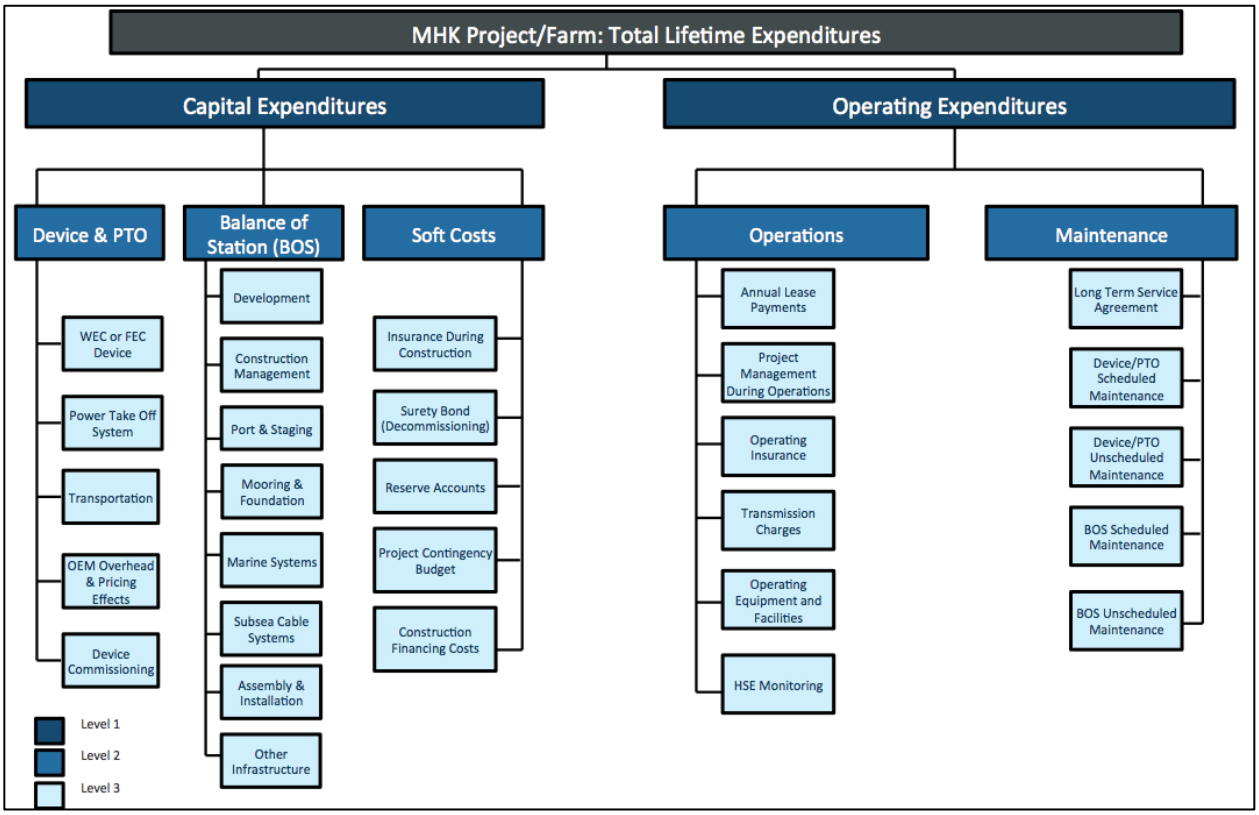

Figure 3 - CBS Levels 1-3

Appendix B – LCOE Reporting Guidance

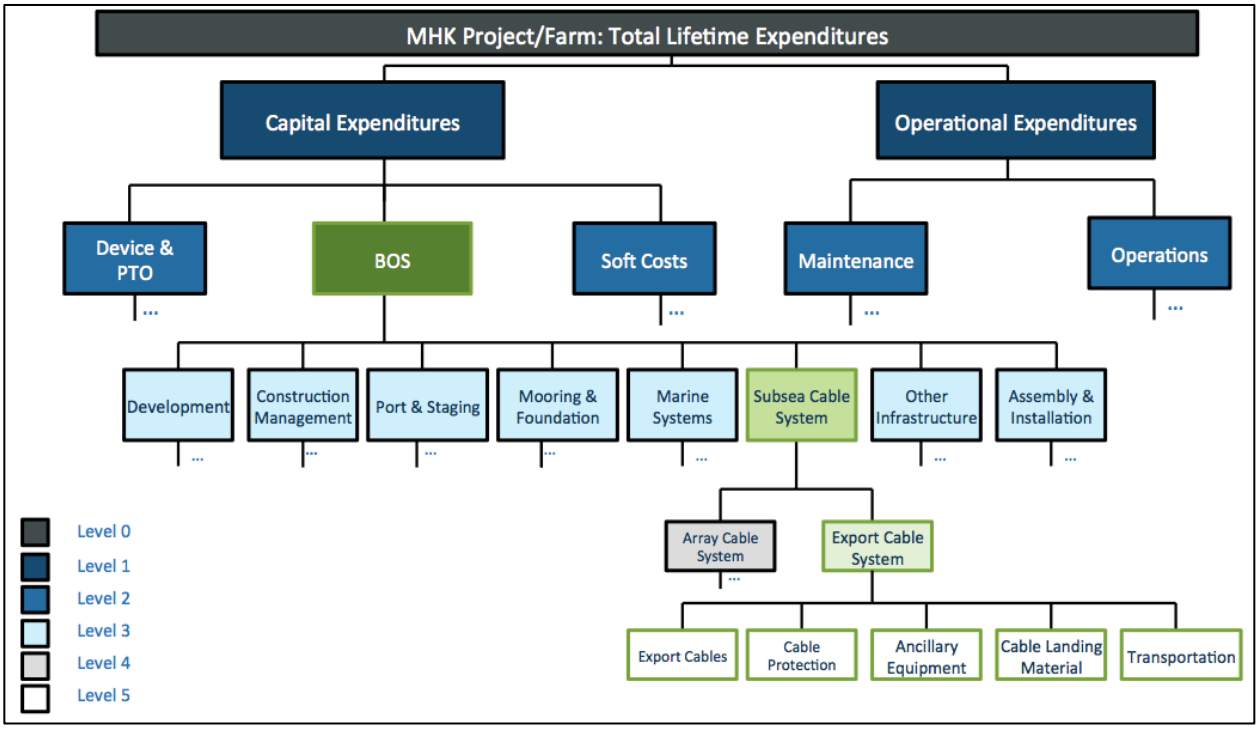

Figure 4 - CBS Level 5 for Export Cable System

The CBS spreadsheet used for reporting purposes is included on OpenEI in a separate discussion forum from the broader LCOE reporting document:

http://en.openei.org/community/document/mhk-cost-breakdown-structure-draft

DOE does not expect all developers to have cost estimates for every level of detail in the CBS, either for a single prototype of a device or for a fully commercial device deployed in a utility scale array (utility scale as defined in the reference resource sections). However, DOE is still requesting that awardees report costs from the perspective of the full lifecycle cost of deployment (the CBS should facilitate reporting costs from this perspective). Awardees are required to provide cost estimates for the first two levels of the CBS; (level 1: CAPEX and OPEX; level 2: Marine Energy Converter, BOS, Soft Costs, Operations, and Maintenance). DOE requests that awardees with sufficient information to estimate costs at a more detailed level (level 3, level 4, or level 5) do so, even if the awardee only has cost estimates for a fraction of the level 3 or level 4 items.

The full lifecycle costs of a fully commercial device deployed in a utility scale array should account for additional costs associated with the necessary infrastructure and proposed installation, operations, and maintenance (IO&M) activities, as well as the anticipated reductions in costs due to economies of scale. DOE provides the following guidance on array scaling and prototype scaling.

Appendix B – LCOE Reporting Guidance

Array-Scaling

To better understand the nature of the unique assumptions underpinning each reported estimate, DOE requires that the following information be provided:

- Description of how Balance of Station (BOS) costs were estimated, including:
  - Mooring (or foundation) assumptions
  - Assembly and installation assumptions
  - Other assumptions about infrastructure or development
- Description of how Soft Costs were estimated (likely to be a percentage of total capital costs)
- Description of how O&M costs were estimated

The purpose of providing these descriptions is to ensure transparency in all cost estimates. It is expected that some cost estimates will be based on more detailed assumptions than others. For example, in some cases, developers will have detailed information about the assumed IO&M strategy; in another case a developer may have a detailed mooring design but only a very rough estimate of the O&M costs. In summary, awardees are required to provide a clear description of assumptions used to estimate array-scale costs.

Prototype Scaling

In addition to scaling single device costs to the cost of an array, many developers of lower TRL devices may not yet have a complete 1:1 scale cost estimate and must instead extrapolate from scale prototype to full scale costs. To ensure complete transparency in the assumptions used to scale from prototype to commercial device parameters, DOE requires that awardees provide a description of their assumptions behind any cost savings realized (e.g. commercial scale device and power conversion chain costs were assumed to be 10% lower than for the prototype). DOE requests that awardees provide a justification for their assumptions (e.g., consistent with the findings in {name of report or publication} we assumed a 10% reduction in device costs).

Summary Reporting Requirements

The CBS is provided in an Excel spreadsheet format. Developers with full cost estimates for a 1:1 scale device should report:

1. Single device costs
2. Estimated array costs

Those developers with only scale device cost estimates should report three cost profiles:

1. Actual scale device costs

2. Estimated full-scale single device costs
3. Estimated array costs.

In addition, please also document the information requested with respect to the assumptions used in array and prototype scaling.

Note: **Costs should not reflect any improvement in technology (e.g. the use of "progress ratios"), only economies of scale in manufacturing, infrastructure, and operations and maintenance.**

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LCOE Financial Assumptions

Under this simplified LCOE methodology, seven parameters, determine the rate at which an MHK project must recover costs through the choice of discount rate and fixed charge rate. The assumptions underlying the choice of financial variables can lead to significant variations in LCOE even when cost and performance are subject to standardized formulations. DOE is specifying the following standardized choice of parameters as seen in the table below.

Table 1 - Standardized Financial Variables

Symbol	Variable	Standard Value
r	Real discount rate (i.e. real WACC[8])	.07
i	Inflation rate	.025
τ	Composite federal-state tax rate	.396
$MACRS_t$	Depreciation schedule	MACRS 5-Year Property
D	Present value of depreciation tax shield	.309
N	Project economic life	20 Years
FCR	Fixed charge rate	.108

Two of these parameters, the depreciation tax shield, *D*, and fixed charge rate, *FCR*, are derived from the choice of other financial variables.

D is the present value of the depreciation tax shield such that:

$$D = \tau \times \sum_{t=1}^{t=6} \frac{MACRS_t}{(1+r)^t * (1+i)^t}$$

[8] Weighted Average Cost of Capital

Where t is the year of the depreciation schedule and $MACRS_t$ is the annual fractional share of installed costs (ICC) according to the full-year convention Manually Accelerated Cost Recovery Schedule for 5-year properties. This implicitly assumes that a) all project costs fall under the MACRS and b) in the future, MHK devices become MACRS-eligible through appropriate legislation.

The Fixed Charge Rate (FCR) is the fraction of capital expenditures necessary to recover project costs and meet investor revenue requirements.

$$\boldsymbol{FCR} = \frac{r}{1 - \frac{1}{(1+r)^N}} \times \frac{1-D}{1-\tau}$$

The only "incentive" that should be included in this LCOE calculation is the use of accelerated depreciation. Other benefits such as bonus depreciation, low-cost financing, grants, and tax-credits should be excluded as they muddle the evaluation of technology competitiveness.

Comment Process and Contact Information

This is intended to be a living document, and your comments and suggestions will only serve to improve the quality of information that DOE receives, and where possible simplify process of providing this information for developers reporting performance to DOE. The standardized guidance documents and excel version of the tidal and wave resource data will be available in the public forum on OpenEI for comment here:

http://en.openei.org/community/discussion/mhk-lcoe-reporting-guidance-draft

Please note that any comments in this forum will be public. If you do not wish to comment publically, you can direct your comment or question to the following individuals:

- For specific questions or comments regarding wave performance reporting or the wave reference resource, please contact Ye Li (ye.li@nrel.gov)

- For specific questions or comments regarding cost reporting and the Cost Breakdown Structure, please contact Kathleen Hallett (kathleen.hallett@nrel.gov) or Cash Fitzpatrick (cash.fitzpatrick@ee.doe.gov)

- For all other comments and general questions regarding this guidance, please contact Alison LaBonte (alison.labonte@ee.doe.gov) or Patrick O'Connor (patrick.o'connor@ee.doe.gov)

Appendix B – LCOE Reporting Guidance

References

Babarit, A.; Hals, J.; Kurniawan, A.; Muliawan, M.; Moan, T. and Krokstad, J. 2011. "The NumWEC project: Numerical estimation of energy delivery from a selection of wave energy converters".

Babarit, A. Hals,J. Muliawan,M.J.,Kurniawan,A. Moan,T. and Krokstad,J.. 2012. "Numerical Benchmarking Study of a Selection of Wave Energy Converters." Renewable Energy 41:44–63.

Babarit, A.. 2012. "A review of the park effect in arrays of wave energy converters." International Conference on Ocean Energy, ICOE, Dublin, Ireland.

Babarit, A.. 2013. "On the park effect in arrays of oscillating wave energy converters". Renewable Energy 58:68-78..

Beels, C. Henriques, J.C.C. Rouck J De,Pontes M.T., Backer,G. De and Verharghe H. 2007 "Wave energy resource in the north sea" 7th European Wave and Tidal Energy Conference, Porto, Portugal.

EPRI. 2011. "Mapping and Assessment of the United States Ocean Wave Energy Resource". Technical Report 1024637.

Folley M, and Whittaker TJT.. 2009. Analysis of the nearshore wave energy resource. Renewable Energy;34:1709-15.

IEC 62600-1. 2011. "Marine energy—Wave, tidal, and other water current converters—Part 1: Terminology".

IEC 62600-100. 2012. "Marine energy—Wave, tidal, and other water current converters—Part 100: Electricity producing wave energy converters—Power performance assessment".

IEC 62600-200. 2012. "Marine energy—Wave, tidal, and other water current converters—Part 200: Power performance assessment of electricity producing tidal energy converters".

Polagye, B. 2012. "Reference Model 1 Tidal Energy: Resource" http://energy.sandia.gov/wp/wp-content/gallery/uploads/RM1_Tidal-Turbine_UW-Tidal-Resource.pdf

Attachment 3

Budget Pages (SF 424A)

Applicant Name: Snohomish County Public Utility District 1 Award Number: DE-EE-00003648.0001 Attachment 3

Budget Information - Non Construction Programs

OMB Approval No. 0348-0044

Section A - Budget Summary						
Grant Program Function or Activity	Catalog of Federal Domestic Assistance Number	Estimated Unobligated Funds		New or Revised Budget		
		Federal	Non-Federal	Federal	Non-Federal	Total
(a)	(b)	(c)	(d)	(e)	(f)	(g)
1. Budget Period 1	81.087			$6,574,258	$12,055,542	$18,629,800
2. Budget Period 2	81.087			$3,425,742	$6,281,953	$9,707,695
3.						$0
4.						$0
5. Totals				$10,000,000	$18,337,495	$28,337,495

Section B - Budget Categories					
6. Object Class Categories	Grant Program, Function or Activity				Total (5)
	(1) Budget Period 1	(2) Budget Period 2	(3)	(4)	
a. Personnel	$402,200	$299,500			$701,700
b. Fringe Benefits	$221,009	$164,575			$385,584
c. Travel	$0	$0			$0
d. Equipment	$0	$0			$0
e. Supplies	$0	$0			$0
f. Contractual	$14,798,811	$7,572,096			$22,370,907
g. Construction	$0	$0			$0
h. Other	$0	$0			$0
i. Total Direct Charges (sum of 6a-6h)	$15,422,020	$8,036,171			$23,458,191
j. Indirect Charges	$3,207,780	$1,671,524			$4,879,304
k. Totals (sum of 6i-6j)	$18,629,800	$9,707,695			$28,337,495
7. Program Income	$0	$0			$0

Previous Edition Usable

SF-424A (Rev. 4-92)
Prescribed by OMB Circular A-102

Authorized for Local Reproduction

Attachment 4

Intellectual Property Provisions

GDLB-1003
Intellectual Property Provisions (GDLB-1003)
Grant - Special Data Statute
Research, Development, or Demonstration
Large Businesses, State and Local Governments, and Foreign Entities

01. 10 CFR 600.325 Appendix A	Rights in Data - Programs Covered Under Special Data Statutes (OCT 2003)
02. 10 CFR 600.325 Appendix A	Patent Rights - (Large Business Firms - No Waiver) (OCT 2003)*
03. FAR 52.227-23	Rights to Proposal Data (Technical) (JUN 1987)

NOTE: In reading these provisions, any reference to “contractor” shall mean “recipient,” and any reference to “contract” or “subcontract” shall mean “award” or “subaward.”

* If a waiver of patent rights is granted, then provisions approved by the DOE patent counsel, in accordance with 10 CFR 784, will be substituted for this Patent Rights provision.

01. 10 CFR 600.325 Appendix A, Rights in Data - Programs Covered Under Special Data Statutes (OCT 2003)

(a) Definitions

Computer Data Bases, as used in this clause, means a collection of data in a form capable of, and for the purpose of, being stored in, processed, and operated on by a computer. The term does not include computer software.

Computer software, as used in this clause, means (i) computer programs which are data comprising a series of instructions, rules, routines, or statements, regardless of the media in which recorded, that allow or cause a computer to perform a specific operation or series of operations and (ii) data comprising source code listings, design details, algorithms, processes, flow charts, formulae and related material that would enable the computer program to be produced, created or compiled. The term does not include computer data bases.

Data, as used in this clause, means recorded information, regardless of form or the media on which it may be recorded. The term includes technical data and computer software. The term does not include information incidental to administration, such as financial, administrative, cost or pricing or management information.

Form, fit, and function data, as used in this clause, means data relating to items, components, or processes that are sufficient to enable physical and functional interchangeability as well as data identifying source, size, configuration, mating and attachment characteristics, functional characteristics, and performance requirements except that for computer software it means data identifying source, functional characteristics, and performance requirements but specifically excludes the source code, algorithm, process, formulae, and flow charts of the software.

Limited rights data, as used in this clause, means data (other than computer software) developed at private expense that embody trade secrets or are commercial or financial and confidential or privileged.

Restricted computer software, as used in this clause, means computer software developed at private expense and that is a trade secret; is commercial or financial and confidential or privileged; or is published copyrighted computer software; including modifications of such computer software.

Protected data, as used in this clause, means technical data or commercial or financial data first produced in the performance of the award which, if it had been obtained from and first produced by a non-federal party, would be a trade secret or commercial or financial information that is privileged or confidential under the meaning of 5 U.S.C. 552(b)(4) and which data is marked as being protected data by a party to the award.

Protected rights, as used in this clause, mean the rights in protected data set forth in the Protected Rights Notice of paragraph (g) of this clause.

Technical data, as used in this clause, means that data which are of a scientific or technical nature. Technical data does not include computer software, but does include manuals and instructional materials and technical data formatted as a computer data base.

Unlimited rights, as used in this clause, means the right of the Government to use, disclose, reproduce, prepare derivative works, distribute copies to the public, and perform publicly and display publicly, in any manner and for any purpose whatsoever, and to have or permit others to do so.

(b) Allocation of Rights

(1) Except as provided in paragraph (c) of this clause regarding copyright, the Government shall have unlimited rights in--

(i) Data specifically identified in this agreement as data to be delivered without restriction;

(ii) Form, fit, and function data delivered under this agreement;

(iii) Data delivered under this agreement (except for restricted computer software) that constitute manuals or instructional and training material for installation, operation, or routine maintenance and repair of items, components, or processes delivered or furnished for use under this agreement; and

(iv) All other data delivered under this agreement unless provided otherwise for protected data in accordance with paragraph (g) of this clause or for limited rights data or restricted computer software in accordance with paragraph (h) of this clause.

(2) The Recipient shall have the right to--

(i) Protect rights in protected data delivered under this agreement in the manner and to the extent provided in paragraph (g) of this clause;

(ii) Withhold from delivery those data which are limited rights data or restricted computer software to the extent provided in paragraph (h) of this clause;

(iii) Substantiate use of, add, or correct protected rights or copyrights notices and to take other appropriate action, in accordance with paragraph (e) of this clause; and

(iv) Establish claim to copyright subsisting in data first produced in the performance of this agreement to the extent provided in subparagraph (c)(1) of this clause.

(c) Copyright

(1) Data first produced in the performance of this agreement. Except as otherwise specifically provided in this agreement, the Recipient may establish, without the prior approval of the Contracting Officer, claim to copyright subsisting in any data first produced in the performance of this agreement. If claim to copyright is made, the Recipient shall affix the applicable copyright notice of 17 U.S.C. 401 or 402 and acknowledgment of Government sponsorship (including agreement number) to the data when such data are delivered to the Government, as well as when the data are published or deposited for registration as a published work in the U.S. Copyright Office. For such copyrighted data, including computer software, the Recipient grants to the Government, and others acting on its behalf, a paid-up nonexclusive, irrevocable, worldwide license to reproduce, prepare derivative works, distribute copies to the public, and perform publicly and display publicly, by or on behalf of the Government, for all such data.

(2) Data not first produced in the performance of this agreement. The Recipient shall not, without prior written permission of the Contracting Officer, incorporate in data delivered under this agreement any data that are not first produced in the performance of this agreement and that contain the copyright notice of 17 U.S.C. 401 or 402, unless the Recipient identifies such data and grants to the Government, or acquires on its behalf, a license of the same scope as set forth in subparagraph (c)(1) of this clause; provided, however, that if such data are computer software, the Government shall acquire a copyright license as set forth in subparagraph (h)(3) of this clause if included in this agreement or as otherwise may be provided in a collateral agreement incorporated or made a part of this agreement.

(3) Removal of copyright notices. The Government agrees not to remove any copyright notices placed on data pursuant to this paragraph (c), and to include such notices on all reproductions of the data.

(d) Release, Publication and Use of Data

(1) The Recipient shall have the right to use, release to others, reproduce, distribute, or publish any data first produced or specifically used by the Recipient in the performance of this contract, except to the extent such data may be subject to the Federal export control or national security laws or regulations, or unless otherwise provided in this paragraph of this clause or expressly set forth in this contract.

(2) The Recipient agrees that to the extent it receives or is given access to data necessary for the performance of this agreement which contain restrictive markings, the Recipient shall treat the data in accordance with such markings unless otherwise specifically authorized in writing by the Contracting Officer.

(e) Unauthorized Marking of Data

(1) Notwithstanding any other provisions of this agreement concerning inspection or acceptance, if any data delivered under this agreement bears any restrictive or limiting markings not authorized by this agreement, the Contracting Officer may at any time either return the data to the Recipient or cancel or ignore the markings. However, the following procedures shall apply prior to canceling or ignoring the markings.

(i) The Contracting Officer shall make written inquiry to the Recipient affording the Recipient 30 days from receipt of the inquiry to provide written justification to substantiate the propriety of the markings.

(ii) If the Recipient fails to respond or fails to provide written justification to substantiate the propriety of the markings within the 30-day period (or a longer time not exceeding 90 days approved in writing by the Contracting Officer for good cause shown), the Government shall have the right to cancel or ignore the markings at any time after said period and the data will no longer be made subject to any disclosure prohibitions.

(iii) If the Recipient provides written justification to substantiate the propriety of the markings within the period set in subdivision (e)(1)(i) of this clause, the Contracting Officer shall consider such written justification and determine whether or not the markings are to be cancelled or ignored. If the Contracting Officer determines that the markings are authorized, the Recipient shall be so notified in writing. If the Contracting Officer determines, with concurrence of the head of the contracting activity, that the markings are not authorized, the Contracting Officer shall furnish the Recipient a written determination, which determination shall become the final agency decision regarding the appropriateness of the markings unless the Recipient files suit in a court of competent jurisdiction within 90 days of receipt of the Contracting Officer's decision. The Government shall continue to abide by the markings under this subdivision (e)(1)(iii) until final resolution of the matter either by the Contracting Officer's determination become final (in which instance the Government shall thereafter have the right to cancel or ignore the markings at any time and the data will

no longer be made subject to any disclosure prohibitions), or by final disposition of the matter by court decision if suit is filed.

(2) The time limits in the procedures set forth in subparagraph (e)(1) of this clause may be modified in accordance with agency regulations implementing the Freedom of Information Act (5 U.S.C. 552) if necessary to respond to a request thereunder.

(f) Omitted or Incorrect Markings

(1) Data delivered to the Government without the restrictive or limiting markings or notices authorized by this agreement shall be deemed to have been furnished with unlimited rights, and the Government assumes no liability for the disclosure, use, or reproduction of such data. However, to the extent the data has not been disclosed without restriction outside the Government, the Recipient may request, within 6 months (or a longer time approved by the Contracting Officer for good cause shown) after delivery of such data, permission to have notices placed on qualifying data at the Recipient's expense, and the Contracting Officer may agree to do so if the Recipient--

(i) Identifies the data to which the omitted notice is to be applied;

(ii) Demonstrates that the omission of the notice was inadvertent;

(iii) Establishes that the use of the proposed notice is authorized; and

(iv) Acknowledges that the Government has no liability with respect to the disclosure, use, or reproduction of any such data made prior to the addition of the notice or resulting from the omission of the notice.

(2) The Contracting Officer may also:

(i) Permit correction at the Recipient's expense of incorrect notices if the Recipient identifies the data on which correction of the notice is to be made, and demonstrates that the correct notice is authorized; or

(ii) Correct any incorrect notices.

(g) Rights to Protected Data

(1) The Recipient may, with the concurrence of DOE, claim and mark as protected data, any data first produced in the performance of this award that would have been treated as a trade secret if developed at private expense. Any such claimed ``protected data'' will be clearly marked with the following Protected Rights Notice, and will be treated in accordance with such Notice, subject to the provisions of paragraphs (e) and (f) of this clause.

PROTECTED RIGHTS NOTICE

These protected data were produced under agreement no. DE-EE0003648 with the U.S. Department of Energy and may not be published, disseminated, or disclosed to others outside the Government until five (5) years from the date the data were first produced, unless express written authorization is obtained from the recipient. Upon expiration of the period of protection set forth in this Notice, the Government shall have unlimited rights in this data. This Notice shall be marked on any reproduction of this data, in whole or in part.

(End of notice).

(2) Any such marked Protected Data may be disclosed under obligations of confidentiality for the following purposes:

(a) For evaluation purposes under the restriction that the ``Protected Data'' be retained in confidence and not be further disclosed; or

(b) To subcontractors or other team members performing work under the Government's program, including to Federally Funded Research and Development Centers or other research partners to develop performance models.

(3) The obligations of confidentiality and restrictions on publication and dissemination shall end for any Protected Data:

(a) At the end of the protected period;

(b) If the data becomes publicly known or available from other sources without a breach of the obligation of confidentiality with respect to the Protected Data;

(c) If the same data is independently developed by someone who did not have access to the Protected Data and such data is made available without obligations of confidentiality; or

(d) If the Recipient disseminates or authorizes another to disseminate such data without obligations of confidentiality.

(4) However, the Recipient agrees that the following types of data are not considered to be protected and shall be provided to the Government when required by this award without any claim that the data are Protected Data: General test results and data that demonstrates advancement in the technical and operational readiness of marine and hydrokinetic systems and components; results and data related to environmental impact, including device and marine interaction and any aggregated industry data, including cost and performance data, provided that otherwise protected data from this award can not be ascertained based solely from the aggregated industry data. The parties agree that notwithstanding the foregoing lists of types of data, nothing precludes the Government from seeking delivery of additional data in accordance with this award, or from making publicly available additional nonprotected data, nor does the foregoing list constitute any admission by the Government that technical data not on the list is Protected Data.

(5) The Government's sole obligation with respect to any protected data shall be as set forth in this paragraph (g).

(h) Protection of Limited Rights Data

(1) When data other than that listed in subparagraphs (b)(1)(i), (ii), and (iii) of this clause are specified to be delivered under this agreement and such data qualify as either limited rights data or restricted computer software, the Recipient, if the Recipient desires to continue protection of such data, shall withhold such data and not furnish them to the Government under this agreement. As a condition to this withholding the Recipient shall identify the data being withheld and furnish form, fit, and function data in lieu thereof.

(2) Notwithstanding subparagraph (h)(1) of this clause, the agreement may identify and specify the delivery of limited rights data, or the Contracting Officer may require by written request the delivery of limited rights data that has been withheld or would otherwise be withholdable. If delivery of such data is so required, the Recipient may affix the following “Limited Rights Notice” to the data and the Government will thereafter treat the data, in accordance with such Notice:

LIMITED RIGHTS NOTICE

(a) These data are submitted with limited rights under Government agreement No. DE-EE0003648 (and subaward/contract No. ____, if appropriate). These data may be reproduced and used by the Government with the express limitation that they will not, without written permission of the Recipient, be used for purposes of manufacture nor disclosed outside the Government; except that the Government may disclose these data outside the Government for the following purposes, if any, provided that the Government makes such disclosure subject to prohibition against further use and disclosure:

(1) Use (except for manufacture) by Federal support services contractors within the scope of their contracts;

(2) This “limited rights data” may be disclosed for evaluation purposes under the restriction that the “limited rights data” be retained in confidence and not be further disclosed;

(3) This “limited rights data” may be disclosed to other contractors participating in the Government's program of which this Recipient is a part for information or use (except for manufacture) in connection with the work performed under their awards and under the restriction that the “limited rights data” be retained in confidence and not be further disclosed;

(4) This “limited rights data” may be used by the Government or others on its behalf for emergency repair or overhaul work under the restriction that the “limited rights data” be retained in confidence and not be further disclosed; and

(5) Release to a foreign government, or instrumentality thereof, as the interests of the United States Government may require, for information or evaluation, or for emergency repair or overhaul work by such government. This Notice shall be marked on any reproduction of this data in whole or in part.

(b) This Notice shall be marked on any reproduction of these data, in whole or in part.

(End of notice)

(i) Subaward/Contract

The Recipient has the responsibility to obtain from its subrecipients/contractors all data and rights therein necessary to fulfill the Recipient's obligations to the Government under this agreement. If a subrecipient/contractor refuses to accept terms affording the Government such rights, the Recipient shall promptly bring such refusal to the attention of the Contracting Officer and not proceed with subaward/contract award without further authorization. In this regard, for subawards with for-profit organizations, awardees may include the appropriate Rights in Data provision set forth in 10 CFR 600.325, Subpart D, Appendix A, suitably modified to identify the parties. For subawards with nonprofit organizations, subawardees are generally subject to the data provisions of 10 CFR 600.136.

(j) Additional Data Requirements

In addition to the data specified elsewhere in this agreement to be delivered, the Contracting Officer may, at any time during agreement performance or within a period of 3 years after acceptance of all items to be delivered under this agreement, order any data first produced or specifically used in the performance of this agreement, including, but not limited to the following:

Data related to or about device general specifications, including a description of energy capture technology, such as major hardware and electrical components, depth below the surface and above the sea or river bed of the energy capture axis and principle of operation; normal range of operating parameters; extreme event operating parameters; standard dimensions; device weight and displacement; power production, including electrical-rated power output, average (over one year) power output, efficiency and availability; hydrodynamic design codes and results, including predicted resource mean and turbulent turbine inflow field, blade steady and unsteady load predictions, shaft steady and unsteady load predictions, cowling and tower steady and unsteady load predictions, blade cavitation inception predictions, and rotor power and efficiency predictions; structural design codes and results, including blade steady stress/strain predictions, blade vibration natural frequencies and mode shapes predictions, blade vibration response to unsteady loads predictions, blade fatigue and radiated noise predictions, cowling and tower stress and strain predictions, tower vibration response to unsteady loads predictions, CAD drawing of the device, and list of components with weights and materials; mooring design, if applicable, including geometry, anchor type and weight, CAD drawing of anchors, arrangement drawing with dimensions, and mooring line, type, arrangement (slack and taught), thickness and weight; power conversion chain codes and results, including breakdown schematic of power conversion components, steady and unsteady loads predictions and predictions of the response to those loads, technical specifications of components (dimensions, weight), control algorithm, if applicable, failure rate distribution of each component (by cycles or time), and scheduled maintenance requirements (e.g., gearbox oil replacement needs); electrical system, including electrical topology, subsystems/components (e.g., size, weight), and EMF output (e.g., device and cables); biofouling effects, including on-blade steady loads and power output and on-system unsteady loads and response; and cost, including cost basis rationale and itemized list of components with cost estimates at time of design.

Data related to or about device measurements, including resource assessment sensors and results, such as turbine rotor inflow mean and turbulent velocities; model and full scale hydrodynamic sensors and results, including mean and turbulent velocities into, through and downstream of the rotor, mean and turbulent velocities into, over and downstream of the cowling and tower, blade, cowling and tower steady and unsteady loads, and cavitation types and inception. All measured results should have uncertainties quantified and presented, and compare all measured results with those from design predictions for code verification.

Data related to or about device measurements, including model and full scale structural response sensors and results, such as blade, cowling and tower steady stresses and strains, blade vibration natural frequencies and mode shapes, and blade and tower vibration response and fatigue. All measured results should have uncertainties quantified and presented, and compare all measured results with those from design predictions for code verification.

Data related to or about device measurements, including the power conversion chain, such as internal temperature, generator temperature, rotational velocity, generator rotor or shaft stress and strain (as applicable), and major component vibrations; mooring, if applicable, line tension, line angle, and line vibrations; power (e.g., power quality, minimum sampling rate of 50 kHz (1 minute average)), device voltage, device current, grid voltage (if applicable), and grid current (if applicable); system health, including water intrusion, internal humidity, internal temperature, fault status, and vibrations

and internal noise; acoustic data, including radiated noise levels; and video data, including subsurface video of device and surroundings to monitor environmental impact.

Data related to or about installation, operations, and maintenance, including final assembly procedures at port (e.g., cranes, cost); Installation procedure, schedule and cost; required dedicated O&M Vessel(s) and support personnel; required onshore O&M facilities and support personnel; and O&M equipment purchases and cost.

Data related to or about grid connection, including an overview map showing deployment location, grid interconnection point, and distances; cable design details, such as dimensions, rated capacity, frequency, number of conductors; device or array connection to power transmission cable; packing density (array layouts for: 1, 10, 100 devices); voltage frequency and the permitted tolerances; prevailing grid conditions that may have limited the power output during the test period; grid connection voltage, current, frequency including measures of voltage flicker and fluctuations, harmonic distortion (including existing grid harmonics and harmonic emission from device), power factor, and voltage unbalance.

Data related to or about environmental measurements, including metocean measurements, such as in-flow data, e.g, detailed overall current velocity profile, water properties, temperature (profile with depth if applicable), salinity, pH, conductivity, dissolved oxygen, suspended sediment (concentration, particle size), turbidity, dissolved nutrients (e.g. nitrate, phosphate, silicate); acoustic data, including ambient noise spectra and seasonal variations; electromagnetic field (EMF) data, including strength and spectra data.

Data related to or about bathymetry, including bathymetry and topology of sea or river bed (i.e., data that could show a potential effect on performance of devices or mooring systems, such as quality of tidal currents). For these data, please specify measurement method (e.g., multi-beam and/or single-beam, side scan, video).

Data related to or about bathymetry, including sub-bottom and sediment core samples with soil characteristics (geotechnical data for designing foundations and anchoring systems), bulk density with depth measurements, particle size distribution with depth measurements, and total organic carbon (to help characterize benthic habitat).

Data related to or about biological characteristics and effects, including all baseline pre-installation biological survey data; all biological monitoring for effects during construction, operation and decommissioning; baseline assessments of marine animals in area, particularly threatened or endangered species (e.g., marine mammals, seabirds, resident and migratory fish, commercially important invertebrates like crab); monitoring data (post installation) of direct and indirect interactions of marine animals with devices; benthic substrate characteristics, before and after installation; measures of productivity of systems, such as chlorophyll; animals affected by acoustics (noise) and acceptable noise level thresholds for each; animals affected by EMF from devices or cables and acceptable EMF level thresholds; near shore habitat that will be affected by cable crossings, grid connection; benthic habitat surveys before and after deployment; surveys of macrofauna before and after deployment; ROV survey results; type of monitoring equipment and methodology; and season and duration of monitoring.

Data related to or about siting and appearance, including fishing (e.g., commercial, recreational, and subsistence); key recreational uses; navigation and commercial shipping; outreach activities; demographic studies; other marine industries; nearby port and landing facilities; outline of required studies; study cost estimates; and permitting process cost and timelines.

This clause is applicable to all data ordered under this subparagraph. Nothing contained in this subparagraph shall require the Recipient to deliver any data the withholding of which is authorized by this clause or data which are specifically identified in this agreement as not subject to this clause. When data are to be delivered under this subparagraph, the Recipient will be compensated for converting the data into the prescribed form, for reproduction, and for delivery.

(k) The Recipient agrees, except as may be otherwise specified in this agreement for specific data items listed as not subject to this paragraph, that the Contracting Officer or an authorized representative may, up to 3 years after acceptance of all items to be delivered under this contract, inspect at the Recipient's facility any data withheld pursuant to paragraph (h) of this clause, for purposes of verifying the Recipient's assertion pertaining to the limited rights or restricted rights status of the data or for evaluating work performance. Where the Recipient whose data are to be inspected demonstrates

to the Contracting Officer that there would be a possible conflict of interest if the inspection were made by a particular representative, the Contracting Officer shall designate an alternate inspector.

(End of clause)

02. 10 CFR 600.325 Appendix A, Patent Rights - (Large Business Firms - No Waiver) (OCT 2003)

(a) Definitions

DOE patent waiver regulations, as used in this clause, means the Department of Energy patent waiver regulations in effect on the date of award. See 10 CFR part 784.

Invention, as used in this clause, means any invention or discovery which is or may be patentable of otherwise protectable under title 35 of the United States Code or any novel variety of plant that is or may be protectable under the Plant Variety Protection Act (7 U.S.C. 2321, et seq.). Subject invention, as used in this clause, means any invention of the Recipient conceived or first actually reduced to practice in the course of or under this agreement.

(b) Allocations of Principal Rights

(1) Assignment to the Government. The Recipient agrees to assign to the Government the entire right, title, and interest throughout the world in and to each subject invention, except to the extent that rights are retained by the Recipient under subparagraph (b)(2) and paragraph (d) of this clause.

(2) Greater rights determinations. The Recipient, or an employee-inventor after consultation with the Recipient, may request greater rights than the nonexclusive license and the foreign patent rights provided in paragraph (d) of this clause on identified inventions in accordance with the DOE patent waiver regulation. Each determination of greater rights under this agreement shall be subject to paragraph (c) of this clause, unless otherwise provided in the greater rights determination, and to the reservations and conditions deemed to be appropriate by the Secretary of Energy or designee.

(c) Minimum Rights Acquired by the Government

With respect to each subject invention to which the Department of Energy grants the Recipient principal or exclusive rights, the Recipient agrees to grant to the Government: A nonexclusive, nontransferable, irrevocable, paid-up license to practice or have practiced each subject invention throughout the world by or on behalf of the Government of the United States (including any Government agency); ``march-in rights'' as set forth in 37 CFR 401.14(a)(J); preference for U.S. industry as set forth in 37 CFR 401.14(a)(I); periodic reports upon request, no more frequently than annually, on the utilization or intent of utilization of a subject invention in a manner consistent with 35 U.S.C. 202(c)(50); and such Government rights in any instrument transferring rights in a subject invention.

(d) Minimum Rights to the Recipient

(1) The Recipient is hereby granted a revocable, nonexclusive, royalty-free license in each patent application filed in any country on a subject invention and any resulting patent in which the Government obtains title, unless the Recipient fails to disclose the subject invention within the times specified in subparagraph (e)(2) of this clause. The Recipient's license extends to its domestic subsidiaries and affiliates, if any, within the corporate structure of which the Recipient is a part and includes the right to grant sublicenses of the same scope to the extent the Recipient was legally obligated to do so at the time the agreement was awarded. The license is transferable only with the approval of DOE except when transferred to the successor of that part of the Recipient's business to which the invention pertains.

(2) The Recipient may request the right to acquire patent rights to a subject invention in any foreign country where the Government has elected not to secure such rights, subject to the minimum rights acquired by the Government similar to paragraph (c) of this clause. Such request must be made in writhing to the DOE Patent Counsel as part of the disclosure required by subparagraph (e)(2) of this clause, with a copy to the DOE Contracting Officer. DOE approval, if given, will be based on a determination that this would best serve the national interest.

(e) Invention Identification, Disclosures, and Reports

(1) The Recipient shall establish and maintain active and effective procedures to assure that subject inventions are promptly identified and disclosed to Recipient personnel responsible for patent matters within 6 months of conception and/or first actual reduction to practice, whichever occurs first in the performance of work under this agreement. These procedures shall include the maintenance of laboratory notebooks or equivalent records and other records as are reasonably necessary to document the conception and/or the first actual reduction to practice of subject inventions, and records that show that the procedures for identifying and disclosing the inventions are followed. Upon request, the Recipient shall furnish the Contracting Officer a description of such procedures for evaluation and for determination as to their effectiveness.

(2) The Recipient shall disclose each subject invention to the DOE Patent Counsel with a copy to the Contracting Officer within 2 months after the inventor discloses it in writing to Recipient personnel responsible for patent matters or, if earlier, within 6 months after the Recipient becomes aware that a subject invention has been made, but in any event before any on sale, public use, or publication of such invention known to the Recipient. The disclosure to DOE shall be in the form of a written report and shall identify the agreement under which the invention was made and the inventor(s). It shall be sufficiently complete in technical detail to convey a clear understanding, to the extent known at the time of the disclosure, of the nature, purpose, operation, and physical, chemical, biological, or electrical characteristics of the invention. The disclosure shall also identify any publication, on sale, or public use of the invention and whether a manuscript describing the invention has been submitted for publication and, if so, whether it has been accepted for publication at the time of disclosure. In addition, after disclosure to DOE, the Recipient shall promptly notify DOE Patent Counsel of the acceptance of any manuscript describing the invention for publication or of any on sale or public use planned by the Recipient. The report should also include any request for a greater rights determination in accordance with subparagraph (b)(2) of this clause. When an invention is disclosed to DOE under this paragraph, it shall be deemed to have been made in the manner specified in Sections (a)(1) and (a)(2) of 42 U.S.C. 5908, unless the Recipient contends in writing at the time the invention is disclosed that it was not so made.

(3) The Recipient shall furnish the Contracting Officer a final report, within 3 months after completion of the work listing all subject inventions or containing a statement that there were no such inventions, and listing all subawards/contracts at any tier containing a patent rights clause or containing a statement that there were no such subawards/contracts.

(4) The Recipient agrees to require, by written agreement, its employees, other than clerical and nontechnical employees, to disclose promptly in writing to personnel identified as responsible for the administration of patent matters and in a format suggested by the Recipient each subject invention made under subaward/contract in order that the Recipient can comply with the disclosure provisions of paragraph (c) of this clause, and to execute all papers necessary to file patent applications on subject inventions and to establish the Government's rights in the subject inventions. This disclosure format should require, as a minimum, the information required by subparagraph (e)(2) of this clause.

(5) The Recipient agrees, subject to FAR 27.302(j), that the Government may duplicate and disclose subject invention disclosures and all other reports and papers furnished or required to be furnished pursuant to this clause.

(f) Examination of Records Relating to Inventions

(1) The Contracting Officer or any authorized representative shall, until 3 years after final payment under this agreement, have the right to examine any books (including laboratory notebooks), records, and documents of the Recipient relating to the conception or first actual reduction to practice of inventions in the same field of technology as the work under this agreement to determine whether--

(i) Any such inventions are subject inventions;

(ii) The Recipient has established and maintains the procedures required by subparagraphs (e)(1) and (4) of this clause; or

(iii) The Recipient and its inventors have complied with the procedures.

(2) If the Contracting Officer learns of an unreported Recipient invention which the Contracting Officer believes may be a subject invention, the Recipient may be required to disclose the invention to DOE for a determination of ownership rights.

(3) Any examination of records under this paragraph will be subject to appropriate conditions to protect the confidentiality of the information involved.

(g) Subaward/Contract

(1) The recipient shall include the clause PATENT RIGHTS (SMALL BUSINESS FIRMS AND NONPROFIT ORGANIZATIONS) (suitably modified to identify the parties) in all subawards/contracts, regardless of tier, for

experimental, developmental, demonstration, or research work to be performed by a small business firm or domestic nonprofit organization, except where the work of the subaward/contract is subject to an Exceptional Circumstances Determination by DOE. In all other subawards/contracts, regardless of tier, for experimental, developmental, demonstration, or research work, the Recipient shall include this clause (suitably modified to identify the parties), or an alternate clause as directed by the contracting officer. The Recipient shall not, as part of the consideration for awarding the subaward/contract, obtain rights in the subrecipient's/contractor's subject inventions.

(2) In the event of a refusal by a prospective subrecipient/contractor to accept such a clause the Recipient:

(i) Shall promptly submit a written notice to the Contracting Officer setting forth the subrecipient/contractor's reasons for such refusal and other pertinent information that may expedite disposition of the matter; and

(ii) Shall not proceed with such subaward/contract without the written authorization of the Contracting Officer.

(3) In the case of subawards/contracts at any tier, DOE, the subrecipient/contractor, and Recipient agree that the mutual obligations of the parties created by this clause constitute a contract between the subrecipient/contractor and DOE with respect to those matters covered by this clause.

(4) The Recipient shall promptly notify the Contracting Officer in writing upon the award of any subaward/contract at any tier containing a patent rights clause by identifying the subrecipient/contractor, the applicable patent rights clause, the work to be performed under the subaward/contract, and the dates of award and estimated completion. Upon request of the Contracting Officer, the Recipient shall furnish a copy of such subaward/contract, and, no more frequently than annually, a listing of the subawards/contracts that have been awarded.

(5) The Recipient shall identify all subject inventions of a subrecipient/contractor of which it acquires knowledge in the performance of this agreement and shall notify the Patent Counsel, with a copy to the contracting officer, promptly upon identification of the inventions.

(h) Atomic Energy

(1) No claim for pecuniary award of compensation under the provisions of the Atomic Energy Act of 1954, as amended, shall be asserted with respect to any invention or discovery made or conceived in the course of or under this agreement.

(2) Except as otherwise authorized in writing by the Contracting Officer, the Recipient will obtain patent agreements to effectuate the provisions of subparagraph (h)(1) of this clause from all persons who perform any part of the work under this agreement, except nontechnical personnel, such as clerical employees and manual laborers.

(i) Publication

It is recognized that during the course of the work under this agreement, the Recipient or its employees may from time to time desire to release or publish information regarding scientific or technical developments conceived or first actually reduced to practice in the course of or under this agreement. In order that public disclosure of such information will not adversely affect the patent interests of DOE or the Recipient, patent approval for release of publication shall be secured from DOE Patent Counsel prior to any such release or publication.

(j) Forfeiture of Rights in Unreported Subject Inventions

(1) The Recipient shall forfeit and assign to the Government, at the request of the Secretary of Energy or designee, all rights in any subject invention which the Recipient fails to report to DOE Patent Counsel within six months after the time the Recipient:

(i) Files or causes to be filed a United States or foreign patent application thereon; or

(ii) Submits the final report required by subparagraph (e)(3) of this clause, whichever is later.

(2) However, the Recipient shall not forfeit rights in a subject invention if, within the time specified in subparagraph (e)(2) of this clause, the Recipient:

(i) Prepares a written decision based upon a review of the record that the invention was neither conceived nor first actually reduced to practice in the course of or under the agreement and delivers the decision to Patent Counsel, with a copy to the Contracting Officer, or

(ii) Contending that the invention is not a subject invention, the Recipient nevertheless discloses the invention and all facts pertinent to this contention to the DOE Patent Counsel, with a copy of the Contracting Officer; or

(iii) Establishes that the failure to disclose did not result from the Recipient's fault or negligence.

(3) Pending written assignment of the patent application and patents on a subject invention determined by the Secretary of Energy or designee to be forfeited (such determination to be a final decision under the Disputes clause of this

agreement), the Recipient shall be deemed to hold the invention and the patent applications and patents pertaining thereto in trust for the Government. The forfeiture provision of this paragraph (j) shall be in addition to and shall not supersede other rights and remedies which the Government may have with respect to subject inventions.

(End of clause)

03. FAR 52.227-23 Rights to Proposal Data (Technical) (JUN 1987)

It is agreed that as a condition of award of this contract, and notwithstanding the conditions of any notice appearing thereon, the Government shall have unlimited rights (as defined in the "Rights in Data--General" clause contained in this contract) in and to the technical data contained in the proposal dated June 7, 2010 upon which this contract is based.

(End of clause)

Appendix V

OPENHYDRO NON-DISCLOSURE AGREEMENT FORM

In association with this Contract, the CONTRACTOR shall be required to sign a Non-Disclosure Agreement. The standard agreement form shall be designed around the protection of the intellectual property rights associated with the tidal turbine technology.

Appendix B

FERC License Order

146 FERC ¶ 61,197
UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

Before Commissioners: Cheryl A. LaFleur, Acting Chairman;
Philip D. Moeller, John R. Norris,
and Tony Clark.

Public Utility District No. 1 of Snohomish County, Washington — Project No. 12690-005

ORDER ISSUING PILOT PROJECT LICENSE
(MINOR PROJECT)

(Issued March 20, 2014)

INTRODUCTION

1. On March 1, 2012, Public Utility District No. 1 of Snohomish County, Washington (Snohomish PUD) filed, pursuant to Part I of the Federal Power Act (FPA),[1] an application for a 10-year license to construct, operate, and maintain its proposed Admiralty Inlet Pilot Tidal Project No. 12690. The 600-kilowatt (kW) project will be located on the east side of Admiralty Inlet in Puget Sound, Washington, about 0.6 mile west of Whidbey Island, entirely within Island County, Washington.[2]

2. As discussed below, this order issues a license for the project.

BACKGROUND

3. On March 1, 2012, Snohomish PUD filed a license application for the Admiralty Inlet Project. Snohomish PUD proposes to install and operate a hydrokinetic turbine over a 10-year period to investigate the tidal energy resources of Puget Sound, Washington in order to determine if commercial development is viable. The temporary, in-water testing of this project will evaluate its performance, cost, and environmental effects. Snohomish

[1] 16 U.S.C. §§ 791a-828c (2012).

[2] Pursuant to section 23(b)(1) of the FPA, 16 U.S.C. § 817(1) (2012), the project is required to be licensed because it is located in navigable waters of the United States.

PUD requested a license under the Commission's pilot project licensing process as this process is available to developers seeking to test technologies that propose to study, monitor, and evaluate the environmental, economic, and cultural effects of hydrokinetic energy.

4. On April 23, 2012, the Commission issued a public notice that was published in the *Federal Register* accepting the application, indicating the application was ready for environmental analysis, and soliciting motions to intervene and protests, comments, terms and conditions, recommendations and prescriptions.[3] The Washington State Department of Ecology (Washington Ecology), the Washington State Department of Fish and Wildlife (Washington Fish and Wildlife), the Washington State Department of Natural Resources (Washington Natural Resources), the United States Department of Interior (Interior), and the National Marine Fisheries Service (NMFS) filed timely notices of intervention.[4] The Tulalip Tribes of Washington, Whidbey Environmental Action Network, the Sauk-Suiattle Indian Tribe, PC Landing Corp. (PC Landing),[5] and the Swinomish Indian Tribal Community filed timely motions to intervene.[6] On August 14, 2013, the Orca Conservancy filed a late motion to intervene, which was denied by the Secretary's notice on September 16, 2013. In addition, the Public Safety and Homeland Security Bureau of the Federal Communications Commission (FCC), U.S. Army Corps of Engineers (Corps), GCI Communication Corporation, the Point No Point Treaty Council (Treaty Council),[7] and the U.S. Navy, Naval Facilities Engineering Command filed comments on the application.

[3] 77 *Fed. Reg.* 25,157-01 (April 27, 2012).

[4] Under Rule 214(a)(2) of the Commission's Rules of Practice and Procedure, these entities became parties to the proceeding upon their notices of intervention. 18 C.F.R. § 385.214(c) (2013).

[5] PC Landing's motion to intervene was accompanied by a protest.

[6] Timely, unopposed motions to intervene are granted by operation of Rule 214(c)(1) of the Commission's Rules of Practice and Procedure. 18 C.F.R. § 385.214(c)(1) (2013).

[7] The Treaty Council is a tribal organization that provides services to the Jamestown S'Klallam and Port Gamble S'Klallam Tribes.

5. On August 6, 2012, Commission staff held a technical confrence to discuss issues raised by the proximity of the proposed project to a fiber optic communication cable (PC-1 North).

6. On January 15, 2013, Commission staff issued a draft Environmental Assessment (EA), analyzing the potential environmental impacts of the proposed project and alternatives to it.[8] Washington Fish and Wildlife, the North American Submarine Cable Association, Snohomish PUD, Whidbey Environmental Action Network, PC Landing, the Suquamish Tribe, Washington Natural Resources, the Treaty Council, the National Park Service, Tulalip Tribes, Washington State Ferries, Orca Conservancy, the United States Environmental Protection Agency, Congressmen Ed Whitfield and Greg Walden, and the Pacific Whale Watch Association filed comments on the draft EA.

7. On April 18, 2013, Commission staff held a technical conference to discuss issues raised by Snohomish PUD's revised emergency shutdown procedures.

8. On August 9, 2013, Commission staff issued a final EA. The Pacific Whale Watch Association, Orca Conservancy, and PC Landing filed comments on the final EA. Snohomish PUD filed responses to PC Landing's comments. The interventions, comments, and recommendations have been considered in determining whether, and under what conditions, to issue this license for the Admiralty Inlet Project.

PROJECT DESCRIPTION

A. Proposed Project Facilities

9. The Admiralty Inlet Project will consist of: (1) two approximately 19.2-foot-high, 300-kW OpenHydro tidal turbines (Turbine 1 and Turbine 2) each mounted on a triangular subsea base; (2) adaptable monitoring devices attached to each turbine base that include environmental monitoring equipment, vibration monitoring instrumentation, and differential settlement monitoring equipment;[9] (3) two approximately 7,000-foot-long, four-kilovolt (kV) trunk cables, extending from each turbine to an onshore cable termination vault; (4) an approximately 3.9-foot-long, 5.8-foot-wide, 2.9-foot-high onshore cable termination vault; (5) two 40-foot-long conduits to convey the cables from

[8] The U.S. Department of Energy was a cooperating agency on the preparation of the draft and final EAs.

[9] An integrated tilt sensor, or an approved alternate instrument, will be mounted on the turbine subsea base to monitor for any differential settling that might cause the turbine base to tilt.

the cable termination vault to a cable control building; (6) a 24-foot-wide, 30-foot-long onshore cable control building to house power and monitoring equipment; (7) a 17.2-kV step-up transformer located adjacent to the cable control building; (8) a 10-foot-long, buried 7.2-kV transmission line from the transformer to a connection with Puget Sound Energy's electrical distribution system; and (9) appurtenant facilities.

B. Project Area and Boundary

10. The project will be located in Admiralty Inlet in the northwestern portion of Puget Sound between the Olympic Peninsula and Whidbey Island where the northwestern end of Puget Sound meets the Strait of Juan de Fuca. This inlet serves as the main route for shipping traffic for the ports of Everett, Seattle, Tacoma, and Olympia. The project's cable control building will be located on Whidbey Island near Fort Casey State Park. The turbines will be placed approximately one kilometer west-southwest from the shoreline of the state park (Admiralty Head) at a water depth of approximately 58 meters. Peak tidal currents in this area exceed three meters per second.

11. The project boundary will enclose 22.82 acres, including: (1) approximately 22.45 acres of seabed for the turbines and subsea cables; (2) approximately 0.12 acres of tidelands for the two subsea cables; and (3) approximately 0.25 acres of onshore land for the power control and conversion building, transmission vault, conduits, transformer, and transmission line.

C. Proposed Installation and Removal

12. Installation will begin by constructing the onshore cable control building. Next, Snohomish PUD will use horizontal directional drilling to install the conduits that will convey the trunk cables ashore. The cables will be laid by two tugboats directing a cable-laying barge from the turbines' sites to shore. A third tugboat will provide standby assistance. A remotely operated vehicle (ROV) will inspect the laying of the trunk cables on the seafloor. After the cables are laid, they will be pulled through the conduits.

13. The turbines will be installed separately, by the same process, when conditions are optimal. A turbine will be suspended in the center of a turbine installation barge, which will be towed to the installation site by a tugboat. A second tugboat will provide standby assistance. Once at the installation site, each turbine will be lowered to the seafloor, and an ROV will monitor its placement. The installation process for each turbine is expected to take less than one hour.

14. The turbines will be removed by reversing the installation process. The trunk cables will be removed or left in place according to Commission approval after

Snohomish PUD consults with a Marine Aquatic Resource Committee (MARC)[10] and Washington Ecology.

D. Proposed Project Operation

15. The project's OpenHydro System is designed to generate electricity over a range of water flow velocities, within a stationary turbine frame, but with the turbines turning in both ebb and flood tides. The turbines will convert the kinetic energy of water flowing in current from 0.7 meters per second to 3.3 meters per second into rotational motion and deliver that energy through the rotors into the generators. The turbines are expected to rotate about 70 percent of the time.

16. The system will be monitored 24 hours a day, seven days a week by Snohomish PUD personnel via an internet connection. Monitoring equipment will be housed in the onshore control building.

E. Proposed Project Maintenance

17. Snohomish PUD will implement monitoring, inspection, and maintenance measures for the term of the license, including monitoring the project to detect any anomalies in position (e.g., tilt) and function.

18. The licensee will conduct visual inspection of the offshore facilities to assess the overall structural integrity of each turbine and base, biological growth on the turbines and bases, the condition and position of the turbines, blades, and anodes,[11] and the position and condition of the trunk cables.

19. Major maintenance of the turbines is expected to occur five years after deployment. The turbines will be removed and all mechanical and electric parts will be inspected and repaired or replaced, as needed. The adaptable monitoring devices

[10] The MARC will be composed of the following entities: Snohomish PUD, NMFS, U.S. Fish and Wildlife Service, Washington Fish and Wildlife, Washington Ecology, Washington Natural Resources, Tulalip Tribes, Suquamish Tribe, Swinomish Indian Tribal Community, and Sauk-Suiattle Tribe. Additional members can be added by unanimous agreement by the MARC. As is explained further below, Snohomish PUD's monitoring and mitigation plans provide for consultation with the MARC.

[11] Anodes are metal pieces installed to attract the saltwater corrosion process and corrode sacrificially to reduce corrosion of the more important metal components of the turbine and base.

attached to each turbine will be recovered and redeployed every three to six months. Unscheduled maintenance may be triggered by a failure of the environmental monitoring equipment or an operational problem with a turbine. In such an event, Snohomish PUD likely will use an ROV that can be mobilized in a matter of days to inspect the turbine or equipment before deciding how to proceed.

20. If shutdown is required, Snohomish PUD will implement the following procedures in accordance with its Emergency Shutdown Plan: (1) engage a mechanical brake using an ROV during the next viable slack tide, which will lock the turbine rotor in position and cease electrical generation; (2) electrically isolate the subsea systems from the grid; and (3) file a report with the Commission, agencies, and tribes detailing the measures taken during the shutdown. The time between the decision to cease turbine rotation and engaging the mechanical brake is likely to be less than a day and no more than four days. If a turbine must be removed, the process could take up to four weeks to complete. Any marine vessels mobilized as part of a maintenance event will have to comply with the International Rules for Preventing Collisions at Sea and coordinate with the Coast Guard, as outlined in the Navigation Safety Plan.

F. Proposed Safety Plans

21. To address safety concerns with the technology, Snohomish PUD will implement: (1) a Project and Public Safety Plan; (2) a Navigation Safety Plan; (3) an Emergency Shutdown Plan; (4) a Project Removal Plan; and (5) a Hazard Identification and Risk Assessment.

G. Proposed Environmental Measures

22. Snohomish PUD will construct and operate the project with environmental protection, mitigation, and enhancement measures, including implementation of: (1) an Acoustic Monitoring and Mitigation Plan; (2) a Benthic Habitat Monitoring and Mitigation Plan; (3) a Marine Mammal Monitoring and Mitigation Plan; (4) a Near-Turbine Monitoring and Mitigation Plan; (5) a Derelict Gear Monitoring Plan; (6) a Water Quality Monitoring Plan; (7) an Adaptive Management Framework; (8) a Horizontal Directional Drilling Plan; (9) an Interpretation and Education Plan; and (10) measures to minimize the introduction and spread of invasive species. In addition, Snohomish PUD will install project facilities during a Washington Fish and Wildlife approved work window of July 16 to October 14, or outside this window only by agreement with the MARC and after Commission approval.

LICENSE FOR A PILOT PROJECT

23. Commission staff developed hydrokinetic pilot project licensing procedures, based on the Integrated Licensing Process, to facilitate the testing of new hydropower

technologies. For these new technologies, where the environmental effects are not well understood, the risks of adverse environmental impacts can be minimized through monitoring and safeguard plans that ensure the protection of the public and the environment. The goal of the pilot project approach is to allow developers to test new hydrokinetic technologies, determine appropriate sites for these technologies, and study a technology's environmental and other effects without compromising the Commission's oversight of a project or limiting agency and stakeholder input.

24. As outlined in Commission staff's pilot project licensing process white paper,[12] a pilot project should be: (1) small; (2) short term; (3) located in non-sensitive areas based on the Commission's review of the record; (4) removable and able to be shut down on short notice; (5) removed, with the site restored, before the end of the license term (unless a new license is granted); and (6) initiated by a draft application in a form sufficient to support environmental analysis.

25. PC Landing argues that the Admiralty Inlet Project does not meet these criteria.[13] In support, PC Landing states: (1) the project will be located in a "sensitive area" because its use of the seabed conflicts with PC Landing's PC-1 North trans-oceanic international subsea fiber optic cable,[14] which is located about 170 meters from the

[12] *See* FERC, Federal Energy Regulatory Commission Licensing Hydrokinetic Pilot Projects, *available at* http://www.ferc.gov/industries/hydropower/gen-info/licensing/hydrokinetics/pdf/white_paper.pdf (issued April 14, 2008, with modifications by staff February 4, 2009, and February 19, 2010).

[13] Though PC Landing argues the project is not eligible for a pilot project license, it does not take issue, nor does any other party, with the specific waivers Snohomish PUD requested in this proceeding, which includes waivers of portions of sections 4.75 through 5.16, and 5.18(c) of the Commission's regulations. 16 U.S.C. §§ 4.7–5.16, 5.18(c) (2013). Accordingly, because the only regulatory significance of this license being a pilot license as opposed to a standard license is the grant of the reqested waivers, PC Landing's argument on this matter is moot.

[14] PC-1 North is part of the larger PC-1 Landing cable system that runs in a loop between the U.S. and Japan, with two landing stations in Japan, and two landing stations in the U.S. Within Washington State, the PC-1 Landing cable system includes two cables: a north cable (PC-1 North) that links with Japan and an east cable (PC-1 East) that links with a landing site in Grover Beach, California. Both cables traverse Admiralty Inlet and land at Harbour Pointe, in the town of Mukilteo, approximately 20 miles southeast of the proposed turbine installation site. The entire PC-1 Landing cable system

(continued…)

project site;[15] and (2) the project will pose unacceptable risks and significant adverse impacts to the PC-1 North cable. The Tulalip Tribes and the Suquamish Tribe also argue that Admiralty Inlet is a "sensitive area" because of the site's fishery and cultural resources.

26. In this case, it is appropriate to grant the waivers and modifications of our licensing process necessary for the Admirality Inlet Project. Regarding the pilot project criteria, while we understand the rationale for the criteria set forth in the staff white paper, they are illustrative and not binding on the Commission, and we will, as we do for all pilot projets, examine the facts of individual cases to determine whether and how to accommodate our licensing process. Here, parties have suggested that the proposed project does not qualify for a pilot project license because the proposed location is a sensitive area. While we understand PC Landing's concern for its cable, we do not believe a pilot project's proximity to what might be considered a sensitive resource, (developmental or environmental) equates to an area being "sensitive" unless the project's potential effects on that resource are significant and unmitigable. In this case, as explained below, the license includes safeguards that should adequately protect PC Landing's PC-1 North cable. As to impacts on fish and wildlife species, we understand the Tribes' concern for sensitive fish and wildlife resources. Nonetheless, we conclude that where, as here, the federal and state resource agencies and our staff have determined that the project in question can be constructed and operated without undue impacts to protected species and their habitats, it is appropriate to issue a pilot project license. We also note that the Admiralty Inlet Project has been developed over several years, rather than in the expedited timeframe envisioned in the pilot process whitepaper. Accordingly, it is not necessary to apply strictly here all of the criteria that were designed for a shorter process.

27. Moreover, to minimize the possibility of impacts to the uses and resources of Admiralty Inlet, this license contains adaptive management and monitoring requirements (in which the Tribes will be involved), which will identify potential hazards and specify mitigation, if and when mitigation is needed. In regard to the PC-1 North cable, we are requiring Snohomish PUD to consult with PC Landing and develop specific procedures for installing, maintaining, and removing the project to avoid conflicts with the cable. If

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includes approximately 12,900 miles of subsea cable. PC-1 North is closest to the proposed project site.

[15] Snohomish PUD originally proposed to locate the turbines within 100 meters of PC-1 North, but, because of concerns raised by PC Landing, Snohomish PUD relocated the proposed project site to achieve a minimum separation distance of 170 meters.

unforeseen problems arise that risk public safety or result in unauthorized injury of threatened and endangered species or marine mammals, this license requires Snohomish PUD to implement procedures to shut down the project.

28. The ability to shut down the turbines on short notice in order to protect public safety and environmental resources is a fundamental characteristic of a pilot project. Staff held a technical conference on this subject, and determined that the use of a mechanical brake system in concert with the procedures specified in the extensive monitoring plans and adaptive management mitigation measures meet the criterion for shutting down the project on short notice.

SUMMARY OF LICENSE REQUIREMENTS

29. As summarized below, this license, which authorizes 600 kW of renewable energy generating capacity, requires a number of measures to protect and enhance fish, wildlife, cultural, and aesthetic resources at the project.

30. To ensure public safety, the license requires Snohomish PUD to implement: (1) a Project and Public Safety Plan, which includes measures for identifying and responding to emergencies at the project (Article 305); (2) a Navigation Safety Plan, which includes consultation and notification protocols with the U.S. Coast Guard to review project safety and protect navigation (Article 306); (3) a Emergency Shutdown Plan, which includes procedures to shut down the project's turbines within four days in response to emergencies at the project (Article 307); (4) a Project Removal and Site Restoration Plan, which includes procedures to remove project works and restore the affected area (Article 401); and (5) procedures to remove any unreasonable obstructions to navigation identified by the Corps (Article 308).

31. To avoid any adverse effects to fish and marine mammals, the license prohibits Snohomish PUD from constructing the project between October 15 and July 15, unless by agreement with the state and federal agencies and Tribes and with Commission approval (Article 410).

32. To identify and characterize noise radiated by the project, the license requires Snohomish PUD to implement a Acoustic Monitoring and Mitigation Plan, which includes the use of a combination of a drifting noise measurement system and hydrophones mounted on the turbine foundations to measure noise radiating from the project and determine if noise is occurring at levels requiring corrective action to minimize adverse effects on marine mammals (Article 404).

33. To monitor and mitigate for effects the project may have on the local benthic community as well as on sediment accumulation and scour,[16] the license requires Snohomish PUD to implement a Benthic Habitat Monitoring and Mitigation Plan, which includes ROV-conducted visual surveys of the turbine and cable burial route (Article 405).

34. To quantify and address any unanticipated adverse effects of the project on fish, birds, and marine mammals, the license requires Snohomish PUD to implement a Near-Turbine Monitoring and Mitigation Plan (Article 406) and a Marine Mammal Monitoring and Mitigation Plan (Article 407), which contain measures to identify the use of the project area by fish and marine mammals, determine if the project is causing changes in these species' behaviors, and identify the need for corrective actions, including potentially shutting down the turbines.

35. To locate any derelict fishing gear accumulating on the project and to minimize accumulated hazards to marine fish, birds, and mammals, the license requires Snohomish PUD to implement a Derelict Gear Monitoring Plan, which includes the use of periodic ROV surveys and turbine-mounted cameras to inspect the project (Article 409).

36. To educate the public about the project, the potential ocean energy resources in Puget Sound, and the natural and cultural environment of the project area, the license requires Snohomish PUD to develop and implement an Interpretation and Education Plan, which includes installation of an interpretive display at Fort Casey State Park, subject to state approval, or at another appropriate location to be determined in consultation with stakeholders (Article 413).

37. To control the introduction and spread of invasive plants on project lands during site construction and project removal, the license requires Snohomish PUD to develop and implement an Invasive Plant Management Plan, which includes requirements to revegetate disturbed areas with native species and inspect any fill and disturbed areas for invasive plants annually (Article 403).

38. To minimize and control effects to water quality during construction, operation, and removal of the project, the license requires Snohomish PUD to implement a Horizontal Directional Drilling Plan (Article 402) and a Water Quality Monitoring Plan

[16] Scour or erosion is the suspension and subsequent movement of sediments and cobbles from the sea floor resulting from the movement of water.

(ordering paragraph (E), which include procedures to minimize turbidity, limit occurrences of frac-out,[17] and measures to control oil spills.

39. To ensure protection of any cultural resources in the project area, the license requires Snohomish PUD to consult with the Washington State Historical Preservation Office regarding unanticipated discoveries of cultural materials or human remains during construction activities and over the license term (Article 415).

40. To ensure that installation, maintenance, and removal of the project has no effect on the PC-1 North cable, the license requires Snohomish PUD to implement its Hazard Identification and Risk Assessment, which is to be refined by Snohomish PUD in consultation from relevant federal agencies and PC Landing (Article 411).

41. To ensure that installation and removal of the project does not unduely delay or interfere with ferry service for the Port Townsend-Coupeville Ferry route, the license requires Snohomish PUD to create and implement a Ferry Service Operation Coordination Plan, which requires Snohomish PUD to coordinate project installation and removal with the Washington State Ferries Service (Article 417).

WATER QUALITY CERTIFICATION

42. In instances where the Clean Water Act (CWA) applies, section 401(d) of the CWA[18] provides that, where the state water quality certifying agency has issued a water quality certification for a proposed hydroelectric project, the certification shall become a condition of any federal license that authorizes construction or operation of the project.

43. On February 9, 2012, Snohomish PUD submitted an application for certification with Washington Ecology. On February 6, 2013, Snohomish PUD withdrew its application and reapplied for certification. On December 3, 2013, Washington Ecology issued a certification for the Admiralty Inlet Project. The certification contains 57 conditions, which are organized in nine groups. The conditions of the certification are incorporated into this license by Ordering Paragraph E and are attached in Appendix A.

44. The certification requires the licensee to prepare plans and reports for approval by Washington Ecology. To ensure the Commission also receives these plans and reports,

[17] "Frac-out" is a drilling term used to describe a situation where the ground through which a drill is moving fractures and drilling fluid escapes through the fracture to the surface.

[18] 33 U.S.C. § 1341(d) (2012).

Article 401 of this license identifies the plans and reports that must be filed with the Commission for approval in addition to Washington Ecology. In some cases, for efficiency, the applicant is required to submit to the Commission certain plans and reports at times different from those required by Washington Ecology in the certification.

45. Because the certification also contains several conditions that encompass plans and measures that agencies and Commission staff recommended, we do not separately require as license articles these requirements. Specifically, Commission staff recommended in its EA[19] that Snohomish PUD develop and implement a Project Removal Plan, but Condition F2 of the certification requires the submittal of a similar Project Removal Plan. Therefore, we require Snohomish PUD to file the Washington Ecology required Project Removal Plan with the Commission for approval (Article 401). Similarily, Snohomish PUD originally proposed, and agencies recommended, implementation of a Water Quality Monitoring Plan. However, because the certification requires the licensee to implement a similar plan, we do not separately require the filing of the Water Quality Monitoring Plan as a license article.

COASTAL ZONE MANAGEMENT ACT

46. Under section 307(c)(3)(A) of the Coastal Zone Management Act (CZMA), the Commission cannot issue a license for a project within or affecting a state's coastal zone unless the state CZMA agency concurs with the license applicant's certification of consistency with the state's CZMA program, or the agency's concurrence is conclusively presumed by its failure to act within six months of its receipt of the applicant's certification.[20]

47. On February 10, 2014, Washington Ecology informed the Commission that it had waived its CZMA certification authority. Therefore, Washington Ecology's concurrence with Snohomish PUD's CZMA certification is conclusively presumed.

SECTION 18 FISHWAY PRESCRIPTION

48. Section 18 of the FPA[21] provides that the Commission shall require the construction, maintenance, and operation by a licensee of such fishways as may be prescribed by the Secretary of the Interior or the Secretary of Commerce, as appropriate.

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[19] EA at 166.

[20] 16 U.S.C. § 1456(3)(A) (2012).

[21] *Id.* § 811.

49. By letter filed May 23, 2013, Interior requested that the Commission reserve its authority to prescribe fishways. Consistent with Commission policy, Article 412 of this license reserves the Commission's authority to require fishways that may be prescribed by Interior for the Admiralty Inlet Project.

THREATENED AND ENDANGERED SPECIES

50. Section 7(a)(2) of the Endangered Species Act of 1973[22] (ESA) requires federal agencies to ensure that their actions are not likely to jeopardize the continued existence of federally listed threatened and endangered species, or result in the destruction or adverse modification of their designated critical habitat.

51. There are existing populations of 13 federally listed species within the Admiralty Inlet Project area.[23] These species include one plant and one bird species: the threatened Golden Paintbrush and the threatened marbled murrelet (respectively). There are two listed marine mammals: the endangered southern resident killer whale and the endangered North Pacific humpback whale. Also, there are nine fish species: (1) the threatened Puget Sound Chinook salmon; (2) the threatened Hood Canal summer-run chum salmon; (3) the threatened Puget Sound steelhead; (4) the threatened bull trout; (5) the threatened green sturgeon; (6) the endangered bocaccio; (7) the threatened canary rockfish; (8) the threatened yelloweye rockfish; and (9) the threatened Pacific eulachon. In addition, critical habitat has been designated for the following species in the project area: Puget Sound Chinook salmon, chum salmon, bull trout, green sturgeon, southern resident killer whale, and marbled murrelet.

52. On April 24, 2012, Commission staff requested the U.S. Fish and Wildlife Service's (FWS) concurrence that licensing the Admiralty Inlet Project is not likely to adversely affect bull trout and the marbled murrelet or to adversely modify their designated critical habitats, and that licensing the project will not affect the golden paintbrush. FWS concurred with Commission staff's finding by letter dated June 7, 2012.

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[22] *Id*. § 1536(a).

[23] Staff's April 23, 2012 letter to NMFS also determined that the project may adversely affect the Steller sea lion. In a December 3, 2013 biological opinion, NMFS informed the Commission that on November 4, 2013, the Eastern Pacific Distinct Population Segment of the Steller sea lion was removed from the List of Endangered and Threatened Wildlife under the ESA. Therefore, it was no longer a subject of consultation.

53. On April 23, 2012, Commission staff requested NMFS's concurrence that licensing the project is not likely to adversely affect Puget Sound Chinook salmon and its designated critical habitat, Hood Canal summer-run chum salmon and its designated critical habitat, Puget Sound steelhead, bull trout, green sturgeon, bocaccio, canary rockfish, yelloweye rockfish, Pacific eulachon, and North Pacific humpback whale, and is not likely to adversely modify designated critical habitat for the southern resident killer whale. Because Commission staff determined in its biological assessment (BA) that licensing the project may adversely affect the southern resident killer whale, Commission staff requested formal consultation with NMFS on this species.

54. On December 3, 2013, NMFS issued a biological opinion (BO) for the project. NMFS concurred with Commission staff's determinations that licensing the project is not likely to adversely affect the green sturgeon and the Pacific eulachon; and that it is not likely to adversely modify designated critical habitat for the Puget Sound Chinook salmon, Hood Canal summer-run chum salmon, and southern resident killer whale species. NMFS did not agree that the project was not likely to adversely affect the Puget Sound Chinook salmon, Puget Sound steelhead, Hood Canal summer-run chum salmon, bocaccio, canary rockfish, yelloweye rockfish, and the humpback whale, but concluded that it was not likely to jeopardize these species. NMFS agreed with Commission staff that the project may adversely affect, but would not jeopardize the southern resident killer whale.

55. The BO includes an incidental take statement with three reasonable and prudent measures (as well as six terms and conditions to implement the measures) to minimize the take of Puget Sound Chinook salmon, Hood Canal summer-run chum salmon, Puget Sound steelhead, bocaccio, canary rockfish, and yelloweye rockfish. The reasonable and prudent measures require that the licensee: (1) monitor and evaluate sound levels at the turbine and away from the turbines to a distance at which sound levels drop below 120 dB and mitigate adverse sound effects according to the Acoustic Monitoring and Mitigation Plan; (2) monitor to evaluate the risk of blade strike and mitigate for any effects of blade strike according to the Near-Turbine Monitoring and Mitigation Plan; and (3) monitor and report on level of take.

56. The six terms and conditions are included in Appendix B and made part of this license in ordering paragraph F. The terms and conditions require Snohomish PUD to: (1) cease operating and obtain NMFS approval to resume operations if sound levels exceed 180 dB any distance from the turbines or if sound levels of 120 dB propogate to a distance of 750 meters or more from the turbines; (2) provide the preliminary results on sound level monitoring and sound propagation distances within 120 days of beginning operation; (3) collect data on fish passing through the plane of the turbines sufficient to

identify the number and taxonomic group[24] of at least half of the individuals passing during operation; (4) provide preliminary monitoring results within 14 days if salmon, steelhead, or rockfish are visibly injured, killed, or seen passing between the turbine blades rather than through the hole in the center of the turbine rotor; (5) contact NMFS within 48 hours if it is reasonably foreseeable that the number of fish crossing the plane of the turbines will exceed the number authorized for take in the BO;[25] and (6) obtain documented approval from NMFS for all changes to the Adaptive Management Framework or the monitoring and mitigation plans affecting ESA-listed species.

57. NMFS did not include an incidental take statement for the southern resident killer whale or humpback whale. NMFS states that it has chosen not to issue an incidental take statement for these species at this time because Snohomish PUD has not yet been issued incidental harassment authorizations under the Marine Mammal Protection Act, which are discussed further below. NMFS states that after Snohomish PUD receives these authorizations, it may then decide to issue an incidental take statement for these marine mammals.

MARINE MAMMAL PROTECTION ACT

58. The Marine Mammal Protection Act (MMPA)[26] prohibits, with certain exceptions, the "take" of marine mammals in U.S. waters and the high seas. Take means to harass, hunt, capture, or kill any marine mammal.[27] The MMPA includes a mechanism for allowing, upon request, the incidental taking of small numbers of marine mammals by U.S. citizens engaged in a specified activity within a specified geographical region.[28]

[24] Two species of salmon—Chinook and chum—are grouped by NMFS with the closely related steelhead as "salmon." For clarity, we refer to this group of three salmonid species as "salmon/steelhead."

[25] The incidental take statement authorizes ten adult salmon/steelhead, one adult yelloweye rockfish, one adult canary rockfish, and one adult Bocaccio to swim through the plane of the turbines in a given year. *See* NMFS' December 3, 2013 BO at 109–13. Article 406 of this order separately requires the licensee to notify the Commission of any such related report.

[26] 16 U.S.C. §§ 1361 *et seq.* (2012).

[27] 50 C.F.R. § 216.3 (2013).

[28] 16 U.S.C. § 1371(a)(5) (2012). Any take of marine mammals listed as threatened or endangered under the ESA must be authorized under both the ESA and

(continued…)

Take authorization is granted through either a letter of authorization or conditions contained in an incidental harassment authorization.[29]

59. Based on the analysis in the EA, staff concluded that the project may subject marine mammal species to harassment as defined under the MMPA.[30] These mammals include ESA-listed species including the killer whale and the humpback whale, and non-listed marine mammals, such as the steller sea lion and harbor porpoise. These marine mammals, plus others less common in the project area, may be subjected to Level B harassment[31] associated with noise from operation of the turbines.[32]

60. Unlike the ESA, the MMPA does not require consultation by the federal action agency, but prohibits the actions cited above. Consequently, Snohomish PUD must work with NMFS to satisfy the requirements of the MMPA. With regard to the Commission's responsibilities to protect marine mammals, section 7(a)(2) of the ESA requires federal agencies to consult with NMFS to ensure that any actions these agencies authorize are not likely to jeopardize the continued existence of a listed species. As noted above, NMFS found that licensing the project will not jeopardize these species, but has elected to not issue an incidental take statement for marine mammals at this time. Therefore, to ensure protection of these marine mammals, Article 408 requires the licensee to file an annual

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MMPA; an ESA incidental take statement cannot be issued until the MMPA authorization is completed. *See id.* § 1536(b)(4)(C).

[29] An incidental harassment authorization, valid for one year, is an expedited process to authorize the incidental take of small numbers of marine mammals by harassment, which includes actions that have the potential to disturb a marine mammal by causing disruption of behavioral patterns, including migration, breathing, nursing, breeding, feeding, or sheltering, but which does not have the potential to seriously injure the mammal. 50 C.F.R. § 216.3 (2013). A letter of authorization is valid for five years and authorizes harassment that has the potential to injure a marine mammal.

[30] EA at 9.

[31] Under the 1994 Amendments to the MMPA (50 C.F.R. § 216.3), Level B Harassment is to disturb a marine mammal or marine mammal stock in the wild by causing a disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering, but which does not have the potential to injure a marine mammal or mammal stock in the wild.

[32] EA at 9.

report documenting its consultations with NMFS and provide information as to whether its compliance with the MMPA requires it to modify aspects of the project, including project construction, operation, maintenance, and removal. Article 408 also requires the licensee to seek any needed amendments to its license as a result of these consultations.

ESSENTIAL FISH HABITAT

61. Section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act[33] (Magnuson-Stevens Act) requires federal agencies to consult with the Secretary of Commerce regarding any action or proposed action authorized, funded, or undertaken by the agency that may adversely affect Essential Fish Habitat (EFH) identified under the Act. Under section 305(b)(4)(A) of the Magnuson-Stevens Act, NMFS is required to provide EFH conservation recommendations for actions that would adversely affect EFH.[34] Under section 305(b)(4)(B) of the Magnuson-Stevens Act, an agency must, within 30 days after receiving recommended conservation measures from NMFS or a Regional Fishery Management Council, describe the measures proposed by the agency for avoiding, mitigating, or offsetting the effects of the agency's activity on the EFH.[35]

62. The project area contains EFH for Pacific groundfish, Pacific salmon, and several coastal pelagic species. Commission staff found in the EA that the project would not likely adversely affect EFH for any of these species.[36] On December 3, 2013, NMFS concurred that the project would have no effect on EFH, and it thus did not include any conservation measures.

NATIONAL HISTORIC PRESERVATION ACT

63. Under section 106 of the National Historic Preservation Act (NHPA),[37] and its implementing regulations,[38] federal agencies must take into account the effect of any

[33] 16 U.S.C. § 1855(b)(2) (2012).

[34] *Id.* § 1855(b)(4)(A).

[35] *Id*. The measures recommended by the Secretary of Commerce are advisory, not prescriptive. However, if the federal agency does not agree with the recommendations, the agency must explain its reasons for not following the recommendations.

[36] EA at 9.

[37] 16 U.S.C. § 470 (2012).

proposed undertaking on properties listed, or eligible for listing, in the National Register (defined as historic properties) and afford the Advisory Council on Historic Preservation a reasonable opportunity to comment on the undertaking. This process generally requires the Commission to consult with the State Historic Preservation Officer (SHPO) to determine whether and how a proposed action may affect historic properties, and to seek ways to avoid or minimize any adverse effects.

64. On November 7, 2008, Commission staff designated Snohomish PUD as its non-federal representative for the purposes of conducting section 106 consultation under the NHPA. Pursuant to section 106, and as the Commission's designated non-federal representative, Snohomish PUD consulted with the Washington SHPO to locate and determine the National Register eligibility of any discovered cultural resource and to assess any potential project-related adverse effects to those considered eligible for the National Register. In a March 1, 2012 letter filed with the license application, the Washington SHPO concluded that the project will have no adverse effect on cultural resources. Based on this finding, Commission staff concluded that a programmatic agreement to resolve adverse effects to historic properties was not necessary.[39] However, to ensure the proper treatment of any cultural resources that may be discovered during the course of constructing or developing project works or other facilities at the project, Article 415 requires the licensee to stop all land-clearing and land-disturbing activities in the vicinity of any discovered cultural resources and consult with the Washington SHPO.

RIVERS AND HARBORS ACT

65. Section 10 of the Rivers and Harbors Act prohibits the creation of any unauthorized "obstruction" to the navigable capacity of the waters of the United States, unless the U.S. Army Corps of Engineers (Corps) authorizes such an obstruction.[40] On June 18, 2012, the Corps stated that installation of the project will not have an adverse effect on navigation. Nevertheless, the Corps requested a reservation of authority to require the removal, relocation, or alterations to the project if it becomes an obstruction. Therefore, Article 308 includes a reservation of authority to require the removal, relocation, or alteration to the structural work of the project if the Corps, after approval from the Commission, determines such action is necessary to prevent unreasonable obstructions to navigation.

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[38] 36 C.F.R. Part 800 (2013).

[39] EA at 10.

[40] 33 U.S.C. § 403 (2012).

RECOMMENDATIONS OF FEDERAL AND STATE FISH AND WILDLIFE AGENCIES PURSUANT TO SECTION 10(J) OF THE FPA

66. Section 10(j)(1) of the FPA[41] requires the Commission, when issuing a license, to include conditions based on recommendations submitted by federal and state fish and wildlife agencies pursuant to the Fish and Wildlife Coordination Act,[42] to "adequately and equitably protect, mitigate damages to, and enhance fish and wildlife (including related spawning grounds and habitat)" affected by the project.

67. In response to the April 23, 2012 public notice that the project was ready for environmental analysis, NMFS, FWS, and Washington Fish and Wildlife filed a total of nine different recommendations under section 10(j). One recommendation was determined to be outside the scope of section 10(j) and is discussed in the next section. The license includes conditions consistent with the eight remaining recommendations that are within the scope of section 10(j) and require implementation of: (1) the Acoustic Monitoring and Mitigation Plan (Article 404); (2) the Marine Mammal Monitoring and Mitigation Plan (Article 407 and Ordering Paragraph F); (3) the Near-Turbine Monitoring and Mitigation Plan (Article 406 and Ordering Paragraph F); (4) the Benthic Habitat Monitoring and Mitigation Plan (Article 405 and Ordering Paragraphs E and F); (5) the Derelict Gear Monitoring Plan (Article 409 and Ordering Paragraph E); (6) the Water Quality Monitoring Plan (Ordering Paragraph E); (7) the Project Safeguard Plans (Articles 305, 306, 307, and Ordering Paragraph E); and (8) the Horizontal Directional Drilling Plan (Article 402 and Ordering Paragraph E).

SECTION 10(A)(1) OF THE FPA

68. Section 10(a)(1) of the FPA[43] requires that any project for which the Commission issues a license be best adapted to a comprehensive plan for improving or developing a waterway or waterways for the use or benefit of interstate or foreign commerce; for the improvement and utilization of waterpower development; for the adequate protection, mitigation, and enhancement of fish and wildlife; and for other beneficial public uses, including irrigation, flood control, water supply, recreation, and other purposes.

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[41] 16 U.S.C. § 803(j)(1) (2012).

[42] *Id.* §§ 661 *et seq*.

[43] 16 U.S.C. § 803(a)(1) (2012).

A. Washington Fish and Wildlife's Recommendations

69. Washington Fish and Wildlife made one recommendation under section 10(j)—the establishment of the MARC, which would assist in the creation and review of monitoring and management plans, including adaptive management provisions—that is not a specific measure to protect, mitigate damages to, or enhance fish and wildlife. Consequently, this recommendation is not considered under section 10(j) of the FPA. Instead, this recommendation is considered under the broad public-interest standard of section 10(a)(1).[44]

70. As discussed in the EA,[45] each of Snohomish PUD's monitoring and mitigation plans provides for consultation with the MARC, so the stakeholders clearly contemplate the establishment of that entity. These monitoring and mitigation plans also include adaptive management provisions, which will be implemented in consultation with the MARC. We are requiring implementation of the plans, including the consultation and adaptive management requirements. Therefore, a separate license condition requiring the establishment of the MARC is unnecessary. Further, the Commission lacks authority to require any entity other than the licensee to participate in the MARC. Therefore, we will not include provisons regarding the establishment of the MARC in this license.

B. Safety and Proximity to PC-1 North Undersea Cable

71. PC Landing argues that the installation, operation, and removal of the project's turbines could adversely affect its PC-1 North cable, which is located 170 meters from the Turbine 1 site and 238 meters from the Turbine 2 site. PC Landing's concerns include: (1) the potential of the turbines to cause scour on the seabed potentially exposing PC-1 North, or causing the turbine to topple or tilt, either of which could make the cable vulnerable to damage; (2) potential damage to the cable if a turbine or anchor drops on the cable from vessels installing, monitoring, or performing maintenance activities; and (3) any reduced ability of PC Landing to maintain and repair its PC-1 North cable due to the proximity of the turbines. PC Landing recommends that the Commission follow available guidance established by the International Cable Protection Committee (ICPC)[46] and require a minimum separation distance from its PC-1 North

[44] *Id.*

[45] EA at 173.

[46] The International Cable Protection Committee is a non-profit organization headquartered in the United Kingdom that helps to protect submarine cables from man-made and natural hazards by, among other services, producing and maintaining industry

(continued…)

cable of 750 meters,[47] or in the alternative, that the Commission deny a license to Snohomish PUD.[48] Short of increasing the separation distance or denying the license, PC Landing recommends that Snohomish PUD's license include additional conditions to protect the safety and integrity of PC-1 North. We address each of these concerns in turn below.

1. Scour-Related Threats

72. PC Landing asserts increased separation between the project and PC-1 North is required because Snohomish PUD does not know what underlies the seabed where the turbines will be placed. It states that if the seabed is underlain by soft materials, a turbine's footings could penetrate the seabed causing the turbine to settle unevenly, resulting in the need for additional maintenance and repair. PC Landing argues that exposure of the soft underlying sediments to currents can cause significant scouring hundreds of meters away, potentially causing the turbines to tilt or topple or undermine PC-1 North and expose it to damage.

73. In the EA, staff determined that relocating the turbines further away from PC-1 North was not necessary because the available data indicates that the potential for scour around the turbine's foundation will be limited, and the rate of erosion will be gradual and unlikely to reach PC-1 North. Further, staff explained that Snohomish PUD will submit to the Commission for approval plans and specifications and a supporting design report confirming that the size of the turbine footings is appropriately designed (Article 303), and that Snohomish PUD will work with the turbine manufacturer to conservatively design the size of the turbine footings to prevent penetration of the cobble-pavement

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recommendations that define the minimum standards for cable route planning, installation, operation, maintenance, and protection; and facilitating the exchange of technical, environmental, and legal information pertaining to submarine cable systems.

[47] PC Landing's March 23, 2013 Motion to Intervene and Protest at 13-14. In subsequent filings, PC Landing argues, based on ICPC recommendation No. 13, that a minimum of 500 meters and an undefined buffer is needed to provide an adequate separation distance between the turbines and PC-1 North.

[48] PC Landing also argues that Commission staff failed to sufficiently weigh conclusions made by the FCC regarding an appropriate setback distance. We address this argument further below in our section discussing compliance with the National Environmetnal Protection Act.

seabed.[49] Staff also found that the use of tilt sensors and monitoring measures included in Snohomish PUD's Project Safeguard Plans[50] and Benthic Habitat Monitoring and Mitigation Plan will ensure that any scouring that may occur around the turbine foundation is measured and monitored, and that if such scour propagates towards the PC-1 North cable, scour protection measures[51] will be implemented to correct the problem before it affects PC-1 North.[52]

74. Nonetheless, to define when corrective actions are required, staff recommended a license condition requiring Snohomish PUD to identify, in consultation with state and federal agencies and PC Landing, specific scour width and depth thresholds that will trigger mitigation measures.[53]

75. Therefore, to facilitate the Commission's oversight of turbine operation, this license requires Snohomish PUD to file a Project Operation and Monitoring Plan with the Commission's regional engineer (Article 309). The Project Operation and Monitoring Plan must specify the normal operating parameters of the turbines; all electrical and mechanical monitoring devices (i.e., turbine-tilt meter, accelerometer, etc.) and the respective threshold levels indicating abnormal operations (e.g., excessive vibration or tilt); response procedures to address mechanical alarm settings; the scour thresholds (i.e., depth and width measurements) requiring implementation of scour protection measures; and a schedule for ROV inspections.[54] Snohomish PUD must consult with PC

[49] EA at 33-34.

[50] Snohomish PUD's Project Safeguard Plans include: (1) Project and Public Safety Plan; (2) Navigation Safety Plan; (3) Project Removal Plan; and the (4) Emergency Shutdown Plan.

[51] Such scour protection measures include installing scour skirts or utilizing scour-resistant materials.

[52] *See* EA at 32-34.

[53] *Id.* at 172.

[54] ROV inspections are to occur at a minmum of: (1) immediately following installation of both turbines; (2) by day 30 of initiation of operation; (3) by day 90 of initiation of operation; (4) by day 180 of initiation of operation; (5) by day 270 of initiation of operation; (6) by day 365 of initiation of operation; (7) by day 540 of initiation of operation; (8) by day 720 of initiation of operation; and (9) twice annually thereafter until the project is removed.

Landing in developing the scour thresholds, and the plan must describe how PC Landing's concerns have been addressed. By December 31 of each year, following the start of operations, Snohomish PUD must file a report that describes the results of the project monitoring and operations (Article 309).

76. With the above provisions, relocating the turbines should not be necessary. This license contains measures protecting PC Landing's PC-1 North cable such that any scour produced by the project will be limited, and that for any scour which may occur, the conditions of this license will ensure that such scouring problems are corrected and/or scour protection measures are put into place to safeguard PC-1 North.

2. Project Installation, Maintenance, and Removal Activities

77. PC Landing asserts that there should be a greater separation distance between PC-1 North and the project turbines to mitigate the risk of dropping a turbine or anchor on the cable. To establish an appropriate separation distance, PC Landing argues the Commission should rely on, and not depart from, available guidance from institutions such as the International Cable Protection Committee (ICPC).[55] PC Landing also alleges that beyond the direct impact to PC-1 North, approval of the project would create significant issues for the telecommunication industry as it would create precedent for authorizing turbines at an unsafe distance from major submarine telecommunication cables.

78. As staff acknowledged in the EA, dropping a turbine or an anchor on PC-1 has the potential to damage the cable and increasing the distance between the cable and turbines would provide an increased margin of safety during installation, maintenance and removal activities.[56] However, the EA concluded that implementing measures proposed by Snohomish PUD will adequately minimize such risks without jeopardizing the information to be gained from the project or increasing project costs.[57] These measures include: (1) installing, removing, and maintaining the turbines under only the most favorable weather and tidal conditions; (2) using "live-boat" techniques, allowing Snohomish PUD to install and remove the turbines without the use of anchors; and

[55] On August 22, 2013, the North American Submarine Cable Association also asserted that there is an inadequate separation distance between PC-1 North and the turbines.

[56] *See* EA at 170-71.

[57] *Id.* at 129-31, 170-71.

(3) developing and implementing a Hazard Identification and Risk Assessment in consultation with the Coast Guard, the Corps, and PC Landing.

79. The Hazard Identification and Risk Assessment, which is discussed further below, will establish criteria for weather and wave conditions that must exist before marine operations can occur throughout deployment or recovery. It will also require the use of industry-approved equipment and include redundancy in the use of equipment and vessels (e.g., back-up tugboat for emergencies). Further, it requires the establishment of criteria for aborting operations in emergency situations, and requires the establishment of a "port of refuge," located at least two kilometers away from PC-1 North, in the event of unanticipated adverse weather or other events.

80. The other guidelines cited by PC Landing, including the ICPC guidelines, contain recommendations transferred from other industries and locations. Though these recommendations assisted Commission staff in assessing the risks to PC-1 North, Commission staff's site-specific analysis of the project's effects provides a thorough basis upon which to evaluate this specific project and establish appropriate license conditions. Because it is Commission policy to analyze proposed projects on a site-specific basis, licensing the Admiralty Inlet Project, under the conditions and terms specific to this project does not necessarily set precedent for the appropriate separation distance for future marine and hydrokinetic project proposals.

81. For these reasons, we find that Commission staff appropriately reviewed industry guidelines when recommending the project, and that given the minimal risks to PC-1 North, especially in light of protection measures included in this license, it is reasonable to issue a license for the Admiralty Inlet Project. Articles 305, 306, and 411 require Snohomish PUD to implement the above-described measures to protect PC Landing's cable.

3. Repair of PC-1

82. PC Landing states, and Snohomish PUD concurs, that if a fault of PC-1 North occurs in the area of the turbines, normal repair of the cable could not be undertaken due to the proximity of the project. PC Landing argues that to repair its cable, an additional 480 meters of slack cable will be required, which could become entangled on the turbine, threatening the turbine and the cable-repair crew. PC Landing also argues that the EA fails to consider this repair-related impact.[58]

[58] We address Commission staff's compliance with the National Environmental Policy Act further below.

83. As staff described in the EA,[59] if a cable fault occurred near the location of the turbines, a ship would have to make a cut in the cable north of the turbines and a second cut in the cable south of the turbines. The north end of the cable would be hauled to the surface and spliced to a new cable section on board the ship sufficient to span the distance between the north cut and the south cut. The south end of the cable would then be brought to the surface and spliced to the other end of the new cable section. The repaired cable, with the new section installed, would then be relaid on the sea floor or buried, as required. The time required for a repair ship to make the additional cuts, the additional time to repair two spliced ends instead of one, the additional time to relay the longer length of cable on the sea floor, and the cost of the new cable required to span the length of sea floor between the north and south cuts with enough slack to be lowered from the repair ship would all contribute to an increased cost to repair the cable. The additional cuts and repairs would also lengthen the time of cable outage, resulting in lost data transmission for PC Landing's customers.

84. Staff found it highly unlikely that a cable fault would occur at the turbine location for reasons not related to the project.[60] However, Commission staff determined that if such a repair was needed, it could be completed by PC Landing.[61] While the EA did not specifically acknowledge the additional 480 meters of slack cable described by PC Landing, the EA did consider the repairs as described by both PC Landing and Snohomish PUD and concluded that the procedures would not be dissimilar to those used if other obstructions were encountered during a repair. Furthermore, and as Snohomish PUD points out in its March 8, 2013 response to PC Landing Corp's comments, any additional cable needed to conduct a repair of PC-1 North would be laid west of the existing cable route. Since the turbines will be located to the east of PC-1 North, any additional cable needed for a fault repair will be located a considerable distance away from the proposed turbines. Thus, the cables are unlikely to become entangled with the turbines. In sum, because needed repairs to PC-1 North are unlikely, but are not prohibited by the installation and operation of the project, we find that staff adequately considered the repair-related effects to PC-1.

[59] EA at 130-31.

[60] *Id.* at 130.

[61] *Id.*

4. Additional Protection Measures

85. PC Landing argues that the Hazard Identification and Risk Assessment is inadequate to protect the safety and integrity of PC-1 North. To provide further protection, PC Landing requests that the Commission require the following additional 12 provisions through a proximity agreement or as commitments in Snohomish PUD's Hazard Identification and Risk Assessment:[62]

(1) Provide PC Landing a minimum of 14-days advance notice and an opportunity to consult on all planned marine operations occurring within 1,000 meters of PC-1 North, and notice as soon as reasonably practicable of any emergency marine operations;
(2) Ensure that any contractor used for the work is suitably qualified and experienced in carrying out the type of work for which it is engaged;
(3) Provide PC Landing the right to have a representative on board the lead vessel for all installation, removal, repair operations within 1,000 meters of PC-1 North at Snohomish PUD's expense, and the right to request, at its own expense, a representative on board the lead vessel for other marine operations. The PC Landing representative may, after consultation with Snohomish PUD's representative, request that the work be suspended if, in the representative's opinion, the actions in carrying out the work are likely to cause or result in damage to PC-1 North or such actions are not in accordance with the Hazard Identification and Risk Assessment or proximity agreement;
(4) Station a cable guard vessel over PC-1 North at Snohomish PUD's expense during all installation, removal, and repair operations;
(5) Provide PC Landing daily progress reports during marine operations, including precise times when equipment enters and leaves the area adjacent to PC-1 North, and a full report on the marine operations following completion of the activity, including a full report of any damages to PC-1 North;
(6) Provide PC Landing real time access to all monitoring data throughout the project term;
(7) In the event that scour or uneven settling of the turbines requires additional marine operations, such as installation of scour resistant material or scour skirts, give PC Landing the option to require, at Snohomish PUD's expense, the installation of physical protection measures around PC-1 North;

[62] PC Landing's September 5, 2013 comment letter at 15-17.

(8) Require a full indemnification and a surety bond by Snohomish PUD for all marine operations occurring within 1,000 meters of PC-1 North to protect against possible damage to the cable;
(9) Provide PC Landing the opportunity to review and comment on final turbine foundation and footing design before construction is permitted to begin;
(10) Provide PC Landing final as-built drawings of the position of turbines and route of the trunk cables;
(11) As part of the monitoring program, require Snohomish PUD to conduct ROV inspections of PC-1 North adjacent to the turbines for potential physical impacts on the cable;
(12) In the event that repair of PC-1 North is required in the vicinity of the turbines:
    (i) require Snohomish PUD to coordinate with PC Landing on the repair of PC-1North;
    (ii) require Snohomish PUD to shut down the turbines prior to commencement of PC-1 North repair activity;
    (iii) require Snohomish PUD to cease all project marine operations during the PC-1 repair, and except in an emergency, ensure that PC Landing has priority to complete the repair of PC-1 North over repair of the turbines; and
    (iv) ensure that Snohomish PUD will indemnify PC Landing for all additional costs of repair as a result of the proximity of the turbines to PC-1 North.

86. Snohomish PUD opposes the additional conditions and states the measures do not offer any additional protection to PC-1 North as they are redundant to the measures already addressed by the Hazard Identification and Risk Assessment. Unrelated to PC Landing's filing, Snohomish PUD requests clarification that the Hazard Identification and Risk Assessment applies to only in-water construction within 1,000 meters of the PC-1 North cable. Although PC Landing's proposed measures and Snohomish PUD's request for clarification were submitted late in this proceeding, we address each below, including Snohomish PUD's specific arguments why PC Landing's additional measures are not needed.

87. Snohomish PUD argues that PC Landing's request for consultation for marine operations occurring within 1,000 meters of PC-1 North is expressly established through staff's recommendation to develop the Hazard Identification and Risk Assessment in consultation with PC Landing. Snohomish PUD further argues that to the extent PC Landing desires to be notified of the timing when certain marine operations will take place, it may request such a condition in the development of the Hazard Identification and Risk Assessment. We agree with PC Landing that it should be notified of the timing of marine operations that include the installation, repair, or removal of the turbines taking

place within 1,000 meters of PC-1 North. This requested provision is reasonable, is not already provided for in the Hazard Identification and Risk Assessment, and will provide PC Landing with notice of Snohomish PUD's relevant marine operations. Similarly, keeping PC Landing informed as to the progress of turbine installation, maintenance, and removal until such actions are completed is reasonable. The frequency and notification procedures are best left to the process of defining the details of the final Hazard Identification and Risk Assessment. Thus, Article 411 requires that the Hazard Identification and Risk Assessment include such notification procedures.

88. Snohomish PUD asserts that a requirement to provide full indemnification and a surety bond for all marine operations occurring within 1,000 meters of PC-1 North is unnecessary and inappropriate because liability for damage is already addressed by relevant common law and the FPA. We concur. Section 10(c) of the FPA provides that a licensee "shall be liable for all damages occasioned to the property of others by the construction, maintenance, or operation of the project works or the works appurtenant or accessory thereto, constructed under the license . . . ."[63] Because nothing in this license shields the licensee from any damages it may inflict on the property of others, including on property owned by PC Landing, we find this measure unnecessary.

89. Snohomish PUD contends that a requirement to provide PC Landing with final, as-built drawings of the position of the turbines and route of the trunk cables is not necessary because the license already requires the public filing of such drawings. Snohomoish PUD also states that in the event all or part of the revised exhibits must be designated as Critical Energy Infrastructure Information (CEII) or as otherwise protected material, PC Landing can gain access to such material using the Commission's CEII procedures. We find that PC Landing's request for the final, as built drawings of the project is reasonable, is not unduly burdensome to Snohomish PUD, and will enable PC Landing to confirm the location of the project. Therefore, in Article 304 we require Snohomish PUD to send a courtesy copy of the revised Exhibit G to PC Landing.

90. Snohomish PUD states that while it is willing to coordinate with PC Landing on necessary repairs to PC-1 North, a mandatory requirement for such coordination, automatic shutdown of the project, cessation of all marine operations, and indemnification for repair costs sought by PC Landing is premature and unnecessary. Snohomish PUD argues that it would be speculation at this point to attempt to set out what conditions might be required or appropriate for a theoretical repair of PC-1 North,

[63] 16 U.S.C. § 803(c) (2012). *See also Pacific Gas and Electric Co.*, 78 FERC ¶ 61,094, at 61,337 (1997) (explaining that it is "licensee's fundamental responsibility to keep a project safe and operational.") (citation omitted).

including shutdown and cessation of marine operations. Snohomish PUD states that such a decision would require an analysis of the particular facts and circumstances, the anticipated repair plan, and other factors. Further, it states that the Project Safety Plan and the Emergency Shutdown Plan, required by Articles 305 and 307 of this license, already provide that where a hazardous condition arises, including regarding potential issues with PC-1 North repairs, Snohomish PUD will evaluate the condition and current operation parameters and modify or cease turbine operation until the hazard can be circumvented or resolved. We concur with Snohomish PUD that such a measure is speculative and not necessary.

91. In addition, many of PC Landing's proposed measures are not needed because of the scour protection requirements included in this license. These measures include requests by PC Landing for real-time monitoring data, PC Landing's ability to require unspecified physical protection measures around PC-1 North at Snohomish PUD's expense, and the requirement to conduct ROV inspections of PC-1 North adjacent to the turbines. The Project Safety and the Project Operations and Monitoring plans include reporting requirements, will consider the monitoring and mitigation of scour, and require Snohomish PUD to quantify scour, deposition, or other changes to the seabed. Implementation of the Project Safety Plan and Emergency Shutdown Plan will ensure appropriate coordination during any repair to PC-1 North. Likewise, implementation of the Project Operations and Monitoring Plan and providing the Annual Performance Report to PC Landing (Article 310) will ensure PC Landing is timely notified if scour thresholds are exceeded or if the turbines are not performing within their specifications, respectively. In addition, as we have previously discussed, defining the protective measures needed to protect PC-1 North at this time is premature and would be best determined if and when site-specific issues arise. Therefore, we will not require these measures.

92. The remaining proposed conditions, including a requirement for a PC Landing representative to be aboard the lead installation vessel to monitor installation activities and have the authority to request that work be suspended under certain circumstances are also unnecessary. We fully expect Snohomish PUD to use contractors with the necessary experience to install, maintain, and remove the turbines. As staff indicated in the EA, OpenHydro has successfully installed the turbines within an accuracy of a few meters and Snohomish PUD has indicated it intends to use OpenHydro's procedures for installation, maintenance, and removal. Further, the license requires Snohomish PUD to implement the Hazard Identification and Risk Assessment, which will ensure safe installation and protection of PC-1 North. The need for a guard vessel is also unnecessary because the operators installing, maintaining, and removing the turbines will use the same types of geographic positioning systems to place the turbine as the guard vessel would use to identify the PC-1 North. Consequently, the work vessels will be fully aware of the position of both the turbines and PC-1 North.

93. As to Snohomish PUD's request that the Hazard Identification and Risk Assessment only apply to in-water construction within 1,000 meters of the PC-1 North cable, we deny the request. In the EA,[64] staff recognized that activities associated with the horizontal directional drilling and connection of the trunk cables at the drilling exit will require the use of anchors,[65] and the barges and tugs needed to implement such actions must navigate across PC-1 North before and after such operations begin. Therefore, the Hazard Identification and Risk Assessment should be completed and filed at least 90 days prior to the start of any in-water construction.

C. Tribal Concerns

94. The Suquamish Tribe, Tulalip Tribes, and the Treaty Council (collectively, Tribes) state that they have treaty-reserved fishing rights under the Treaty of Point Elliot,[66] reserving their right to take fish in usual and accustomed fishing areas.[67] These Tribes' state that the site for the proposed Admiralty Inlet Project is located in one of their usual and accustomed fishing areas, and that the project would violate their tribal fishing rights because the potential of fishing gear or anchor lines getting caught in the project's turbines would effectively close this area for fishing.[68] The Tribes also express concern that the monitoring plans for the project are not capable of monitoring behavioral changes in fish or observing harm of fish.

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[64] *See* EA at 127.

[65] Article 411 clarifies that the use of "live boating" techniques will not be required during the horizontal directional drilling and connection of the trunk cables.

[66] *See* 12 Stat. 927 (1855); and *United States v. Washington*, 459 F. Supp. 1020, 1039 (W.D. Wash. 1978).

[67] Article V of the treaty states:

> The right of taking fish at usual and accustomed grounds and stations is further secured to said Indians in common with all citizens of the Territory, and of erecting temporary houses for the purpose of curing, together with the privilege of hunting and gathering roots and berries on open and unclaimed lands.

See 12 Stat. 927.

[68] Citing *Muckleshoot v. Hall*, 698 F. Supp. 1504 (W.D. Wash 1988).

95. Pursuant to sections 10(a)(2)(B) and 10(a)(3) of the FPA, the Commission solicits and considers recommendations, including fish and wildlife recommendations, of Indian tribes affected by a proposed project.[69] The Commission has stated that these sections of the FPA give such Indian tribes "a special status of their own" in the licensing process parallel to that of resource agencies.[70] Accordingly, the Commission has given the tribes' comments and recommendations consideration similar to that given those of resource agencies under section 10(a) of the FPA.

96. Though we respect the Tribes' perspective and concerns, we disagree that licensing this project will adversely affect their treaty rights. The known fishing areas in Admiralty Inlet are located several kilometers or more from the proposed turbine sites.[71] The project will be short-term, will occupy an extremely small portion of Admiralty Inlet,[72] and no travel or navigational restrictions on project waters are needed.[73] More importantly, this license contains no prohibitions on the right to fish in and around project waters, and, as explained below, the license contains appropriate conditions to protect tribal fisheries.

97. In regard to harm to fish, staff's analysis in the EA revealed little risk to individual fish and almost no risk at a population or fishery scale.[74] Adverse effects from sound are estimated to occur for only short periods of time (less than five percent overall) and only within a short distance of the turbines (10 meters).[75] Staff determined that fish spawning

[69] "Affected" tribes are those whose legal rights as a tribe may be affected by the project. *See* 18 C.F.R. § 4.30(b)(10) (2012).

[70] Regulations Governing Submittal of Proposed Hydropower License Conditions and Other Matters (Order No. 533), 56 Fed. Reg. 23108-01 (May 20, 1991), FERC Stats. & Regs., Regulations Preambles 1991-1996, ¶ 30,921, at 30,107 (May 8, 1991).

[71] EA at 126.

[72] The project, and installation of various components, would occupy less than 0.05 percent of the horizontal cross section of Admiralty Inlet.

[73] The U.S. Coast Guard is not requiring a Regulated Navigation Area, which would have restricted towing, anchoring, bottom fishing, dredging, or other deep-water activities in the Regulated Navigation Area. *See* Jennifer Harper, FERC, November 27, 2012 Telephone Memorandum in this proceeding.

[74] EA at B-9.

[75] *Id.* at 76.

will also be protected with seasonal restrictions on in-water construction (Article 410), and that fish will be protected by the measures required in the Near Turbine Monitoring and Mitigation Plan (Article 406) and the Acoustic Monitoring and Mitigation Plan (Article 404), discussed above and summarized further below.

98. The conditions included in NMFS's BO will provide additional protection for tribal fisheries. As previously discussed, to protect against noise-related effects, the licensee is required to cease operating the project if sound levels of 120 dB extend beyond 750 meters from the turbine or if a sound level of 180 dB is exceeded any distance from the turbines. Also, to protect against turbine strike of fish, the licensee is required to collect data on the fish passing through the plane of the turbine sufficient to identify the number and taxonomic group of at least half of the individuals passing through the turbine during operation, and NMFS's incidental take statement authorizes incidental take of only ten adult salmon or steelhead, one adult yelloweye rockfish, one adult canary rockfish, one adult Bocaccio swimming through the plane of the turbines in a given year. With a low risk of harm to fish combined with these protection measures and the short term of the project, the risk to tribal fisheries is extremely low.

99. In addition, a number of the license articles require Snohomish PUD to consult with the Tribes as to environmental and other project-related matters, and the Tribes will be members of the MARC. Accordingly, there will be multiple fora in which the Tribes' concerns can be raised and addressed during the term of the license.[76]

100. For these reasons, we find that this license will adequately monitor and protect fish, will enable the Commission to require the licensee to stop project operations if it is observed that the project results in inappropriate harm to fish, and in light of the lack of navigational or fishing restrictions on project waters, will not restrict the right of the Tribes to access their treaty-reserved fishing areas.

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[76] Specifically, this license requires Snohomish PUD to consult with the Tulalip Tribes, the Suquamish Tribe, the Swinomish Indian Tribal Community, and the Sauk-Suiattle Tribe on the: (1) Project Removal and Site Restoration Plan (Article 401); (2) Acoustic Monitoring and Mitigation Plan (Article 404); (3) Benthic Monitoring and Mitigation Plan (Article 405); (4) Near-Field Monitoring and Mitigation Plan (Article 406); (5) Marine Mammal Monitoring and Mitigation Plan (Article 407); (6) Derelict Gear Monitoring Plan (Article 409); and (7) In-Water Construction Schedule (Article 410). Among other things, these plans require consultation with the tribes on: the results of studies, possible changes to project monitoring, on changes to the required plans requested by the licensee, and possible measures to address adverse effects identified by the licensee.

D. Horizontal Directional Drilling and Construction Noise Abatement

101. To minimize soil disturbance at the seafloor and protect shoreline resources, Snohomish PUD prepared an HDD Plan.[77] The plan defines the techniques and materials needed for the drilling process and provides methods to avoid causing erosion or spills. Because the drilling and construction process will occur near residences, staff recommended that drilling be conducted between 7:00 a.m. and 7:00 p.m. However, once drilling starts, it may not be practicable to stop drilling until the bore hole is completed. Therefore, in the EA,[78] Commission staff recommended provisions to implement noise abatement measures in the event HDD processes extend into nighttime hours. Article 402 requires implementation of the plan with staff's additional provisions.

102. Washington Ecology included several requirements related to protecting water quality during HDD in its Water Quality Certificate. Those measures are discussed above and required by this license (Ordering Paragraph, E, Article 402, and Appedix A).

E. Invasive Species Management and Control

103. To minimize the potential introduction and spread of invasive plants, staff recommended Snohomish PUD use weed-free fill material and native plants and soils to revegetate disturbed areas; regularly inspect disturbed areas for colonizing invasive plants; and promptly take steps to eradicated invasive plants.[79] Article 403 requires implementing these measures.

F. Interpretation and Education Plan

104. To educate the public about the project, the National Park Service recommended that Snohomish PUD develop and install an interpretive display at the project. Staff recommended[80] Snohomish PUD file a plan for the installation of such a display at a publicly accessible site within view of the turbine locations. Article 413 requries this measure.

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[77] *Id.* at 30-31.

[78] *Id.* at 141-42.

[79] *Id.* at 113.

[80] *Id.* at 121.

G. Project Safety Plans

105. FWS and Washington Fish and Wildlife recommended implementation of the Project Safeguard Plans, which include the Project and Public Safety Plan, the Navigation Safety Plan, the Emergency Shutdown Plan, and the Project Removal Plan. The Project and Public Safety Plan and Navigation Safety Plan are not within the scope of section 10(j) because they are not specific fish and wildlife measures, but are considered under the broad public-interest standard of section 10(a)(1) and are required by Articles 305 and 306, respectively.

COMPLIANCE WITH THE NATIONAL ENVIRONMENTAL POLICY ACT

106. The draft and final EAs analyze the potential impacts to aquatic resources, terrestrial resources, threatened and endangered species, recreation, land use and aesthetics, cultural resources, other developmental activities such as the PC-1 North cable, and cumulative impacts. In addition to Snohomish PUD's proposal, staff considered two alternatives: (1) Snohomish PUD's proposal with staff modifications; and (2) the no-action alternative, meaning the project would not be constructed and there would be no change to the existing environment.[81]

107. The staff alternative included Snohomish PUD's proposals, with modifications, to implement measures for: (1) removing the project and restoring the site; (2) preventing further turbine interaction during emergency shutdowns (discussed further below); (3) abating noise associated with the HDD processes in nighttime hours; (4) mitigating scour among the turbine footings on the seafloor; (5) installing an interpretive display for public education; (6) preventing damage to archeological or historic properties; (7) preventing unreasonable obstructions the project might have on navigation; and (8) coordinating project installation and maintenance with Washington State Ferries to avoid disruptions to scheduled ferry services.[82]

108. As described in the EA, constructing and operating the project would result in minor and short-term effects including: (1) disturbances to the seabed during the HDD process and during installation of the turbines; (2) noise and visual effects during the construction of the onshore facilities; (3) navigability over project waters on fishermen, recreational boaters, and ferry operators during project installation, onsite maintenance, and project removal; and (4) operational noise effects on fish and marine mammals.

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[81] *Id*. at 15-23.

[82] *Id*. at 23-24.

Commission staff also determined that the environmental monitoring plans proposed by Snohomish PUD and as modified by Commission staff would provide information to confirm such impacts.[83] Based on these findings, staff found that issuance of a license for the Admiralty Inlet Project, with staff's recommended environmental measures, would not constitute a major federal action significantly affecting the quality of the human environment.[84]

A. Analysis of Effects and Mitigation Measures

109. PC Landing argues the EA inadequately analyzes the potential impacts to PC-1 North resulting from new marine operations due to the project's mechanical brake, including the potential risk of increased anchor drops. PC Landing also argues that the EA inadequately evaluates scour impacts because the EA fails to address the uncertainty of the underlying subsurface sediments and turbine footing design. PC Landing states that the EA should identify the specific thresholds at which observed scour will trigger mitigation and require notice to PC Landing, and define the specific mitigation measures that will be put in place.[85]

110. We disagree. Section 102(2)(E) of NEPA requires agencies to take a "hard look" at the potential environmental consequences of their proposed actions.[86] However, in carrying out their NEPA responsibilities, agencies are governed by a rule of reason.[87] Commission staff determined that the need to cease turbine rotation would likely occur in four situations, including: (1) if a killer whale is injured by the project; (2) if acoustic monitoring indicates noise levels have the potential to injure marine mammals; (3) if

[83] *Id*. at 173-74.

[84] *Id.* at 179.

[85] PC Landing (citing *Dine Citizens Against Ruining Our Env't. v. Klein*, states that by not identifying what marine operations will take place to correct scour impacts, Commission staff violated NEPA by deferring analysis of the mitigation. 747 F. Supp. 2d 1234, 1258-59 (D. Colo. 2010) (Dine Citizens)).

[86] *Alabama Power Co.*, 141 FERC ¶ 61,127, at P 80 (citing *Comm. for Auto Responsibility v. Solomon*, 603 F.2d 992, 1002 (D.C. Cir. 1979), *cert. denied*, 445 U.S. 915 (1980)).

[87] *Natural Res. Defense Council v. Morton*, 458 F.2d 827, 834-37 (D.C. Cir. 1972).

monitoring suggests injuries or mortality beyond incidential take limits specified by NMFS; and (4) if vibration or differential settlement in excess of design thresholds are detected. Commission staff explained,[88] and we have summarized in this order, that the probability of any of these conditions occurring is very low.

111. Nevertheless, Commission staff also explained,[89] and we affirm, that the measures proposed by Snohomish PUD will adequately minimize the risk of any anchor drops causing damage to PC-1 North. These measures include: (1) installing, removing, and maintaining the turbines under only the most favorable weather and tidal conditions; (2) using "live-boat" techniques, allowing Snohomish PUD to conduct marine operations without the use of any anchors; and (3) developing and implementing a Hazard Identification and Risk Assessment in consultation with the Coast Guard, the Corps, and PC Landing. These measures apply to Snohomish PUD's mechanical brake operations.

112. In regard to scour, Commission staff found that any scour caused by the project's turbines will likely be minimal and limited to the area surrounding the foundational footings of the turbines.[90] Staff also recommended, and this license requires in Article 304, that Snohomish PUD submit to the Commission plans and specifications to confirm that the size of the footings are appropriately designed. To further ensure that PC-1 North is not affected by any scouring caused by the project, staff recommended,[91] and this license requires (Article 309), Snohomish PUD to monitor and measure scour, to define scour thresholds triggering mitigation measures in consultation with PC Landing and state and federal agencies, and to implement protection measures to correct scouring that propagates towards PC-1 North.

113. Although PC Landing argues that the scour protection measures should be identified and evaluated prior to licensing, Commission staff determined, and we confirm, that any number of solutions may be implemented to correct scour, including the use of scour skirts or scour-resistant materials, or even project removal. Therefore, it is unreasonable to develop more detailed plans for a problem that is unlikely to occur and best dealt with through the development of problem-specific solutions.

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[88] EA at 82-84.

[89] *Id.* at 126-31, 170-71.

[90] *Id.* at 32-35.

[91] *See id.* at 32-34.

114. Further, there is no requirement that a determination of mitigation plans be made at the time of license issuance.[92] PC Landing cites *Dine Citizens* in its contention that Commission staff violated NEPA by deferring analysis of mitigation.[93] However, in *Dine Citizens* the inadequate EA contained only "vague reference to 'mitigation/data recovery plans'" that were to be prepared.[94] Here, where Commission staff analyzed specific mitigation measures, including monitoring designed to ensure that scouring towards PC-1 North is measured and corrected appropriately, the Commission has satisfied NEPA's requirement to reasonably consider and discuss mitigation measures.[95]

115. For these reasons, we disagree with PC Landing and find that Commission staff thoroughly evaluated the potential impacts to PC-1 North resulting from the project's mechanical brake and thoroughly considered and mitigated the scour-related impacts the project may have on PC-1 North.

B. Analysis of "Worst-Case" Scenarios

116. PC Landing states that although the EA addresses normal installation, removal, and maintenance, it fails to describe or analyze non-standard marine operations or potential hazards to PC-1 North from marine operations in the event of differential settling or scour from turbine failure and efforts to recover a failed turbine. Without such a "worst-case" assessment, PC Landing claims the Commission cannot make a finding that there would be no impacts to PC-1 North resulting from the project.

117. NEPA does not require the precision PC Landing Corp seeks in our NEPA analysis. Concerning speculative and unknown information, "An EIS [or an EA] is required to furnish only such information as appears to be reasonably necessary under the circumstances for evaluation of the project rather than to be so all-encompassing in scope

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[92] *See City of Seattle, Washington, Dep't of Lighting*, 4 FERC ¶ 61,114 (1978); *see also Idaho Power Co.*, 110 FERC ¶ 61,242, at PP 12-18 (2005) (finding that the details of specific mitigation and enhancement measures approved in the license order may be developed in post-license plans).

[93] 747 F. Supp. 2d 1234 (D. Colo. 2010).

[94] *Id.* at 1258.

[95] *Marysville Hydro Partners*, 62 FERC ¶ 61,011, n.52 (1993) ("[T]he Supreme Court has held that NEPA does not require agencies to develop a final mitigation plan prior to a proposed agency action.") (citing *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332 (1989)).

that the task of preparing it would become either fruitless or well[-]nigh impossible."[96] We find that it would be pure speculation as to what a so called "worst-case" scenario may involve, and that such conjecture on the various permutations of non-routine marine operations, as PC Landing requests, is not reasonably foreseeable or needed at this time.

C. Need for an Environmental Impact Statement

118. The Treaty Council asserts that the Admiralty Inlet Project will significantly affect the quality of the human environment and that, therefore, under NEPA's requirements,[97] an Environmental Impact Statement (EIS) rather than an EA is required. PC Landing also contends that because of the substantial unknowns in operational procedures inherent in the experimental project, particularly in regard to the braking system, the Commission should conduct an EIS.

119. The test for determining the need for an EIS is whether an action will have a significant impact on the quality of the human environment.[98] To that end, staff prepared an EA to assist in determining whether to prepare an EIS.[99] As explained throughout this order, in preparing the EA, staff thoroughly considered the potential impacts of licensing the project on all of the potentially effected resources, including impacts to marine mammals, fish, fishing, benthic communities, threatened and endangered species, navigation, submerged cables, terrestrial vegetation, water quality, aquatic species, wildlife, and recreation. Although staff identified potential impacts to some resources, these impacts are minor and short term.

120. Included in its analysis of potential impacts, staff analyzed Snohomish PUD's proposal to use a mechanical brake to shut down the turbines,[100] which will require Snohomish PUD to use an ROV to insert a pin through the outer ring of a turbine and into the blade housing. The complete shutdown process is estimated to take up to four days,

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[96] *Natural Res. Def. Council v. Callaway*, 524 F.2d 79, 88 (2nd Cir. 1975).

[97] 42 U.S.C. §§ 4321-4370(f) (2012).

[98] *Id.* § 4332(2)(c).

[99] 40 C.F.R. § 1501.4(c) (2013).

[100] *See* EA at 80-84.

but is more likely to take less than a day.[101] Snohomish PUD's proposal to employ a mechanical braking system is novel, as the Commission, to date, has only approved tidal and in-river pilot projects with remotely activated, electrical brakes. However, staff held a technical conference on this subject, which PC Landing attended and participated therein. Staff determined that although the need to deploy the mechanical brake is low, the mechanical brake can work within a reasonable timeframe should it be necessary to protect environmental resources, PC-1 North, or public safety.[102]

121. The Council on Environmental Quality's regulations implementing NEPA state that whether a project will have significant impacts on the environment depends on both "context" and "intensity" of the impacts.[103] The context for this project involves a very small portion of Admiralty Inlet for a short-time period, and the intensity of the impacts is low, especially because of the monitoring and adaptive management procedures associated with the project. Therefore, we agree with the analysis and findings in the EA that the anticipated impacts of the project, taken as a whole, are not of sufficient magnitude to significantly affect the human environment.

D. Alternatives Considered

122. PC Landing asserts that the EA did not consider a reasonable range of "alternatives" that it proposed, such as: (1) alternative thresholds of tidal power density necessary for a commercially viable tidal energy project; and (2) alternative sites located west of the proposed turbine location, about 500 to 950 meters from PC-1 North. PC Landing contends that, in declining to consider these alternatives, the EA does not satisfy the NEPA requirement that a reasonable range of alternatives be defined and considered.[104]

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[101] Snohomish PUD states that its mechanical braking system could be employed within 3–9 hours. *See* Snohomish PUD's May 7, 2013 Supplemental Information Filing at 6.

[102] *See* EA at 84.

[103] 40 C.F.R. § 1508.27(b) (2013).

[104] PC Landing also argues that Commission staff failed to provide analysis in the EA to address many of its concerns, including impacts on PC-1 North because of anchor drops and how to mitigate such impacts; impacts to PC-1 North resulting from turbine failure; and repair-related impacts to PC-1 North.

123. The range of alternatives that must be considered under NEPA is within an agency's discretion.[105] The discussion of alternatives need not be exhaustive and need only provide sufficient information to permit a reasoned choice of alternatives, i.e., "reasonable" alternatives.[106] There is also no requirement to examine each proposed mitigation or enhancement measure (or groups of such measures submitted by an entity) as a separate alternative or alternatives.[107]

124. The EA discussed PC Landing's recommendations, comments, and proposed alternative measures as they applied to the particular resources at issue.[108] To the extent the EA did not specifically include in the staff alternative certain measures that PC Landing and others recommended, it discussed the reasons for not adopting those recommendations.[109] Accordingly, the analytical approach taken in the EA considered a reasonable range of alternatives and enabled staff to make informed recommendations concerning the licensing of the Admiralty Inlet Project.

E. Cumulative Impacts

125. PC Landing asserts that the EA's cumulative impact analysis is deficient primarily because it does not consider the risks posed by the project in the context of any and all other proposed tidal energy projects located, or planned to be located, adjacent to submarine telecommunication cables. Specifically, PC Landing argues the Commission should consider ORPC Alaska 2, LLC's East Foreland Tidal Energy Project No. 13821, proposed to be located in Nikiski, Alaska, which is currently being studied under a preliminary permit.

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[105] *Vermont Yankee Nuclear Power Corp. v. NRDC*, 435 U.S. 519, 551-52 (1976).

[106] *See* section 102(2)(C)(iii) of NEPA, 42 U.S.C. § 4332(2)(C)(iii); and *North Carolina v. FPC*, 533 F.2d 702, 707 (D.C. Cir. 1976) (citing *Natural Res. Def. Council v. Morton*, 485 F.2d 827 (D.C. Cir. 1972)).

[107] *Idaho Power Co.*, 110 FERC ¶ 61,242, at PP 80-85 (2005).

[108] *See, e.g.*, discussion of impacts related to: anchor drops (*see* EA at 126-31); turbine failure (*see* EA at 126-31); and repairs to PC-1 North (*see* EA at 126-31).

[109] *See, e.g.*, discussion of why the turbine site locations enable Snohomish PUD to gain information to determine if the energy potential for a commercial scale project is feasible without negative impacts to the PC-1 North cable (*see* EA at 126-31); and discussion of why EA did not recommend adopting PC Landing's recommended location for siting of the project's turbines (*see* EA at 170-72, B-6).

126. In the EA, Commission staff analyzed the cumulative impacts the project would have on marine fish and mammals in combination with the other activities that occur within Admiralty Inlet, including commercial fishing and vessel traffic. Commission staff also determined that the installation of additional hydrokinetic devices adjacent to undersea communication cables may be possible in the future, but that their development is not well enough defined to be reasonably foreseeable at this time.[110]

127. We agree with Commission staff's analysis of the cumulative impacts of the project, and find that due to the uncertainty of whether the preliminary permit issued for the East Foreland Tidal Energy Project No. 13821 will ultimately lead to a license application,[111] consideration of that preliminary permit's cumulative effect, if any, is unforeseeable and speculative at this time.

F. Recommendations from the Federal Communications Commission

128. On October 4, 2012, the FCC submitted a letter stating that it does not oppose the Commission's licensing of the Admiralty Inlet Project at a minimum separation distance of 170 meters, "so long as [the Commission] determines that the [p]roject does not present material risk to PC-1 [North]," and if the Commission is able to ensure that Snohomish PUD adheres to the safety and separation distance representations it has made.[112] Subsequently, on April 22, 2013, the FCC invited the Commission to nominate a representative for membership on the Communications Security, Reliability, and Interoperability Council (CSRIC) to encourage the development of guidance in determining appropriate separation distances between hydrokinetic energy projects and undersea communications cables. Towards that end, the FCC stated in its invitation that it believes the Commission's participation in the CSRIC is important because "neither FERC nor the FCC currently has sufficient expert guidance available to resolve the important issue of appropriate separation distance[s] between undersea communications . . . and undersea renewable energy projects . . . ."[113]

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[110] EA at 84.

[111] It is the Commission's experience that preliminary permits infrequently result in the development of a license application.

[112] FCC's October 4, 2012 letter at 3.

[113] *Id.* at 2.

129. PC Landing argues that the EA fails to sufficiency weigh the FCC's conclusions, and that further study is needed before a proper separation distance can be established.

130. Snohomish PUD responds that the FCC has not concluded that further study is necessary to determine an appropriate setback distance in this proceeding because the FCC has not changed its view from its October 4, 2012 letter, which states that the FCC does not oppose the project so long as the Commission determines that the project does not pose a material risk to PC-1 North. Snohomish PUD also states that Commission staff fully analyzed appropriate industry guidelines and recommendations in its EA when it recommended approving the location of the project with a separation distance of 170 and 238 meters.

131. In the EA, Commission staff weighed both the FCC's recommendations, industry guidelines, and Snohomish PUD's proposed measures in determining that a setback distance of 170 meters, along with strict conditions under which installation, maintenance, and removal occur, will protect the safety of the PC-1 North cable. As PC Landing points out, the FCC in its April 22, 2013 invitation to join the CSRIC, indicates that future project proposals may benefit by collaboration between CSRIC stakeholders to identify appropriate separation distances between hydrokinetic devices and undersea communications cables. However, the FCC has not disavowed its October 4, 2012 letter, deferring to the Commision whether or not to license the project upon a determination that it does not present a material risk to the cable and that Snohomish PUD will adhere to its safety and seperation representations. With the safety measures discussed and the setback distance of 170 meters, the Admiralty Inlet Project will not pose a material risk to the PC-1 North Cable, and the FCC's concerns are accordingly addressed.

G. Impacts to Killer Whales

132. The ORCA Conservancy and the Pacific Whale Watch Association filed comments on the EA, asserting that the project should not be licensed because, as proposed, it poses unacceptable risks to killer whales. They state that juvenile whales or whales in pursuit of fish could swim into the blades and be injured or killed. They question the effectiveness of the emergency shutdown mechanism because of the time it could take to implement it (up to four days). They express concern that the sound generated by the turbines will cause pain for the whales and will cause behavioral displacement or discourage passage through the inlet. They question whether the project can be authorized under section 7 of the ESA, arguing that recent deaths have reduced the southern resident population of killer whales to the point where any take could result in jeopardy to the population. They also request that the project not be authorized without affirmative proof that it will not harm whales.

133. The EA sufficiently considered the project's impacts on marine mammals, including the killer whale, and determined the probability of whale interaction with the

turbines as low. Specifically, staff reported that killer whales will primarily be passing through Admiralty Inlet in transit, and that they dive to the depths of the turbines infrequently.[114] Further, staff determined that the noise produced by the turbines will likely cause the whales to avoid the turbines.[115] However, staff also found that should a killer whale be struck by a blade, the animal would likely only be bruised.[116]

134. In regard to turbine noise, the EA concluded that the nature of the noise coming from the relatively slow turbines and passive mechanics was not likely to harm or displace whales or fish.[117] Staff determined that outside of a few hundred meters from the operating turbines, the chance of marine mammals, including killer whales, from distinguishing the turbines from background noise was less than 25 percent.[118]

135. This license contains requirements that will protect killer whales and other marine mammals. The Near Turbine Monitoring and Mitigation Plan requires detection of fish and should provide observation of nearby killer whales. Those observations combined with the hydrophone monitoring required under the Marine Mammal Protection and Mitigation Plan will allow detection and observation of killer whales if they come near the turbines. The adaptive management provisions of the Marine Mammal Protection and Mitigation Plan will also allow adjustments to project operation if potential harm to killer whales is detected or, in the very unlikely event, a whale is injured. In addition, the Acoustic Monitoring and Mitigation Plan will allow detection of sounds exceeding acceptable thresholds and the Marine Mammal Monitoring and Mitigation Plan will allow detection of behavioral change, including adaptive management strategies permitting adjustments, if necessary.

136. This license also contains noise-related requirements that will ensure the project does not have detrimental effects on killer whale behavior. The Acoustic Monitoring and Mitigation Plan of this license requires that if the sound level from turbine operation exceeds 120 dB[119] at a distance greater than 750 meters from the turbine when the turbine

[114] EA at 108-09.

[115] NMFS's December 3, 2013 BO at 106.

[116] EA at 108-109.

[117] *Id.* at 78.

[118] *Id.*

[119] A sound level of 120 dB is NMFS's threshold for harassment.

is operating at the 95th percentile of blade rotation velocity, the licensee shall engage the turbine brake until modifications to turbine operations or configuration can be made to reduce the sound level. If the maximum allowable area of 750 meters around the turbines was affected by noise emanating from the project, that affected area would occupy less than 15 percent of the cross section of Admiralty Inlet, leaving the remainder of the inlet available for whale passage or foraging. If killer whales were to respond negatively to noise levels, a behavioral change of this degree will not have a detrimental energy cost to a highly mobile killer whale.[120]

137. Given the very low probability of injury or harm, small project footprint, and short license term, coupled with monitoring to detect possible adverse effects and mitigation available to address such effects, including shutdown options if needed, we find that the risk from this project to the killer whale is small and relatively well understood.

EXEMPTION OF THE FERC FORM 80 RECREATION REPORT

138. The FERC Form 80 Recreation Report (Form 80) collects recreation usage data on recreation facilities at projects through the term of their licenses. Since the Admiralty Inlet Project has little or no potential for recreation facilities, the licensee is exempt from filing the Form 80 during the term of its license (Article 414).

ADMINISTRATIVE PROVISIONS

A. Annual Charges

139. The Commission collects annual charges from licensees for administration of the FPA. Article 201 provides for the collection of funds for administration of the FPA. Under the regulations currently in effect, projects with authorized installed capacity of less than or equal to 1,500 kW, including this project, will not be assessed an annual charge.

B. Exhibit F and G Drawings

140. The Commission requires licensees to file sets of approved project drawings on microfilm and in electronic file format. Article 202 requires the filing of these drawings.

[120] NMFS's December 3, 2013 BO at 75, 107.

C. Project Financing

To ensure that sufficient funds are available for project construction, operation, maintenance, and removal, Article 203 requires the licensee to file for Commission approval documentation of project financing at least 90 days before starting any construction associated with the project.

D. Project Land Rights Progress Report

141. The project will occupy 0.245 acres. Standard Article 5 set forth in L-Form 14 requires the licensee to acquire title in fee or the right to use in perpetuity all lands, other than lands of the United States, necessary or appropriate for the construction, maintenance, and operation of the project, within five years. In order to monitor compliance with Standard Article 5, Article 204 requires the licensee to file no later than four years after license issuance, a report detailing its progress on acquiring title in fee or the necessary rights to all lands within the project boundary. The report shall include specific documentation on the status of the rights that have been acquired as of the filing date of the progress report, and a plan and schedule to acquire all remaining land prior to the five-year deadline.

E. Use and Occupancy of Project Lands and Waters

142. Requiring a licensee to obtain prior Commission approval for every use or occupancy of project land would be unduly burdensome. Therefore, Article 416 allows the licensee to grant permission, without prior Commission approval, for the use and occupancy of project lands and waters for such minor activities as landscape planting. Such uses must be consistent with the purposes of protecting and enhancing the scenic, recreational, and environmental values of the project.

F. L-Form Modification

143. Pursuant to Ordering Paragraph (F), this license is subject to the standard license articles set forth in Form L-14 (October 1975), entitled, "Terms and Conditions of License for Unconstructed Minor Project Affecting Navigable Waters of the United States,"[121] with a modification to Article 11 to include the Secretary of Commerce as a recommending entity.

[121] L-14 is reprinted at 54 FPC 1876 *et seq.* (1975).

G. Start of Construction

144. Article 301 requires the licensee to commence construction within two years from the issuance date of the license and to complete construction of the project within five years of the issuance date of the license.

H. Review of Final Plans and Specifications

145. Article 303 requires the licensee to provide the Commission's Division of Dam Safety and Inspection (D2SI), Portland Regional Office with final contract drawings and specifications, a quality control and inspection program, a temporary construction emergency action plan, a soil erosion and sediment control plan, and a supporting design report consistent with the Commission's engineering guidelines.

146. Article 302 requires the licensee to provide design drawings and letters of approval for any cofferdams and deep excavations at least 30 days before the start of any on-site construction authorized by the license.

147. Where new construction or modifications to the project are involved, the Commission requires licensees to file revised drawings of project features as-built. Article 304 provides for the filing of these drawings.

I. Safeguard Plans

148. The Safeguard Plans in this license include a Project and Public Safety Plan, Navigation Safety Plan, a Project Removal Plan, and an Emergency Shutdown Plan.[122] The Project and Public Safety Plan includes measures for identifying and responding to emergencies at the project (Article 305). The Navigation Safety Plan provides strategies for avoiding collisions with and the snagging of the turbines by tow cables and provides for ongoing consultation with the U.S. Coast Guard (Article 306). The Project Removal Plan includes a schedule for project removal, methods for the removal of the project cables, and a plan for restoring the project area to pre-project conditions (Article 401).

[122] As previously discussed, Snohomish PUD has proposed an Emergency Shutdown Plan under which shutting down the turbines could take up to four days, though it likely will take less than a day. In the event of a need for shutdown, it could be important to keep the area near the turbines clear of unnecessary traffic for public safety and to facilitate the shutdown. Therefore, in Article 307, we have required the licensee to consult with the U.S. Coast Guard to prevent interactions with the turbines or interference with shutdown efforts while a shutdown is ongoing.

The Emergency Shutdown Plan includes procedures for the shutdown of the project turbines in response to emergencies at the project (Article 307). Because of the potential delay in installing the mechanical brake, Article 307 requires the filing of a revised Emergency Shutdown Plan to specify additional measures to be taken (such as notification of United States Coast Guard, deployment of buoys or warning devices, etc.) during an emergency to keep the area near the turbines clear of unnecessary traffic and preventing further interaction with the turbine until the shutdown is complete.

149. These plans will work interdependently to ensure that the project is operated and maintained in a safe manner such that the potential for harm to the public and environmental and developmental resources in the project area is minimal. Revisions to these plans may be necessary as experience is gathered with project operations through the term of the license. Therefore, the licensee should submit any revised plans to the Commission's Division of Dam Safety and Inspections for review and comment prior to implementation.

J. Annual Performance Report and Certification

150. Article 310 requires Snohomish PUD to submit a report to the Commission's Division of Dam Safety and Inspections describing the project's performance, including the adequacy of project monitoring and operations, the findings of inspections, and a summary of the major maintenance and repairs performed during the previous year.

STATE AND FEDERAL COMPREHENSIVE PLANS

151. Section 10(a)(2)(A) of the FPA[123] requires the Commission to consider the extent to which a project is consistent with federal or state comprehensive plans for improving, developing, or conserving a waterway or waterways affected by the project.[124] Under section 10(a)(2)(A), federal and state agencies filed comprehensive plans that address various resources in Washington. Of these, Commission staff identified and reviewed six comprehensive plans that are relevant to this project.[125] No conflicts were found.

[123] 16 U.S.C. § 803(a)(2)(A) (2012).

[124] Comprehensive plans for this purpose are defined at 18 C.F.R. § 2.19 (2013).

[125] The list of applicable plans can be found in section 5.5 of the EA for the project.

SAFE MANAGEMENT, OPERATION, AND MAINTENANCE OF THE PROJECT

152. Staff reviewed Snohomish PUD's preliminary plans to build the project as described in the license application. The project will be safe when constructed, operated, and maintained in accordance with the Commission's standards and provisions of this license.

NEED FOR POWER

153. The Snohomish PUD is the second-largest publicly owned utility in the Pacific Northwest and the twelfth-largest in the nation in terms of customers served. In 2010, Snohomish PUD received 3,100 requests for new electric service connection, and this growth is expected to continue.[126]

154. The Admiralty Inlet Project is within the Western Electricity Coordinating Council's (WECC) Northwest Power Pool (NWPP) area. WECC's 10-year coordinated plan summary for the period 2010 through 2019 projects an average compound growth rate in summer peak demand of 1.2 percent. Capacity additions of 1,158 MW are planned for the NWPP area over the 10-year period. The 600-kW Admiralty Inlet Project will produce about 244,000 kWh of power annually.

155. While the project will produce a limited amount of energy to serve the customers of Snohomish PUD, the project has value in determining the potential of an emergent renewable energy industry segment that could bring clean, competitively-priced electricity to commercial and residential consumers in Washington and other states.

PROJECT ECONOMICS

156. In determining whether to issue a license for an original hydrokinetic pilot project, the Commission considers a number of public interest factors, including the economic benefits of project power. Under the Commission's approach to evaluating the economics of hydropower projects, as articulated in *Mead Corp.*,[127] the Commission uses current costs to compare the costs of the project and likely alternative power with no

[126] Snohomish PUD's 2010 Annual Report, *available at* http://www.snopud.com/Site/Content/Documents/finance/SnohomishPUDAR-revised426.pdf .

[127] 72 FERC ¶ 61,027 (1995).

forecasts concerning potential future inflation, escalation, or deflation beyond the license issuance date. The basic purpose of the Commission's economic analysis is to provide a general estimate of the potential power benefits and the costs of a project, and of reasonable alternatives to project power. The estimate helps to support an informed decision concerning what is in the public interest with respect to a proposed license.

157. In applying this analysis to the Admiralty Inlet Project, two options have been considered: Snohomish PUD's proposal and the project as licensed herein. As proposed by Snohomish PUD, the levelized annual cost of operating the Admiralty Inlet Project is $1,847,627 or $7,572.24 /MWh. The project will generate an estimated average of 244,000 kWh of energy annually. The annual value of alternative power under Snohomish PUD's proposal will be $7,320 or $30.00/MWh.[128] Therefore, in the first year of operation, project power will cost $1,840,307 or 7,542.24/MWh more than the cost of alternative power.

158. As licensed herein with the staff recommended measures, the levelized annual cost of operating the project will be about $1,848,294 or $7,574.98/MWh. Based on an estimated average generation of 244,000 kWh as licensed, the annual value of alternative power under the staff alternative will be $7,320 or $30.00/MWh. Therefore, in the first year of operation, the project power will cost $1,840,974 or $7,544.98/MWh more than the cost of alternative power.

159. The project has relatively high capital, operation, and maintenance costs with respect to the amount of power produced. Although our analysis shows that the project as licensed herein will cost more to operate than our estimated cost of alternative power, it is the applicant who must decide whether to accept this license and any financial risk that it entails.

160. Although staff does not explicitly account for the effects that inflation may have on the future cost of electricity, the fact that hydropower generation is relatively insensitive to inflation compared to fossil-fueled generators is an important economic consideration for power producers and the consumers they serve. This is one reason project economics is only one of the many public interest factors the Commission considers in determining whether or not, and under what conditions, to issue a license.

[128] The alternative power cost is based on the Energy Information Administration's *Annual Energy Outlook 2012, available at* http://www.eia.gov/forecasts/aeo/index.cfm.

COMPREHENSIVE DEVELOPMENT

161. Sections 4(e) and 10(a)(1) of the FPA[129] require the Commission to give equal consideration to the power development purposes and to the purposes of energy conservation, the protection, mitigation of damage to, and enhancement of fish and wildlife, the protection of recreational opportunities, and the preservation of other aspects of environmental quality. Any license issued shall be such as in the Commission's judgment will be best adapted to a comprehensive plan for improving or developing a waterway or waterways for all beneficial public uses. The decision to license this project, and the terms and conditions included herein, reflect such consideration.

162. The EA for the project contains background information, analysis of effects, and support for related license articles. Based on the record of this proceeding, including the EA and the comments thereon, licensing the Admiralty Inlet Project as described in this order would not constitute a major federal action significantly affecting the quality of the human environment. The project will be safe if operated and maintained in accordance with the requirements of this license.

163. Based on an independent review and evaluation of the Admiralty Inlet Project, recommendations from the resource agencies and other stakeholders, and the no-action alternative, as documented in the EA, the proposed Admiralty Inlet Project has been selected, with the measures herein, and found to be best adapted to a comprehensive plan for improving or developing Admiralty Inlet.

164. This alternative has been selected because: (1) issuing a license for pilot project will allow Snohomish PUD to test the generating equipment's dependability as a source of electrical energy for the region; (2) the 600 kW of electric energy generated during the 10-year license for pilot project will come from a renewable resource, which will not contribute to atmospheric pollution; (3) the recommended environmental and public safety measures will adequately protect, mitigate, and enhance fish and wildlife and cultural resources, recreation, navigation, and other uses of Admiralty Inlet that could be affected by the project; and (4) the monitoring required for the project will provide an improved understanding of the environmental effects of tidal energy projects that will be instrumental in assessing the potential effects of future projects of this type and identifying measures to minimize adverse environmental effects.

[129] 16 U.S.C. §§ 797(e) and 803(a)(1) (2012).

LICENSE TERM

165. We are issuing a 10-year license for the Admiralty Inlet Project. Although we typically set terms of at least 30 years for original licenses, the FPA does not establish a minimum license term for such licenses. Snohomish PUD requested a 10-year license to allow it sufficient time to procure and install the project, operate for five years, and either remove the project or develop a subsequent license application before license expiration. Accordingly, a ten-year license term is appropriate.

The Commission orders:

(A) This license is issued to Public Utility District No. 1 of Snohomish County, Washington (licensee), for a period of ten years, effective the first day of the month in which this order is issued, to construct, operate, and maintain the Admiralty Inlet Pilot Tidal Project. This license is subject to the terms and conditions of the Federal Power Act (FPA), which are incorporated by reference as part of this license, and subject to the regulations the Commission issues under the provisions of the FPA.

(B) The project consists of:

(1) All lands, to the extent of the licensee's interests in these lands, enclosed by the project boundary shown by exhibit G filed on October 15, 2012:

Exhibit G Drawing	FERC No. 12690-005	Description
Sheet 1	1	Overall Site & Control - Plan
Sheet 2	2	Project Corridor
Sheet 3	3	Building Site Detail

(2) Project works consisting of: (1) two approximately 19.2-feet-high, 300-kilowatt OpenHydro tidal turbines mounted on a triangular subsea base; (2) adaptable monitoring packages attached to each turbine base containing environmental monitoring equipment, vibration monitoring instrumentation, and differential settlement measurement equipment; (3) two approximately 7,000-foot-long, four-kilovolt (kV) trunk cables, extending from each turbine to the onshore cable termination vault; (4) an approximately 3.9-foot-long, 5.8-foot-wide, 2.9-foot-high onshore cable termination vault; (5) two 40-foot-long conduits to convey the cables from the cable termination vault to a cable control building; (6) a 24-foot-wide, 30-foot-long onshore cable control building that will house power and monitoring equipment; (7) a 17.2-kV step-up transformer located adjacent to the cable control building; (8) a 10-foot-

long, buried 7.2-kV transmission line from the transformer to a connection with Puget Sound Energy; and (9) appurtenant facilities.

The project works generally described above are more specifically shown and described by those portions of exhibits A and F shown below:

Exhibit A: The following section of exhibit A filed on December 7, 2012:

Section 2, pages A-1 through A-8, entitled "Project Description," describing the mechanical, electrical, and transmission equipment within the application for license.

Exhibit F: The following exhibit F drawings filed on March 1, 2012:

Exhibit F Drawing	FERC No. 12690-005	Description
Sheet 1	1	Power Conditioning Building Site Plan
Sheet 2	2	Power Conditioning Building Elevations
Sheet 3	3	6 M Gravity Base & Turbine Assembly

(3) All of the structures, fixtures, equipment or facilities used to operate or maintain the project, all portable property that may be employed in connection with the project, and all riparian or other rights that are necessary or appropriate in the operation or maintenance of the project.

(C) The exhibits A, F, and G described above are approved and made part of the license.

(D) The following sections of the FPA are waived and excluded from the license for this minor project: 4(b), except the second sentence; 4(e), insofar as it relates to approval of plans by the Chief of Engineers and the Secretary of the Army; 6, insofar as it relates to public notice and to the acceptance and expression in the license of terms and conditions of the Act that are waived here; 10(c), insofar as it relates to depreciation reserves; 10(d); 10(f); 14, except insofar as the power of condemnation is reserved; 15; 16; 19; 20; and 22.

(E) This license is subject to the conditions submitted by the Washington Department of Ecology under section 401(a)(1) of the Clean Water Act, 33 U.S.C. § 1341(a)(1), as those conditions are set forth in Appendix A to this order.

(F) This licernse is subject to the reasonable and prudent measures and terms and conditions of the Biological Opinion, dated December 3, 2013, by the National

Marine Fisheries Service under section 7 of the Endangered Species Act, as set forth in Appendix B of this order.

(G) This license is also subject to: (a) the articles set forth in Form L-14 (October 1975), entitled, "Terms and Conditions of License for Unconstructed Minor Project Affecting Navigable Waters of the United States" (*see* 54 FPC 1876) with the modification to Article 11 to include the Secretary of Commerce as a recommending entity and (b) the following additional articles:

Article 201. *Administrative Annual Charges*. The licensee shall pay the United States annual charges as determined in accordance with the provisions of the Commission's regulations in effect from time to time, effective as of the date of commencement of project operation, to reimburse the United States for the cost of administration of Part 1 of the Federal Power Act. The authorized installed capacity for that purpose is 600 kilowatts (kW). Under the regulations currently in effect, projects with authorized installed capacity of less than or equal to 1,500 kW will not be assessed an annual charge.

Article 202. *Exhibit Drawings*. Within 45 days of the date of issuance of this license, the licensee shall file the approved exhibit drawings in aperture card and electronic file formats.

(a) Three sets of the approved exhibit drawings shall be reproduced on silver or gelatin 35mm microfilm. All microfilm shall be mounted on type D (3-1/4" X 7-3/8") aperture cards. Prior to microfilming, the FERC Project-Drawing Number (i.e., P-12690-# through P-12690-#) shall be shown in the margin below the title block of the approved drawing. After mounting, the FERC Drawing Number shall be typed on the upper right corner of each aperture card. Additionally, the Project Number, FERC Exhibit (i.e., F-1, G-1, etc.), Drawing Title, and date of this license shall be typed on the upper left corner of each aperture card.

Two of the sets of aperture cards shall be filed with the Secretary of the Commission, ATTN: OEP/DHAC. The third set shall be filed with the Commission's Division of Dam Safety and Inspections Portland Regional Office.

(b) The licensee shall file two separate sets of exhibit drawings in electronic raster format with the Secretary of the Commission, ATTN: OEP/DHAC. A third set shall be filed with the Commission's Division of Dam Safety and Inspections Portland Regional Office. Exhibit F drawings must be separated from other project exhibits and identified as Critical Energy Infrastructure Information (CEII) material under 18 C.F.R. § 388.113(c) (2012). Each drawing must be a separate electronic file, and the file name shall include: FERC Project-Drawing Number, FERC Exhibit, Drawing Title, date of this license, and file extension in the following format [P-12690-#, G-1, Project

Boundary, MM-DD-YYYY.TIF]. Electronic drawings shall meet the following format specifications:

IMAGERY - black & white raster file
FILE TYPE – Tagged Image File Format, (TIFF) CCITT Group 4
RESOLUTION – 300 dpi desired, (200 dpi min)
DRAWING SIZE FORMAT – 24" X 36" (min), 28" X 40" (max)
FILE SIZE – less than 1 MB desired

Each Exhibit G drawing that includes the project boundary must contain a minimum of three known reference points (i.e., latitude and longitude coordinates, or state plane coordinates). The points must be arranged in a triangular format for GIS geo-referencing the project boundary drawing to the polygon data, and must be based on a standard map coordinate system. The spatial reference for the drawing (i.e., map projection, map datum, and units of measurement) must be identified on the drawing and each reference point must be labeled. In addition, each project boundary drawing must be stamped by a registered land surveyor.

(c) The licensee shall file two separate sets of the project boundary data in a geo-referenced electronic file format (such as ArcView shape files, GeoMedia files, MapInfo files, or a similar GIS format) with the Secretary of the Commission, ATTN: OEP/DHAC. The filing shall include both polygon data and all reference points shown on the individual project boundary drawings. An electronic boundary polygon data file(s) is required for each project development. Depending on the electronic file format, the polygon and point data can be included in a single file with multiple layers. The geo-referenced electronic boundary data file must be positionally accurate to ±40 feet in order to comply with National Map Accuracy Standards for maps at a 1:24,000 scale. The file name(s) shall include: FERC Project Number, data description, date of this license, and file extension in the following format [P-12690, boundary polygon/or point data, MM-DD-YYYY.SHP]. The data must be accompanied by a separate text file describing the spatial reference for the geo-referenced data: map projection used (i.e., UTM, State Plane, Decimal Degrees, etc.), the map datum (i.e., North American 27, North American 83, etc.), and the units of measurement (i.e., feet, meters, miles, etc.). The text file name shall include: FERC Project Number, data description, date of this license, and file extension in the following format [P-12690, project boundary metadata, MM-DD-YYYY.TXT].

Article 203. *Documentation of Project Financing*. At least 90 days before starting construction, the licensee shall file with the Commission, for approval, the licensee's documentation for the project financing. The documentation must show that the licensee has acquired the funds, or commitment for funds necessary to construct and operate the project in accordance with this license. The documentation must include, at a minimum, financial statements, including a balance sheet, income statement, and a

statement of actual or estimated cash flows over the license term which provide evidence that the licensee has sufficient assets, credit, and projected revenues to cover project construction, operation, maintenance and removal expenses, and any other estimated project liabilities and expenses.

The financial statements must be prepared in accordance with generally accepted accounting principles and signed by an independent certified public accountant. The licensee shall not commence construction associated with the project before the filing is approved.

Article 204. *Project Land Rights Progress Report*. No later than four years after license issuance, the licensee shall file a report with the Commission describing the status of acquiring title in fee or the rights for all the lands within the project boundary. The report must provide an overview map of each parcel and summary table identifying the licensee's rights over each parcel within the project boundary. The report shall also include specific supporting documentation showing the status of the land rights on all parcels of land within the project boundary that: (1) have been acquired up to the date of filing of the report, including pertinent deeds, lease agreements, and/or bill of sale information that specifically verify the licensee's rights; and (2) the licensee's plan and schedule for acquiring all remaining project lands prior to the five-year deadline, including a history of actions taken, current owner information, the type of ownership to be acquired whether in fee or by easement, and the timeline for completing property acquisition.

Article 301. *Start of Construction*. The licensee shall commence construction of the project works within two years from the issuance date of the license and shall complete construction of the project within five years from the issuance date of the license.

Article 302. *Cofferdam and Deep Excavation Construction Drawings*. Should construction require cofferdams or deep excavations, the licensee shall: (1) review and approve the design of contractor-designed cofferdams and deep excavations prior to the start of construction; and (2) shall ensure that construction of cofferdams and deep excavations is consistent with the approved design. At least 30 days before starting construction of any cofferdams or deep excavations, the licensee shall submit one copy of the approved cofferdam and deep excavation construction drawings and specifications, and the letters of approval, to the Commission's Division of Dam Safety and Inspections (D2SI Portland Regional Engineer) and two copies to the Commission (one of these copies shall be a courtesy copy to the Commission's Director, D2SI).

Article 303. *Contract Plans and Specifications*. At least 60 days prior to the start of any construction, the licensee shall submit one copy of its plans and specifications and supporting design document to the Commission's Division of Dam Safety and

Inspections (D2SI) Portland Regional Engineer, and two copies to the Commission (one of these shall be a courtesy copy to the Director, D2SI). The supporting design report and specifications shall include, but not be limited to, a foundation report sufficient to confirm the design of the turbine footings.

The submittal to the D2SI Portland Regional Engineer must also include as part of preconstruction requirements: a Quality Control and Inspection Program, a Temporary Construction Emergency Action Plan, a Soil Erosion and Sediment Control Plan, and the Horizontal Directional Drilling Work Plan and Frac-Out and Surface Spill Contingency Plan required by Washington Department of Ecology water quality certification (Appendix A, conditions D7 and D8, respectively).

The licensee may not begin construction until the D2SI Portland Regional Engineer has reviewed and commented on the plans and specifications, determined that all preconstruction requirements have been satisfied, and authorized start of construction.

Article 304. *As-built Drawings*. Within 90 days of completion of construction of the facilities authorized by this license, the licensee shall file for Commission approval, revised Exhibits A, F, and G, as applicable, to describe and show those project facilities as built. A courtesy copy shall be filed with the Commission's Division of Dam Safety and Inspections (D2SI) Portland Regional Engineer; the Director, D2SI; and the Director, Division of Hydropower Administration and Compliance. A courtesy copy of the revised Exhibit G shall also be provided to PC Landing Corp.

Article 305. *Project and Public Safety Plan*. Upon license issuance, the licensee shall implement the Project and Public Safety Plan, filed February 14, 2013. This plan may not be amended without prior Commission approval.

Article 306. *Navigation Safety Plan*. Upon license issuance, the licensee shall implement the *Navigation Safety Plan*, filed February 14, 2013. This plan may not be amended without prior Commission approval.

Article 307. *Emergency Shutdown Plan.* At least 60 days before starting construction, the licensee shall file with the Commission for approval a revised Emergency Shutdown Plan. The plan shall be based on the Emergency Shutdown Plan filed with Commission on February 14, 2013, and shall include additional measures (such as notification of United States Coast Guard, deployment of buoys or warning devices, etc.) during an emergency for keeping the area near the turbines clear of unnecessary traffic and preventing interaction with the turbine until the shutdown is completed. The licensee shall prepare the plan after consultation with the United States Coast Guard. The licensee shall allow a minimum of 30 days for the U.S. Coast Guard to comment and to make recommendations before filing the plan with the Commission. If the licensee does not adopt a recommendation, the filing shall include the licensee's reasons based on project-specific information.

Article 308. *Removal of Obstructions to Navigation*. If the U.S. Army Corps of Engineers determines that the project presents an unreasonable obstruction to the free navigation of navigable waters, the licensee shall, upon due notice from the Corps and upon Commission approval, remove, relocate, or alter the structural work or obstructions caused thereby, without expense to the United States.

Article 309. *Project Operations and Monitoring Plan*. At least 60 days before starting project operations, the licensee shall submit one copy of a Project Operations and Monitoring Plan to the Commission's Division of Dam Safety and Inspections (D2SI)-Portland Regional Engineer, and two copies to the Commission (one of these shall be a courtesy copy to the Director, D2SI). The plan shall define the normal operating parameters of the turbines; describe all electrical and mechanical monitoring devices (i.e. tilt meter, accelerometer, etc.) and the respective threshold levels indicating abnormal operations (e.g., excessive vibration or tilt); define response procedures to address the mechanical alarm settings; define the scour thresholds (i.e., depth and width measurements) requiring implementation of scour protection measures; and specify the schedule for remote operated vehicle (ROV) inspections. ROV inspections shall occur at a minimum of: (1) immediately following installation of both turbines; (2) by day 30 of initiation of operation; (3) by day 90 of initiation of operation; (4) by day 180 of initiation of operation; (5) by day 270 of initiation of operation; (6) by day 365 of initiation of operation; (7) by day 540 of initiation of operation; (8) by day 720 of initiation of operation; and (9) twice annually thereafter until the project is removed.

Snohomish PUD shall consult with PC Landing Corp. in developing the scour thresholds and the notification procedures if the scouring threshholds are exceeded. The plan shall describe how PC Landing's concerns have been addressed.

The licensee shall not install the turbines until the D2SI-Regional Engineer approves the plan.

Article 310. *Annual Performance Report and Certification*. Following start of operations and by December 31 of each year thereafter, the licensee shall submit one copy of a report describing the project's performance to the Commission's Division of Dam Safety and Inspections (D2SI)-Portland Regional Engineer, and two copies to the Commission (one of these shall be a courtesy copy to the Director, D2SI). The report shall include: (1) the adequacy of project monitoring and operations; (2) the findings of inspections; and (3) a summary of the major maintenance and repairs performed during the previous year. The report shall certify that the project features are being operated, monitored, inspected, and maintained in accordance with the license and approved plans. A copy of the report shall also be provided to PC Landing Corp. by December 31 of each year.

Article 401. *Commission Approval, Notification, and Filing of Amendments*. Various conditions of the Washington Department of Ecology's (Washington Ecology) Water Quality Certification (WQC) require the licensee to prepare plans and reports for approval by Washington Ecology (Appendix A), but do not require Commission review and approval. For the plans and reports listed below, the licensee shall submit such plan or report to the Commission by the date shown for Commission approval.

(a) Requirement to file plans

Each of the following plans required by the Washington Ecology as part of its WQC shall be submitted to the Commission for approval:

WQC Condition No.	*Plan Name*	*Due Date to Commission*
F1	Project Removal and Site Restoration Plan	Six months before license expiration or 60 days before project removal, whichever comes first
G1	Spill Prevention and Containment Plan	Within six months of license issuance or 90 days before the start of project installation, whichever come first

The licensee shall include with each plan filed with the Commission documentation that the licensee developed the plan in consultation with Washington Ecology and has received approval from Washington Ecology. The Commission reserves the right to make changes to any plan submitted. Upon Commission approval, the plan becomes a requirement of the license, and the licensee shall implement the plan or changes in project operations or facilities, including any changes required by the Commission.

In addition, the Project Removal and Site Restoration Plan shall be developed after consultation with National Marine Fisheries Service, U.S. Fish and Wildlife Service, Washington Department of Fish and Wildlife, Washington Ecology, Washington Department of Natural Resources, the Tulalip Tribes, Suquamish Tribe, Swinomish Indian Tribal Community, and Sauk-Suiattle Tribe. The submittal shall include copies of comments and recommendations on the plan made by these entities and licensee's specific descriptions of how the entities' comments are accommodated by the revised plan.

(b) Requirement to File Reports

Each of the following reports required by Washington Ecology as part of its WQC shall be submitted to the Commission for approval:

WQC Condition No.	*Description*	*Due date to Commission*
I3	Status report if construction is not completed within 13 months of issuance of WQC	January 3, 2015, and every 12 months thereafter until construction is completed
B8	Exceedances detected through water quality sampling	File a report on the nature of exceedance, turbidity results, and other pertinent information within 10 days of the exceedance.
G4c and d	Any work out of compliance with the WQC, particularly relating to spills or distressed or dying fish	Notify the Commission within 24 hours, and within 10 days file a report on the nature of the event, corrective action taken, and measures to be taken to prevent reoccurrence.

The licensee shall submit to the Commission documentation of any consultation, and copies of any comments and recommendations made by any consulted entity in connection with each report. The Commission reserves the right to require changes to project operations or facilities based on the information contained in the report and any other available information.

Article 402. *Horizontal Directional Drilling Plan.* Upon license issuance, the licensee shall implement the Horizontal Directional Drilling Plan, filed March 1, 2012, with the following modification.

Horizontal directional drilling operations shall be conducted between the hours of 7:00 a.m. and 7:00 p.m. to minimize disturbance to nearby residences. In the event that horizontal directional drilling must occur outside of the defined work hours, the licensee

shall implement noise abatement contingency measures, such as the placement of a temporary sound barrier (or appropriate alternative), to reduce noise impacts on neighboring residences. Contingency measures must be readily available to maintain sound levels below 55 decibels at both the east and west property boundaries of the HDD drill site. Any implementation of contingency measures shall be reported within 48 hours to the Commission's Division of Dam Safety and Inspections (D2SI) – Portland Regional Engineer.

Article 403. *Invasive Plant Management Plan*. To control the introduction and spread of invasive plants on project lands during construction and project removal, the licensee shall: (1) use gravel, rock, or other fill material from a weed free source; (2) revegetate disturbed areas with species native to Keystone Spit, with the source material (seeds or cuttings) collected from Keystone Spit; (3) ensure that no imported soil, fertilizer, or tackifiers will be used in revegetating disturbed areas; and (4) inspect any fill and disturbed areas for invasive plants annually, between early and mid-June and again in August, and eradicate any detected invasive plants promptly. Within six months of completing site revegetation efforts, the licensee shall file a report documenting compliance with the above provisions and annually thereafter until the native vegetation has become established and is free of invasive plants.

Article 404. *Acoustic Monitoring and Mitigation Plan.* Upon license issuance, the licensee shall implement the Acoustic Monitoring and Mitigation Plan, filed on February 14, 2013. This plan may not be amended without prior Commission approval. Any proposed modifications shall be approved by NMFS before submittal to the Commission for approval. Any such submittal shall also include documentation of consulation with NMFS, U.S. Fish and Wildlife Service, Washington Department of Fish and Wildlife, Washington Department of Ecology, Washington Department of Natural Resources, the Tulalip Tribes, Suquamish Tribe, Swinomish Indian Tribal Community, and Sauk-Suiattle Tribe. The submittal shall include copies of comments and recommendations on the proposed modifications to the plan made by these entities and licensee's specific descriptions of how the entities' comments are accommodated by the revised plan. The Commission reserves the right to require changes to the licensee's proposed modifications. Upon Commission approval, the licensee shall implement modifications, including any changes required by the Commission.

Article 405. *Benthic Habitat Monitoring and Mitigation Plan.* Upon license issuance, the licensee shall implement the Benthic Habitat Monitoring and Mitigation Plan filed on November 16, 2012, with the following modification: by March 31 of each calendar year the licensee shall file a report with the Commission describing changes from the previous calendar year to colonization of the subsea base, power cables, and drill hole exit point and changes to the seabed benthic habitat around the subsea base, including sediment scour and deposition.

Prior to filing the report with the Commission, the licensee shall provide the report to Washington Department of Ecology (Washington Ecology) and allow them 30 days to review and comment on the report. The report filed with the Commission shall include copies of, and address any comments and recommendations received from Washington Ecology. If the licensee does not adopt a recommendation, the licensee shall include its reasons based on project-specific information.

This plan may not be amended without prior Commission approval. Any proposed modifications to the plan shall be approved by Washington Ecology and NMFS before submittal to the Commission for approval. Any such submittal shall include documentation of consultation with National Marine Fisheries Service, U.S. Fish and Wildlife Service (FWS), Washington Department of Fish and Wildlife, Washington Ecology, Washington Department of Natural Resources, the Tulalip Tribes, Suquamish Tribe, Swinomish Indian Tribal Community, and Sauk-Suiattle Tribe. The submittal shall also include copies of comments and recommendations on the proposed modifications to the plan made by these consulted entities, and specific descriptions of how the entities' comments are accommodated by the revised plan.

The Commission reserves the right to require changes to the licensee's modifications. Upon Commission approval, the licensee shall implement modifications, including any changes required by the Commission.

Article 406. *Near-Turbine Monitoring and Mitigation Plan.* Upon license issuance, the licensee shall implement the Near-Turbine Monitoring and Mitigation Plan, filed November 16, 2012, with the following modification to address the National Marine Fisheries Service's (NMFS) incidental take condition 5 in Appendix B: if it is reasonably foreseeable that the number of individual salmon, steelhead, or rockfish crossing the plane of the turbine blades and not through the open center of the rotor will exceed ten adult salmon or steelhead (Chinook, chum, or steelhead); one adult yelloweye rockfish; one adult canary rockfish; or one adult Bocaccio in a year, the licensee shall contact NMFS and the Commission within 48 hours.

This plan may not be amended without prior Commission approval. Any proposed modifications to the plan shall be approved by NMFS before submittal to the Commission for approval. Any such submittal shall include documentation of consultation with NMFS, U.S. Fish and Wildlife Service, Washington Department of Fish and Wildlife, Washington Department of Ecology, Washington Department of Natural Resources, the Tulalip Tribes, Suquamish Tribe, Swinomish Indian Tribal Community, and Sauk-Suiattle Tribe. The submittal shall also include copies of comments and recommendations on the proposed modifications to the plan made by these consulted entities, and specific descriptions of how the entities' comments are accommodated by the revised plan.

The Commission reserves the right to require changes to the licensee's modifications. Upon Commission approval, the licensee shall implement modifications, including any changes required by the Commission.

Article 407. *Marine Mammal Monitoring and Mitigation Plan.* Upon license issuance, the licensee shall implement the Marine Mammal Monitoring and Mitigation Plan, filed November 16, 2012. This plan may not be amended without prior Commission approval. Any such submittal shall include documentation of consultation with the National Marine Fisheries Service, U.S. Fish and Wildlife Service, Washington Department of Fish and Wildlife, Washington Department of Ecology, Washington Department of Natural Resources, the Tulalip Tribes, Suquamish Tribe, Swinomish Indian Tribal Community, and Sauk-Suiattle Tribe. The submittal shall also include copies of comments and recommendations on the proposed modifications to the plan made by these consulted entities, and specific descriptions of how the entities' comments are accommodated by the revised plan.

The Commission reserves the right to require changes to the licensee's modifications. Upon Commission approval, the licensee shall implement modifications, including any changes required by the Commission.

Article 408. *Marine Mammal Protection Act Report*. The licensee shall file with the Commission an annual report documenting its consultations with the National Marine Fisheries Service under the Marine Mammal Protection Act (Act), starting January 1, 2015, and annually therafter until such time as it completes its responsibilities under the Act. Licensee's report must update the Commission on the status of its consultations, include information as to whether its compliance with the Act requires it to modify aspects of project construction, operation, maintenance, or removal, and include information detailing how the licensee will initiate any required modifications to the project. If compliance with the Act requires an amendment to license, licensee must seek Commission approval before implementing the measures.

Article 409. *Derelict Gear Monitoring Plan.* Upon license issuance, the licensee shall implement the Derelict Gear Monitoring Plan, filed December 7, 2012. This plan may not be amended without prior Commission approval. Any such submittal shall include documentation of consultation with the National Marine Fisheries Service, U.S. Fish and Wildlife Service, Washington Department of Fish and Wildlife, Washington Department of Ecology, Washington Department of Natural Resources, the Tulalip Tribes, Suquamish Tribe, Swinomish Indian Tribal Community, and Sauk-Suiattle Tribe. The submittal shall also include copies of comments and recommendations on the proposed modifications to the plan made by these consulted entities, and specific descriptions of how the entities' comments are accommodated by the revised plan.

The Commission reserves the right to require changes to the licensee's modifications. Upon Commission approval, the licensee shall implement modifications, including any changes required by the Commission.

Article 410. *In-water Construction Schedule*. All in-water construction shall be conducted during a work window of July 16 to October 14, or outside of this work window only by agreement with the National Marine Fisheries Service, U.S. Fish and Wildlife Service, Washington Department of Fish and Wildlife, Washington Department of Ecology, Washington Department of Natural Resources, the Tulalip Tribes, Suquamish Tribe, Swinomish Indian Tribal Community, and Sauk-Suiattle Tribe. If in consultation with the above entities, the work window changes or is inconsistent with the water quality certificate, the licensee shall notify the Commission and file an application to amend the license accordingly.

Article 411. *Hazard Identification and Risk Assessment*. At least 90 days prior to the start of in-water construction, the licensee shall file with the Commission for approval a Hazard Identification and Risk Assessment (HIRA) to minimize potential hazards to PC-1 North, PC Landing Corp.'s subsea, fiber optic cable. This assessment shall include and describe: (a) operational procedures for installing, maintaining, and removing the project turbines, including using "live boat" techniques for all marine operations, except during the horizontal directional drilling and connection of the trunk cables at the horizontal directional drilling exit; (b) criteria for weather and wave conditions that must exist before marine operations can occur; (c) redundancy in the use of equipment and/or vessels; (d) criteria for aborting the operations; and (e) the establishment of a "port of refuge," located at least two kilometers away from the PC-1 North cable, in the event of unanticipated adverse weather or other event.

In addition, the HIRA shall include procedures and a schedule for notifying PC Landing Corp. before conducting marine operations associated with installing, removing, or repairing the turbines within 1,000 meters of PC-1 North. The HIRA shall also include procedures for providing PC Landing Corp. progress reports during these marine operations and a full report on the marine operations following completion of these activities.

The licensee shall include with the assessment documentation of consultation with the U.S. Coast Guard, the U.S. Army Corps of Engineers, and PC Landing Corp.; copies of comments and recommendations on the completed assessment after it has been prepared and provided to the consulted entities; and specific descriptions of how the entities' comments are accommodated by the assessment. The licensee shall allow a minimum of 30 days for consulted entities to comment and make recommendations before filing the assessment with the Commission. If the licensee does not adopt a recommendation, the filing shall include the licensee's reasons based on project-specific information.

The Commission reserves the right to require changes to the assessment. In-water construction shall not begin until the assessment is approved by the Commission. Upon Commission approval, the licensee shall implement the procedures contained in the assessment, including any changes required by the Commission.

Article 412. *Reservation of Authority to Prescribe Fishways*. Authority is reserved to the Commission to require the licensee to construct, operate, and maintain, or to provide for the construction, operation, and maintenance of such fishways as may be prescribed by the Secretary of the Interior pursuant to section 18 of the Federal Power Act.

Article 413. *Interpretation and Education Plan.* Within six months of license issuance, the licensee shall develop and file for Commission approval an Interpretation and Education Plan for the installation of an interpretive display at a publicly accessible site within view of the turbine locations at Fort Casey State Park, subject to state approval, that describes the project, the potential ocean energy resource in Puget Sound, and the natural and cultural environment of the project area. If a suitable site at the park is not available, another appropriate location may be proposed.

The licensee shall include with the plan documentation of consultation with the U.S. National Park Service, Washington State Parks and Recreation Commission, Washington Department of Fish and Wildlife, Ebey's Landing Historical Reserve Trust Board, and Island County Marine Resources Committee; copies of comments and recommendations on the completed plan after it has been prepared and provided to the consulted entities; and specific descriptions of how the entities' comments are accommodated by the plan. The licensee shall allow a minimum of 30 days for consulted entities to comment and to make recommendations before filing the plan with the Commission. If the licensee does not adopt a recommendation, the filing shall include the licensee's reasons based on project-specific information.

The Commission reserves the right to require changes to the plan. Upon Commission approval, the licensee shall implement the plan, including any changes required by the Commission.

Article 414. *FERC Form 80 Exemption*. There is little or no potential for recreation facilities within the project boundary. Therefore, upon the issuance date of the license, the licensee is exempt from 18 § C.F.R. 8.11, which requires the filing of the FERC Form 80 recreation report for the Admiralty Inlet Project.

Article 415. *Cultural Resources.* Prior to beginning any land-clearing or land-disturbing activities within the project boundary, other than those specifically authorized in this license, the licensee shall consult with the Washington State Historic Preservation Officer (SHPO). If the licensee discovers previously unidentified archeological or historic properties during the course of constructing, maintaining, or removing project

works or other facilities at the project, the licensee shall stop all land-clearing and land-disturbing activities in the vicinity of the properties and consult with the Washington SHPO.

If a discovered cultural resource is determined to be eligible for the National Register of Historic Places, the licensee shall file for Commission approval a historic properties management plan. The plan shall be prepared by a qualified cultural resource specialist after having consulted with the SHPO. The plan shall include the following items:

(1) a description of each discovered property indicating whether it is listed on or eligible to be listed on the National Register of Historic Places;

(2) a description of the potential effect on each discovered property;

(3) proposed measures for avoiding or mitigating effects;

(4) documentation of the nature and extent of consultation; and

(5) a schedule for mitigating effects and conducting additional studies.

The Commission may require changes to the plan. The licensee shall not begin land-clearing or land-disturbing activities, other than those specifically authorized in this license, or resume such activities in the vicinity of a property discovered during construction, until informed by the Commission that the requirements of this article have been fulfilled.

Article 416. *Use and Occupancy*. (a) In accordance with the provisions of this article, the licensee shall have the authority to grant permission for certain types of use and occupancy of project lands and waters and to convey certain interests in project lands and waters for certain types of use and occupancy, without prior Commission approval. The licensee may exercise the authority only if the proposed use and occupancy is consistent with the purposes of protecting and enhancing the scenic, recreational, and other environmental values of the project. For those purposes, the licensee shall also have continuing responsibility to supervise and control the use and occupancies for which it grants permission, and to monitor the use of, and ensure compliance with the covenants of the instrument of conveyance for, any interests that it has conveyed, under this article. If a permitted use and occupancy violates any condition of this article or any other condition imposed by the licensee for protection and enhancement of the project's scenic, recreational, or other environmental values, or if a covenant of a conveyance made under the authority of this article is violated, the licensee shall take any lawful action necessary to correct the violation. For a permitted use or occupancy, that action includes, if necessary, canceling the permission to use and occupy the project lands and waters and requiring the removal of any non-complying structures and facilities.

(b) The type of use and occupancy of project lands and waters for which the licensee may grant permission without prior Commission approval are: (1) landscape plantings; (2) non-commercial piers, landings, boat docks, or similar structures and facilities that can accommodate no more than 10 water craft at a time and where said facility is intended to serve single-family type dwellings; (3) embankments, bulkheads, retaining walls, or similar structures for erosion control to protect the existing shoreline; and (4) food plots and other wildlife enhancement. To the extent feasible and desirable to protect and enhance the project's scenic, recreational, and other environmental values, the licensee shall require multiple use and occupancy of facilities for access to project lands or waters. The licensee shall also ensure, to the satisfaction of the Commission's authorized representative, that the use and occupancies for which it grants permission are maintained in good repair and comply with applicable state and local health and safety requirements. Before granting permission for construction of bulkheads or retaining walls, the licensee shall: (1) inspect the site of the proposed construction, (2) consider whether the planting of vegetation or the use of riprap would be adequate to control erosion at the site, and (3) determine that the proposed construction is needed and would not change the basic contour of the impoundment shoreline. To implement this paragraph (b), the licensee may, among other things, establish a program for issuing permits for the specified types of use and occupancy of project lands and waters, which may be subject to the payment of a reasonable fee to cover the licensee's costs of administering the permit program. The Commission reserves the right to require the licensee to file a description of its standards, guidelines, and procedures for implementing this paragraph (b) and to require modification of those standards, guidelines, or procedures.

(c) The licensee may convey easements or rights-of-way across, or leases of project lands for: (1) replacement, expansion, realignment, or maintenance of bridges or roads where all necessary state and federal approvals have been obtained; (2) storm drains and water mains; (3) sewers that do not discharge into project waters; (4) minor access roads; (5) telephone, gas, and electric utility distribution lines; (6) non-project overhead electric transmission lines that do not require erection of support structures within the project boundary; (7) submarine, overhead, or underground major telephone distribution cables or major electric distribution lines (69-kV or less); and (8) water intake or pumping facilities that do not extract more than one million gallons per day from a project impoundment. No later than January 31 of each year, the licensee shall file three copies of a report briefly describing for each conveyance made under this paragraph (c) during the prior calendar year, the type of interest conveyed, the location of the lands subject to the conveyance, and the nature of the use for which the interest was conveyed.

(d) The licensee may convey fee title to, easements or rights-of-way across, or leases of project lands for: (1) construction of new bridges or roads for which all necessary state and federal approvals have been obtained; (2) sewer or effluent lines that discharge into project waters, for which all necessary federal and state water quality certification or permits have been obtained; (3) other pipelines that cross project lands or waters but do not discharge into project waters; (4) non-project overhead electric transmission lines that require erection of support structures within the project boundary, for which all necessary federal and state approvals have been obtained; (5) private or public marinas that can accommodate no more than 10 water craft at a time and are located at least one-half mile (measured over project waters) from any other private or public marina; (6) recreational development consistent with an approved report on recreational resources of an Exhibit E; and (7) other uses, if: (i) the amount of land conveyed for a particular use is five acres or less; (ii) all of the land conveyed is located at least 75 feet, measured horizontally, from project waters at normal surface elevation; and (iii) no more than 50 total acres of project lands for each project development are conveyed under this clause (d)(7) in any calendar year. At least 60 days before conveying any interest in project lands under this paragraph (d), the licensee must submit a letter to the Director, Office of Energy Projects, stating its intent to convey the interest and briefly describing the type of interest and location of the lands to be conveyed (a marked Exhibit G map may be used), the nature of the proposed use, the identity of any federal or state agency official consulted, and any federal or state approvals required for the proposed use. Unless the Director, within 45 days from the filing date, requires the licensee to file an application for prior approval, the licensee may convey the intended interest at the end of that period.

(e) The following additional conditions apply to any intended conveyance under paragraph (c) or (d) of this article:

(1) Before conveying the interest, the licensee shall consult with federal and state fish and wildlife or recreation agencies, as appropriate, and the State Historic Preservation Officer.

(2) Before conveying the interest, the licensee shall determine that the proposed use of the lands to be conveyed is not inconsistent with any approved report on recreational resources of an Exhibit E; or, if the project does not have an approved report on recreational resources, that the lands to be conveyed do not have recreational value.

(3) The instrument of conveyance must include the following covenants running with the land: (i) the use of the lands conveyed shall not endanger health, create a nuisance, or otherwise be incompatible with overall project recreational use; (ii) the grantee shall take all reasonable precautions to ensure that the construction, operation, and maintenance of structures or facilities on the conveyed lands will occur in a manner that will protect the scenic, recreational, and environmental values of the project; and (iii) the grantee shall not unduly restrict public access to project waters.

(4) The Commission reserves the right to require the licensee to take reasonable remedial action to correct any violation of the terms and conditions of this article, for the protection and enhancement of the project's scenic, recreational, and other environmental values.

(f) The conveyance of an interest in project lands under this article does not in itself change the project boundaries. The project boundaries may be changed to exclude land conveyed under this article only upon approval of revised Exhibit G drawings (project boundary maps) reflecting exclusion of that land. Lands conveyed under this article will be excluded from the project only upon a determination that the lands are not necessary for project purposes, such as operation and maintenance, flowage, recreation, public access, protection of environmental resources, and shoreline control, including shoreline aesthetic values. Absent extraordinary circumstances, proposals to exclude lands conveyed under this article from the project shall be consolidated for consideration when revised Exhibit G drawings would be filed for approval for other purposes.

(g) The authority granted to the licensee under this article shall not apply to any part of the public lands and reservations of the United States included within the project boundary.

Article 417. *Ferry Service Operation Coordination Plan*. Within six months of license issuance or at least 60 days prior to the start of in-water construction, whichever comes first, the licensee shall file for Commission approval a plan to coordinate the installation and removal (if required) of the trunk cables in or across the regular route of the Port Townsend-Coupeville Ferry to minimize any disruptions in ferry service. The plan shall describe the timing and procedures, including notification requirements, to be followed to minimize disruption of ferry service operations. The licensee shall notify the

Commission within 10 days of when installation and removal (if required) of the trunk cables is complete and disruptions to ferry service is no longer a potential problem.

The licensee shall prepare the plan in consultation with the Washington State Ferry Service. The licensee shall include with the plan an implementation schedule, documentation of consultation, copies of recommendations on the completed plan after it has been prepared and provided to the Washington State Ferries, and specific descriptions of how the Washington State Ferries comments are accommodated by the plan. The licensee shall allow a minimum of 30 days for the Washington State Ferries to comment and to make recommendations before filing the plan with the Commission. If the licensee does not adopt a recommendation, the filing shall include the licensee's reasons, based on project-specific information.

The Commission reserves the right to require changes to the plan. The licensee shall not begin in-water construction until the licensee is notified by the Commission that the plan is approved. Upon Commission approval, the licensee shall implement the plan, including any changes required by the Commission.

(H) The licensee shall serve copies of any Commission filing required by this order on any entity specified in the order to be consulted on matters relating to that filing. Proof of service on these entities must accompany the filing with the Commission.

(I) This order constitutes final agency action. Any party may file a request for rehearing of this order within 30 days from the date of its issuance, as provided in section 313(a) of the FPA, 16 U.S.C. § 825*l* (2012), and section 385.713 of the Commission's regulations, 18 C.F.R. § 385.713 (2013). The filing of a request for rehearing does not operate as a stay of the effective date of this license or of any other date specified in this order. The licensee's failure to file a request for rehearing shall constitute acceptance of this order.

By the Commission.

(S E A L)

Nathaniel J. Davis, Sr.,
Deputy Secretary.

Form L-14
(October, 1975)

FEDERAL ENERGY REGULATORY COMMISSION

TERMS AND CONDITIONS OF LICENSE FOR UNCONSTRUCTED MINOR PROJECT AFFECTING NAVIGABLE WATERS OF THE UNITED STATES

Article 1. The entire project, as described in this order of the Commission, shall be subject to all of the provisions, terms, and conditions of the license.

Article 2. No substantial change shall be made in the maps, plans, specifications, and statements described and designated as exhibits and approved by the Commission in its order as a part of the license until such change shall have been approved by the Commission: Provided, however, That if the Licensee or the Commission deems it necessary or desirable that said approved exhibits, or any of them, be changed, there shall be submitted to the Commission for approval a revised, or additional exhibit or exhibits covering the proposed changes which, upon approval by the Commission, shall become a part of the license and shall supersede, in whole or in part, such exhibit or exhibits theretofore made a part of the license as may be specified by the Commission.

Article 3. The project works shall be constructed in substantial conformity with the approved exhibits referred to in Article 2 herein or as changed in accordance with the provisions of said article. Except when emergency shall require for the protection of navigation, life, health, or property, there shall not be made without prior approval of the Commission any substantial alteration or addition not in conformity with the approved plans to any dam or other project works under the license or any substantial use of project lands and waters not authorized herein; and any emergency alteration, addition, or use so made shall thereafter be subject to such modification and change as the Commission may direct. Minor changes in project works, or in uses of project lands and waters, or divergence from such approved exhibits may be made if such changes will not result in a decrease in efficiency, in a material increase in cost, in an adverse environmental impact, or in impairment of the general scheme of development; but any of such minor changes made without the prior approval of the Commission, which in its judgment have produced or will produce any of such results, shall be subject to such alteration as the Commission may direct.

Upon the completion of the project, or at such other time as the Commission may direct, the Licensee shall submit to the Commission for approval revised exhibits insofar as necessary to show any divergence from or variations in the project area and project

boundary as finally located or in the project works as actually constructed when compared with the area and boundary shown and the works described in the license or in the exhibits approved by the Commission, together with a statement in writing setting forth the reasons which in the opinion of the Licensee necessitated or justified variation in or divergence from the approved exhibits. Such revised exhibits shall, if and when approved by the Commission, be made a part of the license under the provisions of Article 2 hereof.

Article 4. The construction, operation, and maintenance of the project and any work incidental to additions or alterations shall be subject to the inspection and supervision of the Regional Engineer, Federal Energy Regulatory Commission, in the region wherein the project is located, or of such other officer or agent as the Commission may designate, who shall be the authorized representative of the Commission for such purposes. The Licensee shall cooperate fully with said representative and shall furnish him a detailed program of inspection by the Licensee that will provide for an adequate and qualified inspection force for construction of the project and for any subsequent alterations to the project. Construction of the project works or any features or alteration thereof shall not be initiated until the program of inspection for the project works or any such feature thereof has been approved by said representative. The Licensee shall also furnish to said representative such further information as he may require concerning the construction, operation, and maintenance of the project, and of any alteration thereof, and shall notify him of the date upon which work will begin, as far in advance thereof as said representative may reasonably specify, and shall notify him promptly in writing of any suspension of work for a period of more than one week, and of its resumption and completion. The Licensee shall allow said representative and other officers or employees of the United States, showing proper credentials, free and unrestricted access to, through, and across the project lands and project works in the performance of their official duties. The Licensee shall comply with such rules and regulations of general or special applicability as the Commission may prescribe from time to time for the protection of life, health, or property.

Article 5. The Licensee, within five years from the date of issuance of the license, shall acquire title in fee or the right to use in perpetuity all lands, other than lands of the United States, necessary or appropriate for the construction, maintenance, and operation of the project. The Licensee or its successors and assigns shall, during the period of the license, retain the possession of all project property covered by the license as issued or as later amended, including the project area, the project works, and all franchises, easements, water rights, and rights of occupancy and use; and none of such properties shall be voluntarily sold, leased, transferred, abandoned, or otherwise disposed of without the prior written approval of the Commission, except that the Licensee may lease or otherwise dispose of interests in project lands or property without specific written approval of the Commission pursuant to the then current regulations of the Commission.

The provisions of this article are not intended to prevent the abandonment or the retirement from service of structures, equipment, or other project works in connection with replacements thereof when they become obsolete, inadequate, or inefficient for further service due to wear and tear; and mortgage or trust deeds or judicial sales made thereunder, or tax sales, shall not be deemed voluntary transfers within the meaning of this article.

Article 6. The Licensee shall install and thereafter maintain gages and stream-gaging stations for the purpose of determining the stage and flow of the stream or streams on which the project is located, the amount of water held in and withdrawn from storage, and the effective head on the turbines; shall provide for the required reading of such gages and for the adequate rating of such stations; and shall install and maintain standard meters adequate for the determination of the amount of electric energy generated by the project works. The number, character, and location of gages, meters, or other measuring devices, and the method of operation thereof, shall at all times be satisfactory to the Commission or its authorized representative. The Commission reserves the right, after notice and opportunity for hearing, to require such alterations in the number, character, and location of gages, meters, or other measuring devices, and the method of operation thereof, as are necessary to secure adequate determinations. The installation of gages, the rating of said stream or streams, and the determination of the flow thereof, shall be under the supervision of, or in cooperation with, the District Engineer of the United States Geological Survey having charge of stream-gaging operations in the region of the project, and the Licensee shall advance to the United States Geological Survey the amount of funds estimated to be necessary for such supervision, or cooperation for such periods as may be mutually agreed upon. The Licensee shall keep accurate and sufficient records of the foregoing determinations to the satisfaction of the Commission, and shall make return of such records annually at such time and in such form as the Commission may prescribe.

Article 7. The Licensee shall, after notice and opportunity for hearing, install additional capacity or make other changes in the project as directed by the Commission, to the extent that it is economically sound and in the public interest to do so.

Article 8. The Licensee shall, after notice and opportunity for hearing, coordinate the operation of the project, electrically and hydraulically, with such other projects or power systems and in such manner as the Commission may direct in the interest of power and other beneficial public uses of water resources, and on such conditions concerning the equitable sharing of benefits by the Licensee as the Commission may order.

Article 9. The United States specifically retains and safeguards the right to use water in such amount, to be determined by the Secretary of the Army, as may be necessary for the purposes of navigation on the navigable waterway affected; and the

operations of the Licensee, so far as they affect the use, storage and discharge from storage of waters affected by the license, shall at all times be controlled by such reasonable rules and regulations as the Secretary of the Army may prescribe in the interest of navigation, and as the Commission may prescribe for the protection of life, health, and property, and in the interest of the fullest practicable conservation and utilization of such waters for power purposes and for other beneficial public uses, including recreational purposes, and the Licensee shall release water from the project reservoir at such rate in cubic feet per second, or such volume in acre-feet per specified period of time, as the Secretary of the Army may prescribe in the interest of navigation, or as the Commission may prescribe for the other purposes hereinbefore mentioned.

Article 10. On the application of any person, association, corporation, Federal agency, State or municipality, the Licensee shall permit such reasonable use of its reservoir or other project properties, including works, lands and water rights, or parts thereof, as may be ordered by the Commission, after notice and opportunity for hearing, in the interests of comprehensive development of the waterway or waterways involved and the conservation and utilization of the water resources of the region for water supply or for the purposes of steam-electric, irrigation, industrial, municipal or similar uses. The Licensee shall receive reasonable compensation for use of its reservoir or other project properties or parts thereof for such purposes, to include at least full reimbursement for any damages or expenses which the joint use causes the Licensee to incur. Any such compensation shall be fixed by the Commission either by approval of an agreement between the Licensee and the party or parties benefiting or after notice and opportunity for hearing. Applications shall contain information in sufficient detail to afford a full understanding of the proposed use, including satisfactory evidence that the applicant possesses necessary water rights pursuant to applicable State law, or a showing of cause why such evidence cannot concurrently be submitted, and a statement as to the relationship of the proposed use to any State or municipal plans or orders which may have been adopted with respect to the use of such waters.

Article 11. The Licensee shall, for the conservation and development of fish and wildlife resources, construct, maintain, and operate, or arrange for the construction, maintenance, and operation of such reasonable facilities, and comply with such reasonable modifications of the project structures and operation, as may be ordered by the Commission upon its own motion or upon the recommendation of the Secretary of the Interior, Secretary of Commerce, or the fish and wildlife agency or agencies of any State in which the project or a part thereof is located, after notice and opportunity for hearing.

Article 12. Whenever the United States shall desire, in connection with the project, to construct fish and wildlife facilities or to improve the existing fish and wildlife facilities at its own expense, the Licensee shall permit the United States or its designated

agency to use, free of cost, such of the Licensee's lands and interests in lands, reservoirs, waterways and project works as may be reasonably required to complete such facilities or such improvements thereof. In addition, after notice and opportunity for hearing, the Licensee shall modify the project operation as may be reasonably prescribed by the Commission in order to permit the maintenance and operation of the fish and wildlife facilities constructed or improved by the United States under the provisions of this article. This article shall not be interpreted to place any obligation on the United States to construct or improve fish and wildlife facilities or to relieve the Licensee of any obligation under this license.

Article 13. So far as is consistent with proper operation of the project, the Licensee shall allow the public free access, to a reasonable extent, to project waters and adjacent project lands owned by the Licensee for the purpose of full public utilization of such lands and waters for navigation and for outdoor recreational purposes, including fishing and hunting: Provided, That the Licensee may reserve from public access such portions of the project waters, adjacent lands, and project facilities as may be necessary for the protection of life, health, and property.

Article 14. In the construction, maintenance, or operation of the project, the Licensee shall be responsible for, and shall take reasonable measures to prevent, soil erosion on lands adjacent to streams or other waters, stream sedimentation, and any form of water or air pollution. The Commission, upon the request or upon its own motion, may order the Licensee to take such measures as the Commission finds to be necessary for these purposes, after notice and opportunity for hearing.

Article 15. The Licensee shall consult with the appropriate State and Federal agencies and, within one year of the date of issuance of this license, shall submit for Commission approval a plan for clearing the reservoir area. Further, the Licensee shall clear and keep clear to an adequate width lands along open conduits and shall dispose of all temporary structures, unused timber, brush, refuse, or other material unnecessary for the purposes of the project which results from the clearing of lands or from the maintenance or alteration of the project works. In addition, all trees along the periphery of project reservoirs which may die during operations of the project shall be removed. Upon approval of the clearing plan all clearing of the lands and disposal of the unnecessary material shall be done with due diligence and to the satisfaction of the authorized representative of the Commission and in accordance with appropriate Federal, State, and local statues and regulations.

Article 16. Material may be dredged or excavated from, or placed as fill in, project lands and/or waters only in the prosecution of work specifically authorized under the license; in the maintenance of the project; or after obtaining Commission approval, as appropriate. Any such material shall be removed and/or deposited in such manner as to

reasonably preserve the environmental values of the project and so as not to interfere with traffic on land or water. Dredging and filling in a navigable water of the United States shall also be done to the satisfaction of the District Engineer, Department of the Army, in charge of the locality.

Article 17. If the Licensee shall cause or suffer essential project property to be removed or destroyed or to become unfit for use, without adequate replacement, or shall abandon or discontinue good faith operation of the project or refuse or neglect to comply with the terms of the license and the lawful orders of the Commission mailed to the record address of the Licensee or its agent, the Commission will deem it to be the intent of the Licensee to surrender the license. The Commission, after notice and opportunity for hearing, may require the Licensee to remove any or all structures, equipment and power lines within the project boundary and to take any such other action necessary to restore the project waters, lands, and facilities remaining within the project boundary to a condition satisfactory to the United States agency having jurisdiction over its lands or the Commission's authorized representative, as appropriate, or to provide for the continued operation and maintenance of nonpower facilities and fulfill such other obligations under the license as the Commission may prescribe. In addition, the Commission in its discretion, after notice and opportunity for hearing, may also agree to the surrender of the license when the Commission, for the reasons recited herein, deems it to be the intent of the Licensee to surrender the license.

Article 18. The right of the Licensee and of its successors and assigns to use or occupy waters over which the United States has jurisdiction, or lands of the United States under the license, for the purpose of maintaining the project works or otherwise, shall absolutely cease at the end of the license period, unless the Licensee has obtained a new license pursuant to the then existing laws and regulations, or an annual license under the terms and conditions of this license.

Article 19. The terms and conditions expressly set forth in the license shall not be construed as impairing any terms and conditions of the Federal Power Act which are not expressly set forth herein.

APPENDIX A

Water Quality Certificate Conditions for the Admiralty Inlet Project Issued By the Washington Department of Ecology on December 3, 2013

A. General Conditions:

A1. For purposes of this Order, the term "Applicant" shall mean Snohomish County PUD No. 1 and its agents, assignees and contractors.

A2. For purposes of this Order, all submittals required by its conditions shall be sent to Ecology's Northwest Regional Office, Attn: 401/CZM Federal Project Manager, 3190 160th Avenue SE, Bellevue, WA 98008-5452. Any submittals shall reference Order #9337 and FERC Project #12690.

A3. Work authorized by this Order is limited to the work described in the JARPA received by Ecology on February 9, 2012. The Applicant will be out of compliance with this Order and must reapply with an updated application if the information contained in the JARPA is voided by subsequent changes to the project not authorized by this Order.

A4. Within 30 days of receipt of an updated JARPA, Ecology will determine if the revised project requires a new water quality certification and public notice or if a modification to this Order is required.

A5. Copies of this Order shall be kept on the job site and readily available for reference by Ecology personnel, the construction superintendent, construction managers and lead workers, and state and local government inspectors.

A6. The Applicant shall provide access to the project site and all mitigation sites upon request by Ecology personnel for site inspections, monitoring, necessary data collection, and/or to ensure that conditions of this Order are being met.

A7. Nothing in this Order waives Ecology's authority to issue additional orders if Ecology determines that further actions are necessary to implement the water quality laws of the state. Further, Ecology retains continuing jurisdiction to make modifications hereto through supplemental order, if additional impacts due to project construction or operation are identified (e.g., violations of water quality standards, downstream erosion, etc.), or if additional conditions are necessary to further protect water quality.

A8. The Applicant shall ensure that all appropriate project engineers and contractors at the project site have read and understand relevant conditions of this Order and all permits, approvals, and documents referenced in this Order. The Applicant shall provide Ecology a signed statement (see Attachment A for an example) from each project engineer and contractor that they have read and understand the conditions of this Order and the above-referenced permits, plans, documents and approvals. These statements shall be provided to Ecology before construction begins at the project or mitigation sites.

A9. This Order shall be rescinded if the Federal Energy Regulatory Commission does not issue authorization for the project.

A10. This Order does not authorize direct, indirect, permanent, or temporary impacts to waters of the state or related aquatic resources, except as specifically provided for in conditions of this Order.

A11. Failure of any person or entity to comply with this Order may result in the issuance of civil penalties or other actions, whether administrative or judicial, to enforce its terms.

B. <u>Water Quality Conditions</u>:

B1. Admiralty Inlet is classified as "Extraordinary Quality" and the criteria of that class apply except as specifically modified by this Order. This Order does not authorize temporary exceedances of water quality standards beyond the limits established in WAC 173-201A-210(1)(e)(i).

B2. The Applicant shall conduct water quality sampling and monitoring as described in *Water Quality Monitoring Plan*, for the Admiralty Inlet Pilot Tidal Project, dated February 29, 2012, revised December 5, 2012, or as modified by this Order or revised and approved by Ecology.

B3. Water quality monitoring for turbidity shall be conducted during horizontal directional drilling (HDD) activity. Divers may conduct underwater visual monitoring or physical monitoring from a boat shall be conducted.

B4. Water quality monitoring for turbidity shall be conducted during cable removal, unless otherwise approved in writing by Ecology.

B5. Sampling for pH shall be conducted immediately if a frac-out or other release of grout material occurs during HDD activity.

B6. Oil sheen shall be visually monitored during all installation, maintenance, and removal activities.

B7. Reporting: If no exceedances are detected, results of water quality sampling, as determined by the Plan, shall be forwarded to Ecology on a monthly basis in accordance to Condition A2.

B8. Notification of exceedances: Notification of exceedances that are detected through water quality sampling shall be made to Ecology within 24 hours of occurrence. Notification shall be made with reference to Order #9337, Attn: 401/CZM Federal Project Manager, by telephone at (425) 649-7129 or (425) 649-7000, or by fax to (425) 649-7098. The Applicant shall, at a minimum, provide Ecology with the following information:

a. A description of the nature and cause of exceedance.
b. The period of non-compliance, including exact dates, duration, and times and/or the anticipated time when the Applicant will return to compliance.
c. The steps taken, or to be taken, to reduce, eliminate, and prevent recurrence of the non-compliance.
d. In addition, within five (5) days after notification of an exceedance, the Applicant shall submit a written report to Ecology that describes the nature of the exceedance, turbidity results and location, photographs, and any other pertinent information.

C. Conditions for Construction Activities:

General Conditions:

C1. Construction stormwater, sediment, and erosion control best management practices (BMPs; e.g., filter fences, etc.) suitable to prevent exceedances of state water quality standards shall be in place before starting construction at the site.

C2. Sediment and erosion control measures shall be inspected and maintained prior to and during project implementation.

C3. All construction debris shall be properly disposed of on land so that it cannot enter a waterway or cause water quality degradation to state waters.

C4. Machinery and equipment used during construction shall be serviced, fueled, and maintained upland, unless otherwise approved by Ecology, in order to prevent contamination to any surface water.

C5. Wash water containing oils, grease, or other hazardous materials resulting from wash down of equipment or working areas shall be contained for proper disposal, and shall not be discharged into state waters or storm drains.

In-Water Conditions:

C6. Work in or near the water that may affect fish migration, spawning, or rearing shall cease immediately upon a determination by Ecology that fisheries resources may be adversely affected.

C7. Project activities shall be conducted to minimize siltation of the beach area and bed.

C8. The Applicant shall operate the barge(s) and tug in deep water so as to minimize nearshore propeller wash impacts such as suspension of nearshore sediments.

C9. Barges shall not be allowed to ground-out during construction.

C10. Transmission cables shall be laid on the seafloor from the horizontal directional drilling (HDD) exit point to the turbines. Cables shall not be buried in this segment, and trenching of the cable route may not be used for this project.

C11. Aquatic vegetation (eelgrass and kelp) shall be observed for presence prior to construction. If eelgrass and/or kelp are present, the boundaries shall be marked with floats, buoys, or other means as appropriate in order to restrict access and anchoring during construction.

C12. In-water work barges shall not be allowed to anchor in areas where aquatic vegetation is present.

D. Horizontal Directional Drilling Conditions

D1. The Applicant shall conduct HDD activity as described in *Preliminary Horizontal Directional Drilling Plan, Snohomish County Public Utility District No. 1 Tidal Project*, prepared by Sound & Sea Technology, Inc., dated August 29, 2011, or as modified by this Order or revised and approved by Ecology.

D2. Monitoring of pressure and volume shall be conducted in order to minimize the occurrence of a "fracout."

D3. If a fracout occurs, the Applicant shall stop or slow down HDD operations in order to allow the mud to seal the fracout.

D4. All HDD solids and drill tailings shall be placed into plastic-lined dumpsters or hoppers on the uplands and trucked off site to an approved upland disposal facility.

D5. HDD wastewater shall not be allowed to flow back into marine waters.

D6. Prior to reaching the exit point on the ocean floor, the drill string shall be flushed with freshwater and the drilling fluid changed from bentonite to freshwater.

D7. The Applicant shall submit an HDD Work Plan to Ecology per Condition A2 at least 30 days prior to start of horizontal directional drilling activity. The HDD Work Plan shall include drawings and a written description identifying construction detail methods and sequencing.

D8. The Applicant shall submit a Frac-Out and Surface Spill Contingency Plan (hereafter referred to as the 'Contingency Plan') to Ecology per Condition A2 at least 30 days prior to start of horizontal directional drilling activity. The Contingency Plan shall include:

a. Description of procedures for preventing drilling fluid losses or spills into the marine environment and fluid returns to the surface
b. Description of containment and cleanup procedures.

E. <u>Operational Conditions</u>:

E1. No oils, grease, or lubricants shall be utilized for the turbine, and no fluid or oil-filled equipment shall be located underwater.

E2. The use of antifouling paint on the turbines shall be minimized to the extent practicable, and antifouling paint shall be non-flaking.

E3. Coatings and paints shall be approved for use in the marine environment.

E4. All maintenance of the turbines or other in-water components shall be conducted out of the water and appropriate BMPs shall be implemented in order to protect water quality.

E5. If derelict gear is removed during the operation of the turbines, then removal of this gear shall be conducted in such a way as to minimize turbidity.

E6. Benthic habitat at the turbine site and along the cable route shall be monitored according to the *Benthic Habitat Monitoring and Mitigation Plan, Admiralty Inlet*

Tidal Energy Demonstration Project, Federal Energy Regulatory Commission Project No. 12690, dated June 14, 2012 or as modified by this Order or revised and approved by Ecology.

a. Written reports shall be provided annually to Ecology per Condition A2 by March 31 for the prior calendar year of operation. The reports shall describe:
    i. Changes to colonization of the subsea base, power cables, and drill hole exit point.
    ii. Changes to seabed benthic habitat around the subsea base, including sediment scour and deposition.
b. If surveys indicate significant erosion at the contact points between the subsea base and seabed, Ecology shall be consulted to determine if project modifications are necessary.

E7. At the conclusion of the pilot, or prior to the expiration of the FERC Pilot License, the two turbines and two transmission cables shall be removed from Admiralty Inlet, unless otherwise approved by Ecology.

F. <u>Plan Submittal Conditions</u>:

F1. The Applicant shall develop and implement a Project Removal Plan for removal of the turbines and transmission cables. The Project Removal Plan shall be submitted to Ecology per Condition A2 for review and approval at least 60 days prior to removal and include the following:

a. Project removal timing and sequencing
b. <u>Cable Removal</u>: Method of cable removal, best management practices that will be implemented to protect water quality, and water quality monitoring for cable removal.
c. A plan for restoring the project area to pre-project conditions. This plan shall address the horizontal directional exit hole, as well as any erosion/sedimentation impacts caused by the cables.

F2. If the Applicant proposes leave the cables in place at the completion of the project, details of such proposal shall be included in the Project Removal Plan per F1.

G. <u>Emergency/Contingency Measures</u>:

G1. The Applicant shall develop and implement a Spill Prevention and Containment Plan for all aspects of this project.

G2. The Applicant shall have adequate and appropriate spill response materials on hand to respond to emergency release of petroleum products or any other material into waters of the state.

G3. Fuel hoses, oil drums, oil or fuel transfer valves and fittings, etc., shall be checked regularly for drips or leaks, and shall be maintained and stored properly to prevent spills into state waters.

G4. Any work that is out of compliance with the provisions of this Order, or conditions causing distressed or dying fish, or any discharge of oil, fuel, or chemicals into state waters, or onto land with a potential for entry into state waters, is prohibited. If these occur, the Applicant shall immediately take the following actions:

a. Cease operations at the location of the violation or spill.
b. Assess the cause of the water quality problem and take appropriate measures to correct the problem and/or prevent further environmental damage.
c. Notify Ecology of the failure to comply. All oil spills shall be reported immediately to Ecology's 24-Hour Spill Response Team at 1-800-258-5990, **and** within 24 hours of spills or other events to Ecology's 401/CZM Federal Project Manager at (425) 649-7129 or (425) 649-7000.
d. Submit a detailed written report to Ecology within five (5) days that describes the nature of the event, corrective action taken and/or planned, steps to be taken to prevent a recurrence, results of any samples taken, and any other pertinent information.

Compliance with this condition does not relieve the Applicant from responsibility to maintain continuous compliance with the terms and conditions of this Order or the resulting liability from failure to comply.

H. Timing Requirements

H1. All in-water work shall be completed by the work window identified in the most current Hydraulic Project Approval (HPA) issued for this project. Any project change that requires a new or revised HPA should also be sent to Ecology for review.

H2. This Order is valid for a period of 10 years from the date of the FERC Pilot License.

I. Reporting and Notification Requirement Conditions

I1. The Applicant shall provide to Ecology's 401/CZM Federal Permit Manager a copy of the FERC license within 2 weeks of receipt of the license. A copy shall be submitted per condition A2 above.

I2. Applicant shall provide notice to Ecology per Condition A2 for the following activities:

- At least 10 days prior to the pre-construction meeting.
- At least three (3) days prior to the start of construction
- Within 14 days after completion of construction at the project site.
- At least 10 days prior to any maintenance activity.
- At least 10 days prior to removal of the turbines and cables.

I3. If the project construction is not completed within 13 months of issuance of this Order, the Applicant shall submit per Condition A2 a written construction status report and submit status reports every 12 months until construction is complete.

APPENDIX B

Incidental Take Statement Reasonable and Prudent Measures and Terms and Conditions for the Admiralty Inlet Project Issued by the National Marine Fisheries Service on December 3, 2013

Reasonable and Prudent Measures (RPM)

1. FERC will ensure that the licensee will monitor sound produced by the turbines to collect necessary data to evaluate 1) the broadband sound levels at the source (1 meter from the center of the turbine location) over the full range of flow conditions occurring during project operations; and 2) the distance from the center of the turbines where broadband sound levels from operating turbines exceed 120 decibels re: 1 µPa, including an evaluation of levels out to distance of up to 3 kilometers from the center of the turbine location. The licensee will mitigate for adverse effects of sound according to the Acoustics Monitoring and Mitigation Plan.

2. FERC will ensure that the licensee will monitor and collect data necessary to evaluate the risk of blade strike from turbine operations by determining the number of individuals that pass through the turbine plane and reporting any observed injury or direct strike observed. The Licensee will mitigate for any effects of blade strike according to the Near-turbine Monitoring and Mitigation Plan.

3. FERC will ensure that the licensee will complete a monitoring and reporting program to confirm that the incidental take exemption for the proposed action is not exceeded, and that the terms and conditions in the incidental take statement are effective in minimizing incidental take.

Terms and Conditions

1. To implement RPM 1, the licensee monitors and measures sound levels at the turbine location to determine source levels. If sound from the turbine operation 1) exceeds 180 decibels re: 1 µPa at any distance from the turbines; or 2) is propagated at a level of 120 decibels re: 1 µPa at a distance beyond 750 meters when operating at the 95th percentile; the licensee will engage the turbine brake until modifications to turbine operations or configuration to reduce the sound

below this level are complete. NMFS approval must be obtained prior to resuming operations.

2. To implement RPM 1, the licensee will provide the preliminary results of monitoring for sound source levels and propagation distances within 120 days.

3. To implement RPM 2, use methods to collect data on the number of individuals passing through the plane of the turbine that are sufficient to identify the number and species category (salmon, steelhead, rockfish) of the individual adults passing within 5 meters of the turbines at least 50 percent of the time during turbine operations.

4. To implement RPM 2, the licensee will provide the preliminary results of the monitoring within 14 days if individual salmon, steelhead or rockfishes are visibly injured or killed or are recorded crossing through the turbine blades and not through the open center of the rotor.

5. To implement RPM 2, and 3, the licensee will contact NMFS within 48 hours, (and before the limit is exceeded) if it is reasonably foreseeable that the number of individuals crossing the plane of the turbines will exceed the level authorized in this opinion.[130]

6. To implement RPM 1, 2, and 3, the licensee will obtain documented approval from NMFS for all changes to the Adaptive Management Framework and Monitoring and Mitigation plans that affect ESA-listed species or NMFS authorities; and for approval of implementation of mitigation measures, based on adaptive management. The licensee will file all changes with FERC after approval by NMFS.

[130] The incidental take statement authorizes ten adult salmon/steelhead, one adult yelloweye rockfish, one adult canary rockfish, and one adult Bocaccio to swim through the plane of the turbines in a given year.

Appendix C

AMS/OpenHydro Proof of Concept Report

Applied Motion Systems

Simplifying the Complexity of Motion

Proof of Concept Report

ENG-14-01

for

openhydro

a DCNS company

SnoPUD, Admiralty Inlet Proof of Concept

Solution Partner

Factory Automation / Motion Control and CNC

SIEMENS

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Compiled by:	James Jakeway / Systems Engineer	10/15/2014
	Jenna Brown / Systems Engineer	10/15/2014
Approved by:	Ken Brown / CEO / Principal Systems Engineer	10/16/2014

RECORD OF REVISIONS			
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PROPRIETARY AND CONFIDENTIAL

Table of Contents

1. Executive Summary 4
2. Scope 5
3. Testing Methodology 6
3.1. Power Electronic Equipment Overview 6
3.2. Test Generator Overview 6
3.3. Data Collection Equipment Overview 7
3.4. Assumptions 7
3.5. Control Parameters 8
3.6. Terms and Definitions 9
4. POC Testing 11
4.1. Test Scenario 1 – Close Coupled Baseline 11
4.2. Test Scenario 2 – Transformer Baseline 18
4.3. Test Scenario 3 – Undersea Cable Emulator Baseline 27
4.4. Test Scenario 4 – Sinusoidal Filter Baseline 36
5. Power Analysis Summary 49
6. Recommendations for PCCE Sea Facing Inverter Design 55
Appendix A Sine Wave Filter Required Pulse Frequency 56
Appendix B Test Scenario 5 – Starting the Generator Against a Load 57
Appendix C Temperature Rise of System Components 58
Appendix D Applicable Documents 59
Appendix E Critical Drive Parameters 60
Appendix F Effect of PWM Frequency on System Efficiency 63
Appendix G Protecting Submersible Motors from the Effects of PWM Voltage 64

PROPRIETARY AND CONFIDENTIAL

1. Executive Summary

Applied Motion Systems (AMS) has successfully implemented the Siemens S120 drive technology platform to control and convert power from a permanent magnet generator using the transformers and cable emulation hardware provided by OpenHydro.

The Siemens S120 Proof of Concept (POC) system uses a drive in speed control sensorless vector mode to draw power from the generator. The power from the drive is transmitted to a common DC bus that is regulated by a Siemens Smart Line Module (SLM). There are two important pieces of equipment that make this POC system feasible: a Siemens Voltage Sensing Module (VSM) and a Siemens sine wave filter.

The VSM is connected directly to the output of the drive. The VSM provides encoderless closed loop control by sensing the back EMF produced by the generator. This allows the drive to accurately estimate the position of the permanent magnet poles, making field control of the generator possible.

The Siemens sine wave filter is deployed between the drive and the land-based transformer. The sine wave filter reduced waveform distortion by a factor of 4. The addition of the sine wave filter also reduced the operating temperature rise between 30-40% for the cable emulator, transformers and generator. When the cable emulator is used in the test setup the sine wave filter increased the system's power factor at higher frequencies and at higher currents from approximately 0.80 to 0.99.

System performance curves for the S120 drive system were collected using the following four test scenarios:

1. Test Scenario 1 employed a direct connection between the drive and the generator. This configuration provided the highest level of system performance resulting in 94.9% efficient energy recovery at 100% inverter current capacity.
2. Test Scenario 2 employed two transformers arranged in series between the drive and the generator. At 100% inverter current capacity, there was a 13% efficiency decrease as compared to scenario 1.
3. Test Scenario 3 added the cable emulator between the two transformers. At 100% inverter current capacity, there was a 5% efficiency decrease as compared to scenario 2.
4. Test Scenario 4 added a sine wave filter before the first transformer. At 100% inverter current capacity, there was a 4% efficiency increase as compared to scenario 3.

AMS additionally conducted a fifth scenario not planned in the original scope of the project. This test was created to see if the generator could be started from a static condition against a resistive load and was conducted using Scenario 4 configuration. The S120 drive was successful in starting the generator from a static condition up to 66% of the inverter current rating.

The VSM and sine wave filter are critical to the success of the Siemens S120 drive system in the POC. It is AMS' strong recommendation that a VSM and a properly sized sine wave filter be integrated into a Siemens based PCCE solution.

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2. Scope

Applied Motion Systems was engaged by OpenHydro to conduct Proof of Concept (POC) testing to determine the feasibility of using the Siemens S120 technology platform in the Power Conditioning and Control Equipment (PCCE). The PCCE is part of the SnoPUD Admiralty Inlet Environmental Study and is responsible for generator control, battery based energy storage, and power delivery to the grid. Specifically, the study is concerned with testing the operational performance of the generator control aspects of the PCCE.

The AMS POC system simulates the generation of variable frequency 3-phase power from an OpenHydro tidal generator (simulated); this highly variable generator power is converted by the Generator Control Unit (Sinamics S120 inverter) and delivered to the grid by a proposed 3-phase grid side inverter operating in single phase mode.

These tests demonstrated Power Conversion and accurate Generator Control via Siemens hardware and software, when operating with a current / voltage waveform distorted by an undersea cable emulator and transformers simulating a subsea power transmission system.

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3. Testing Methodology

3.1. Power Electronic Equipment Overview

- SIMOTION D425-2 Motion Controller –the main CPU for the test system.
- SINAMIC Smart Line Module – controls the common DC Bus and regulates power to and from the grid.
- S120 9.7 kW Double Motor Module – drives an induction motor that would spin the generator.
- S120 7.5kW Single Motor Module – controls the power coming from the generator.
- SINAMICS Voltage Sensing Module VSM10 – senses the back EMF produced by the generator in order to determine rotor position.
- SIEMENS sine wave filter – reduces waveform distortion associated with interaction of the S120 pulse-width modulation (PWM) inverter output and emulated undersea power transmission system.

3.2. Test Generator Overview

A Parker MPM190 series 3 pole pair permanent magnet motor was used as the generator during testing. With a flux density of 3.16 V/Hz, the generator was configured to run at 480 V with a rated motor frequency of 151.89 Hz (3037.9 RPM). The following data sheet lists critical generator characteristics:

MOTOR DATA @ 460 VAC (SINE)			
MOTOR PARAMETERS		**UNITS**	**VALUE**
HORSEPOWER	HP RATED	Hp	35.7
KILOWATTS	KW RATED	KW	26.7
MAX. OPERATING SPEED	N MAX	RPM	3000
SPEED @ RATED TORQUE	N RATED	RPM	2400
* CONTINUOUS RATED TORQUE @ 2400 RPM		IN-LBS[Nm]	939.0[105.0]
* CONTINUOUS STALL TORQUE		IN-LBS[Nm]	1092.0[123.0]
CONTINUOUS LINE CURRENT		AMPS(RMS/ϕ)	43.8
PEAK TORQUE	Tpk	IN-LBS[Nm]	3276.0[370.0]
PEAK CURRENT		AMPS(RMS/ϕ)	131.5
MAX. THEORETICAL ACCEL.		RAD/SEC²	24,632
TORQUE SENSITIVITY	Kt	IN-LBS/AMP(RMS/ϕ)[Nm/AMP(RMS/ϕ)]	24.9[2.8]
BACK EMF (LINE TO LINE)	±10%	Vrms/Krpm	158.0
D.C. RESISTANCE (P-P)	±10%	OHMS	.19
INDUCTANCE (P-P)	±10%	MILLIHENRIES	3.2
ROTOR INERTIA	Jm	IN-LBS-SEC²[Kg-M²]	.133[.0150]
STATIC FRICTION	Tf	IN-LBS[Nm]	13.0[1.5]

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3.3. Data Collection Equipment Overview

- Digital Oscilloscope – A 200 MHz 4-channel Tektronix TPS 2024 Oscilloscope equipped with isolated 1000 V RMS rated 100 TP5120 probes and a 2000 A rated A621 current clamp was used to view voltage and current waveforms. Waveforms of each phase to phase voltage as well as one line current were recorded at each control point. From this data, RMS measurements, and crest factors were calculated.
- Inverter – The Siemens S120 Motor Module reports output voltage, current, power, and power factor.
- Power Analyzer – An Allen Bradley Powermonitor II was used to verify the data reported by the S120 was accurate. It was also used to measure power, power factor, and reactive power past the filter.
- Infrared Thermometer – A Fluke 61 Infrared thermometer was used to monitor the operating temperature of the test components.

3.4. Assumptions

- POC will scale up to a 300 kW PCCE system in a near linear fashion.
- POC only studied the 1 turbine understanding that there are no technical implications associated with deploying 2 turbines in the same system.
- The undersea cable emulator and provided transformers accurately reflect the resistance, impedance, capacitance, and expected transmission waveforms and harmonics that will occur in the Turbine Control Center (TCC) and the power transmission system.
- Tidal variation is similar to the data OpenHydro provided in CS_00986 SnoPUD Performance Calculator.
- Operating parameters range from 10-70 Hz.
- Sine wave filter will be specified to the optimal current limit of the drive and compatible with the drive switching frequency.

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3.5. Control Parameters

10-70 Hz, 0%-150% Inverter Rating

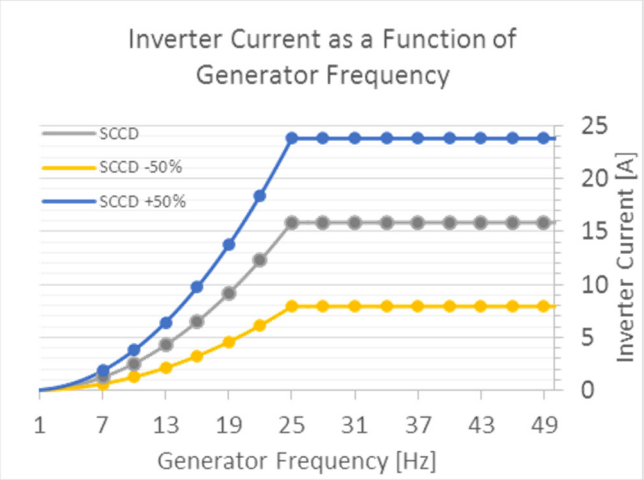
In all test scenarios, the system performance was evaluated from the turbine cut-in speed to the cut-out speed, and at two intermediate frequencies. The current capacity was varied to evaluate changes in performance from 0% - 150% of the inverter current capacity. Measurements were also taken with the inverter disabled (generator freewheeling).

Parameter	Control Values
Generator frequency	10 Hz, 30 Hz, 50 Hz, 70 Hz
Inverter current capacity	Inverter Disabled, 0%, 25%, 50%, 75%, 100%, 150%

The motor modeling the flow operated the generator at the set frequency. The inverter capacity was set within the generator drive. This first set of data shows system performance across the possible operating range of the OpenHydro generator.

7-49 Hz, 50%-150% Scalar Control Current Demand

During Test Scenario 4, in addition to the control parameters used in Scenarios 1-3 outlined above, data was also gathered along the OpenHydro Turbine Generator Scalar Control current curve, at expected operational frequencies. Data was gathered at 3Hz frequency intervals from 7 – 49 Hz along the OpenHydro Scalar Control curve. This second set of data shows performance at intended operating frequencies and currents.



OpenHydro Scalar Control sets the current demand proportional to the generator frequency squared, up to the inverter current limit. This current demand curve was provided in the OpenHydro Tidal Turbine Speed Curves document (SD_00121).

$$I \approx kf^2$$

Where:

$$I = current\ demand$$
$$k = scale\ factor$$
$$f = generator\ frequency$$

This current curve was scaled to the current limit of the POC inverter.

Parameter	Control Values
Generator frequency	7 Hz, 10 Hz, 13 Hz, 16 Hz, 19 Hz, 22 Hz, 25 Hz, 28 Hz, 31 Hz, 34 Hz, 37 Hz, 40 Hz, 43 Hz, 44 Hz, 49 Hz
Inverter current capacity	OpenHydro Scalar control current demand (SCCD), SCCD +50%, SCCD-50%

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3.6. Terms and Definitions

In each test scenario, voltage and current waveforms were documented at the inverter output and at the generator leads. In test scenario 3, voltage and current waveforms were also gathered at the filter output. In addition to the waveforms gathered, the system's efficiency, power factor, real power, reactive power, and crest factor were documented.

3.6.1. Voltage and Current Waveforms

At each test point, the voltage between each phase was measured and plotted on the Tektronix TPS 2024 oscilloscope. At the inverter and filter outputs, a single line current was also measured. In this report, the voltage and current waveforms taken at 30 Hz, 100% inverter capacity are shown as examples of system behavior across every scenario.

3.6.2. System Efficiency

The efficiency of the system was evaluated at 50%, 100%, and 150% of the inverter rating. Data was taken at 10 Hz, 30 Hz, 50 Hz, and 70 Hz at each inverter rating.

The power generated is plotted against the power available.

"Power Generated" is the power in kW converted by the S120 inverter and delivered to the DC bus. This is synonymous with the operation of the proposed sea-facing PCCE, which will deliver power via the common DC bus to the battery based energy storage system and the grid-facing inverter.

"Power Available" is the power in kW available at the generator input shaft. This is the power taken by the motor modeling the flow, less the amount of power it takes the motor to spin at each frequency under no load, thus estimating / compensating for the losses inherent to the induction motor from the equation. This is synonymous to the mechanical power at the turbine.

A "best fit" line is plotted between all the points at each inverter capacity. The efficiency of the inverter at each capacity is equal to the slope of the best fit line. The coefficient of determination (or "R^2 value") of each line is a measure of how much the points vary from the line.

3.6.3. Power Factor

Power factor is the ratio of true power to apparent power. True power is the power in kW converted by the S120 inverter and delivered to the DC bus. Apparent power is the RMS Voltage multiplied by the RMS current which is maximized when the voltage current waveform is in perfect phase with the current waveform. A power factor of 1.0 indicates voltage and current waveforms in perfect alignment. Typically, a higher power factor also indicates more efficient transmission of power.

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3.6.4. Real and Reactive Power

Apparent power is the product of the RMS voltage and RMS current in the system. Apparent power is measured in Volt-Amps, or for this application, kVA. Apparent power has two components, "Real Power" and "Reactive Power."

Real power is measured in watts, and is the product of the instantaneous voltage and instantaneous current at any given time. Real power is the component of apparent power that can be used.

Reactive power is measured in volts-amps-reactive, or VAR. Reactive power occurs in inductive systems, and is due to a leading or lagging between voltage and current waveforms. Reactive power, also termed "imaginary power" is unusable. The less reactive power in a system, the better.

The real power present in the system was reported by the drive.

The reactive power present in the system was calculated as follows:

$$Q = \frac{(1 - pf) \times V_{RMS} \times A_{RMS}}{1000}$$

Where:

Q = Reactive power in kVAR

pf = Power factor as reported by the drive

V_{RMS} = Inverter voltage in Volts RMS

A_{RMS} = Inverter current in Amps RMS

3.6.5. Crest Factor

A good measure of waveform distortion is crest factor. The crest factor of a waveform is the ratio of the maximum value of the waveform to the RMS value of the waveform. The ideal voltage waveform in this application would be a perfect sine wave. The crest factor of a perfect sine wave is equal to the square root of 2, or 1.4142.

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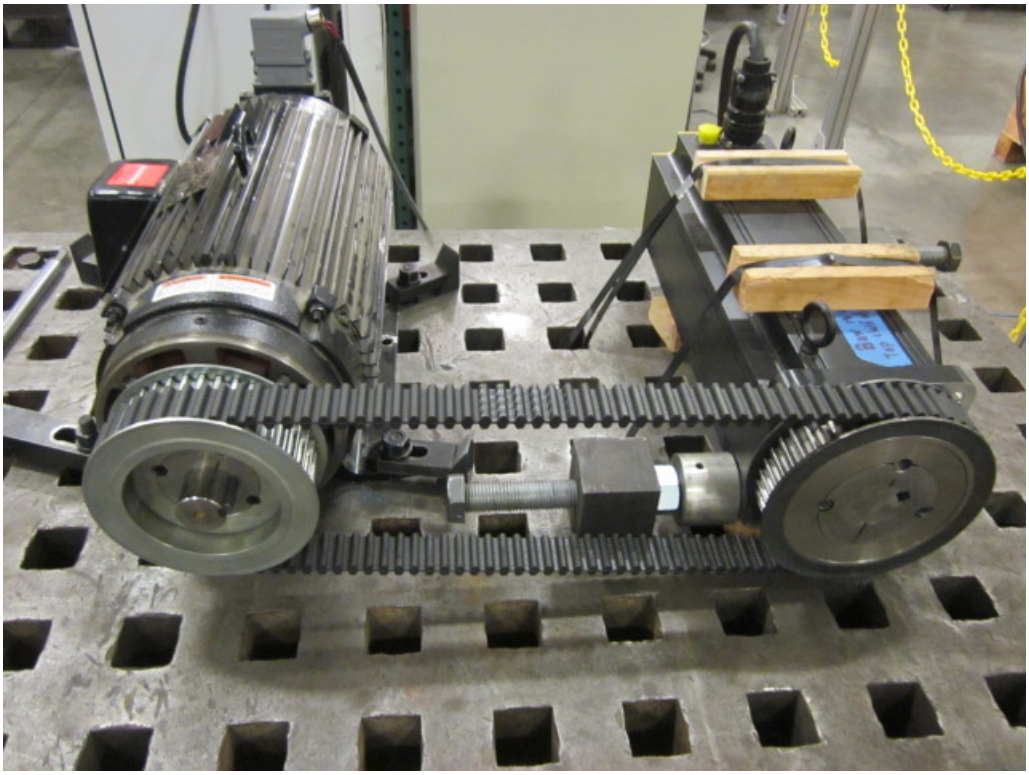
4. POC Testing

AMS evaluated the feasibility of controlling a permanent magnet generator separated from a land-based inverter by 2.6 km, with intermediate step up / step down transformers.

The intended deployment of the separated inverter-generator concept was modeled in the following manner. An S120 9.7 kW Double Motor Module was used to drive an induction motor. This induction motor was coupled to a permanent magnet generator by means of a timing belt. The permanent magnet generator was controlled by an S120 7.5 kW Single Motor Module.



First, baseline tests were done with the permanent magnet generator connected directly to the S120 inverter. Subsequent tests included installation of transformers, undersea cable emulator, and sine wave filter. This step by step process allowed determination of power losses associated with the addition of each component to the system.

4.1. Test Scenario 1 – Close Coupled Baseline

This test scenario employed a direct connection between the Sinamics S120 inverter and the permanent magnet generator. A VSM was installed to sense the back EMF produced by the rotation of the permanent magnet generator.

4.1.1. Purpose

The purpose of this test scenario was to determine if the POC drive system could control the permanent magnet generator. Data was taken to provide baseline measurements of system performance.

4.1.2. Result

The POC drive system could be used to control the permanent magnet generator. The highest level of efficiency and overall performance was accomplished using “Speed Control Sensorless Vector Mode.” The VSM provided encoderless closed loop control by sensing the back EMF produced by the generator.

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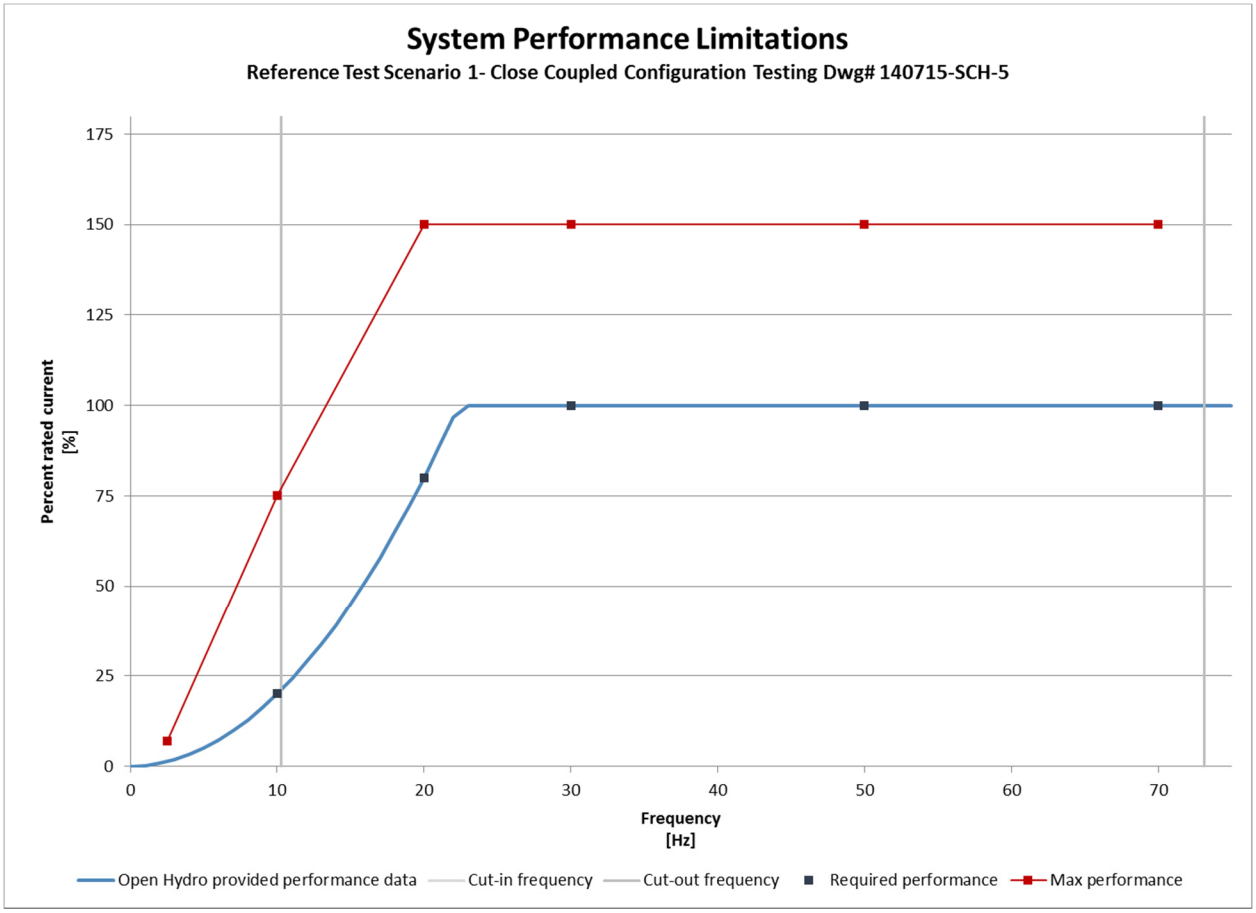
This made synchronous field control of the permanent magnet generator possible. The S120 “Flying Restart” feature allowed the inverter to gain control of the spinning generator and transition from freewheeling to power generation. An internal drive calculation set the speed threshold at which the inverter would attempt to synchronize with the generator at just above 15 Hz, preventing any attempt at commutation below that speed. The speed threshold was manually lowered to 10 RPM (0.5 Hz) and the generator was able to synch below 15 Hz.

With the inverter directly connected, the generator was able to synchronize at frequencies ranging from 2.5 - 70 Hz. Operation was not tested above 70 Hz.

At 10 Hz the drive remained synchronized with the generator up to 75% of the drive capacity before instability prevented reliable power conversion.

The system was 94.9% efficient at 100% of the inverter current rating.

During testing, the generator ran at 49° C, 28 degrees above ambient temperature.



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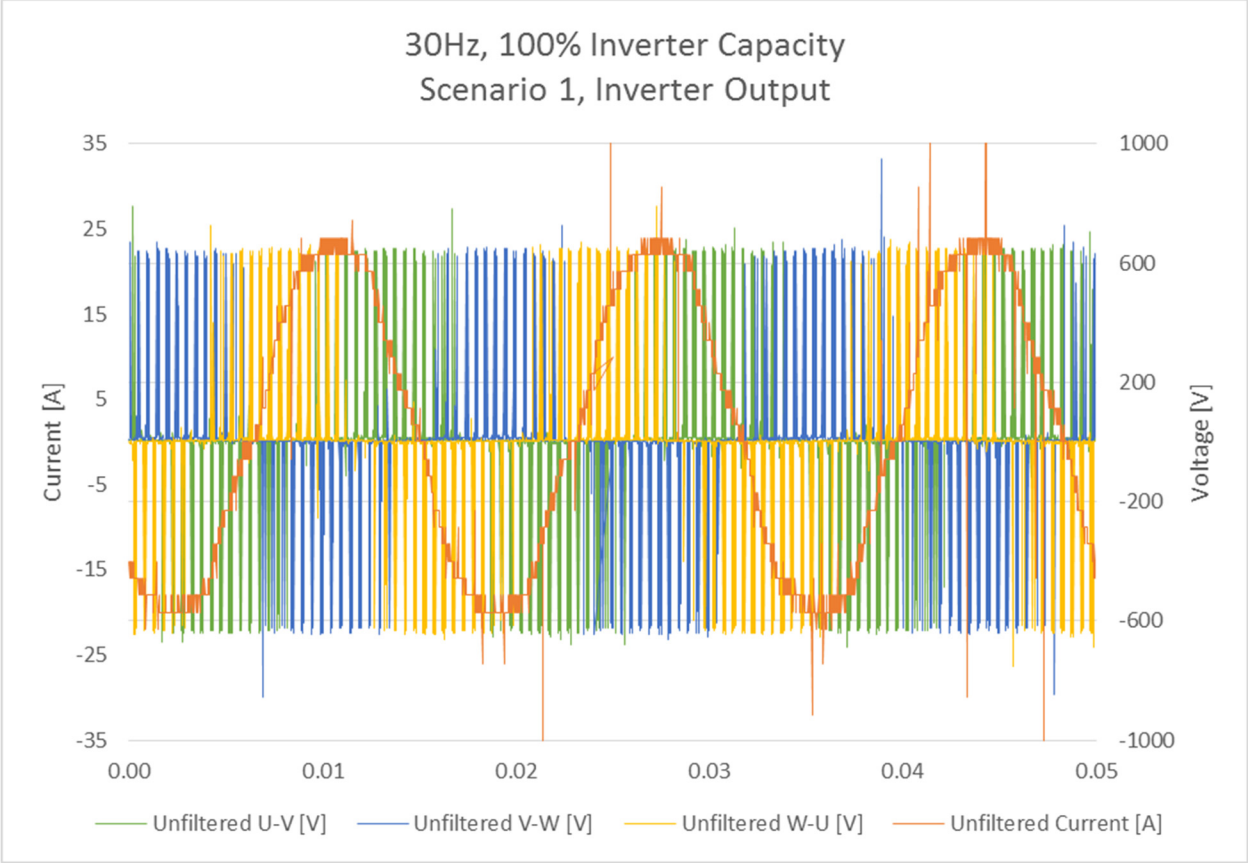
4.1.3. Voltage and Current Waveforms

At the inverter output, the back EMF waveform from the generator is indistinguishable due to the PWM voltage waveform. However, the stator current is clearly seen in the chart below.



The peak to peak voltage at this test point is about 1200 V (+/- 600 V), with voltage spikes up to nearly +/- 1000 V. Also note the current spikes to +/- 35 Amps, which is the current limit setting of the drive. This is significantly higher than the DC bus voltage of about 690 V, evidencing standing voltage waves within the cable. These high voltages must be absorbed by the generator.

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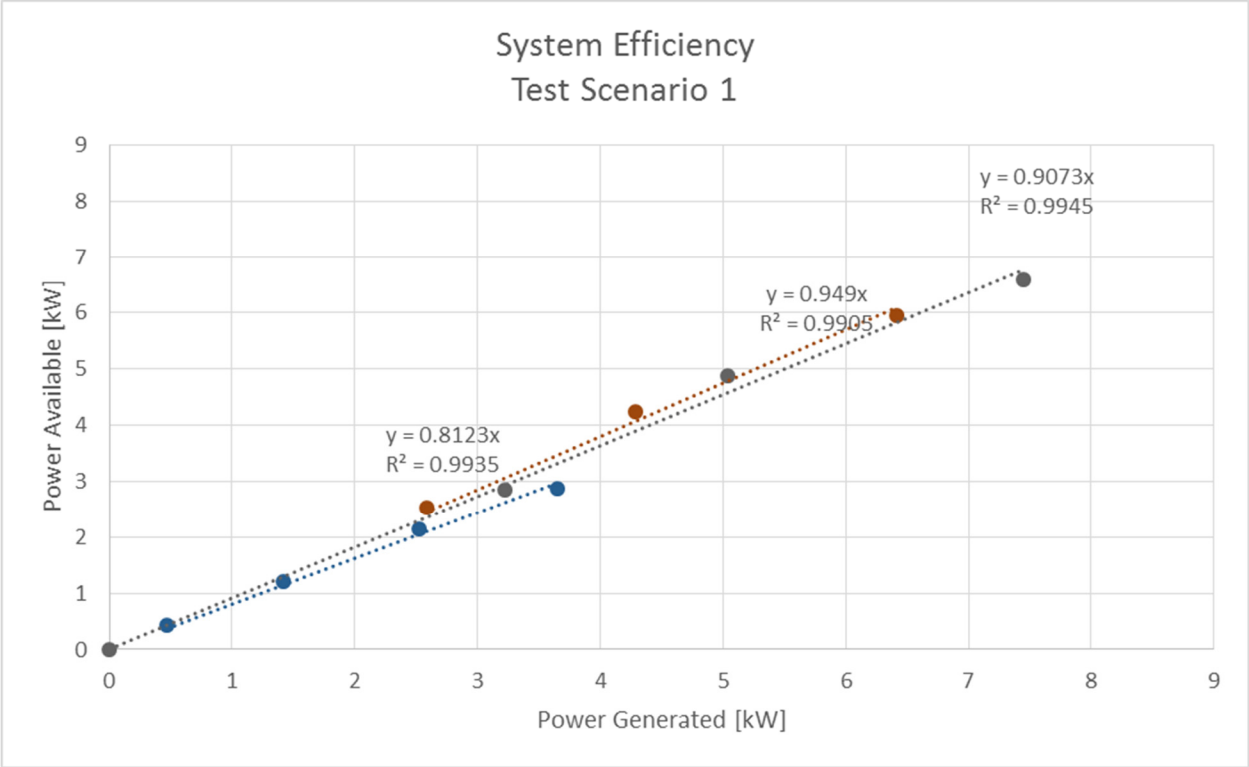
4.1.4. System Efficiency



Inverter Capacity	System Efficiency
50%	87.45%
100%	99.00%
150%	94.05%

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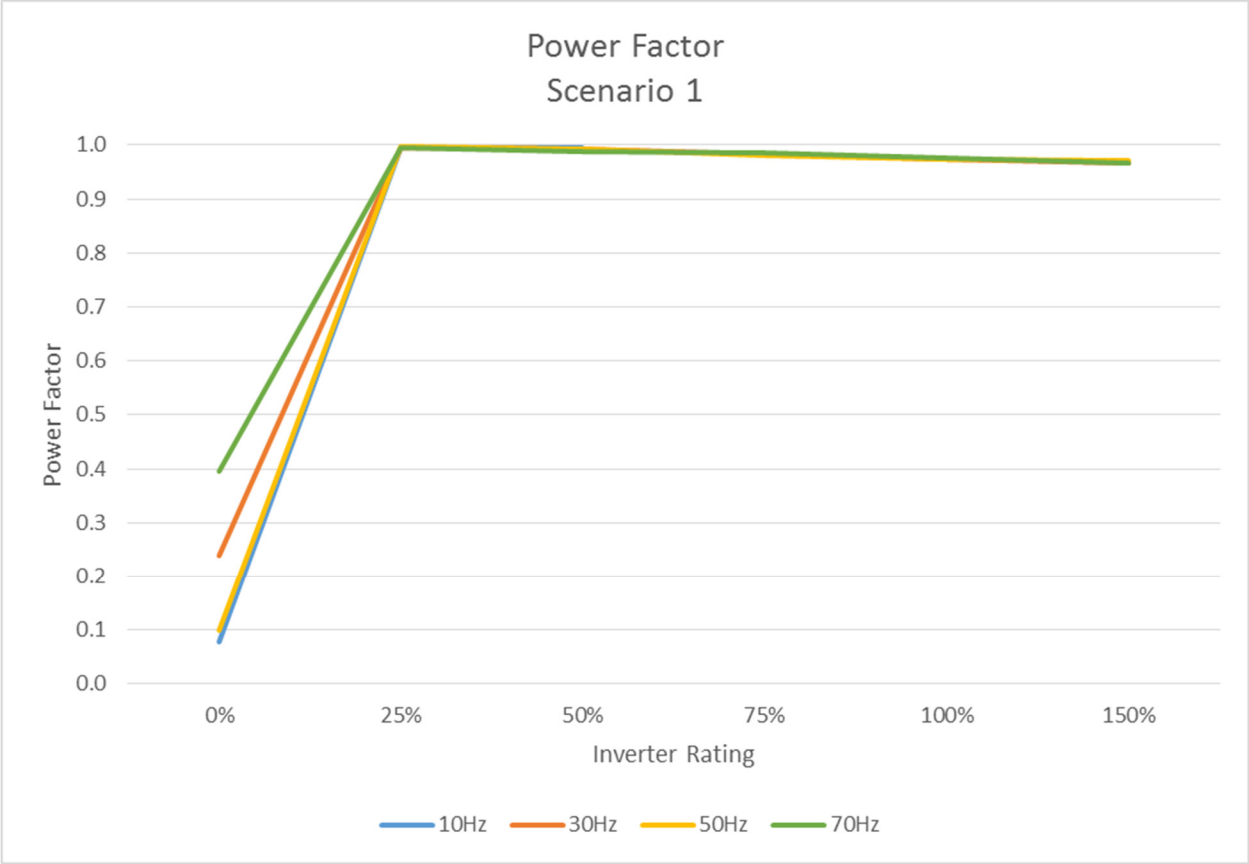
4.1.5. Power Factor



In the above chart, the power factor is near unity across the board. The only place where power factor is not close to one is at 0% of the inverter current rating. At this point, the inverter is putting out only enough current to maintain control of the generator and is drawing negligible power from the system.

There is no data above 50% of the inverter current capacity at 10 Hz, because above this current, the inverter could not synchronize with the generator.

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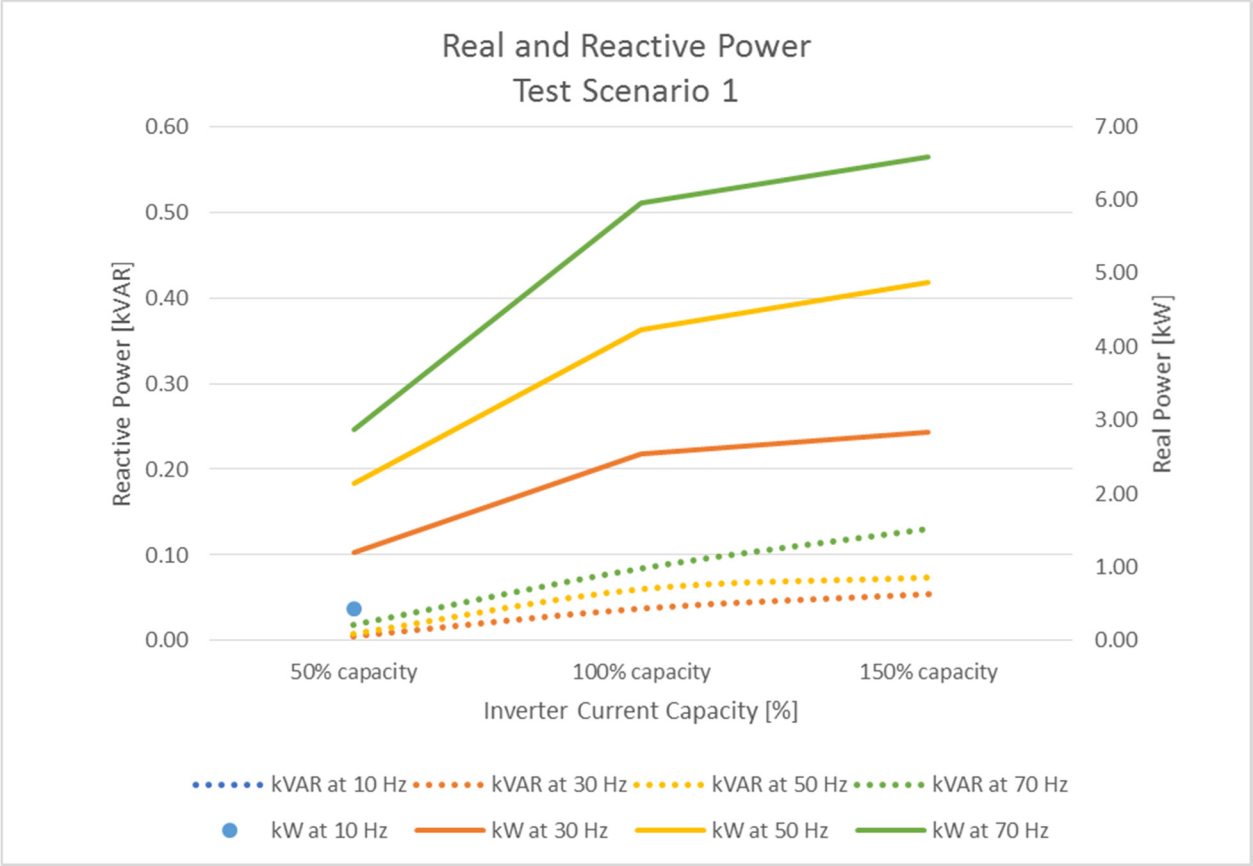
4.1.6. Real and Reactive Power



In the above chart, real power is seen as a function of the inverter capacity for each frequency. As the current increases, so does the power generated. In this first scenario, the generator is the only inductive component in the system, so reactive power is relatively low.

There is no data above 50% of the inverter current capacity at 10 Hz, because above this current, the inverter could not synchronize with the generator.

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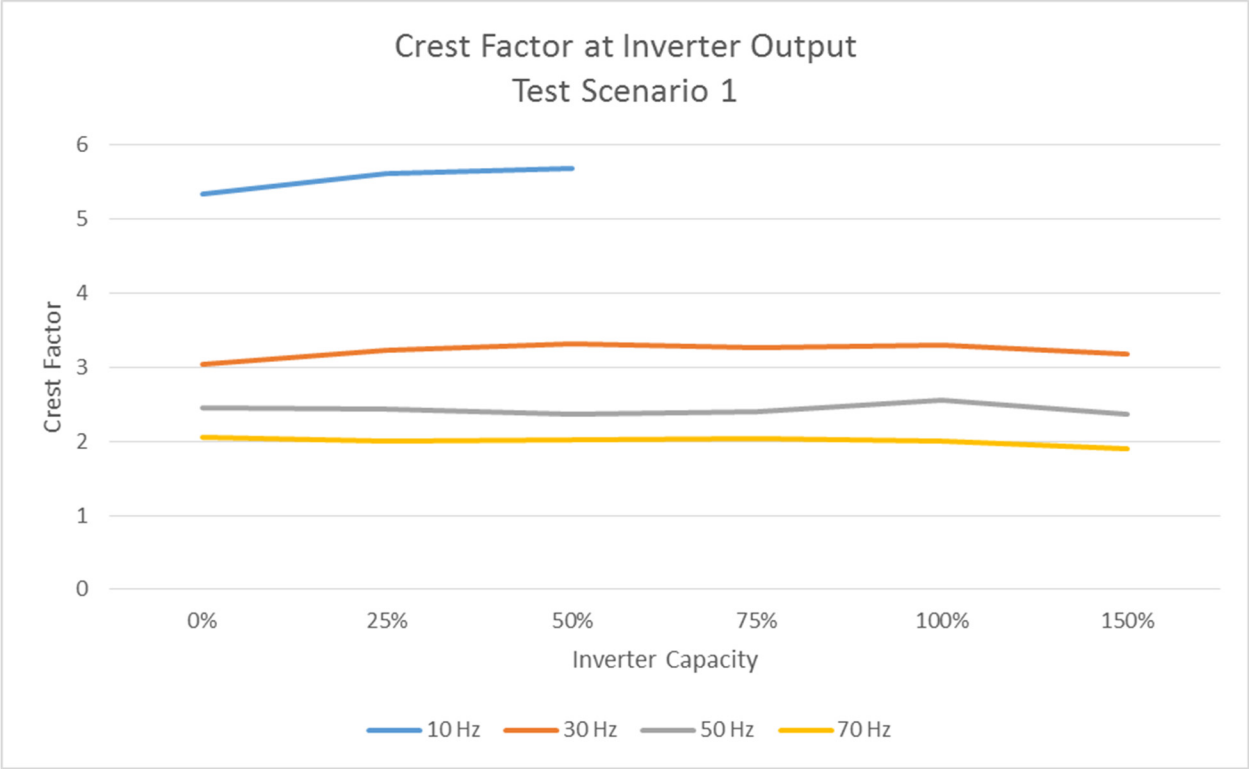
4.1.7. Crest Factor



The PWM waveform typically has peaks voltage of about 600V, with spikes up to 1000V occuring. The RMS value of the voltages in this configuration range from $120V_{RMS}$ to $360V_{RMS}$. Lower frequency waveforms have lower RMS voltages with the same peak voltages that occur at higher frequencies. This means dramatically higher crest factor at lower frequencies, indicating more waveform distortion.

There is no data above 50% of the inverter current capacity at 10 Hz; above this point, the inverter could not synchronize with the generator.

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4.2. Test Scenario 2 – Transformer Baseline

This test scenario includes the 15 kVA 480:240 transformers provided by OpenHydro between the Sinamics S120 drive and the permanent magnet generator. In all other respects, the configuration remained identical to Test Scenario 1.

4.2.1. Purpose

The purpose of this test scenario was to determine if the POC drive system could control the permanent magnet generator through the two transformers provided by OpenHydro. This test measures system performance with the transformers included in the POC drive system.

4.2.2. Result

The POC drive system could be used to control the permanent magnet generator through the two transformers. After the addition of the two transformers, an automatic motor data identification test was run by the S120 drive. The drive calculated the impedance due to the transformers. After the automatic drive adjustments, the POC drive system required no further parameterization to run. The system was tested with the VSM at the generator leads, as well as with the VSM at the drive output. The system performed best with the VSM located at the drive output. An internal drive calculation set the speed threshold at which the inverter would attempt to synchronize with the generator at just above 15 Hz, preventing any attempt at commutation below that speed. The speed threshold was manually lowered to 10 RPM, (0.5 Hz) and the generator was able to synch below 15 Hz.

With the inverter connected to the generator through the transformers, the generator was able to synchronize at frequencies ranging from 4 – 70 Hz. Operation was not tested above 70 Hz.

At 10 Hz, the drive remained synchronized with the generator up to 150% of the drive capacity. Operation was not tested above 150% of the drive capacity.

The system was 81.61% efficient at 100% of the inverter current rating.

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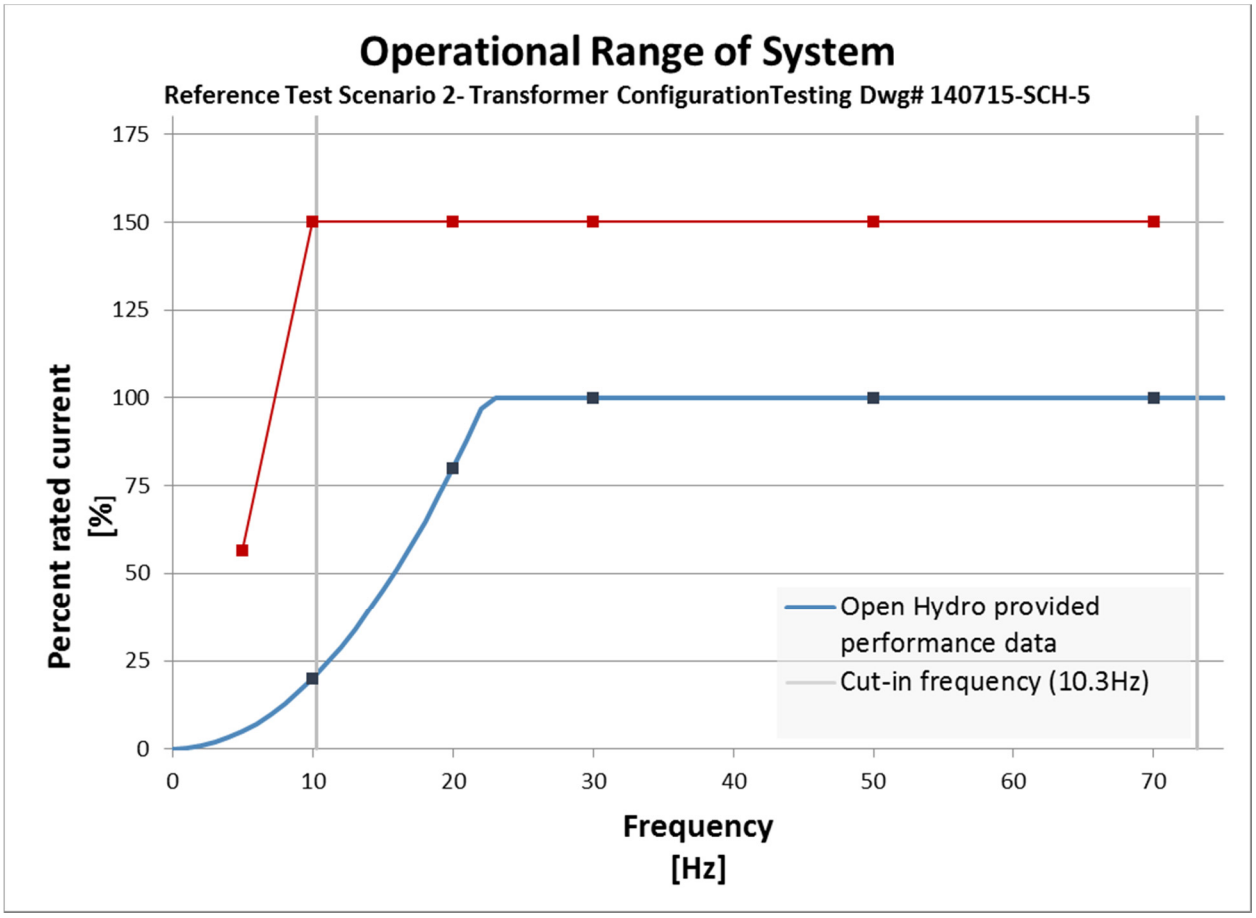
During testing, the generator ran at 43° C, 22 degrees above ambient temperature. However, the first (step up) transformer heated up to 36° C, and the second (step down) transformer heated up to 35° C.



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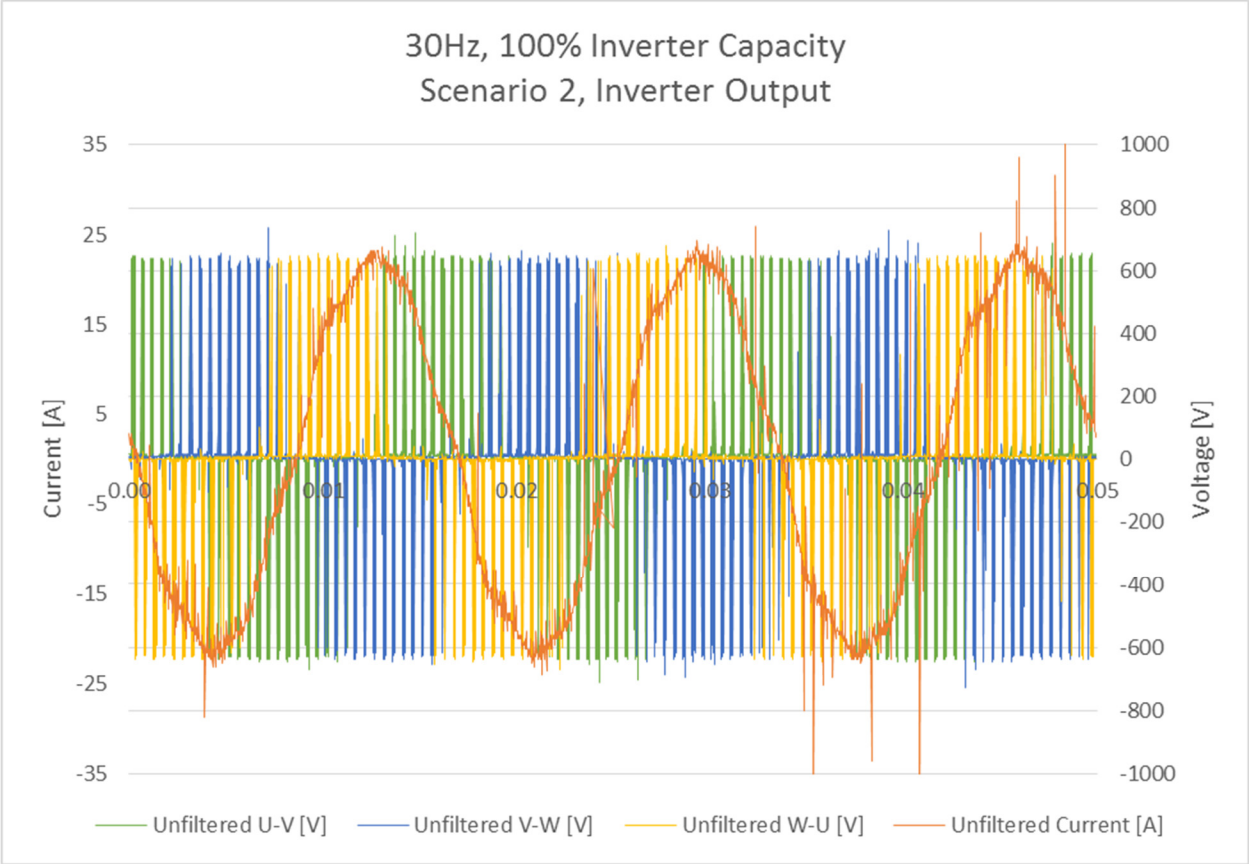
4.2.3. Voltage and Current Waveforms

Inverter output

At the inverter output, the back EMF from the generator is indistinguishable due to the PWM voltage waveform. However, the stator current is clearly seen in the chart below.



The peak to peak voltage at this test point is about 1200 V, with current spikes up to 35 A. The addition of the transformers has eliminated the voltage spikes seen at the inverter output in scenario 1.

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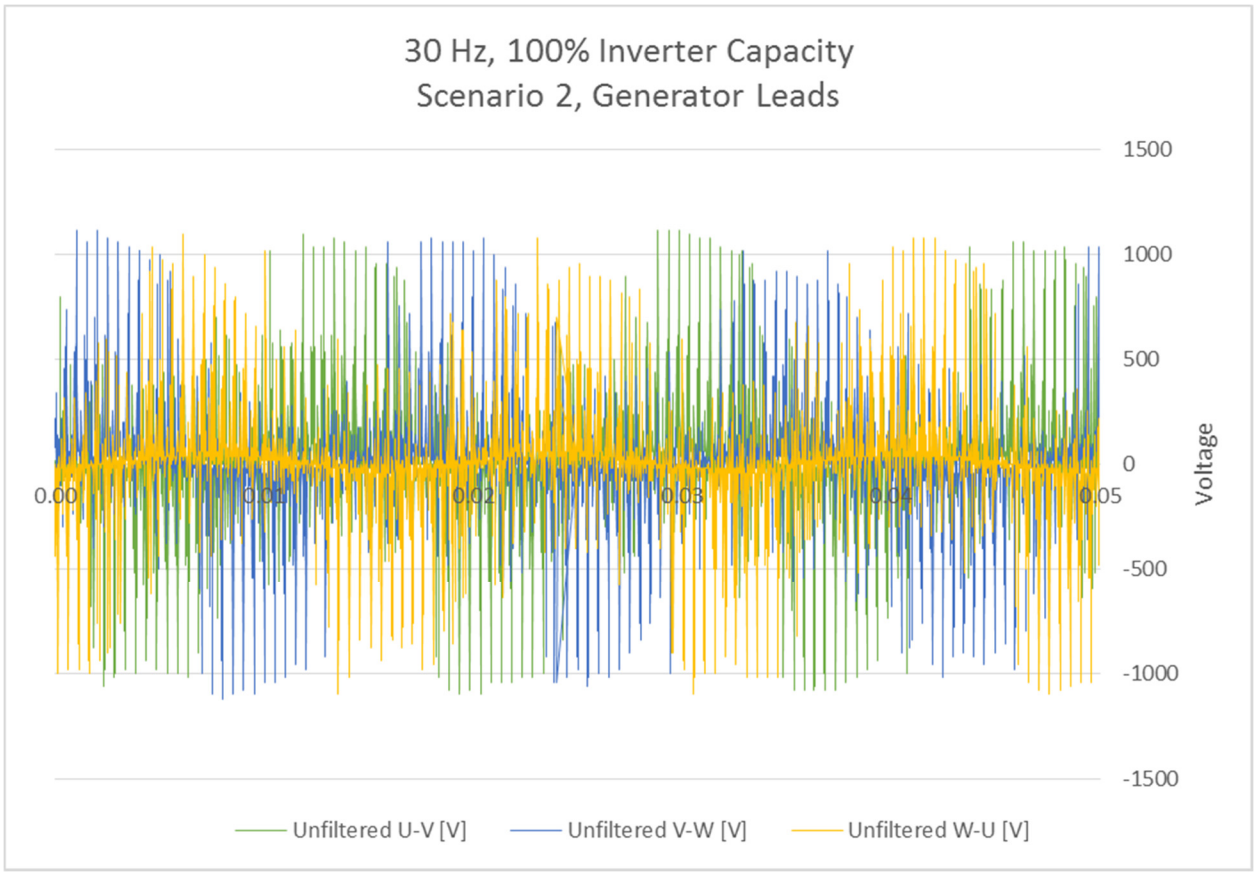
Generator leads

At the generator leads, the back EMF waveform from the generator is somewhat distinguishable despite the PWM voltage waveform.



The peak to peak voltage at this test point is about 2000 V, but there are no major spikes. There is a discernable sine wave, but the waveform is still mostly PWM.

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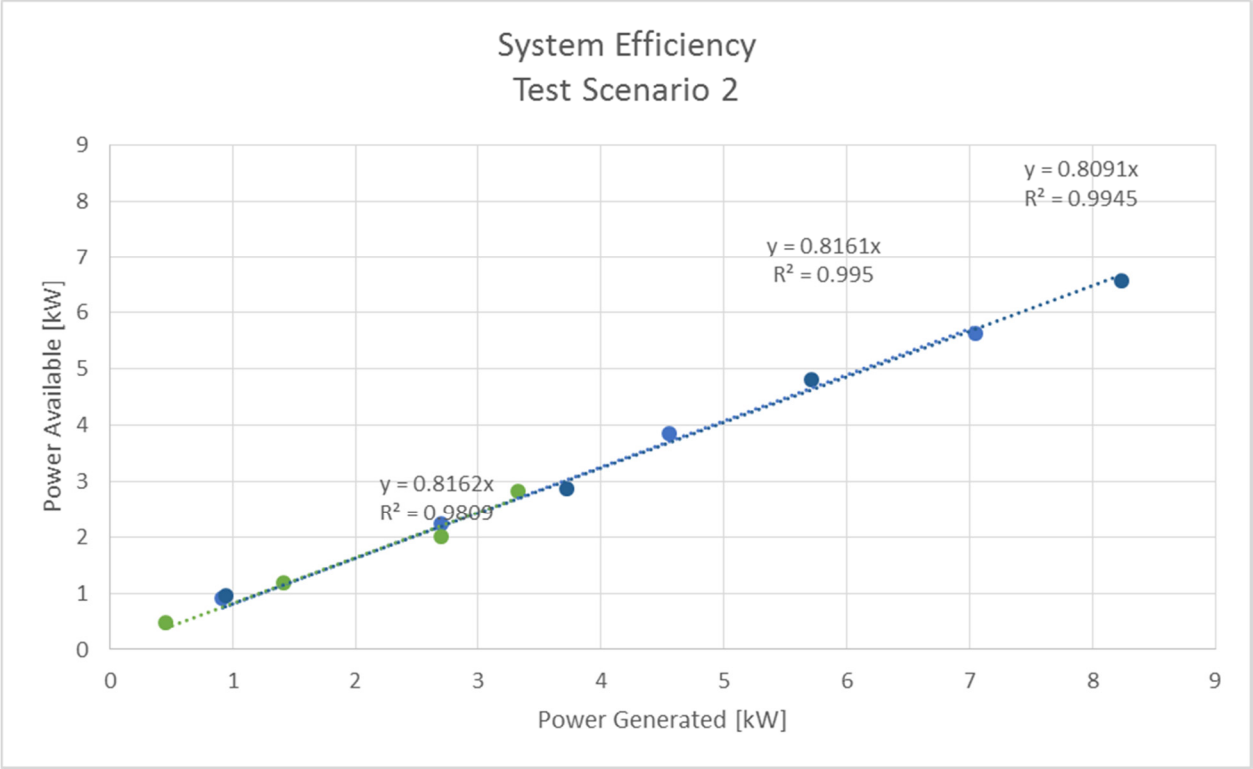
4.2.4. System Efficiency



Inverter Capacity	System Efficiency
50%	87.48%
100%	84.86%%
150%	83.51%

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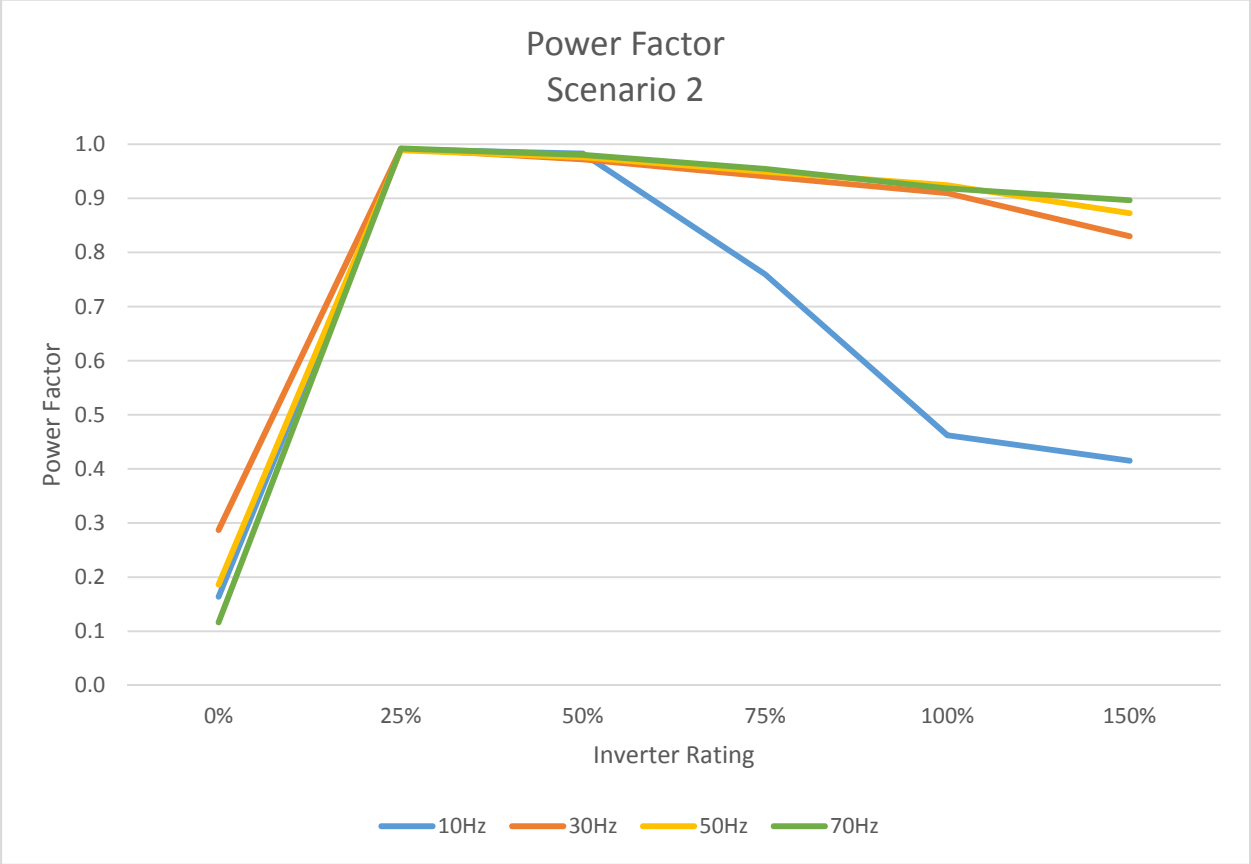
4.2.5. Power Factor



At 0% of the inverter current rating, the power factor is low. Here, the inverter puts out only enough current to maintain control of the generator and draws negligible power from the system. At 25% of the inverter current rating, the power factor reaches 0.99 for all frequencies. Power factor slowly trends downward with increasing inverter rating at 30 Hz, 50 Hz, and 70 Hz, with slightly better power factor at higher frequencies. Because of inherent drive limitations at low frequencies, power factor at 10 Hz declines sharply as the inverter rating increases.

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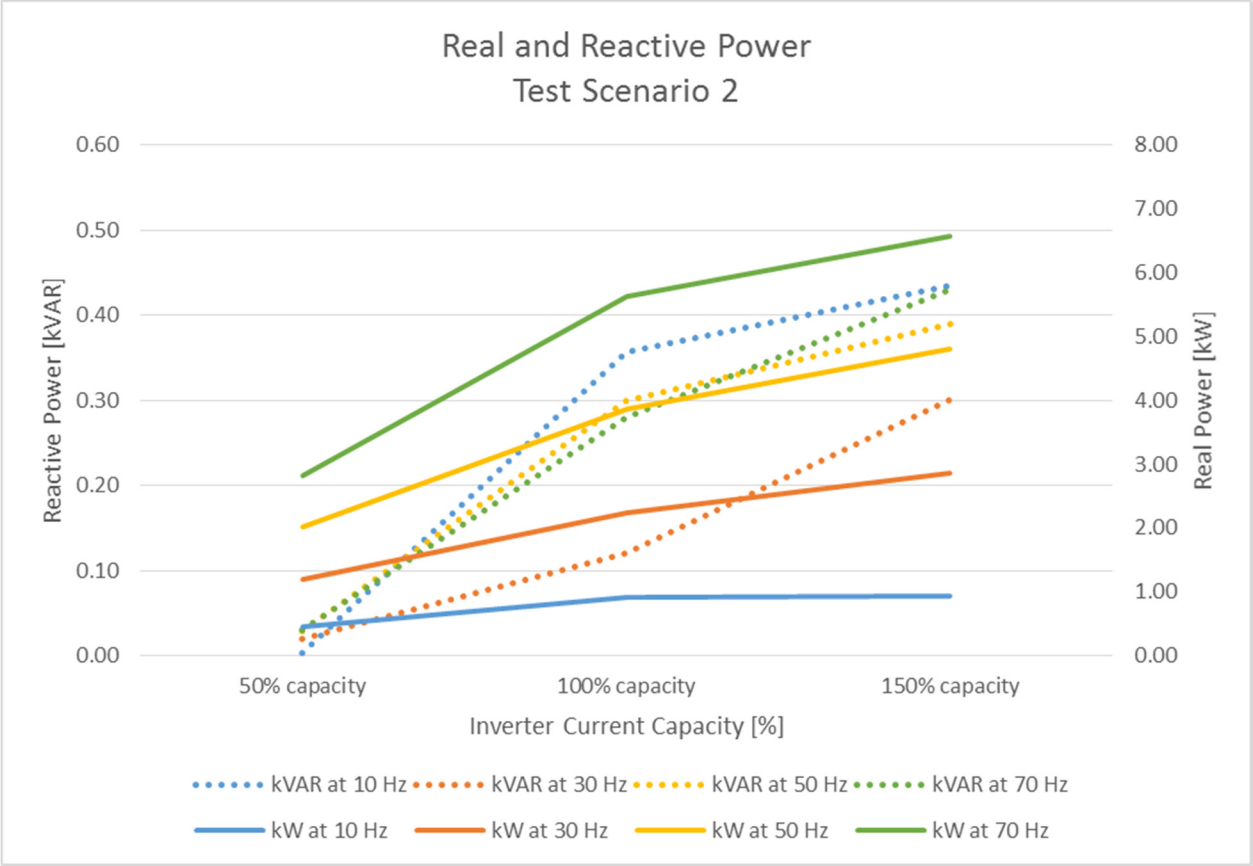
4.2.6. Real and Reactive Power in the System



In the above chart, real power is seen as a function of the inverter capacity for each frequency. As the current increases, so does the power generated. Reactive power is much higher in test scenario 2 because of the inductivity of the transformers.

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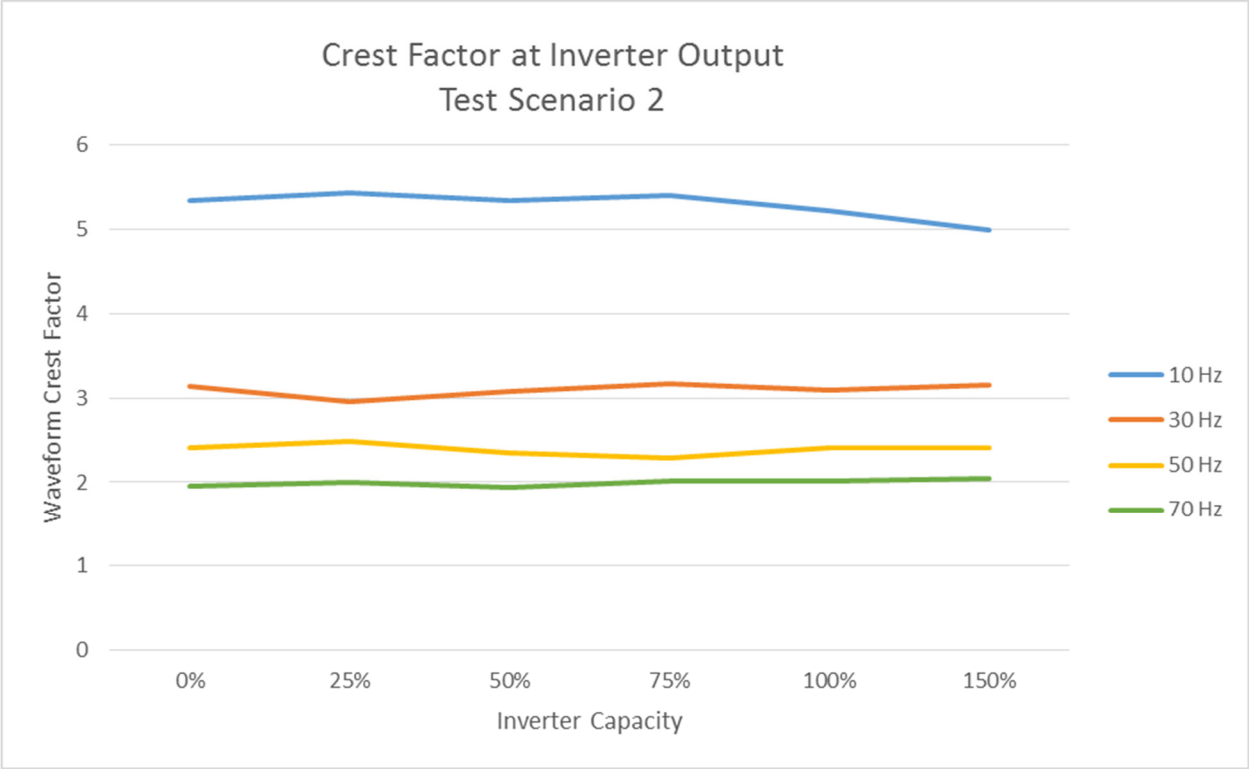
4.2.7. Crest Factor



The crest factor at the inverter output during test scenario 2 remained fairly steady as inverter capacity increased. Crest factor was highest at low frequencies.

Crest factor at inverter output in scenario 2 is nearly identical to crest factor at inverter output in scenario 1.

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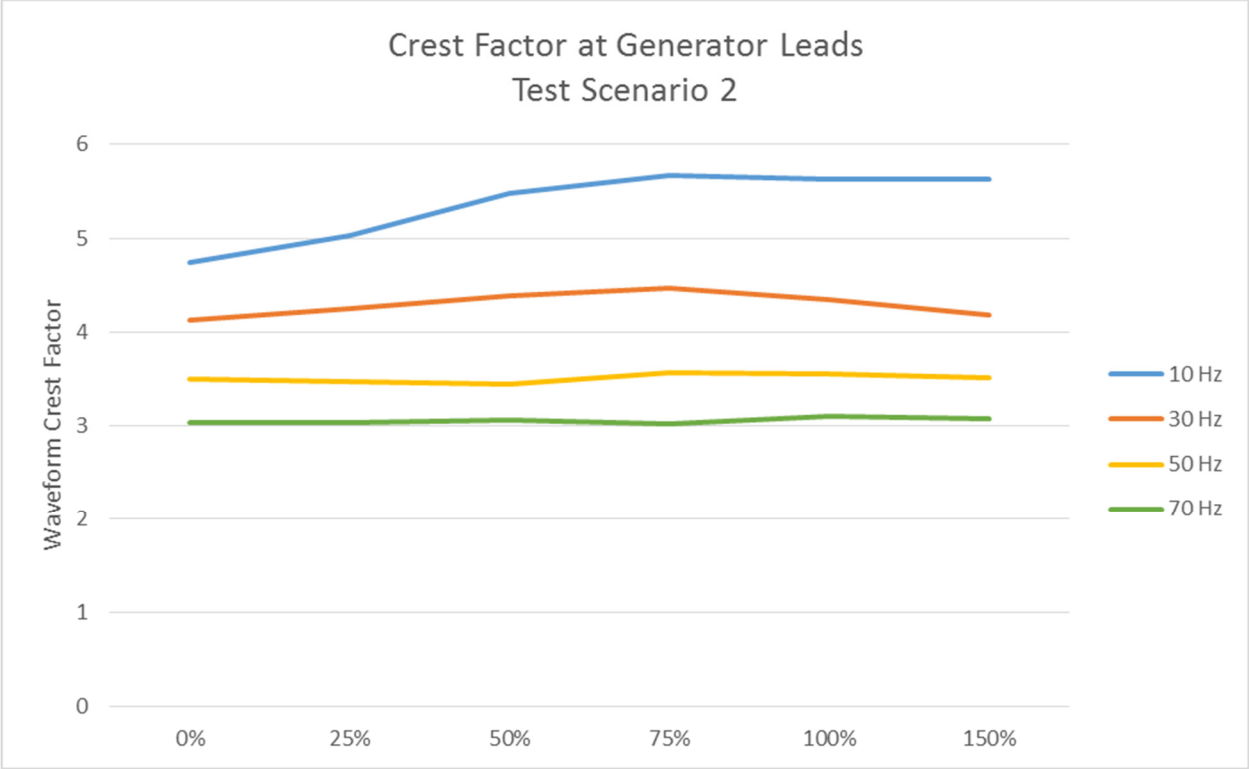

The crest factor at the generator leads during test scenario 2 increased slightly as inverter capacity increased. This increase is most noticeable at 10 Hz. Crest factor was highest at low frequencies. Most crest factors at the generator leads were greater than those at the inverter output. The exception to this is the data taken at 10 Hz and below 50% of the inverter capacity.

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4.3. Test Scenario 3 – Undersea Cable Emulator Baseline

This test scenario includes the undersea cable emulator provided by OpenHydro between the two transformers. In all other respects, the configuration remained identical to Test Scenario 2.

4.3.1. Purpose

The purpose of this test scenario was to determine if the POC drive system could control the permanent magnet generator through the transformers and undersea cable emulator provided by OpenHydro. Data was taken to measure the system performance in this configuration.

4.3.2. Result

The POC drive system could be used to control the permanent magnet generator through the two transformers and undersea cable emulator. After the addition of the cable emulator, an automatic motor data identification test was run by the S120 drive. The drive calculated the impedance due to the transformers and cable emulator. After the automatic drive adjustments, the POC drive system required no further parameterization to run. An internal drive calculation set the speed threshold at which the inverter would attempt to synchronize with the generator at just above 15 Hz, preventing any attempt at commutation below that speed. The speed threshold was manually lowered to 10 RPM, (0.5 Hz) and the generator was able to synch below 15 Hz.

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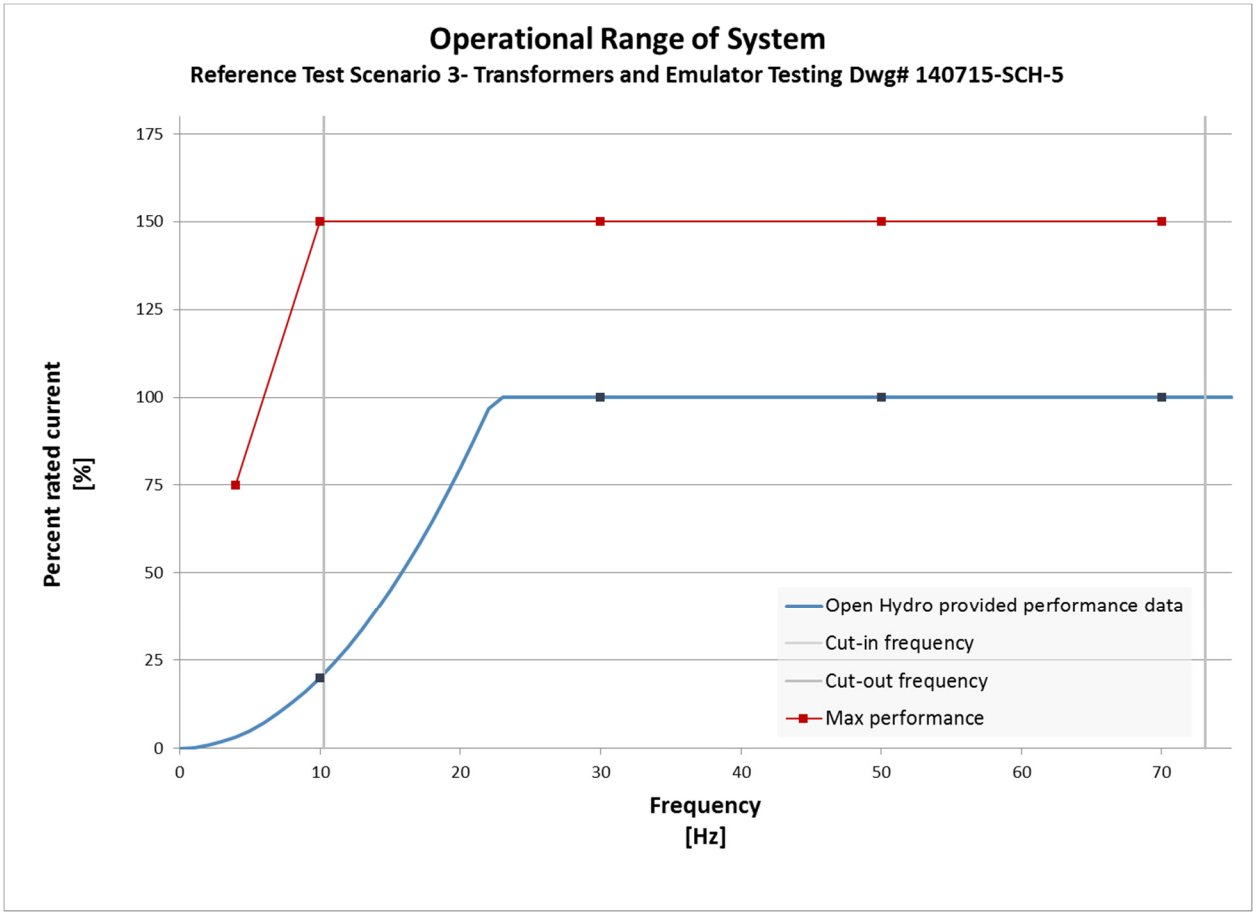
With the inverter connected to the generator through the transformers and undersea cable emulator, the generator was able to synchronize at frequencies ranging from as low as 4 Hz to as high as 70 Hz. Operation was not tested above 70 Hz. At 10 Hz, the drive remained synchronized with the generator up to 150% of the drive capacity. Operation was not tested above 150% of the drive capacity.

The system was 76.69% efficient at 100% of the inverter current rating.

During testing, the generator ran at 43° C, 22 degrees above ambient temperature. The first (step up) transformer heated up to 37 ° C; the undersea cable emulator heated up to 54° C and the second (step down) transformer stayed at a relatively cool 29° C. The large temperature difference between the two transformers in this scenario implied that the cable emulator filtered out much of the PWM noise, leading to reduced heating in transformer 2.



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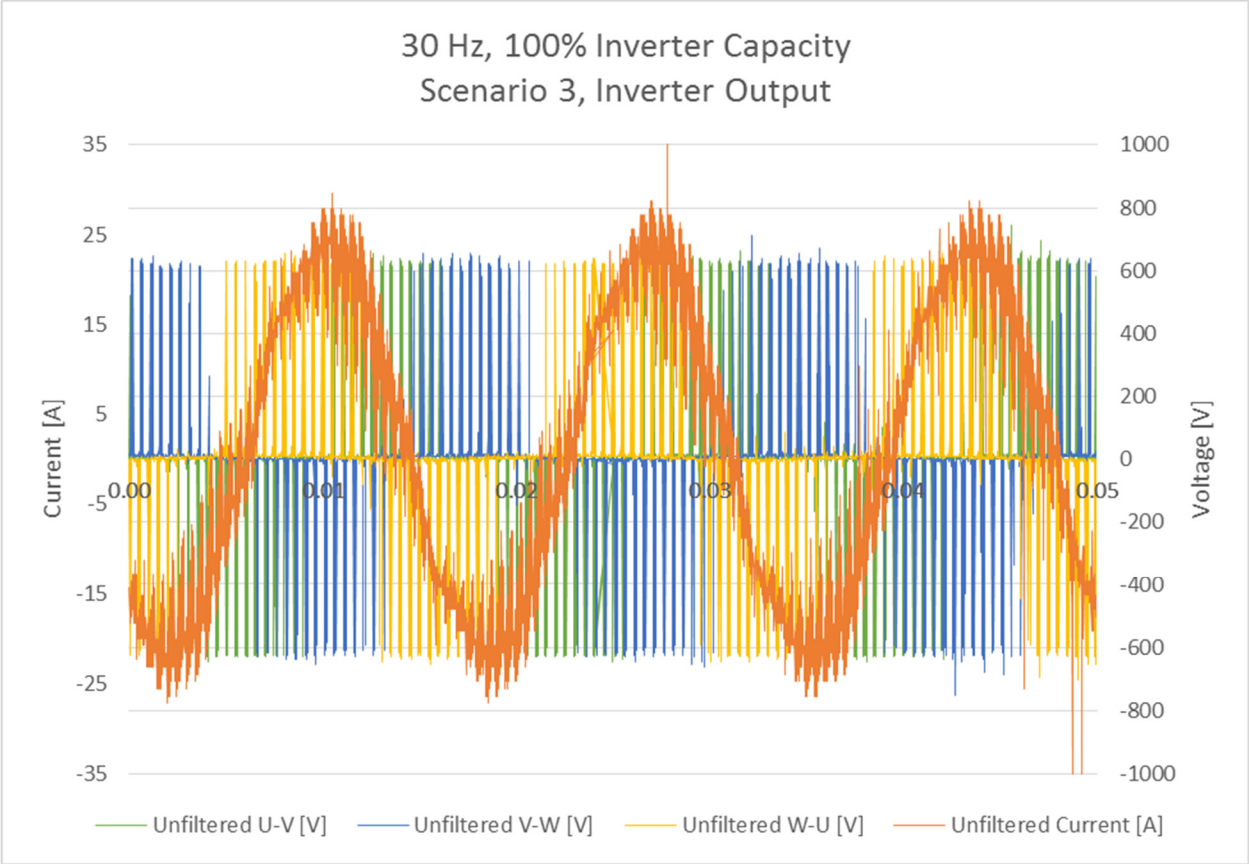
4.3.3. Voltage and Current Waveforms

Inverter output

At the inverter output, the back EMF from the generator is indistinguishable due to the PWM voltage waveform. However, the stator current is clearly seen in the chart below.



The peak to peak voltage at this test point is about 1200 V (+/- 600 V). Also note the current spikes up to 35 Amps, which is the current limit setting of the drive. The addition of the undersea cable emulator resulted in a noisier current signal than that seen in Scenario 2.

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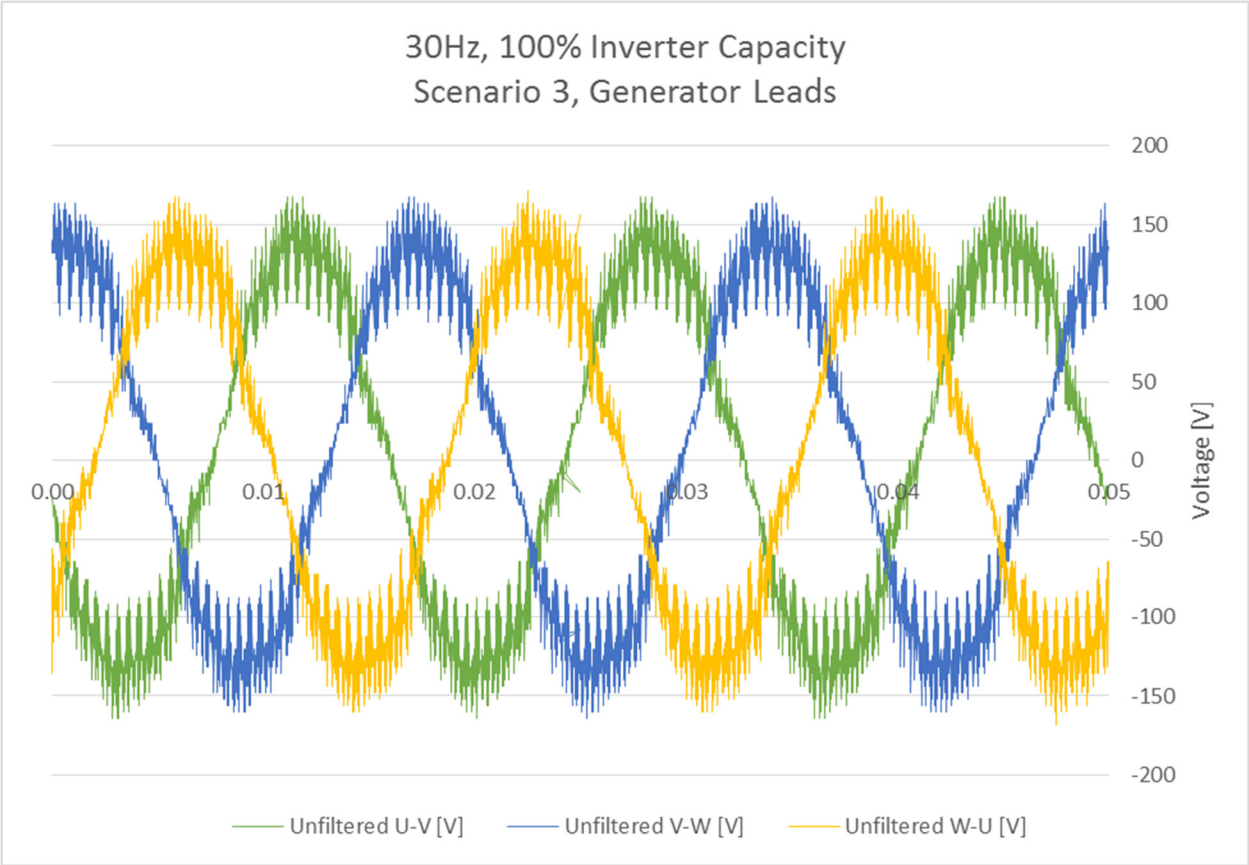
Generator Leads

With the transformers and undersea cable emulator between the inverter and generator, the back EMF from the generator is clearly seen at the generator leads.



The peak to peak voltage at this test point is about 300 V, (+/- 150 V). The undersea cable emulator acted as a filter, absorbing PWM noise and voltage spikes. While the undersea cable emulator is a proper circuit equivalent to a 2.6 km cable, it lacks the physical properties that a 2.6 km cable has that would cause travelling wave effects and voltage multiplication. These effects are well documented by pump manufacturers in the well-drilling industry, where pump motors are operated by VFDs over cables as long as 15,000 feet (roughly 4.5 km). One such study can be reviewed in Appendix G.

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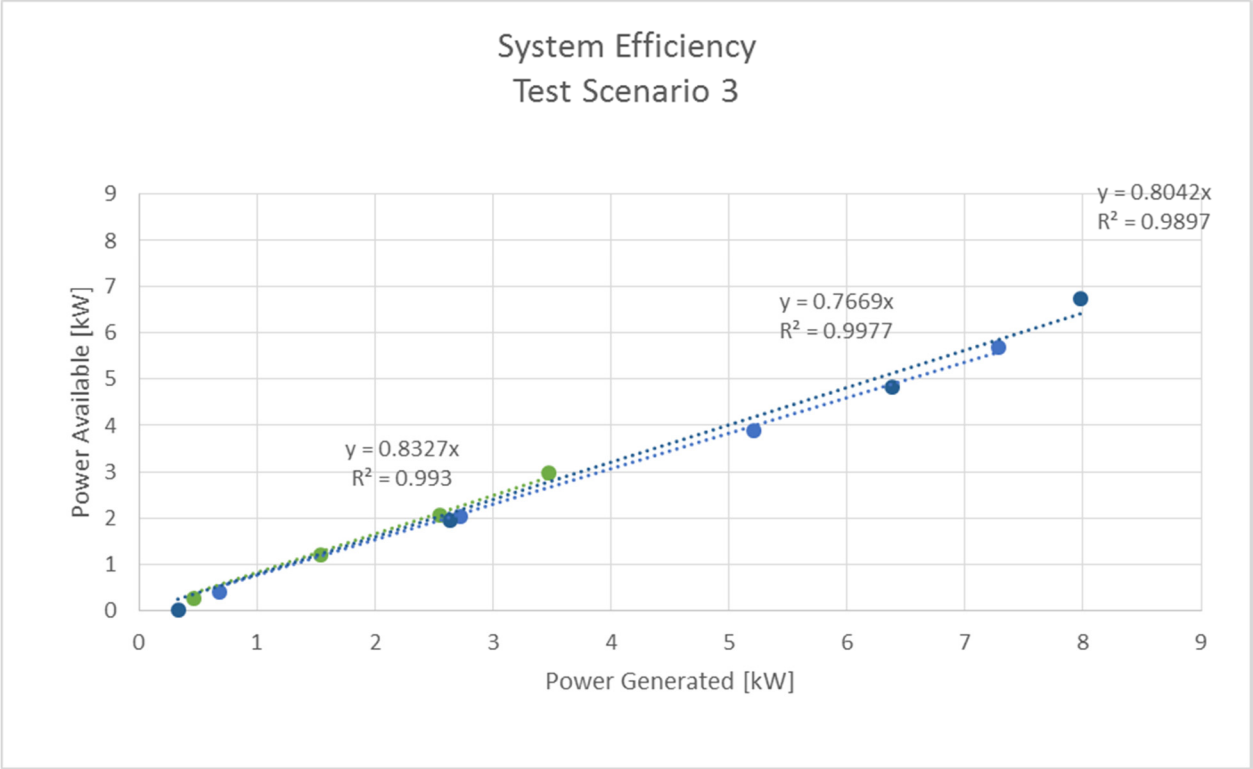
4.3.4. System Efficiency



Inverter Capacity	System Efficiency
50%	89.40%
100%	79.94%
150%	82.87%

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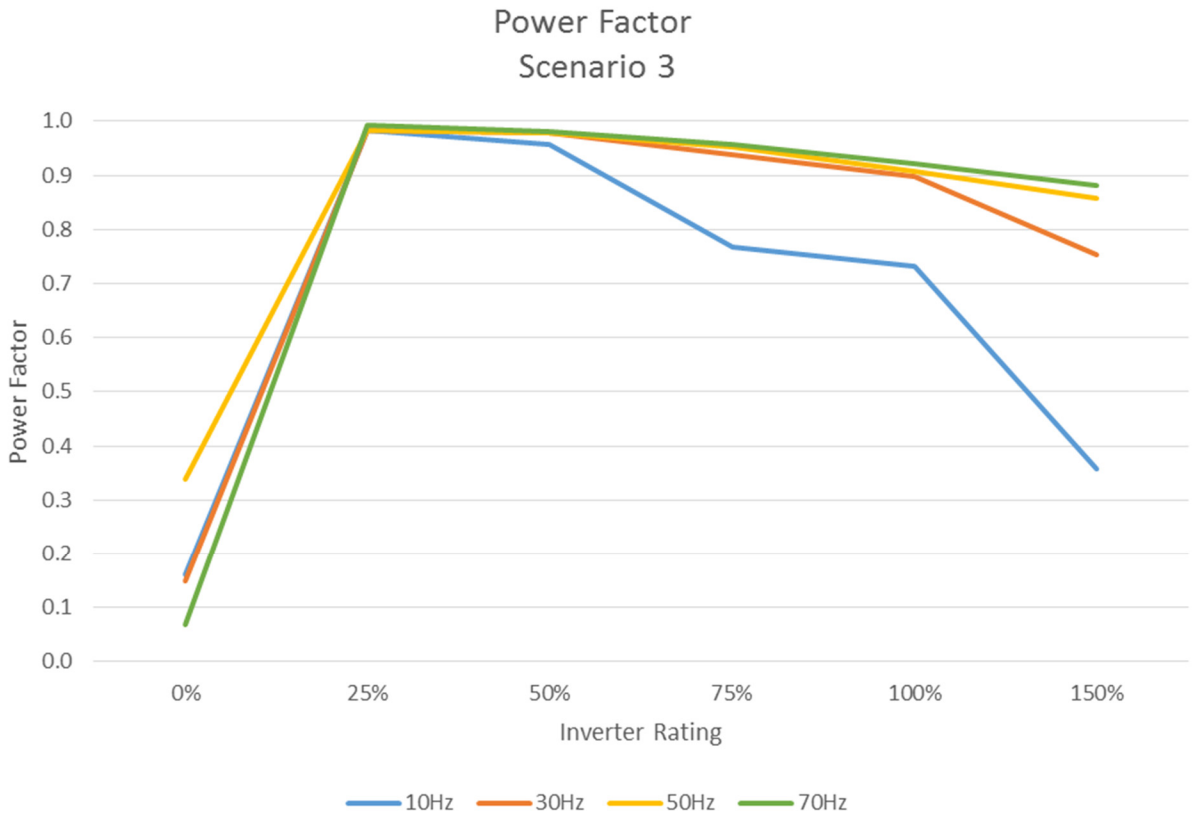
4.3.5. Power Factor



At 0% of the inverter current rating, the power factor is low. Here, the inverter puts out only enough current to maintain control of the generator and draws negligible power from the system. At 25% of the inverter current rating, the power factor reaches 0.99 for all frequencies. Power factor slowly trends downward with increasing inverter rating at 30 Hz, 50 Hz, and 70 Hz, with slightly better power factor at higher frequencies. Because of inherent drive limitations at low frequencies, power factor at 10 Hz declines sharply as the inverter rating increases.

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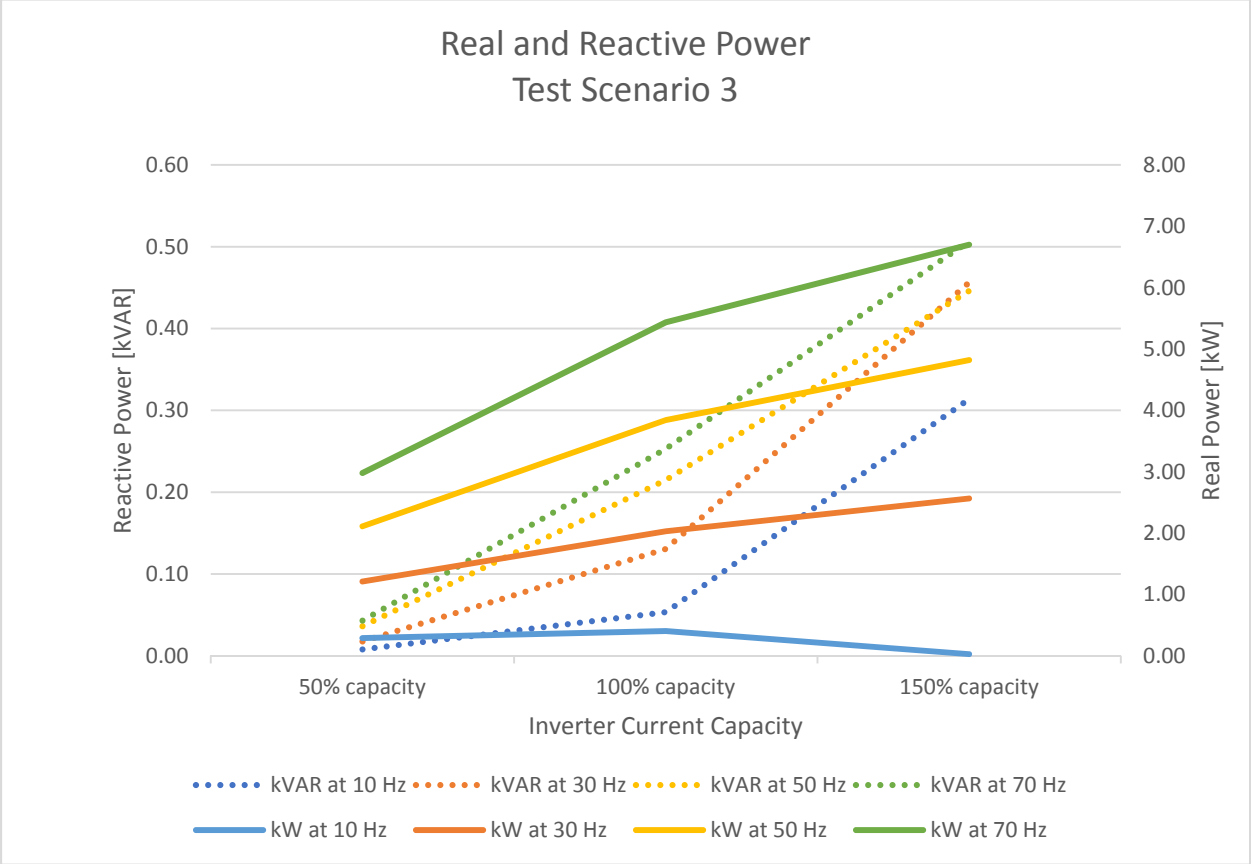
4.3.6. Real and Reactive Power



In the above chart, real power is seen as a function of the inverter capacity for each frequency. As the current increases, so does the power generated. Reactive power is has a slight increase in value from Test Scenario 2 because of additional inductance in the undersea cable emulator.

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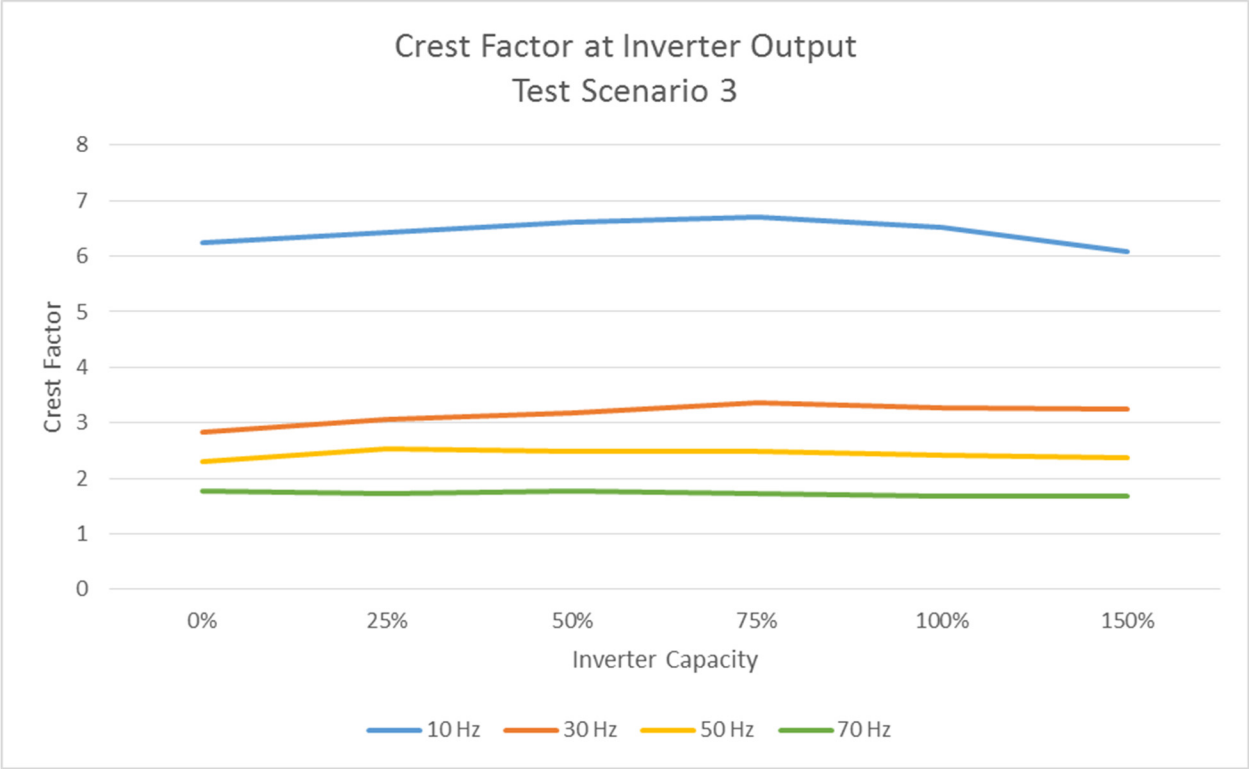
4.3.7. Crest Factor



The crest factor at the inverter output during test scenario 3 increased slightly as inverter capacity increased. The exception to this trend is at 10 Hz, where the crest factor peaks at 75% of the inverter capacity and then decreases. Crest factor was highest at low frequencies.

Crest factor at 10 Hz in scenario 3 is significantly higher than the crest factor at 10 Hz for the two preceding scenarios. Otherwise, crest factor at inverter output in scenario 3 is mostly identical to crest factor at inverter output in scenarios 1 and 2.

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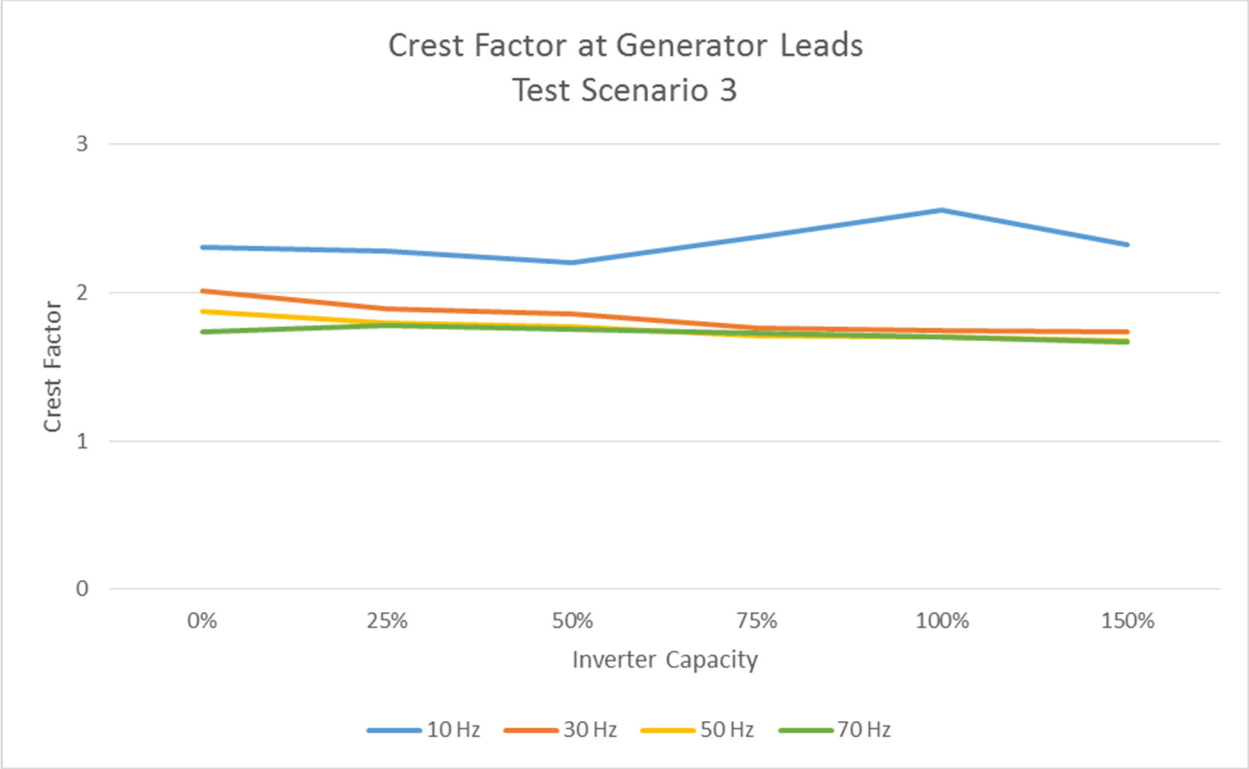

The crest factor at the generator leads during test scenario 3 decreased as inverter capacity increased. The crest factor at 10 Hz is a noticeable exception here, as it decreases to 50%, rises again until 100%, and falls again.

Crest factor at the generator leads in test scenario 3 is significantly lower than the crest factor at generator leads in scenario 2, at all possible points.

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4.4. Test Scenario 4 – Sinusoidal Filter Baseline

This test scenario includes a Siemens sine wave filter between the Sinamics S120 drive and the first transformer. In all other respects, the configuration remained identical to Test Scenario 3.

It was hypothesized that the addition of the sine wave filter would make a substantial improvement in overall system performance. Like test scenarios 1-3, data was taken at 10 – 70 Hz at 0% -150% of the inverter rating. In addition to this, data was also taken along the OpenHydro Turbine Generator Scalar Control current curve, at expected operational frequencies.

4.4.1. Purpose

The purpose of this test scenario was to determine if the POC drive system could be used to control the permanent magnet generator through the two transformers, undersea cable emulator, and sine wave filter. Data was taken to measure system performance in this configuration. This test scenario also seeks to provide data more specific to the intended operating frequencies and current demands.

4.4.2. Results

The POC drive system could be used to control the permanent magnet generator through the two transformers, the undersea cable emulator, and the sine wave filter. The sine wave filter had to be parameterized within the drive. After the addition of the sine wave filter, an automatic motor data

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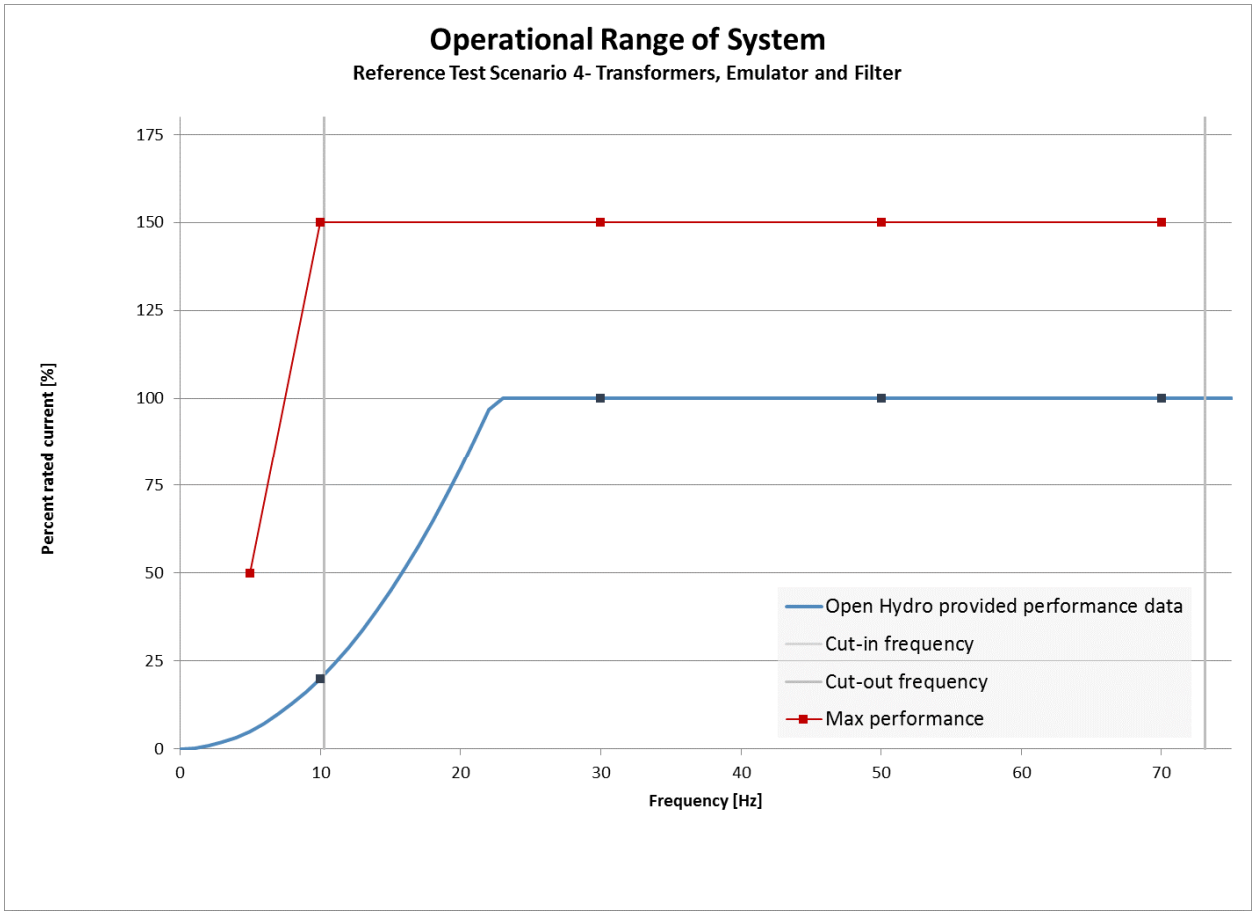
identification test was run by the S120 drive. The drive calculated the impedance due to the transformers, cable emulator, and filter. After the automatic drive adjustments, the POC drive system required no further parameterization to run. An internal drive calculation set the speed threshold at which the inverter would attempt to synchronize with the generator at just above 15 Hz, preventing any attempt at commutation below that speed. The speed threshold was manually lowered to 10 RPM, (0.5 Hz) and the generator was able to synch below 15 Hz.

With the inverter connected to the generator through the transformers, undersea cable emulator, and sine wave filter, the generator was able to synchronize at frequencies ranging from as low as 3Hz to as high as 70 Hz. Operation was not tested above 70 Hz. At 10 Hz, the drive remained synchronized with the generator up to 150% of the drive capacity. Operation was not tested above 150% of the drive capacity.

The system was 80.91% efficient at 100% of the inverter current rating from 10 – 70Hz. The system was 78% efficient along the "OpenHydro Scalar Control" current curve from 7-49 Hz.

The sine wave filter reduced the wave form distortion, reduced the heat generated in the cable emulator, and increased the system's power factor.



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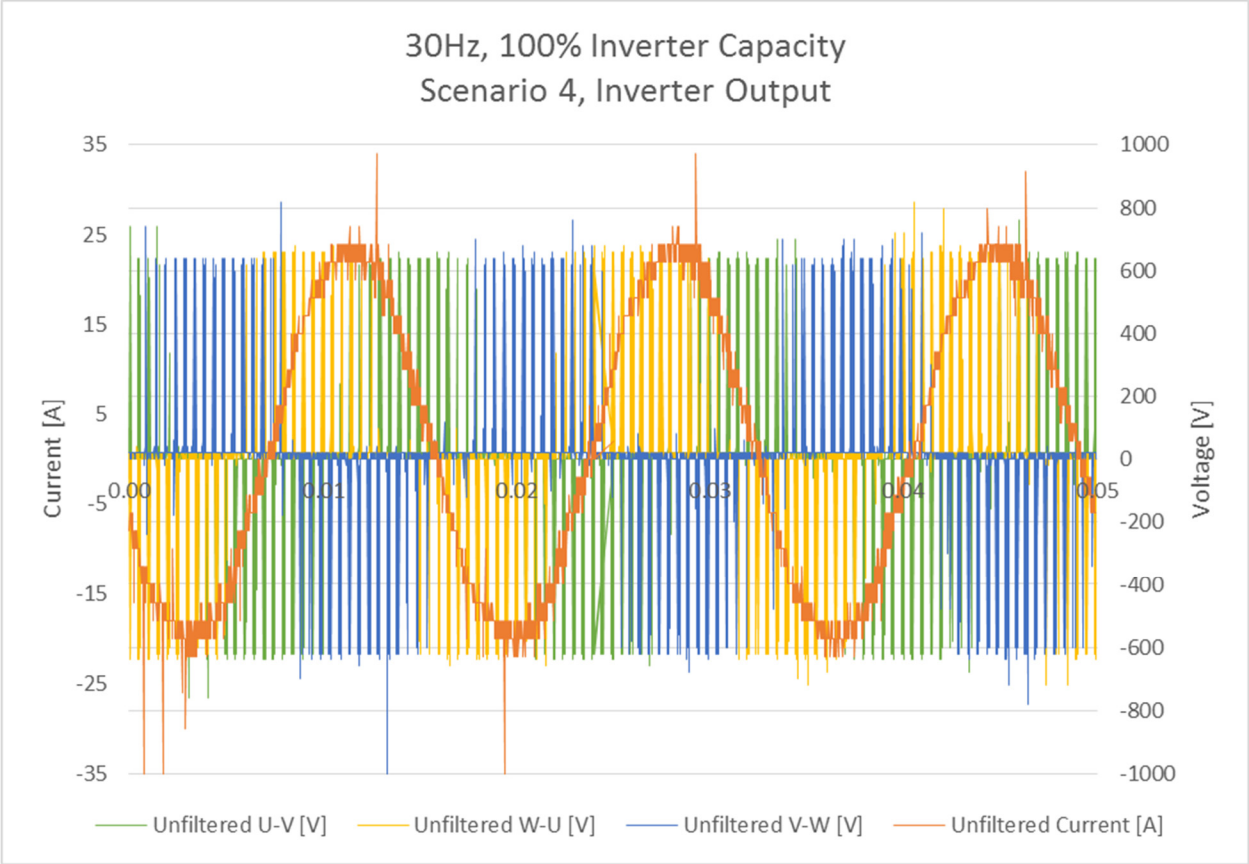
4.4.3. Voltage and Current Waveforms

Inverter Output

At the inverter, the back EMF from the generator is indistinguishable due to the PWM voltage waveform. However, the stator current is clearly seen in the chart below.



The peak to peak voltage at this test point is about 1200 V (+/- 600 V), with current spikes up to 35 A. The addition of the sine wave filter reduced the overall noise in the current wave form, but the number of current spikes increased.

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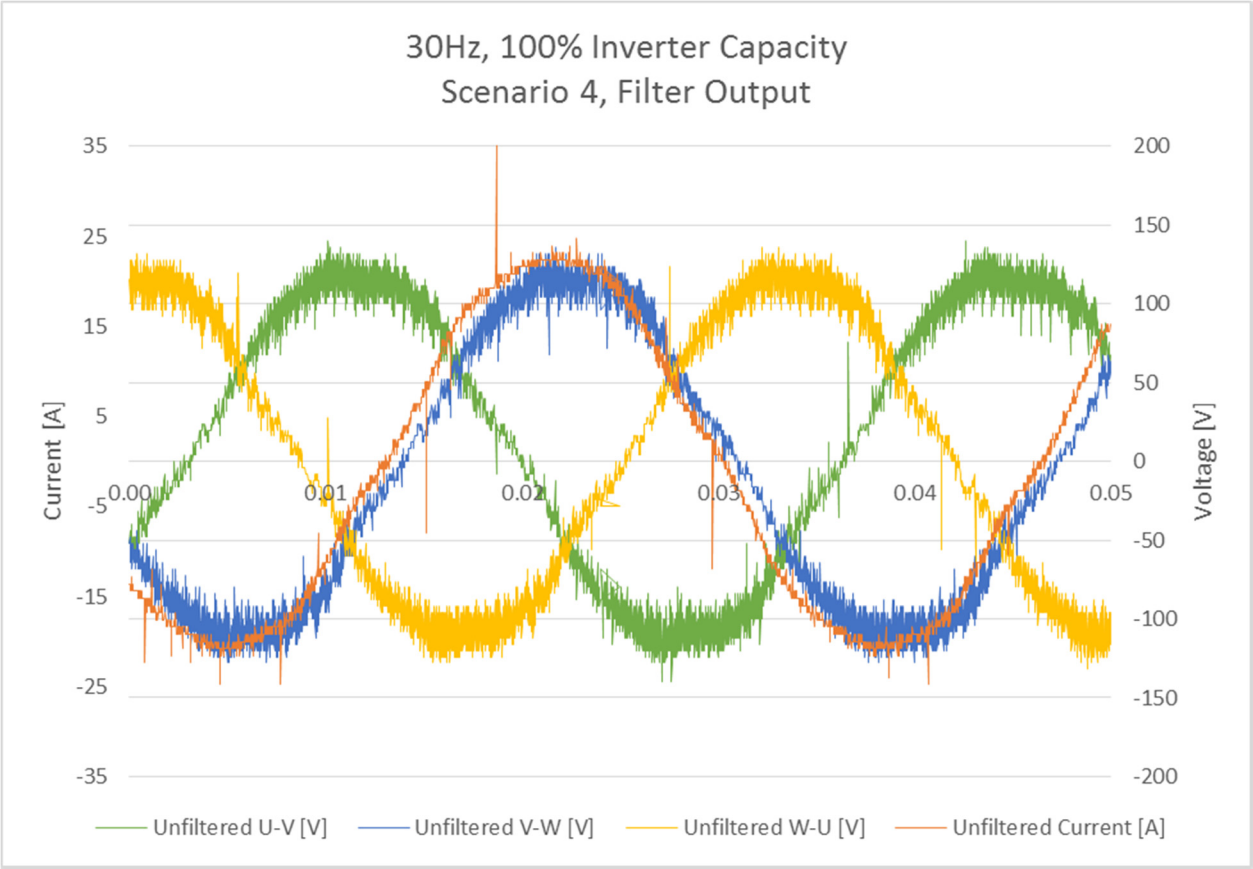
Filter Output

At the sine wave filter output, the voltage waveform is a clear sine wave. PWM characteristics can still be seen, but no longer obscure the generator back EMF.



The peak to peak voltage at this test point is about 280 V (+/- 140 V). There are smaller voltage spikes, but nothing exceeding the waveform peak value. The number of current spikes has been reduced.

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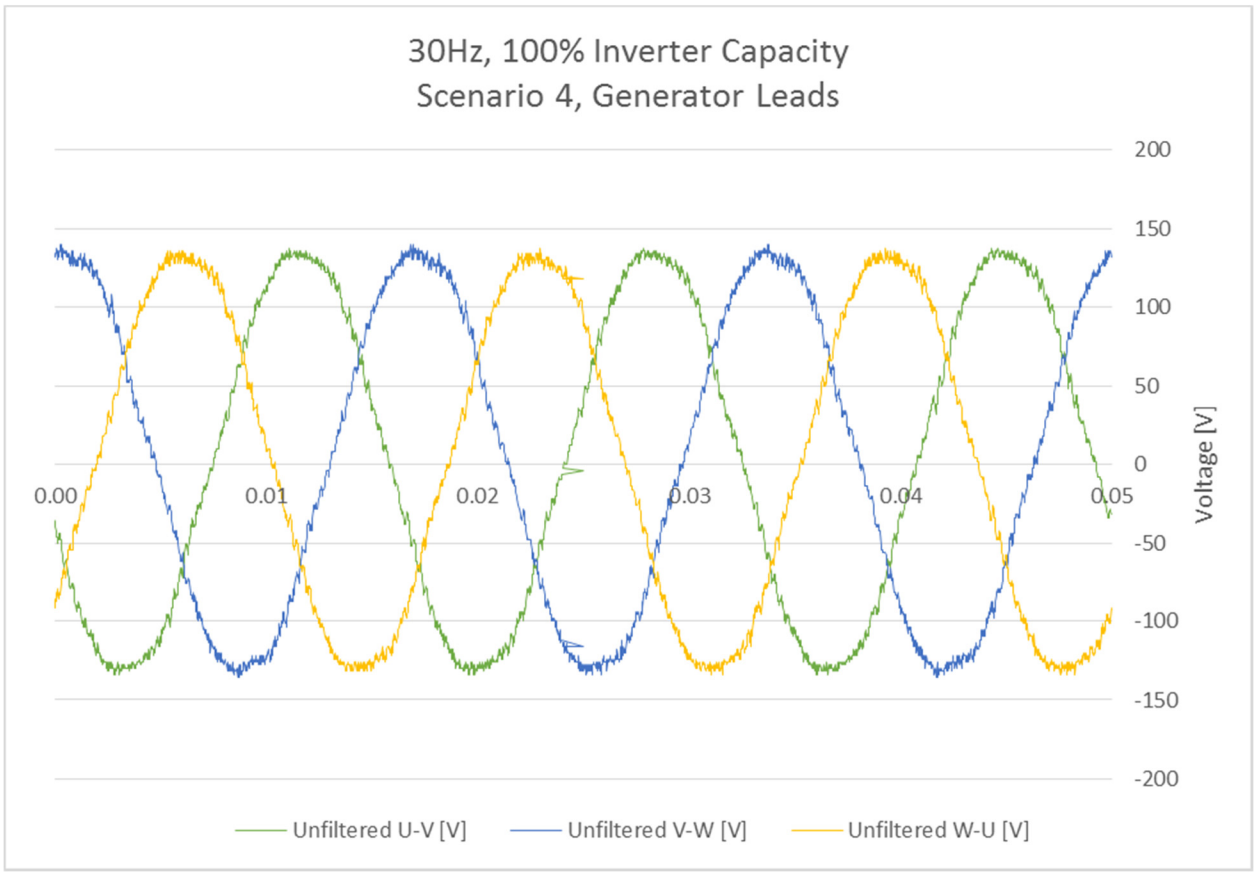
Generator Leads

At the generator leads, a sine wave can be clearly distinguished. Very little PWM noise remains.



The peak to peak voltage at this test point is about 280 V (+/- 140 V). There are no voltage spikes. The only disturbance in the voltage waveform is at 0.025 seconds, and is an artifact of the oscilloscope trigger.

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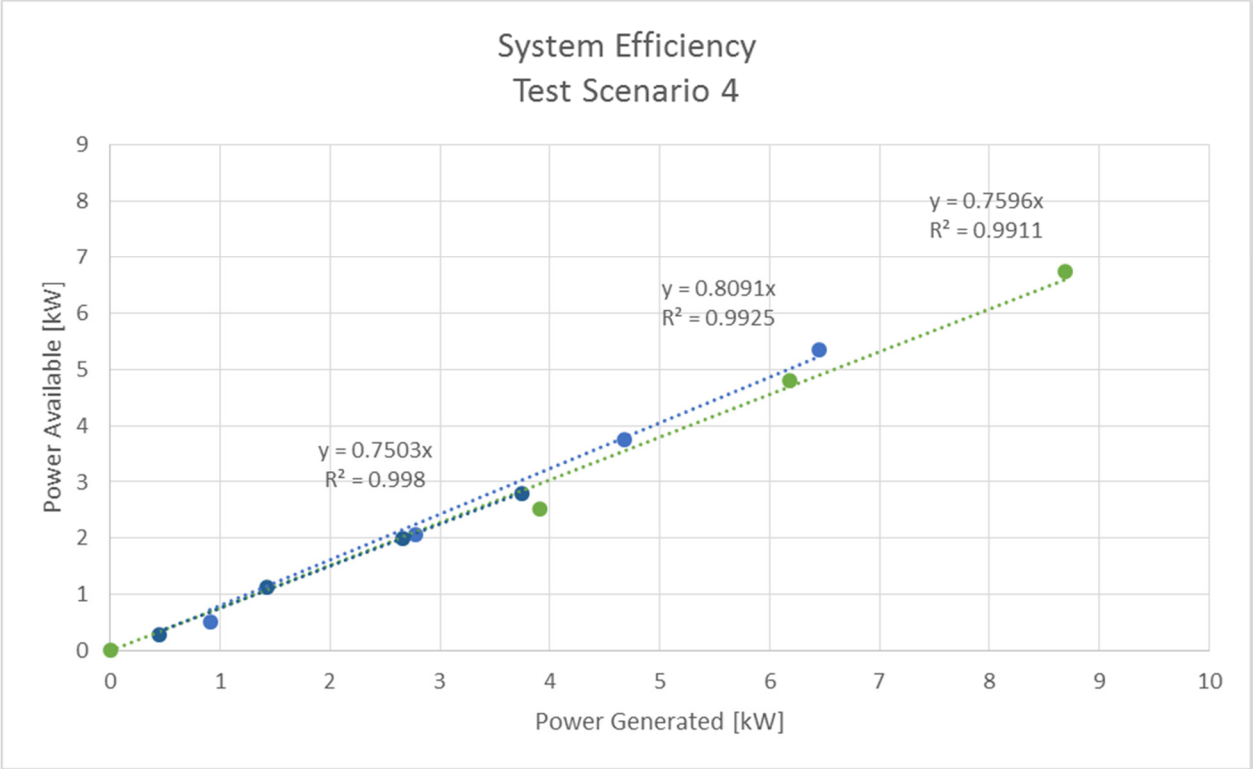
4.4.4. System Efficiency



Inverter Capacity	System Efficiency
50%	80.46%
100%	84.10%
150%	78.21%

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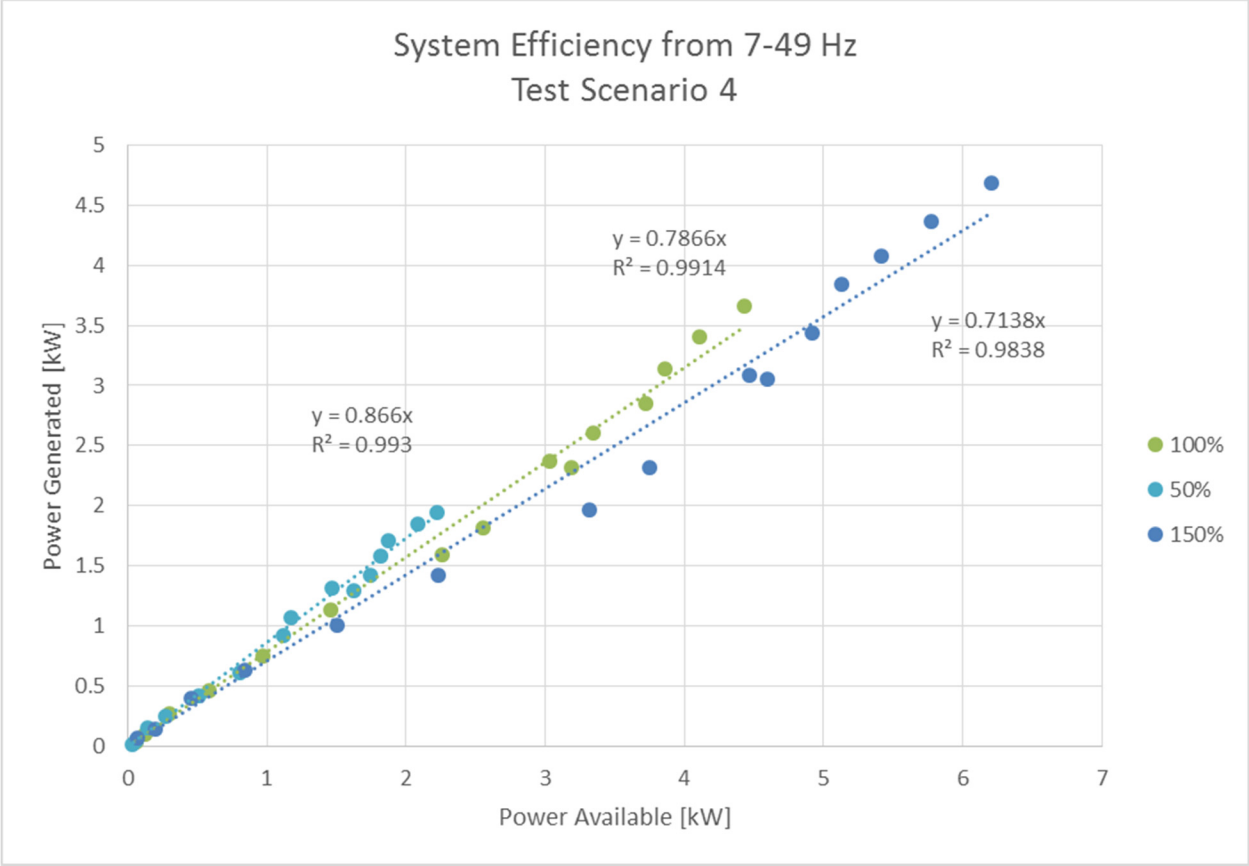
The efficiency of the system was also evaluated from 7-49 Hz along the OpenHydro Scalar Control current demand curve, and at +/- 50% of the current demand. At the proposed test site, it is expected that 99% of the generator's operation will occur between 7 and 49 Hz. This second set of data shows performance at intended operating frequencies and currents.



Inverter Capacity	System Efficiency
50%	86.6%
100%	78.66%
150%	71.38%

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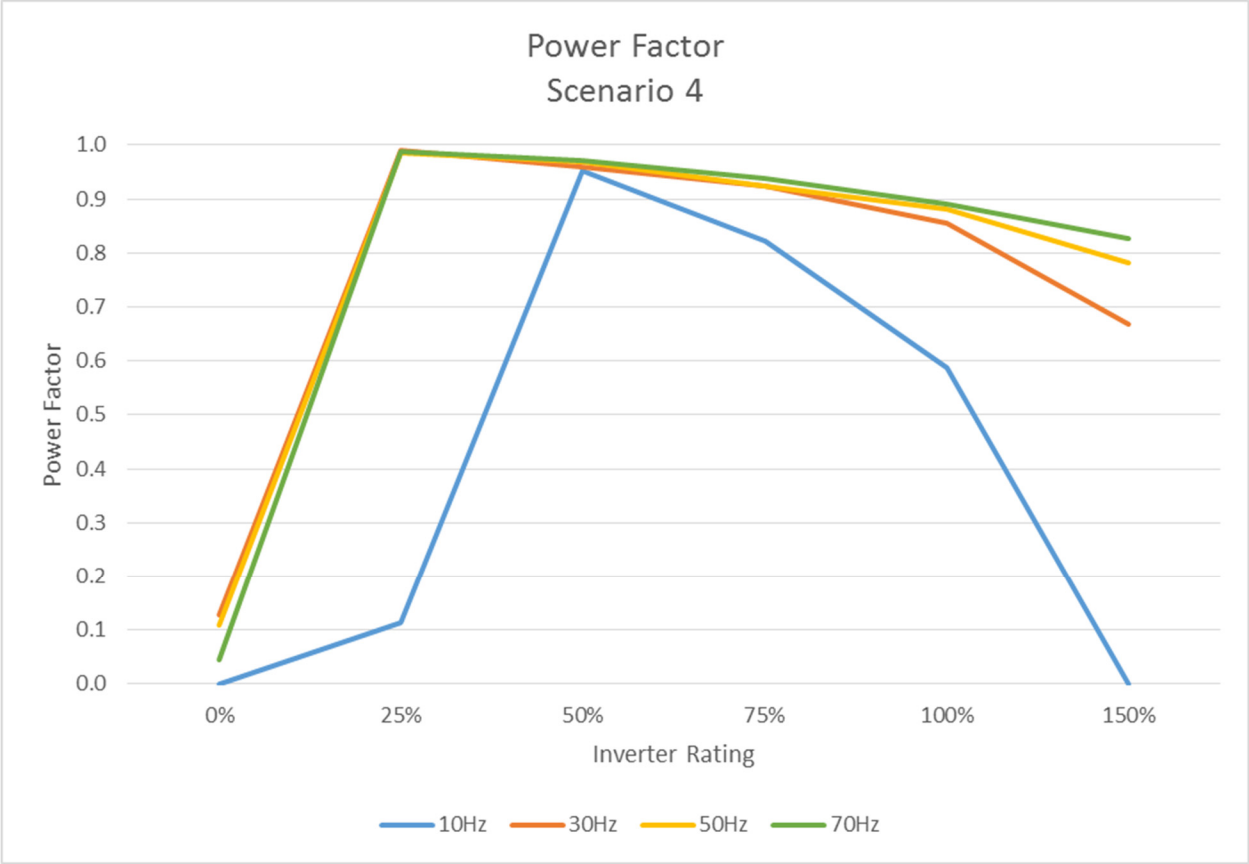
4.4.5. Power Factor



At 0% of the inverter current rating, the power factor is low. Here, the inverter puts out only enough current to maintain control of the generator and draws negligible power from the system. At 25% of the inverter current rating, the power factor reaches 0.99 for all frequencies. Power factor slowly trends downward with increasing inverter rating at 30 Hz, 50 Hz, and 70 Hz, with slightly better power factor at higher frequencies. Because of inherent drive limitations at low frequencies, power factor at 10 Hz declines sharply as the inverter rating increases.

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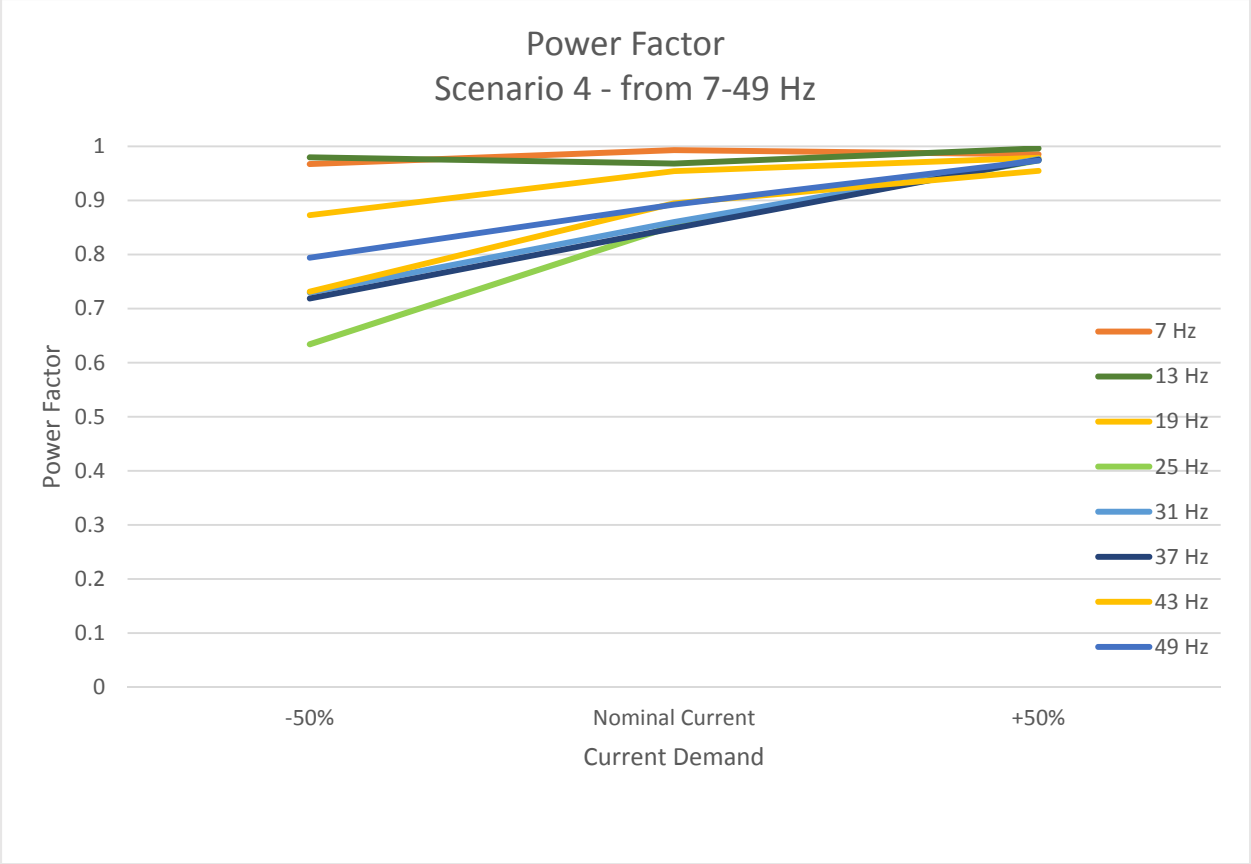

In the above chart, power factor along the "OpenHydro Scalar Control" current demand curve, +/- 50% is shown. Overall, power factor is best at the highest current demand.

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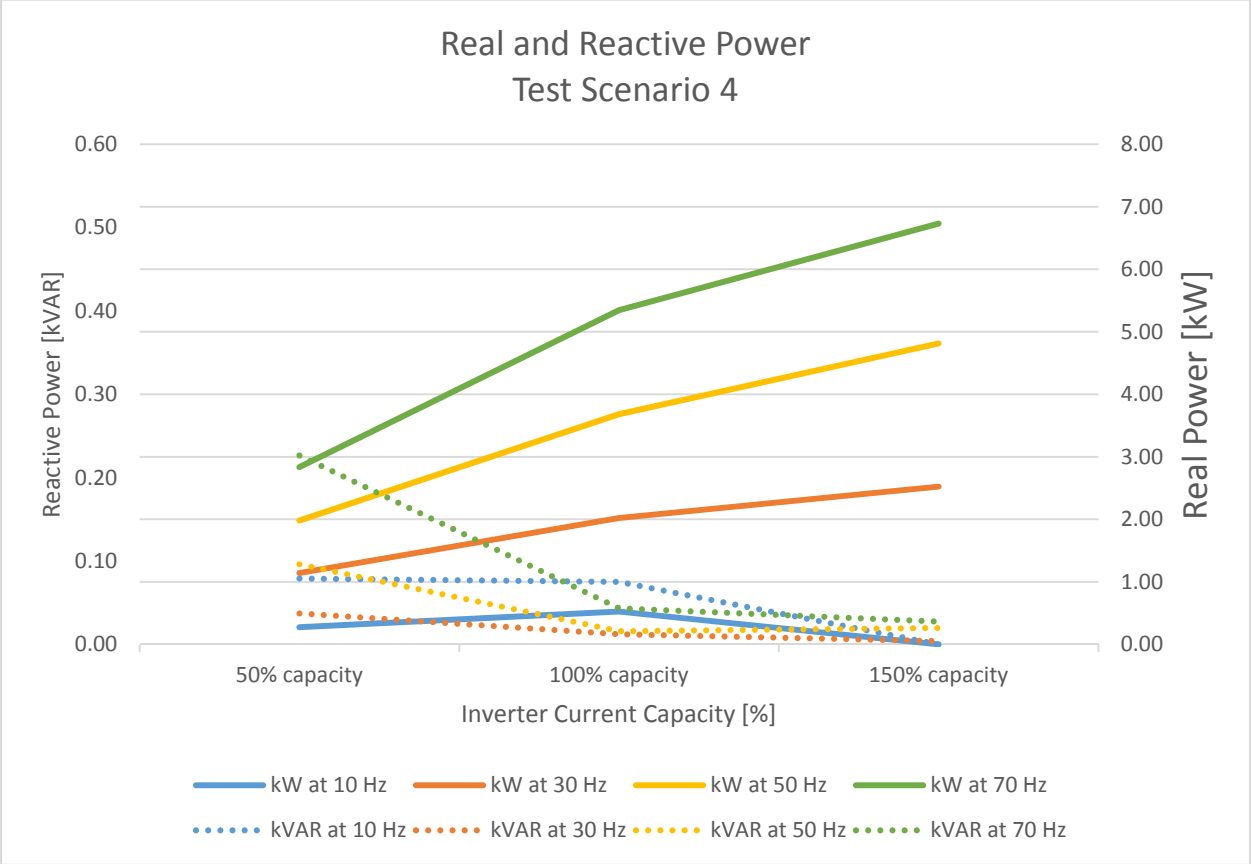
4.4.6. Real and Reactive Power



In the above chart, real power is seen as a function of the inverter capacity for each frequency. As the current increases, so does the power generated. The reactive power in the system is greatly reduced by the addition of the sine wave filter. The capacitance in the sine wave filter cancels some of the inductive effects of the load, correcting the power factor and reducing the reactive power in the circuit.

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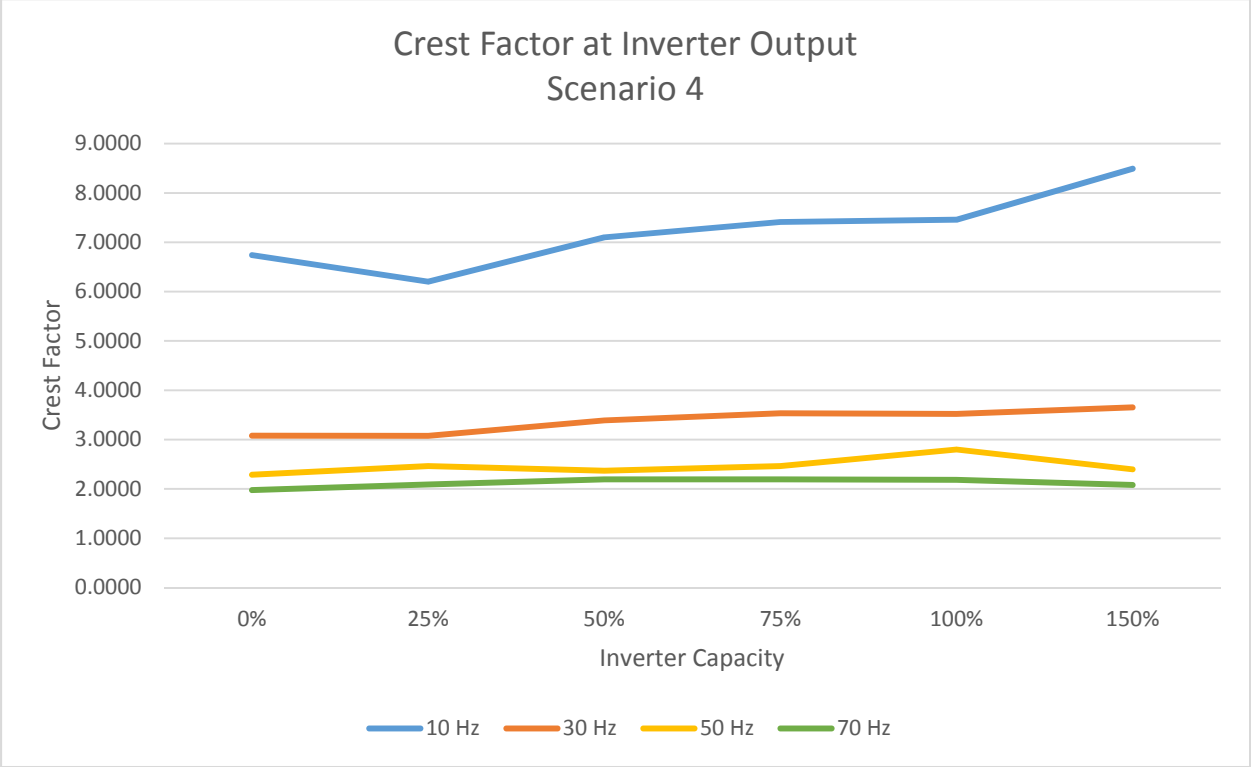
4.4.7. Crest Factor

The crest factor at the inverter output during test scenario 4 increased slightly as inverter capacity increased. Again, the 10 Hz data is an exception to this trend. Here, crest factor at 10 Hz peaks at 50% of inverter capacity and decreases from there.



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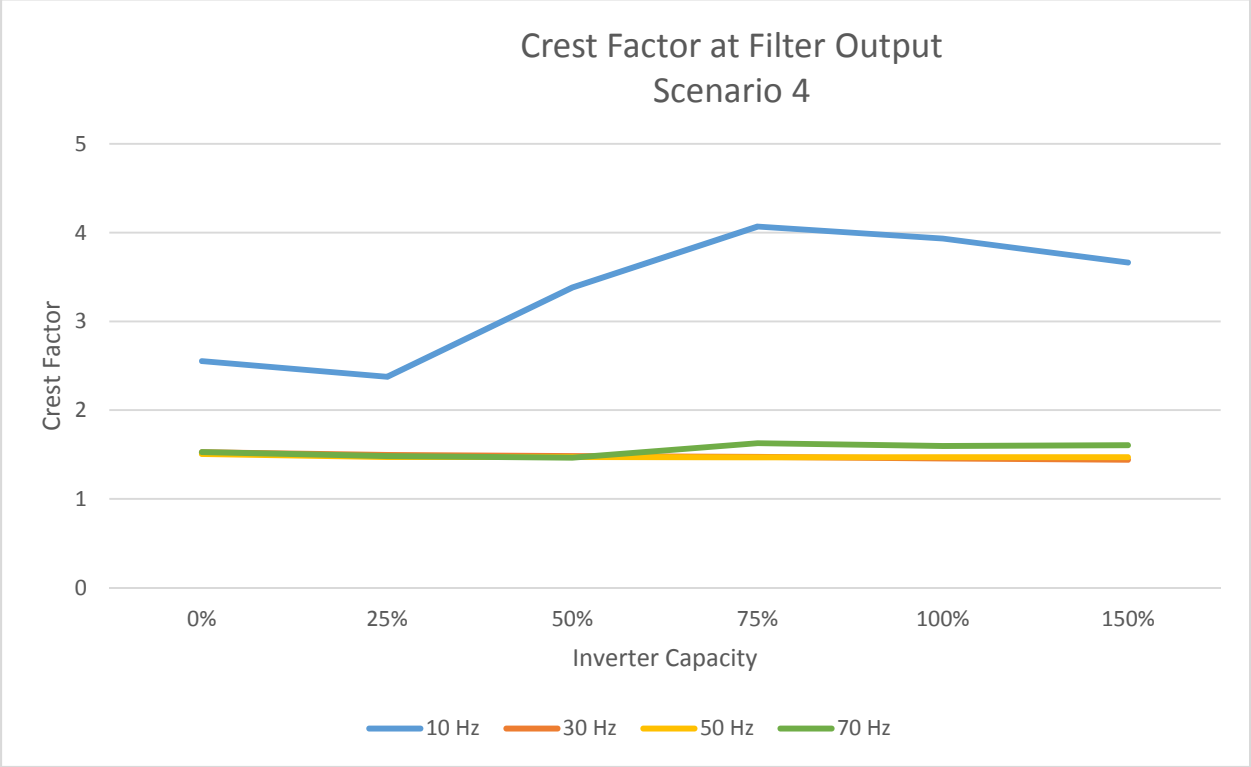
The crest factor at the filter output decreased slightly as inverter capacity increased. With the exception of the 10 Hz data, the crest factor stayed very close to 1.5, nearly ideal. The 10 Hz data is much higher than 1.5, but still better than the crest factor at the inverter output.



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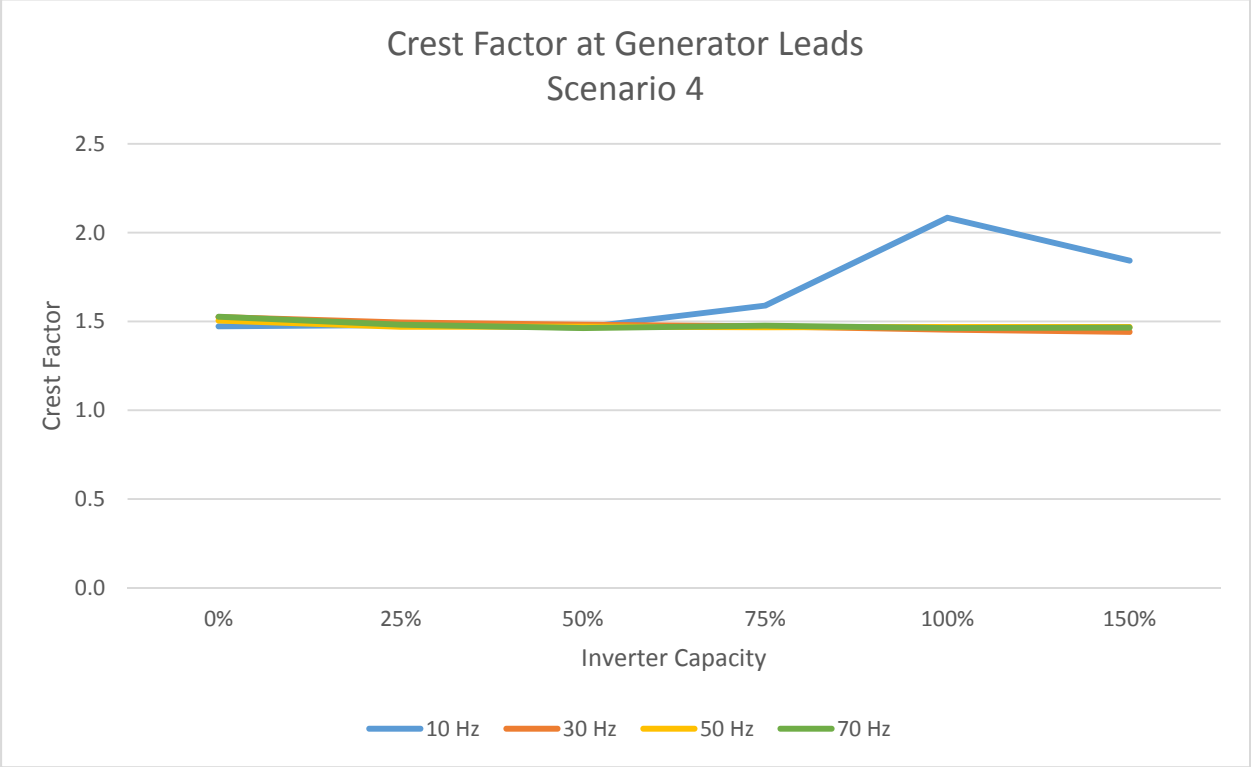
The crest factor at the generator leads approaches very close to 1.4 as the inverter capacity increases. Again, the 10 Hz data shows different behavior, having a peak crest factor of 2. Still, this is very little waveform distortion in comparision to the rest of the system.



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5. Power Analysis Summary

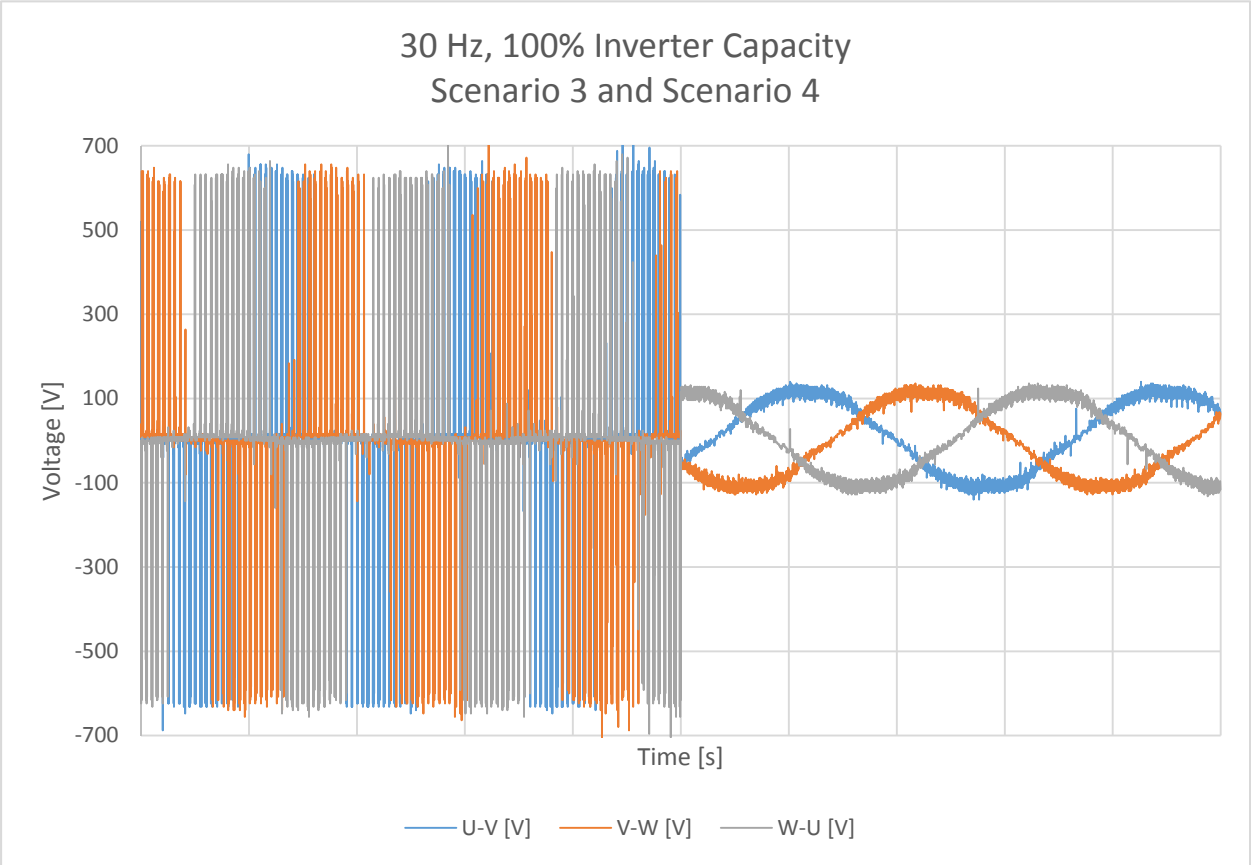
5.1.1. Results

Throughout testing, data was taken to measure system performance in each configuration. In every scenario, the drive system could be used to control the permanent magnet generator.

The direct connection between the generator and inverter provided the highest level of system performance, resulting in 94% efficient energy recovery at 100% inverter current capacity. Adding the two transformers to the system resulted in a 14% efficiency loss at 100% of inverter current capacity. The addition of the undersea cable emulator caused an additional 5% efficiency loss at 100% of the inverter current capacity. The addition of the sine wave filter, however, caused a 4.6% efficiency increase over the prior scenario.

The addition of the sine wave filter to the POC system decreased signal noise, decreased peak voltages seen by power transmission equipment, reduced reactive power and reduced waveform distortion.

5.1.2. Voltage Waveforms



The left side of the chart shows a plot of the inverter output in scenario 3, at 30 Hz and 100% of the inverter capacity. Here, peak-to-peak voltage is over 1200 V, and voltage spikes. On the right side of the chart is the output of the sine wave filter in scenario 4. Here, the peak to peak voltage is only 280 V.

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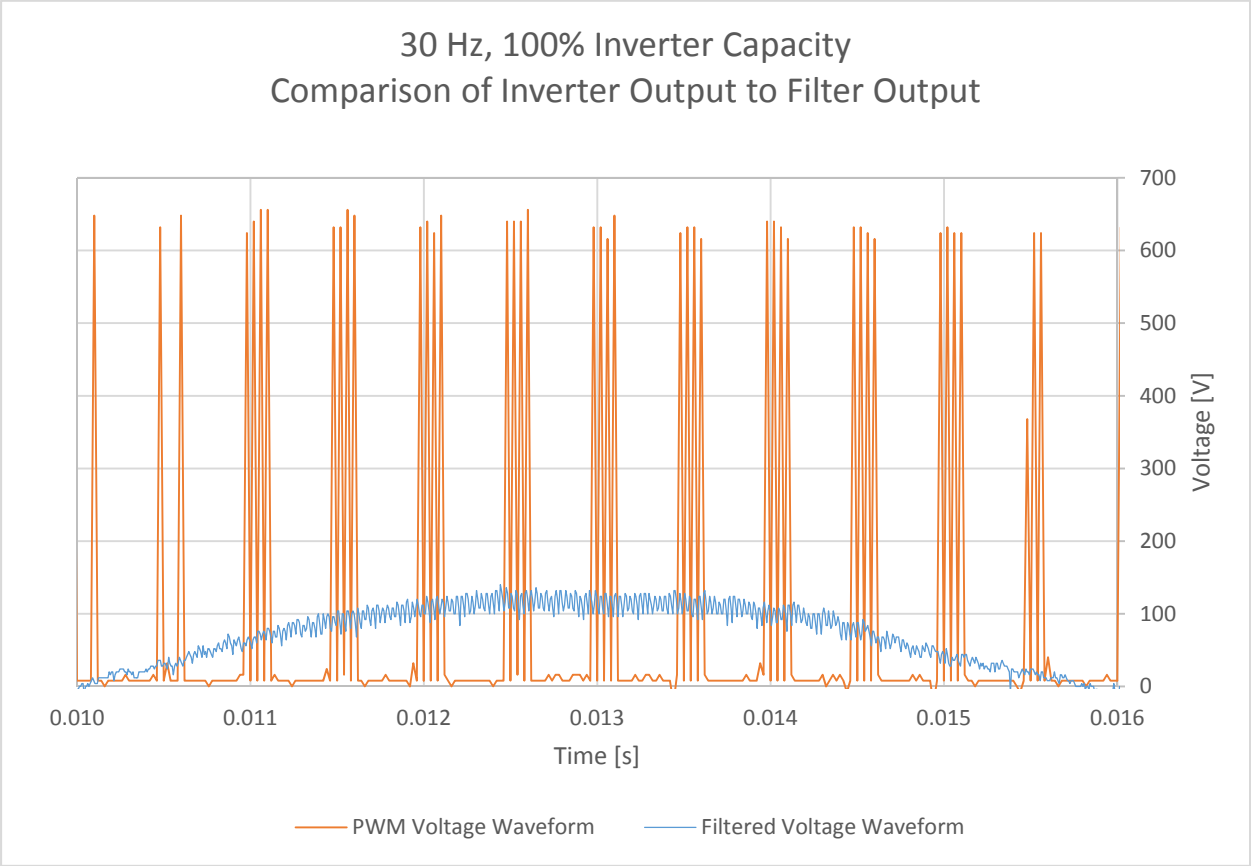

In scenario 3, the power transmission equipment is subjected to a PWM voltage waveform. This involves regular voltage fluctuations of 0 to 650 V at 6 kHz. The measured voltage fluctuates as much as 690 V in 20 microseconds. In scenario 4, the power transmission equipment is subjected to a filtered voltage waveform. This waveform has the same frequency of voltage fluctuation, but the amplitude of the fluctuations is 60 V at the highest.

The sine wave filter reduces both the overall peak to peak voltage and the rate of rise of the voltage. The benefits of this can be observed in the reduced heating of the power transmission equipment and the increase in overall system efficiency.

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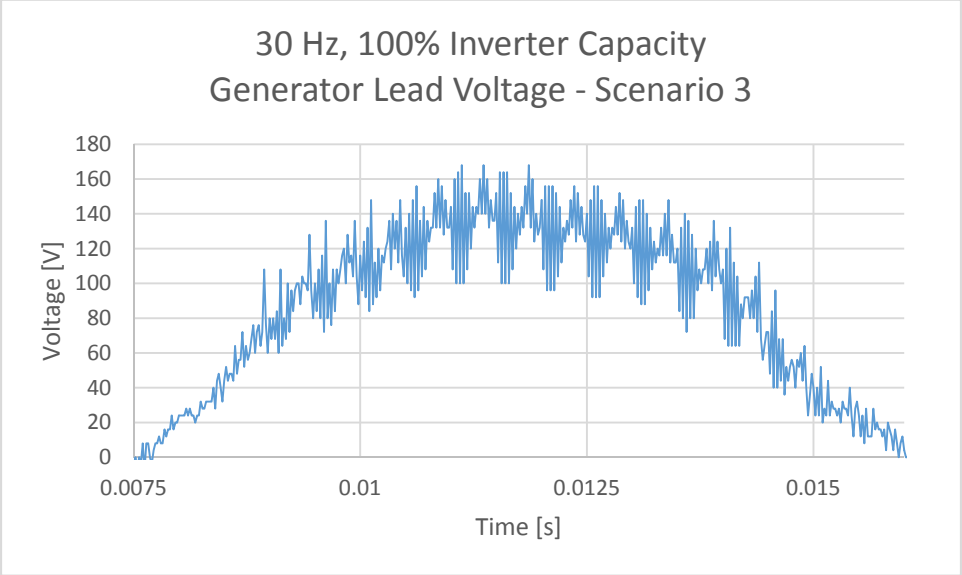
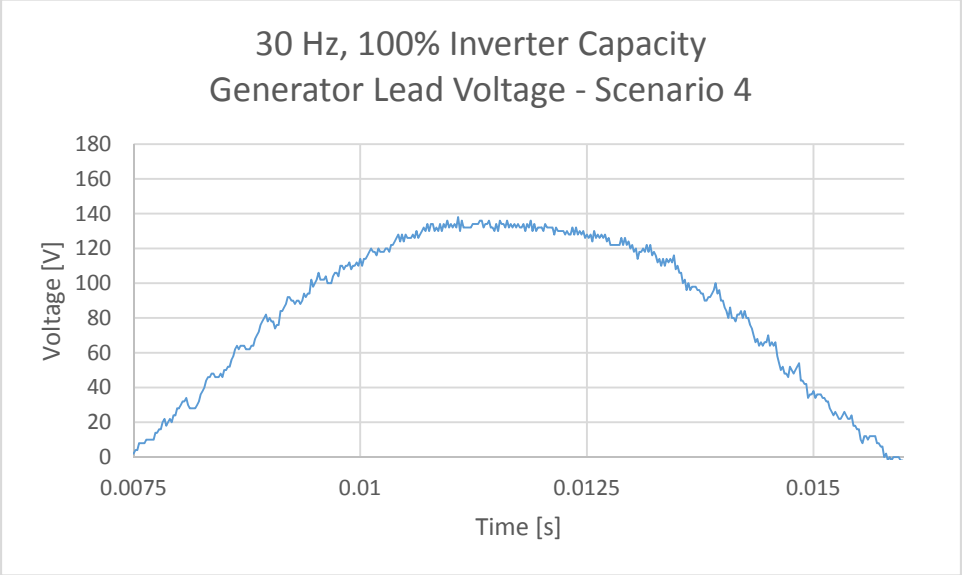
The sine wave filter also decreases the instantaneous voltage change at the generator.



In scenario 3, the generator is subjected to voltage 6 kHz voltage fluctuations as high as 72 V.



In scenario 4, the highest amplitude voltage fluctuation the generator sees is 10 V. A reduced rate of rise of voltage as evidenced by the charts above has been shown to greatly increase the longevity of stator winding insulation.

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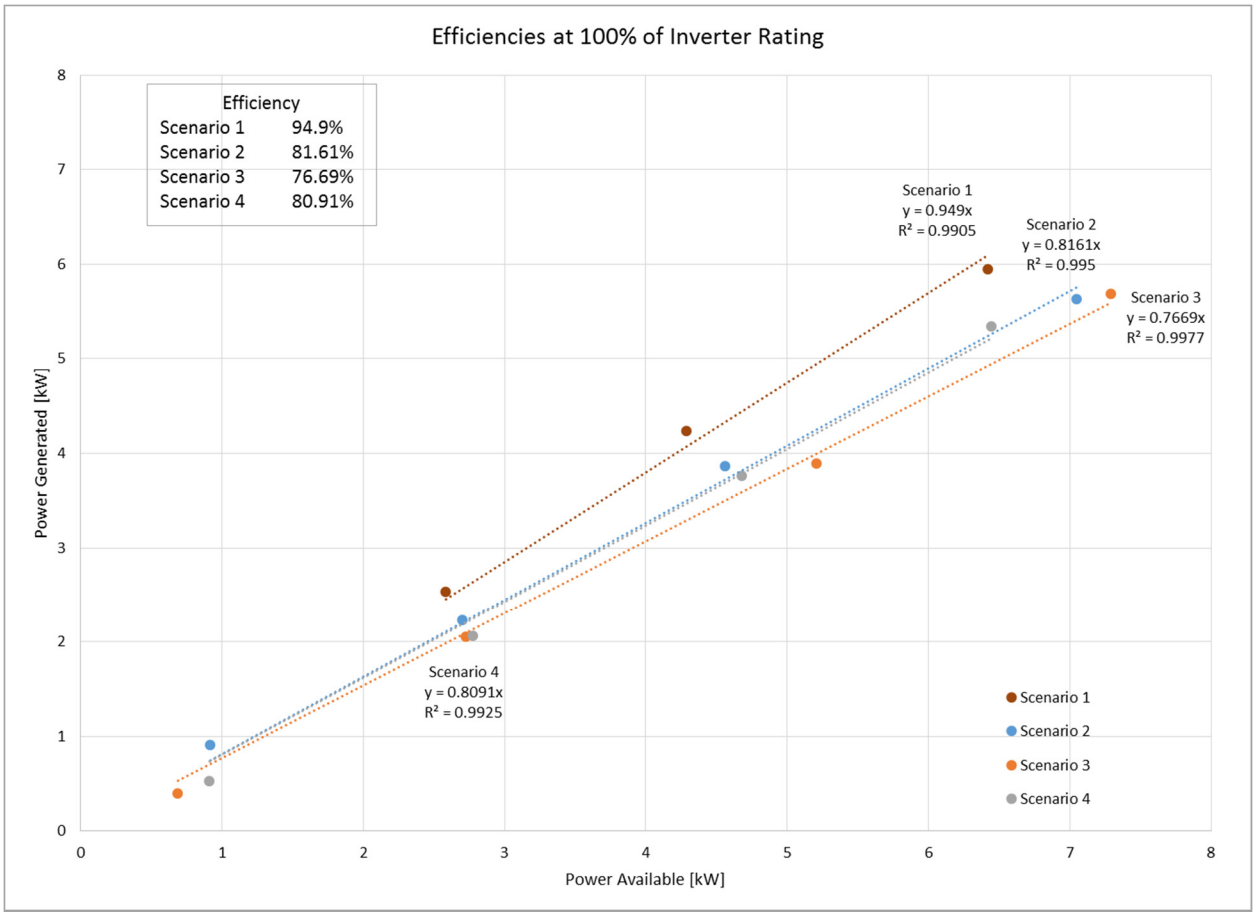
5.1.3. Efficiency



The chart above graphically illustrates the difference in efficiencies of the various test scenarios comparing mechanical power at the generator shaft and energy recovered from the inverter.

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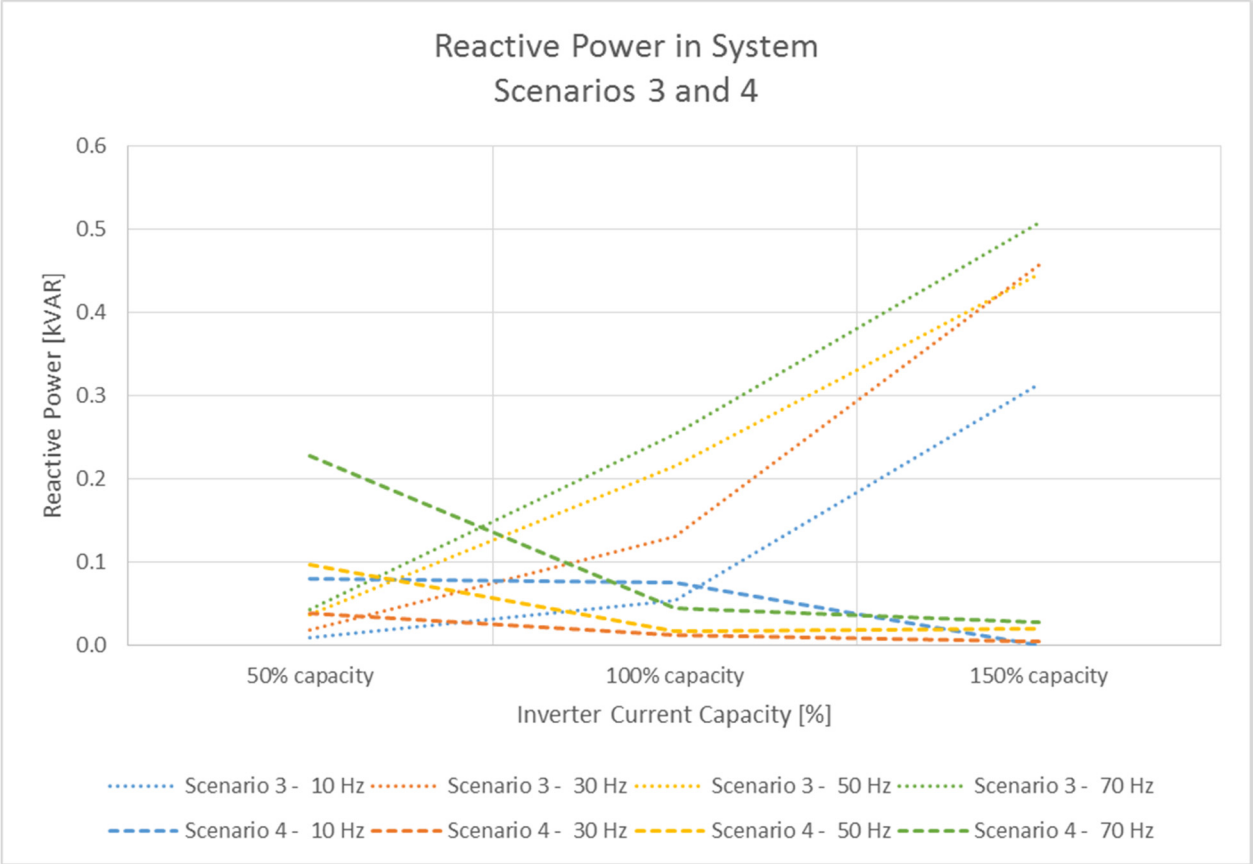
5.1.4. Reactive Power



The reactive power in scenario 4 is much lower than the reactive power in scenario 3. The reactive power in the system is caused by the voltage waveform being out of phase with the current waveform.

The step up / step down transformers are inductive loads, which cause the current waveform to lag the voltage waveform, resulting in reactive power. The capacitance in the sine wave filter counteracts this distortion, and reduces the amount of reactive power in the system considerably.

The reduction of the reactive power in the system means that the voltage and current within the system can more effectively transfer usable power.

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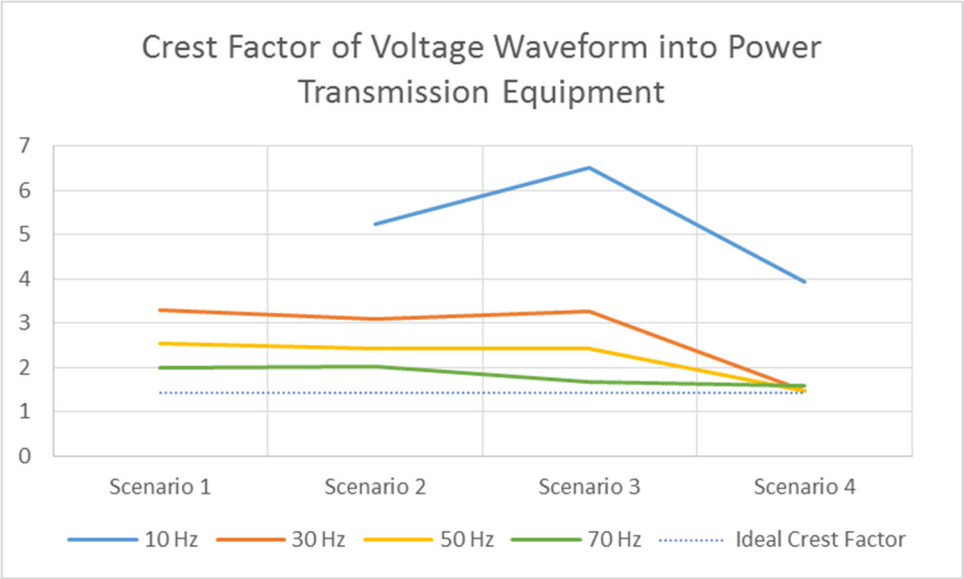
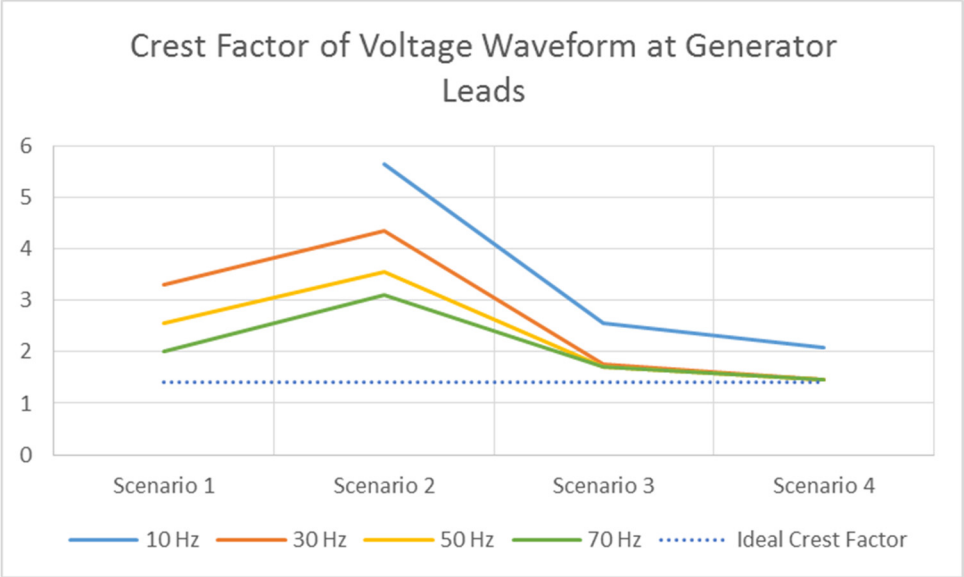
5.1.5. Crest Factor

The sine wave filter reduces waveform distortion both into the power transmission equipment, and at generator leads for all frequencies.



In the above chart, the crest factor of the voltage waveform entering the power transmission equipment is shown for each frequency at 100% of the inverter rating. For Scenarios 1, 2, and 3, this is simply the inverter output. For scenario 4, this is the filter output. While the first three scenarios are very close to one another, scenario 4 shows drastic improvements in the crest factor. The filter takes a lot of the PWM noise out of the system, bringing the waveform close to an ideal sine wave.



In this chart, the crest factor of the voltage waveform at the generator lead is shown for each frequency at 100% of the inverter rating. In scenario 4, at 30, 50, and 70 Hz, the crest factor is nearly ideal, and at 10 Hz, the crest factor is much closer to ideal than at any other point in the system.

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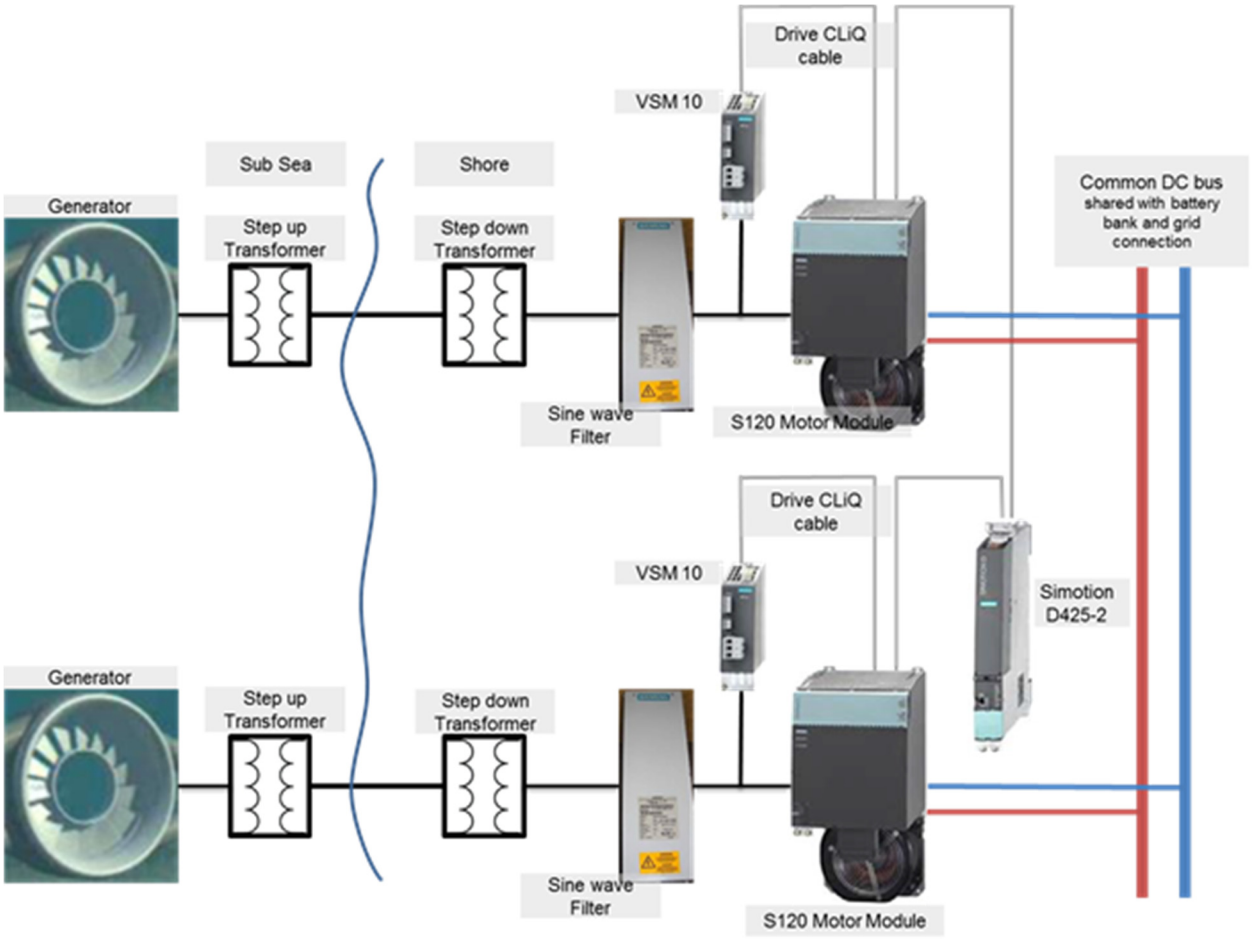
6. Recommendations for PCCE Sea Facing Inverter Design

It is AMS' recommendation that the Siemens Sinamics platform can be used for the Power Conditioning and Control Equipment (PCCE) of the Admiralty Inlet Project utilizing the S120 drive system. For maximum effectiveness, the system should be configured in the following sequence using the correct sized components:



Components should be sized to the application. The sine wave filter must match the drive switching frequency. The majority of power loss occurred in the transformers. Transformers designed to operate closer to the expected generator frequency could reduce these power losses. Design filter for power filter correction.

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Appendix A Sine Wave Filter Required Pulse Frequency

Sine wave filters require a specific IGBT switching frequency to be able to operate. It is essential to adjust the switching frequency of the drive to avoid destroying the sine wave filter. The switching frequency of a Siemens S120 drive is dependent upon 2 values: f_pulse_min and the current loop coarse update rate.

f_pulse_min

f_pulse_min is a calculated term derived from the sine wave filter properties. f_pulse_min is calculated as follows:

$$f_pulse_\min = \frac{1.6}{2\pi\sqrt{(p233)(p234)(p235)}}$$

Where

p233 = filter inductance

p234 = filter capacitance

p235 = number of motor reactors in series

f_pulse_min is rounded up to the nearest integer multiple of the drive pulse frequency. The result is the lowest limit IGBT frequency possible. This value is displayed in r1801 [1].

For this application, the sine wave filter manufacturer required IGBT pulse frequency of 6 kHz. Because of this, the current controller's clock cycle (p115) was set to 500µs so that the drive's internal calculation would allow an f_pulse_min of 6 kHz

Current Loop Coarse Update Rate

The current loop coarse update rate sets the resolution at which the frequency can be changed. The pulse frequency must be an integer multiple of the inverse of the current loop coarse update rate.

$$f_{pulse} = n \times \frac{1}{t}$$

Where

n = ½, 1, 2, 3 . . .

t = current controller update rate

The nominal current controller update rate is 250 µs, which gives a frequency resolution of 4 kHz. To reach 6 kHz, the current controller update rate needs to be doubled to 500 µs. This will result in a 2 kHz resolution and a 6 kHz pulse frequency.

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Appendix B Test Scenario 5 – Starting the Generator Against a Load

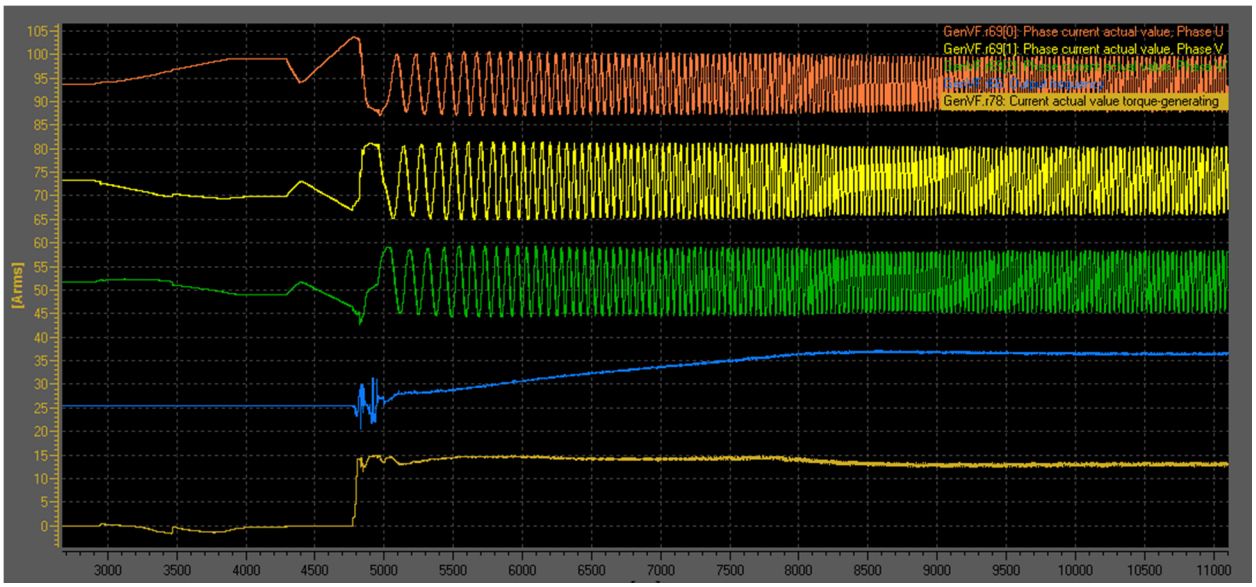
There may be instances where the generator will need to start turning against a load. In this case, the inverter will be used to motor the generator.

In this test scenario, the flow motor speed was set at 0 Hz. The current limit on the flow motor was varied to see what amount of holding torque the generator could break against. The generator was given a speed command of 30 Hz with 150% of inverter current rating made available.

Result

The generator was able to break from a stop up to 66% of the inverter current rating. Shown is a trace of each phase current, as well as the generator frequency and total RMS current.

To break from the load, the inverter uses DC current injection to determine the position of the generator poles. This current injection can be seen from where the drive is enabled at 3000 ms on the strip chart until 4800 ms. Once the position of the generator poles has been determined, current is increased until the load is overcome and the generator begins to move. This ramping process begins at 4800 ms between 4800 ms and 5000 ms, the generator and flow motor both rocked back and forth, making small, rapid movements as seen in the frequency plot. The generator overcame the load of the flow motor, and once in motion, commutation begins and the generator motors up to the set speed.



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Appendix C Temperature Rise of System Components

The temperature of equipment was monitored during testing. Ambient temperature in the testing area ranged between 18-20°C. Temperature rise of system components was observed to be dramatically different across scenarios, and these observed temperatures have been recorded. These temperature recordings are a result of monitoring for system safety, and were not taken in a systematic manner, and should not be used in any way to project future performance of a system. These temperatures useful are in conjunction with the rest of the information contained in this report.

In Scenario 1, the generator ran at 49°C.

The addition of the step up / step down transformers in Scenario 2 lowered the operating temperature of the generator considerably. However, the two transformers heated up to at least 15°C above ambient temperature.

The addition of the undersea cable emulator in Scenario 3 did not change the operating temperature of the generator. It did, however, result in the step-up transformer operating at slightly warmer temperatures than in Scenario 2, and the step-down transformer operated at a much cooler temperature than in Scenario 2. The cable emulator itself heated up to 54°C, at which point a large shop fan was added to increase cooling.

The addition of the sine wave filter in Scenario 4 lowered the operating temperatures of all system components. The sine wave filter only heated up to about 24°C, just a few degrees above ambient temperature. The first transformer and the undersea cable emulator dropped down to 26°C, and the second transformer was only 24°C. The generator ran at 37°C, much cooler than any other scenario.

Temperatures of System Components (Ambient Temperature between 18-20°C)				
	Generator	Transformer 1	Undersea Cable Emulator	Transformer 2
Scenario 1	49	N/A	N/A	N/A
Scenario 2	43	36	N/A	35
Scenario 3	43	37	54	29
Scenario 4	37	26	26	24

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Appendix D Applicable Documents

Customer Provided Documents referenced in this report

Tidal Flow Information - CS_00986 SnoPUD Performance Calculator OW01 AMS Distributed

Request for Proposal - SD_00357 On-shore Power Conditioning and Control System SOW

Generator Specification Document - SD_00121 OCT-06-08 -09 Generator Specification Document

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Appendix E Critical Drive Parameters

p1755	**Motor model changeover speed encoderless operation** This parameter sets a velocity threshold above which the drive will transition from open-loop control to closed-loop control. In order to keep the system operating in closed-loop control at all times, this value must be set less than the minimum cut in frequency
p1900	**Motor data identification and rotating measurement** This parameter initiates a standstill or rotating test that sets the initial motor values inside the drive. These tests allow the drive to adjust for the extra inductance and impedance due to the transformers and cable emulator.
p640	**Current limit** This parameter sets the drive current limit. For vector drives, the parameter cannot exceed four times the rated motor current (p305). The current limit was varied to study system efficiency at different drive capacities.
p1715[0]	**P-gain** This is the drive current loop proportional gain. This value acts on the error generated between the torque-generating current setpoint (r77) and the actual torque-generating current value (r78).
p1717[0]	**I-gain** This is the drive current loop integral gain. This value acts on the error generated between the torque-generating current setpoint (r77) and the actual toque-generating current value (r78).
p1300	**Open-loop/closed-loop control operating mode** This system uses “Speed controlled sensorless vector mode” (p1300 = 20). This drive mode uses the VSM for closed loop control and provides the speed loop with a ramp function generator. It also allows use of the ‘Flying Restart’ feature (see p1200).
p1200	**Flying restart operating mode** Enabling this mode allows the drive to be powered up while the generator is already rotating. The VSM is necessary for flying restart. For all testing scenarios, this parameter is set to ‘always active starting in setpoint direction’ (p1200 = 1).

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p1980	**PolID technique** This parameter identifies the method the drive will use to start the generator from zero speed. For our testing purposes, this parameter is set to DC current injection (p1980 = 10). As the total inertia of the system increases, it might be necessary to adjust the angle commutation offset calibration and pole position ID scaling setpoint (5000% > p1999 > 100%).
p2100[0…19]	**Setting the fault number for fault response** This parameter selects the fault for which the fault response should be changed. The fault is selected by entering the fault number into a bit in p2100. The response is set in the corresponding bit in p2101. It was necessary during some points of the testing to stop the fault 'F07900 Motor Blocked' from shutting down the drive
p2101[0…19]	**Setting the fault response** This parameter selects the fault response for the fault specified in p2100. To keep the 'F07900 Motor Blocked' fault from shutting down the drive, the corresponding bit is set to 0: No response.
p112	**Sampling times pre-setting p0115** This parameter allows either selection of preset sampling times in p0115 or user customization of the sampling times in p0115. This parameter must be set to 'Expert' (p112 = 0). This is necessary to change the IGBT switching frequency to meet the sine wave filter manufacturer specifications.
p113	**Minimum pulse frequency, selection** This parameter pre-assigns p0115 (Sampling times for internal control loops).This parameter can only be changed with p0112 = 0 (expert).
p115[0…6]	**Sampling times for internal control loops** This parameter sets the current loop coarse update rate in microseconds for the drive (See Appendix A). p0115 [0] is preassigned a value equal to the inverse of twice p0113. p115 [1…6] are preassigned values based on p0115 [0] and internal drive calculations. This value is used to determine the settable pulse frequencies and associated maximum output frequencies available for the drive.
p1800	**Pulse frequency setpoint** This parameter sets the IGBT pulse frequency in the drive. For S120 drives in vector mode, acceptable values are determined by the course update rate calculation and the minimum frequency calculation (See Appendix A). The IGBT pulse frequency must be set to meet the sine wave filter manufacturer specifications.

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p230	**Drive filter type motor side** This parameter sets the type of filter at the motor side. If the current controller sampling rate (p0115 [0]) has not been appropriately set, p230 cannot be used to select a sine-wave filter. For testing, this parameter was set to 4 (Sine-wave filter third-party)
P233	**Power unit motor reactor** This parameter sets the inductance of the filter connected at the power unit output. This value is used to calculate the minimum IGBT frequency.
P234	**Power unit sine-wave filter capacitance** This parameter sets the inductance of the filter connected at the inverter output. This value is used to calculate the minimum IGBT frequency.
P235	**Motor reactor in series number** This parameter sets the number of reactors connected in series at the power unit output. This value is used to calculate the minimum IGBT frequency.
p2163	**Speed threshold 4** This parameter sets the maximum allowable deviation between the actual speed and the commanded speed. During power generation, drive speed was set to zero. To avoid causing a fault, p2163 was set to the max testing velocity.

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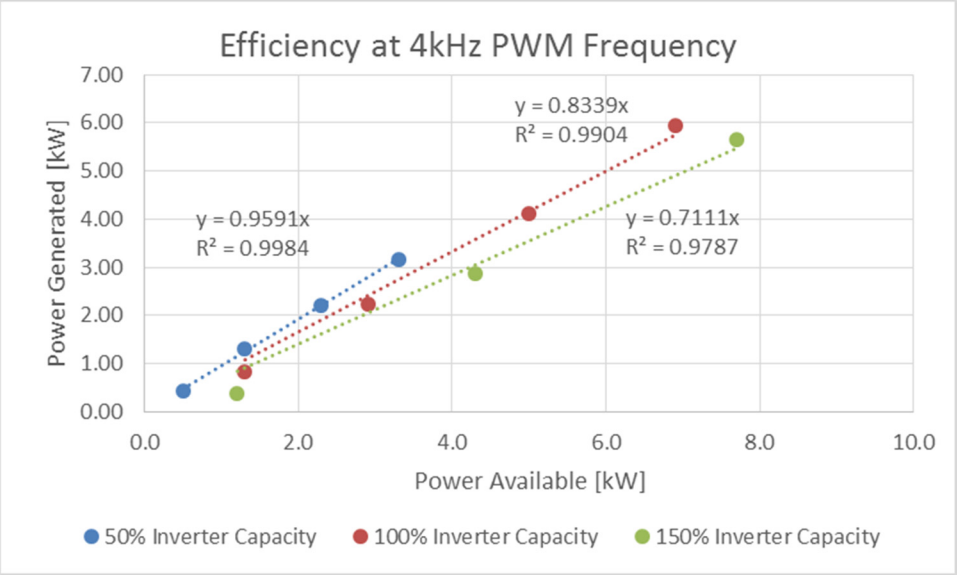
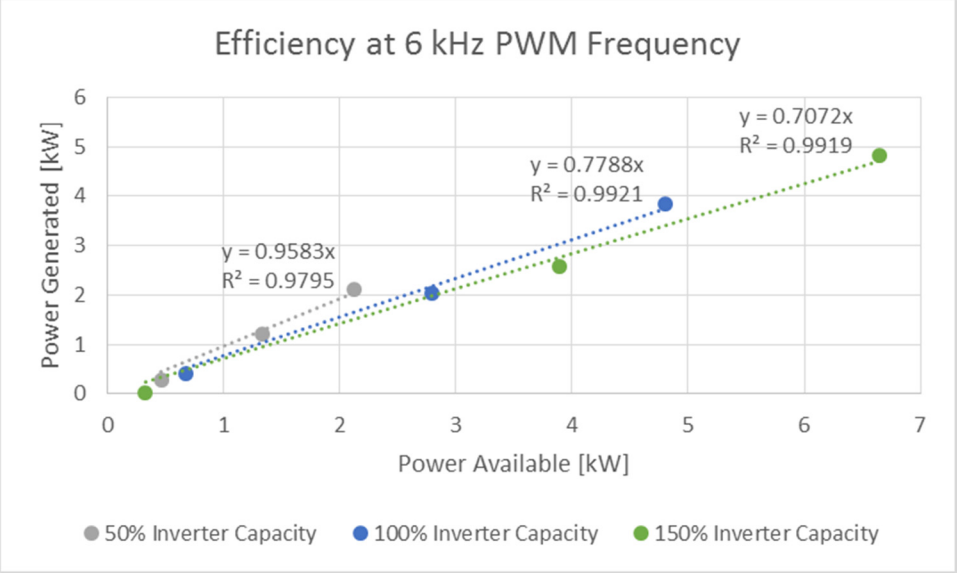
Appendix F Effect of PWM Frequency on System Efficiency

The PWM frequency of the drive was raised from 4 kHz to 6 kHz to allow proper use of the sine wave filter. This higher PWM frequency increases the inductive impedance of the system. Higher system impedance reduces the power factor of the system, leading to a decrease in efficiency. Some efficiency data was taken prior to this adjustment, allowing a comparison of the system efficiency at the two PWM frequencies.

	4 kHz	6 kHz
50% inverter capacity	95.91%	95.83%
100% inverter capacity	83.39%	77.88%
150% inverter capacity	71.11%	70.72%

In all cases, the efficiency at 4 kHz was higher than the efficiency at 6 kHz. This occurred most notably at 100% of the inverter current capacity.





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This paper was presented at the 2009 Brazil Conference for Quality of Electric Energy (CBQEE)

Protecting Submersible Motors from the Effects of PWM Voltage

M. D. Texiera, ARTECHE EDC and J. A. Houdek, *ARTECHE PQ, INC.*

***Abstract*—When induction motors with long cables are controlled by PWM variable frequency drives, they can be subjected to harsh voltage conditions such as fast rising pulses (dv/dt) and excessive peak voltage. Additionally, PWM voltage produced can increase the voltage stress on motor windings causing increased heating and shortened motor life. Submersible motors are a special case where the problems can be more severe and may appear at shorter cable lengths. This paper explains the effects of PWM voltage on motors, addresses the unique characteristics of submersible pumping applications using VFDs, and compares alternative methods for motor protection.**

Index Terms-- dv/dt, filters, IGBT, insulation breakdown, over-voltage, Pulse Width Modulation (PWM), sine wave filter, variable frequency drive (VFD), voltage reflection.

I. Introduction

It is a popular practice to operate submersible motors with variable frequency drives (VFDs) because the drive can substantially improve the system energy efficiency. Submersible pumping applications however, have the tendency to cause stress of the motor windings and insulation system, at distances much shorter than for applications where the motor leads are in air. The typical effects of PWM voltage include:

- Increased peak voltage,
- High dv/dt rate,
- Increased motor watts loss and temperature rise.

A. Typical Motor Capabilities

To explore the effects that PWM voltage can have on motors, it is useful to review some specific characteristics of standard motors. Most commercially available motors have been designed to NEMA standards for operation on sine wave power.[1] A good reference for this is Nema standard MG-1. Nema MG-1, part 30 addresses standard Non-inverter duty motors, while part 31 addresses inverter duty motors. Each part of the standard suggests voltage stress levels that can typically be endured by standard induction motors.

Nema standard MG-1, part 30 states that although "exact quantitative effects of peak voltage and rise time on motor insulations are not fully understood, it can be assumed that when the motor is operated under usual service conditions there will be no significant reduction in service life due to voltage stress, if the following voltage limits at the motor terminals are observed."[5]

The Nema std MG-1, part 30 voltage limits to be observed for non-inverter duty motors are stated in Table 1 below. The standard covers both low voltage ($\leq$ 600V) and medium voltage (> 600V) motors. Low voltage motors conforming to Nema standard MG-1, Part 30 (for non-inverter duty motors) can handle up to 1000 volts peak and voltage rise times of 2micro-seconds or slower. This calculates to a dv/dt of 500V/u-sec. A 230 volt motor has the same voltage limits as a 600 volt motor.

TABLE 1 – NEMA STD MG-1, PART 30 VOLTAGE LIMITS [5]

Motor Parameter	$V_{rated} \leq$600 volts	V_{rated} >600 volts
Peak voltage	$\leq$ 1000 volts	$\leq 2.04 \times V_{rated}$
Rise time	$\geq$ 2 usec	$\geq$ 1 usec

Nema std MG-1, part 31 states the voltage limits to be observed for inverter duty motors in either the low voltage or medium voltage classes. These limits are shown in Table 2.

TABLE 2 – NEMA STD MG-1, PART 31 VOLTAGE LIMITS [5]

Motor Parameter	$V_{rated} \leq$600 volts	V_{rated} >600 volts
Peak voltage	$\leq 3.10 \times V_{rated}$	$\leq 2.04 \times V_{rated}$
Rise time	$\geq$ 0.1 usec	$\geq$ 1 usec

B. VFD PWM Output Voltage

When voltage is measured at the VFD output terminals, the voltage waveform is PWM, not sinusoidal, and its peak voltage is equal to the DC bus voltage as shown in Fig. 1.

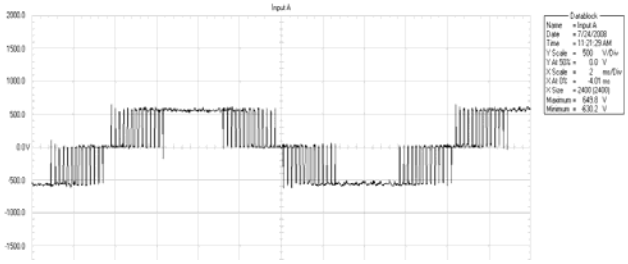


Fig. 1. PWM voltage measured at VFD output terminals [3,4]

For a 480 volt system, the DC bus voltage would normally about 1.35 times the AC line to line input voltage (650VDC). Under normal conditions, the DC bus voltage establishes the peak voltage available for the motor.

Although this magnitude of peak voltage is suitable for standard motors, the PWM voltage waveform can increase motor losses and temperature rise. Most commercially available motors have been designed to NEMA standards for operation on sine-wave power [1]. Operation from PWM voltage increases the watts losses of electric motors and results in higher operating temperature, as shown in Table 3. In general, a 10°C increase in temperature rise can result in a 50% reduction of motor insulation life.

TABLE 3 – MOTOR TEMPERATURE RISE COMPARISON [1]

HP	Voltage	Hz	% Speed	% Torque	Amps	Temp Rise
10HP	Sine	60	100	100	12	51
10HP	PWM	60	100	100	12.5	55
10HP	PWM	15	25	87	12	79
10HP	PWM	6	10	89	12.5	109
50HP	Sine	60	100	100	59.1	62
50HP	PWM	60	100	100	61.4	73
50HP	PWM	30	50	82	56.8	72
50HP	PWM	6	10	70	51.3	94

C. Cable Capacitance

Shielded cables and cables submersed in water have significantly higher capacitance than cables in air. Table 4 shows the dielectric constants for some common media. Since water has a dielectric constant that is approximately 80 times higher than for air, cables that are submersed in water experience much higher capacitance and thus lower characteristic impedance than for cables in air.

TABLE 4 - DIELECTRIC CONSTANTS [2]

Medium	Dielectric Constant
Air	1.0
Methane	1.7
Petroleum	2.1
Water	80

Considering the basic equation (1) for capacitance between two parallel plates (conductors) the impact of the dielectric constant becomes obvious. Capacitance is directly proportional to the dielectric constant (*k*), therefore a higher dielectric constant will result in higher capacitance.

$$C = \left(\frac{k}{4\pi}\right)\frac{A}{l} \qquad (1)$$

where C = Capacitance in Farads, k = dielectric constant, A = area of one plate (cm), and l = the distance between the two plates (cm).

By using equation (2), we see that higher capacitance means lower characteristic (surge) impedance (Z_c) for these cables, which will ultimately result in higher reflected voltages and motor terminal peak voltage at shorter cable lengths.

$$Z_c = \sqrt{\frac{L_c}{C_c}} \qquad (2)$$

D. PWM Voltage Pulse reflection

VFD applications with long motor cable lengths can experience a phenomenon called voltage reflection which increases the motor terminal peak voltage and dv/dt. The typical factors that influence the magnitude of reflected voltage and dv/dt include

- Cable length
- IGBT rise time
- PWM pulse velocity on the cable
- Dielectric medium surrounding the cable
- Characteristic impedance of motor and cable

Since the characteristic impedance of motors is typically considerably higher than for cables, the motor terminal peak voltage will typically be higher than the VFD terminal voltage. When voltage reflection occurs, the peak voltage measured at the motor terminals consists of both the peak voltage of the initial PWM pulses, plus the peak voltage of the reflected pulses. The magnitude of voltage reflection (ρ) can be determined using equation (3).

$$\rho = \frac{Z_m - Z_c}{Z_m + Z_c} \qquad (3)$$

Where *Zm* = motor characteristic impedance and *Zc* = cable characteristic impedance.

For typical motors, the characteristic impedance may range from a few hundred ohms (large power ratings) to several thousand ohms (small power ratings), and for cables it can range from 30 ohms (large power ratings) to 100 ohms (small power ratings). It is clear to see there is typically a mis-match between these impedances and the reflected voltage can be significant. Based on motor cables of sufficient length and conductors in air, some typical reflection coefficients (*P)* are as follows:

Motor	*P*	Vpk at motor
1HP	1.00	2.00 x Vdc = 1300 Vac
25HP	≥ 0.90	1.90 x Vdc = 1235 Vac
100HP	≥ 0.75	1.75 x Vdc = 1137 Vac
200HP	≥ 0.65	1.65 x Vdc = 1072 Vac
400HP	≥ 0.50	1.50 x Vdc = 975 Vac

The reflection coefficient for applications involving submersed electrical cable can be higher, due to increased capacitance.

Theoretically, the magnitude of the reflected voltage can reach DC bus voltage and in some cases, actually exceeds this. The motor terminals see the sum of both the initial pulse voltage plus the reflected pulse voltage. Since pulse reflection can be

100% of the initial pulse, it is possible for doubling of the peak voltage to occur. This means that the motor terminals may see voltage as high as two times the DC bus voltage (about 2.7 times rated motor voltage). Table 5 shows the potential motor terminal voltage for various systems.

TABLE 5 – POTENTIAL MOTOR TERMINAL VOLTAGE

AC Input Voltage	DC Bus Voltage	Motor Terminal Voltage
200	270 – 282	564
240	325 – 340	680
380	513 - 537	1074
415	560 - 587	1174
480	650 - 680	1360
600	810 - 850	1700

E. Motor Terminal Voltage

The sum of the initial pulse and the reflected voltage pulse will determine the peak voltage at the motor terminals. Fig. 2 is an example of a measurement of the motor terminal voltage for a long cable length application. While the RMS voltage is only 466V, and the DC bus voltage is approximately 650 volts, the peak–peak voltage reached as high as 2270V volts, and the peak voltage is clearly over 1000 volts. As seen in this one cycle of PWM voltage, the motor is subjected to repetitive over voltage pulses.

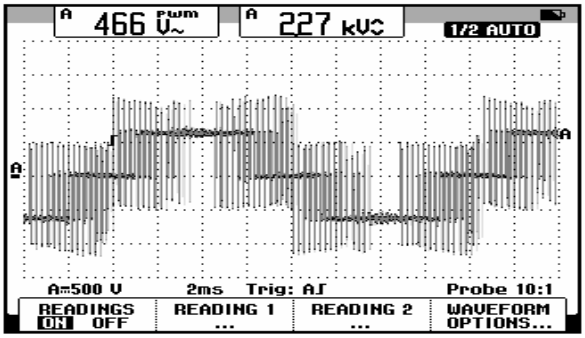


Fig. 2. Motor terminal voltage measurement

F. Safe Motor Cable Length

The critical cable length identifies the cable length where over-voltage begins to occur, and alerts one that exceeding this length could be detrimental to the motor. Critical cable length is a function of the pulse rise time and the velocity at which the pulse travels on the cable. The pulse rise time is primarily influenced by the switching technology (IGBT, BJT, GTO), and the pulse velocity is a function of the cable inductance and capacitance as shown in equation (4).

$$v = \frac{1}{\sqrt{L \cdot C}} (meters\ per\ \mathrm{sec}ond) \quad (4)$$

Typical values for pulse velocity thru air, range from about 100 to 150 meters per second. The higher values of capacitance for submersed cables cause slower pulse velocity, and reduces the critical cable length. Critical cable length may be calculated using equation (5) and is shorter for cables in water due to higher capacitance, lower characteristic impedance and higher voltage reflection.

$$\text{Critical Cable Length} = \frac{v \cdot t_r}{2} (meters) \quad (5)$$

Where: t_r = pulse rise time in micro-seconds

Table 6 shows critical cable length for various pulse rise times using an average pulse velocity rate (125m/sec).

TABLE 6 – CRITICAL CABLE LENGTH

Pulse Rise Time	**Critical Cable Length for cables in air**	
0.040 usec	2.5 meters	8 ft
0.050 usec	3.1 meters	10 ft
0.100 usec	6.25 m	20 ft
0.150 usec	9.37 m	30 ft
0.200 usec	12.5 m	41 ft
0.250 usec	15.6 m	51 ft
0.300 usec	18.75 m	61 ft
0.400 usec	25 m	82 ft
0.500 usec	31 m	101 ft
1 usec	62 m	203 ft
2 usec	125 m	410 ft
Sine Wave	No Limit	

G. Alternative Methods to Protect Submersible Motors

<u>Do nothing (No filter used)</u>

If one chooses to use the motor without any protection, the motor will be best served with a low PWM carrier frequency. In these cases, the PWM carrier frequency of the VFD should be set as low as possible (1.0 – 2.0kHz).

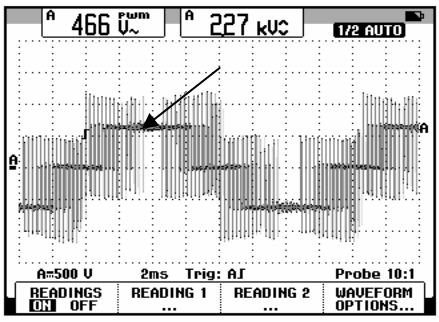


Fig.3. Motor terminal voltage – no filter 2.27kVp-p

From the waveform in Fig 3, it is easy to see the DC bus voltage which is represented by the nearly solid horizontal line (and arrow points to it). The voltage pulses above this are

the reflected pulses. In this case, the voltage measured at the motor terminals is 2270Vpk-pk, or about 1135Vpk. This is high enough to damage a non-inverter duty motor.

dv/dt Filters

Traditional dv/dt filters contain a reactor (L) (usually low impedance such as 1.5%), several resistors (R) and several capacitors (C). The L-R-C circuit basically forms a voltage snubber or clamp. Usually the dv/dt filter is designed to clamp the voltage at some magnitude below 1000 volts peak for 480 volt systems, but at higher voltage levels for 600 volt systems. For most manufacturers of dv/dt filters, voltage clamping is specified to be at 150% of DC bus voltage (at 1000 feet). This is demonstrated by Table 7.

TABLE 7 – TYPICAL VOLTAGE CLAMPING FOR DV/DT FILTERS

AC Input Voltage	DC Bus Voltage	150% of V_{dc} Bus
200	270 – 282	405-423 Vpk
240	325 – 340	487-510Vpk
380	513 - 537	770-808 Vpk
415	560 - 587	840-880 Vpk
480	650 - 680	**975-1020 Vpk**
600	810 - 850	**1215-1275 Vpk**

One set of resistors or capacitors is typically connected in parallel with the reactor coils, creating a lower impedance path for the high frequencies to go around the reactor. The high frequencies therefore bypass the reactor instead of being attenuated by the reactor. Normally a reactor is used to slow down the rate of rise of current through a circuit, however in this case, the fast rising pulses (high frequencies) can actually bypass the reactor.

Table 7, above, demonstrates that for motors rated 460 volts and higher, traditional dv/dt filters provide marginal motor protection at best. The dv/dt filter typically reduces the peak voltage attained by the pulse and its corresponding reflected pulse, but has little effect on the slope of the pulse. dv/dt reduction is primarily obtained through peak voltage reduction (clamping), not so much by wave shaping or changing the slope of the leading edge of the pulse. As illustrated in Fig 4 below, the appearance of the waveform after the dv/dt filter is still PWM, except that the peaks have been reduced slightly.

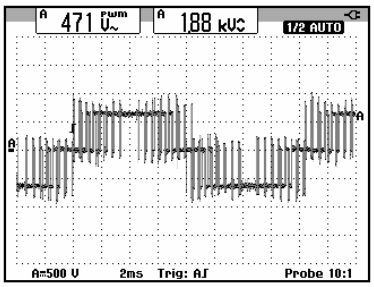


Fig. 4. Motor terminal voltage – with dv/dt filter 1.88kVp-p

Typical specifications for dv/dt filters indicate that (at 1000 feet maximum) the peak voltage will not exceed 1.5 x dc bus voltage. In a 480 volt inverter application, the normal dc bus voltage is about 650 VDC (1.35 x V_{L-L}). Considering a 480 volts system, 650 Vdc x 1.5 = 975 volts, which is marginally close to the NEMA standard MG-1, part 30 standard (maximum 1000 volts peak) for non-inverter duty motors. If line voltage is 5% high, then the possible peak voltage can be nearly 1024 volts. This does not meet the requirements of NEMA MG-1 for non-inverter duty motors. Of course for 600 volts systems, the problem is worse and peak voltage, even with a dv/dt filter in place, can be well over 1200 volts.

Voltage reflection still occurs with traditional dv/dt filters as seen in Fig 4. The waveshape is still PWM. Pulse rise time is considerably faster than for a Sine Wave filter. Voltage distortion is much higher than with a Sine Wave Filter, and motor heating is higher than with a Sine Wave Filter.

Submersible motor applications are susceptible to higher voltage levels and faster dv/dt rates than typical applications with cable sin air. Traditional dv/dt filters are considered inadequate for protecting motors in these environments. There are a number of cases where motor windings have failed due to peak overvoltage, even though a dv/dt filter had been used. In many of these cases, the motor cables were only 50 ft to 150 ft in length.

Sine Wave dv/dt Filters

The Sine Wave dv/dt Filter, as shown in Fig. 5, is a low pass filter that actually converts PWM voltage to a sine wave, with only a small amount of ripple voltage at the carrier frequency. The Sine Wave dv/dt Filter virtually eliminates reflected voltage and minimizes the dv/dt of the motor voltage waveform. A PWM rated reactor is combined with a capacitor to form a filter with a resonant frequency well below the inverter switching frequency. This network removes most of the high frequency content (pulses) from the waveform. The result is nearly a sinewave with relatively low voltage distortion (often about five percent, and with normal peak voltage (approximately 1.00 - 1.10 times the DC bus voltage).

Fig. 5. Sine Wave dv/dt Filter: photo compliments of Arteche.

Since the output voltage is practically a sine wave, virtually infinite motor cable lengths are possible (except for voltage drop). The waveform resulting from proper application of a sine wave dv/dt filter complies with the requirements of NEMA standard MG-1 for non-inverter duty motors. This filter makes it possible to use either a standard non-inverter duty motor or inverter duty motor in a VFD application. If using an inverter duty motor, the Sine Wave dv/dt Filter will reduce motor losses and temperature rise while increasing motor life.

The following waveforms, shown in Fig. 6, were measured using a Fluke 199C scopemeter with VFD carrier frequency set at 5kHZ. When carrier frequency is set higher, the sine wave actually has lower ripple voltage and less harmonic distortion.

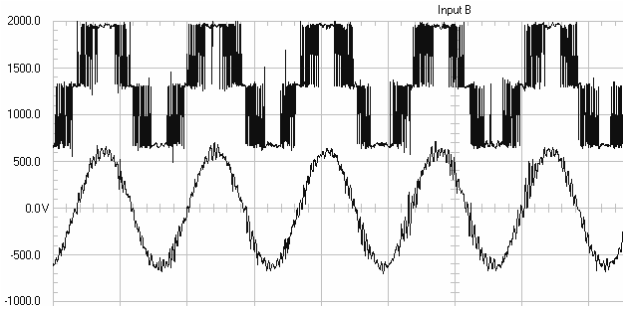


Fig. 6. Voltage; motor at 60hz. [3,4]
Top waveform = VFD output voltage
Bottom waveform = Sine Wave dv/dt Filter output voltage

When the Sine Wave dv/dt Filter is applied on a VFD/ motor system where the cables are in air, the voltage waveform will have an even better appearance as shown below. The waveform can also be further improved by raising the PWM carrier frequency, as illustrated in Fig. 7.

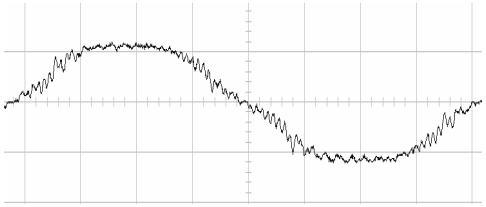


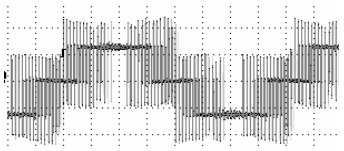
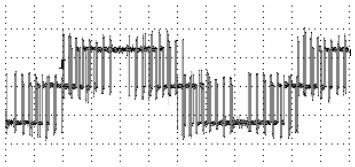
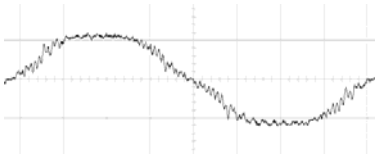
Fig. 7. Sine Wave dv/dt Filter output voltage
Motor cables in air, cable length = 300m/1000ft [3,4]

H. Conclusion

Submersible motor applications increase the voltage stress on motor windings and insulations systems, at shorter distances than normally experienced when motor cables are in air. The cost of removing, repairing and reinstalling a submersible motor can be very high, so this type of application demands absolute protection from dv/dt and excessive peak over-voltage. A Sine Wave dv/dt Filter can provide. This level of protection while increasing system efficiency and extending motor life.

When it comes to protecting submersible motors from the effects of PWM voltage, there are only a few choices. By re-establishing sine wave voltage for the motor, the motor windings are protected, the motor operates with lower temperature rise, motor power losses are reduced and motor lead length restrictions can be removed. Table 7 illustrates the basic choices available for submersible motor protection.

TABLE 8 – COMPARISON OF ALTERNATIVE TECHNIQUES FOR PROTECTING SUBMERSIBLE MOTORS AGAINST THE EFFECTS OF PWM VOLTAGE

Do Nothing Motor subjected to high peak voltage and dv/dt	
Traditional dv/dt Filter Marginal protection	
Sine Wave dv/dt Filter Good and adequate motor protection	

II. REFERENCES

Technical Reports:

[1] T.F. Lowery, and D.W. Petro, "Applying PWM-Inverter Power To Low Voltage Induction Motors: Why Should Engineers Be Concerned?," Reliance Electric, Cleveland, OH.

[2] Dielectric Constants Chart, www.asiinstruments.com.

Technical Publications:

[3] General Data Sheet: Sine Wave dv/dt Filters, Arteche.

[4] Motor Protection for Inverter Applications, Arteche.

Standards:

[5] *Motors and Generators*, NEMA Standards Publication MG1-2006 Revision 1-2007.

BIOGRAPHIES:

Mateus Duarte Teixeira is manager of the Power Quality Unit of Arteche EDC. He earned his BSc in electric engineering at the Federal University of São João del Rei and his MSc in the Federal University of Uberlândia, both in Minas Gerais state.

Prior to joining the Arteche team, Mateus worked as researcher of the LACTEC and has published more than thirty papers in international transactions and conferences related to power quality. Currently, Mateus is responsible for application studies of power quality solutions at both industrial and utility facilities.

John Houdek (M'1985) graduated (1981) from the Milwaukee School of Engineering (MSOE), with a Bachelors Degree in Electrical Engineering Technology, and from Keller Graduate of Management (1989) with a Masters Degree in Business Administration (MBA).

His employment experience included the Square D Company, Eaton Cutler Hammer, Trans-Coil, Inc. and MTE Corporation. Houdek presently serves as a power quality consultant for the power quality group of Arteche, a world leader in electrical system power quality. His special field of interest is in power quality related areas including inverter power quality and motor power factor.

Houdek has authored many technical papers on various aspects of electrical power quality and has delivered power quality seminars throughout the world. Houdek is also an assistant professor at MSOE, where he teaches a course in electrical power quality.

Appendix D

Puget Sound Energy Interconnection Facilities Study

NOTICE: This document may contain Critical Energy Infrastructure Information, the use or disclosure of which is restricted.

NOTICE: This document may contain Critical Energy Infrastructure Information, the use or disclosure of which is restricted.

INTERCONNECTION FACILITIES STUDY

FOR

Snohomish County PUD No. 1

Attendant: Scott Gibson – Generation Engineer

hsgibson@snopud.com

425.267.6361

SnoPUD Tidal Project
13254 SR 20
Coupeville, WA 98239

May 2013

PUGET SOUND ENERGY PROGRAMS
TOTAL ENERGY PLANNING DEPARTMENT

CONTENTS

Introduction 3
Controlling Tariffs 3
Customer Facility 3
Interconnection Facility 3
Distribution System 3
Substation Electrical 4
Protection - Customer System 4
Additions to PSE Distribution System 4
Communications 5
Metering 5
Permitting 5
Real Estate 5
Operational Concerns 5
Commissioning and Testing 6
Cost Estimate 6
Schedule 6
Risks 7
Next Steps 7

EXHIBITS 8
Exhibit E – Commissioning and Testing Procedures ..... Error! Bookmark not defined.
Exhibit A: PSE Distribution Circuit Map – Coupeville Substation to SnoPUD Interconnection 9
Exhibit B-1: PSE Distribution Circuit Map – SnoPUD Tidal Site 11
Exhibit B-2: PSE Distribution Circuit Map – System Modifications 1 12
Exhibit B-3: PSE Distribution Circuit Map – System Modifications 2 13
EXHIBIT C: COST ESTIMATE 14
EXHIBIT D: SCHEDULE 16
Exhibit E: COMMISSIONING AND TESTING PROCEDURES 17

Introduction

This study was commissioned by Snohomish County PUD No. 1 under the terms and conditions of Schedule 80, Attachment J – Facilities Study Agreement (the Study), entered into on April 2, 2013 between PSE and Snohomish County PUD No. 1 (SnoPUD). The subject study is consistent with the standard Small Generator Interconnection Procedures and was performed in accordance with the Open Access Transmission Tariff. In general, this Study provides SnoPUD with the estimated cost and schedule for PSE to install the equipment necessary to safely interconnect power generators with PSE's system. Although this Study may note certain modifications which PSE may require SnoPUD to make at their facility before interconnection, it does not list these modifications as part of the estimated costs.

Controlling Tariffs

Copies of controlling tariffs related to the interconnection of customer facilities are included in the exhibits at the end of this document.

Customer Facility

SnoPUD has requested a facilities study to estimate the cost of connecting 50 kW of tidal-powered electrical generators. The generators are part of SnoPUD's proposed facility, located at 13254 SR 20, Coupeville, Washington (the Project). This location has electrical service provided by PSE's 12.47 kV distribution system. SnoPUD's generators will connect to the existing distribution system through a new underground line extension and an interconnection transformer. Modification to the PSE distribution system will be required as described in this study.

It should be noted that PSE's work force will install the equipment to complete this interconnection. Weather and other events outside of PSE's control will affect the electrical system at times. During these periods, restoration of PSE's system is a priority and may affect the schedule for the completion of the interconnection work as outlined in the Study.

Interconnection Facility

Distribution System

Electric service to the Project site will be provided by PSE's 12.47 kV distribution system originating at Coupeville Substation, located at 30 North Terry Road, Coupeville. Coupeville Substation has a 20 MVA 115-12.47 kV transformer and three distribution circuits (Circuits 12, 13, and 15), which collectively serve approximately 3,354 electric customers. The existing overhead distribution system at the proposed site is single-phase, feeding from distribution circuit 15 (CPV-15). Exhibit A displays the distribution circuit map of CPV-15 and the proposed Project. The facility service will be provided by an overhead transformer and will be metered separately from the generation system.

Substation Electrical

With the interconnection of the Project, the available short circuit current will not exceed the interrupting ratings of existing protective devices on the feeder. The Project does not significantly affect available three-phase and phase-to-phase fault currents.

Please refer to the System Impact Study for Fault Current, Load Flow and System Load for analysis of proposed generator's inverter based system.

If the generation system is modified in any way before, during, or after construction, PSE will require a review of the interconnection to determine if further modifications are required (see Schedule 80, items 32.6b and 32.7f). Similarly, if the PSE distribution system is modified to meet future system requirements, PSE may require a review of the interconnection to determine if further modifications are required.

Protection - Customer System

The interconnection requirements presented in "Technical Specifications and Operating Protocols and Procedures for Generation Interconnections Not Subject to FERC Jurisdiction" (PSE-ET-160.70), dated November 2011,are designed to ensure that the generation will be disconnected in the event of a fault on the PSE system. Since this is a UL 1741 compliant, inverter-based, single-phase system, additional relaying is not required. The system as designed meets PSE protection requirements.

Customers with an anticipated demand of less than 2,500 kVA are served with a fused disconnect near the Point of Delivery (POD). PSE's maximum branch fuses are 100T or 150E fuses rated at 12.47 kV. PSE would install 40T fused disconnects at the proposed project, along with one 50 kVA interconnection transformer.

The 40T fuses enable coordination with the Coupeville feeder relays and line fuses without affecting the reliability or continuity of service to other PSE customers in the event of faults internal to the project.

The installation shall comply with the Harmonic requirements of section 3 of PSE-ET-160.70.

Additions to PSE Distribution System

No modification to PSE's existing distribution facilities will be required in order to interconnect the proposed Project to the CPV-15 distribution circuit.

A new single-phase fused underground termination on pole # 442849-155247 will be installed from the overhead primary wire along SR 20, which is also known as Prairie Road. This new underground 7.2 kV line extension will be constructed to the location of the padmounted interconnection transformer in a customer-provided trench. PSE will provide 7.2 kV to the 120/240 V transformer near the facility. Metering will be on the 120/240 V secondary near the lockable disconnect. Exhibit B-2 and exhibit B-3 illustrate the system configuration.

The point of change of ownership (POCO) is the same as the point of metering (POM). Additionally, the point of delivery (POD) and point of interconnection (POI) are identified on Exhibit B-2, "Distribution Circuit Map."

Communications

As no relaying is required, no communication capability is needed beyond that required for metering, which is self-contained within the meter.

Metering

The point of metering (POM) for the Project will be on the secondary (240 V) side of the PSE transformer. The meter will communicate with PSE via the AMR system. No loss compensation will be applied, due to the meter's proximity to the POI. The customer is responsible for providing a 320-amp form 2S (4 prong) meter base for the generation meter. PSE will provide and install the physical meter head.

The customer is responsible for furnishing and installing an accessible, lockable visible break disconnect switch. The disconnect switch shall be a blade-type visible break connected on the load side of the generation meter (between the generation meter and the generation system). The disconnect switch and PSE revenue meter shall be accessible 24 hours a day, 7 days a week.

The correct meter base will need to be coordinated with PSE. A specification for the correct generation meter base can be provided upon request.

A proposed AMR meter would communicate via wireless radio technology, thereby avoiding the requirement for a telephone line connection.

Permitting

It is assumed that Snohomish PUD will include reviews of PSE's underground distribution line and associated interconnect activities within the scope of their overall project.

Installation of underground conduits in the vicinity of the project on public right-of-way will require the appropriate permits from the Washington State Department of Transportation. Obtaining right-of-way permits can be a relatively costly and lengthy process. The cost estimate and schedule include allowances for both.

PSE understands that SnoPUD will be required to remove the facility, as well as the interconnection, when the operating federal license is terminated. This study does not include the costs to remove PSE facilities at that time.

Real Estate

Appropriate easement will be required for PSE facilities on private property prior to installation. A PSE real estate representative will provide or review the existing powerline easement for the project. Our cost estimate assumes that the easement language will be acceptable without the expense of further negotiation.

Operational Concerns

PSE routinely performs switching to shift load for maintenance activities and for planned and unplanned outages. The generator may be required to be disconnected at any time to facilitate routine system operations. PSE System Operations will be capable

of disconnecting the generator as required. During emergencies, PSE may not be able to give advance warning prior to disconnecting the generator.

It should be noted that PSE system dispatch will not issue a clearance for customer-owned system protection, such as the switch near the meter.

Commissioning and Testing

PSE requires specific actions from our customers to effectively commission and test their interconnection facility. Please see the exhibits for these requirements.

Cost Estimate

Please see the exhibit titled "Cost Estimate" for a cost breakdown. This estimate covers PSE costs associated with engineering, procurement, and construction costs, and does not include any costs associated with SnoPUD's facility. This cost estimate is a refinement of the February 14, 2013 system impact study and includes costs related to location review and inspection of the facility by the Washington State Department of Transportation, since a section of the new line will be within the right-of-way of SR 20.

This estimate includes "contribution in aid of construction" (CIAC) charges. These charges are applied under the provisions of the intertie agreement to meet the requirements of Internal Revenue Service notice 2001-82. A significant requirement is that the interconnection agreement must have a term of at least ten years to avoid application of this fee.

Anticpated Annual Costs to SnoPUD

There will be ongoing operation and maintenance (O&M) charges. The interconnection customer will be responsible for all costs and expenses incurred in connection with the operation and maintenance of the generating facility, and will provide operation and maintenance activities for all equipment beyond the point of interconnection (such as transformer maintenance). The interconnection customer will also be responsible for all costs and expenses incurred in connection with operating, maintaining, repairing, and replacing PSE's interconnection facilities. Currently there are no significant annual costs anticipated for the five-year life of this interconnection.

Schedule

Exhibit D provides a schedule of direct and indirect activities required to install the interconnection facilities. Receiving approval for a right-of-way permit from the Washington State Department of Transportation may take 12 weeks, and is the longest lead-time item for this interconnect. All materials are currently available as standard inventory items. An allowance of five days is included for SnoPUD to provide a trench, meter base, and disconnect switch. Confirmation of the schedule can be provided once PSE receives a notice to proceed.

Risks

An attempt has been made to identify risks to the project. Common risks to implementation and operation of this facility include items beyond PSE's control that affect the construction schedule, weather-related impacts to the project or PSE system, and other items such as interactions with third parties. It should also be noted that while PSE has made best efforts to estimate the cost of interconnection, Snohomish PUD will be liable for any and all additional costs determined by PSE to be the Snohomish PUD's responsibility.

Next Steps

Please see PSE's web site for information concerning customer generation interconnects. The link to this information is:

http://pse.com/aboutpse/Rates/Pages/Electric-Rate-Schedules.aspx?Schedule_x0020_Type=Rules

PSE will begin construction upon completion of an interconnection agreement and a construction application. Certain information, such as contact information, insurance documentation, qualified facility documentation, and other data, may be required from Snohomish PUD to complete the contractual portion of this effort.

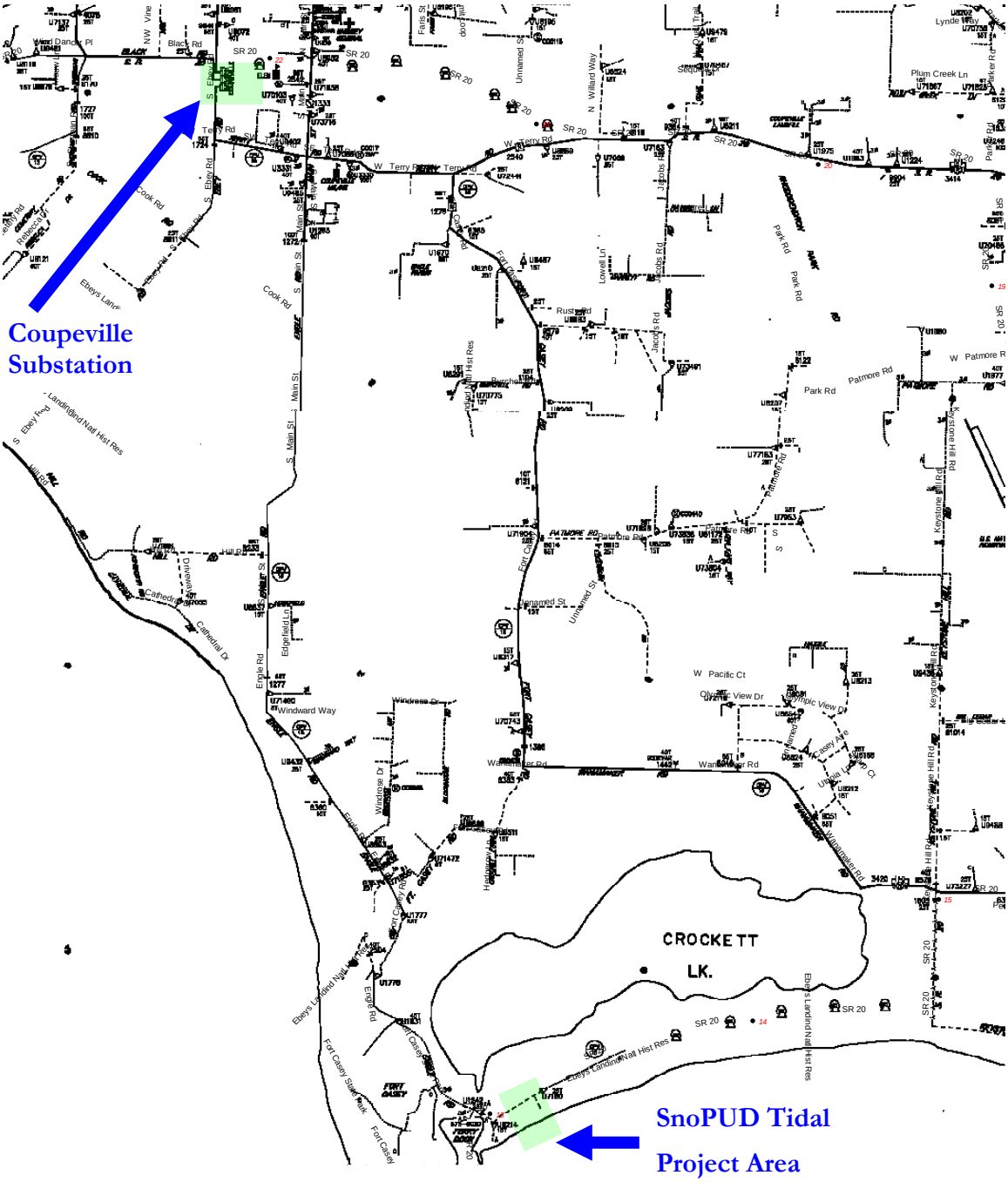
EXHIBITS

Exhibit A: PSE Distribution Circuit Map – Coupeville Substation to SnoPUD Interconnection

SnoPUD Tidal Generation Interconnection Site
13254 SR 20
Coupeville, WA 98239

Circuit: Coupeville-15 (CPV-15)

Approximate 4.5 miles from Coupeville Substation


Coupeville Substation
SnoPUD Tidal Project Area
CROCKETT LK.
SR 20
Terry Rd
Cook Rd
Ebey's Landing Nat'l Hist Res
Fort Casey State Park
Fort Casey
Engle Rd
Main St
Park Rd
Palmore Rd
Patterson Rd
Windward Way
Cathedral Dr
Hill St
Keystone Hill Rd
Jacobs Rd
Lowell Ln
Unnamed St
Pacific Ct
Olympic View Dr
Plum Creek Ln
Parker Rd
Rustad Rd
Ebey Rd
S Ebey Rd
Ebey's Landing
Rebecca Ln
Black Rd
Windrose Dr
Edgefield Ln
Hillcrest Dr
Warrington Rd
Waterman Rd
Ft Casey Rd
Ft Casey Golf Rd
Ft Casey Shell Walk
Ft Casey Rd
Ebey's Landing Nat'l Hist Res
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Ebey's Landing Nat'l Hist Res

Exhibit B-1: PSE Distribution Circuit Map – SnoPUD Tidal Site

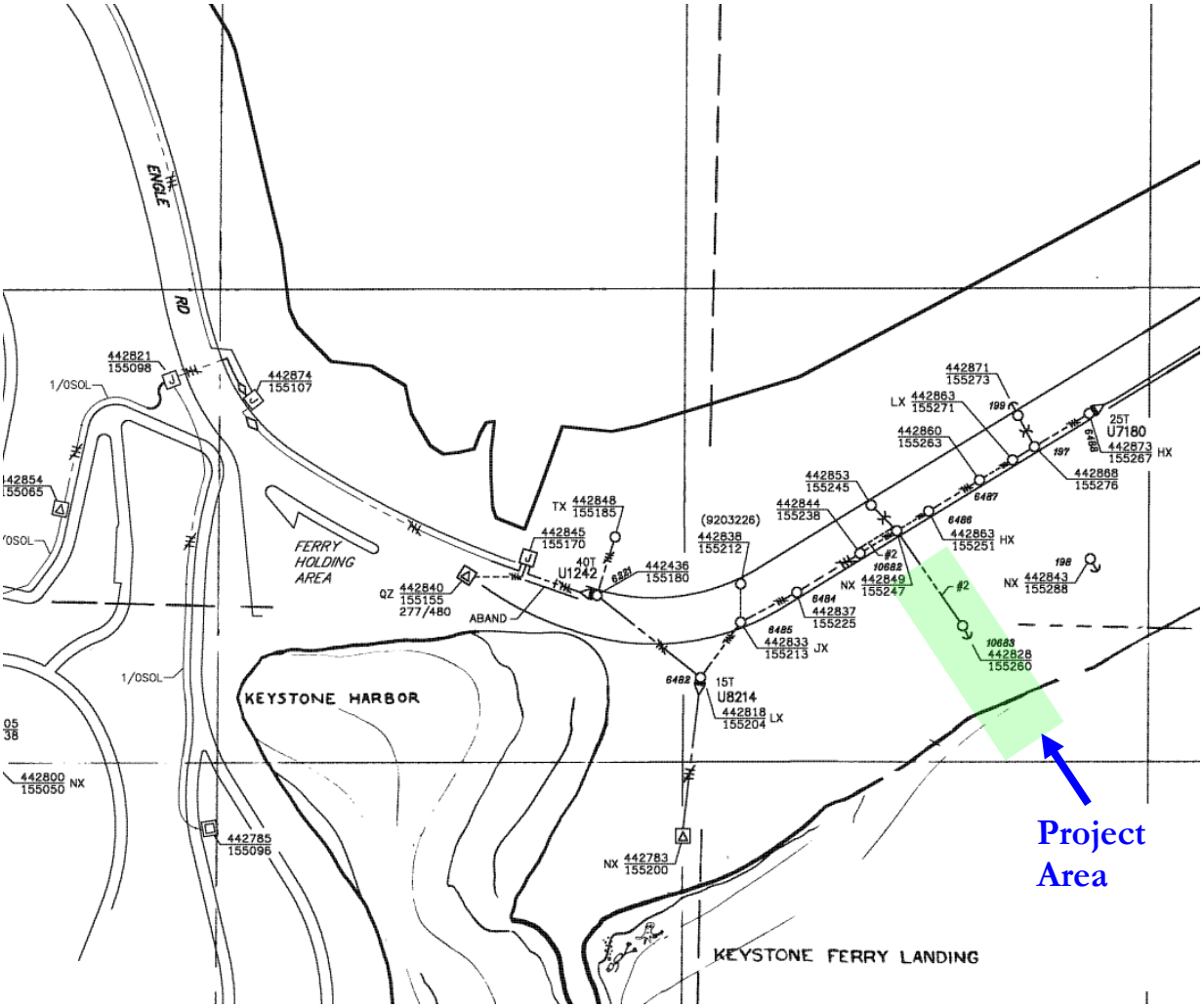


Exhibit B-2: PSE Distribution Circuit Map – System Modifications 1

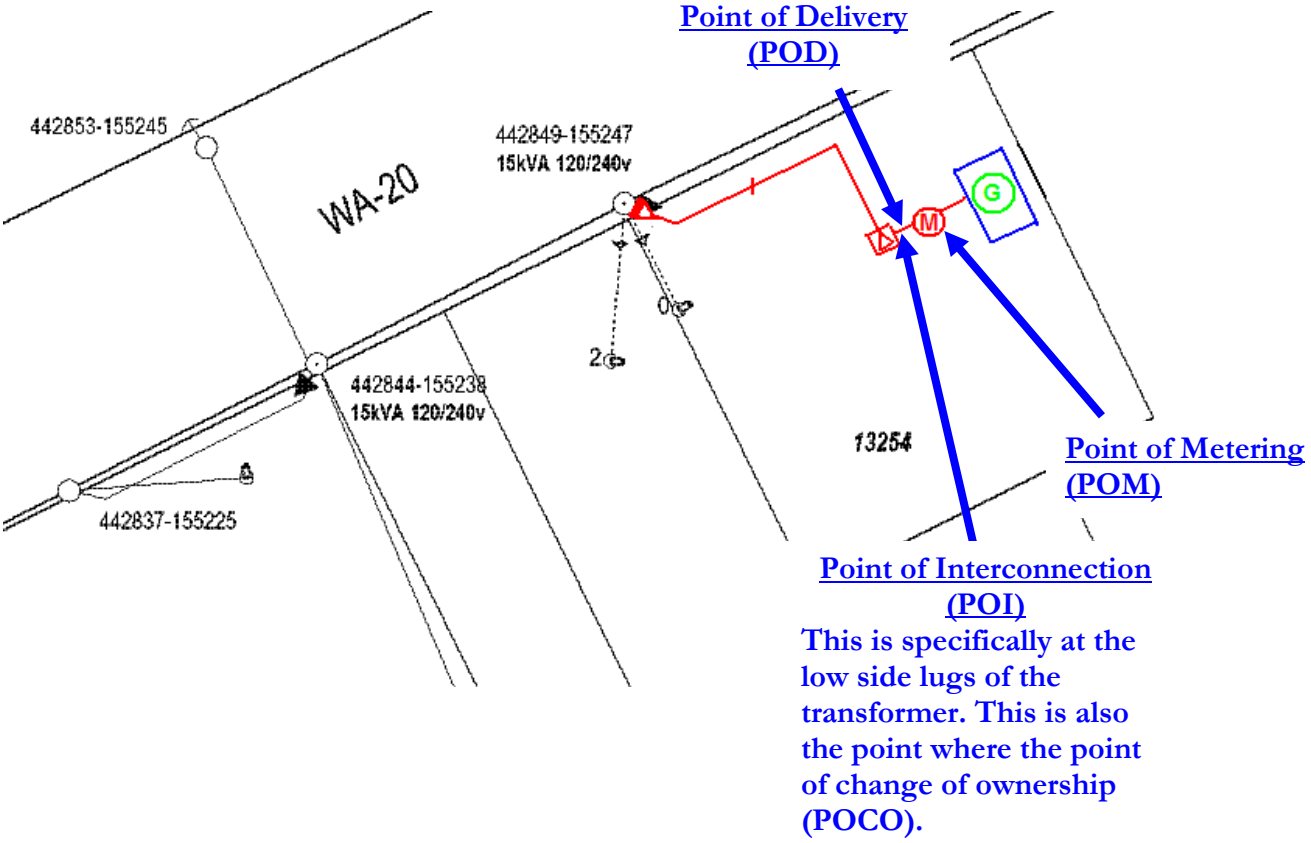


Exhibit B-3: PSE Distribution Circuit Map – System Modifications 2

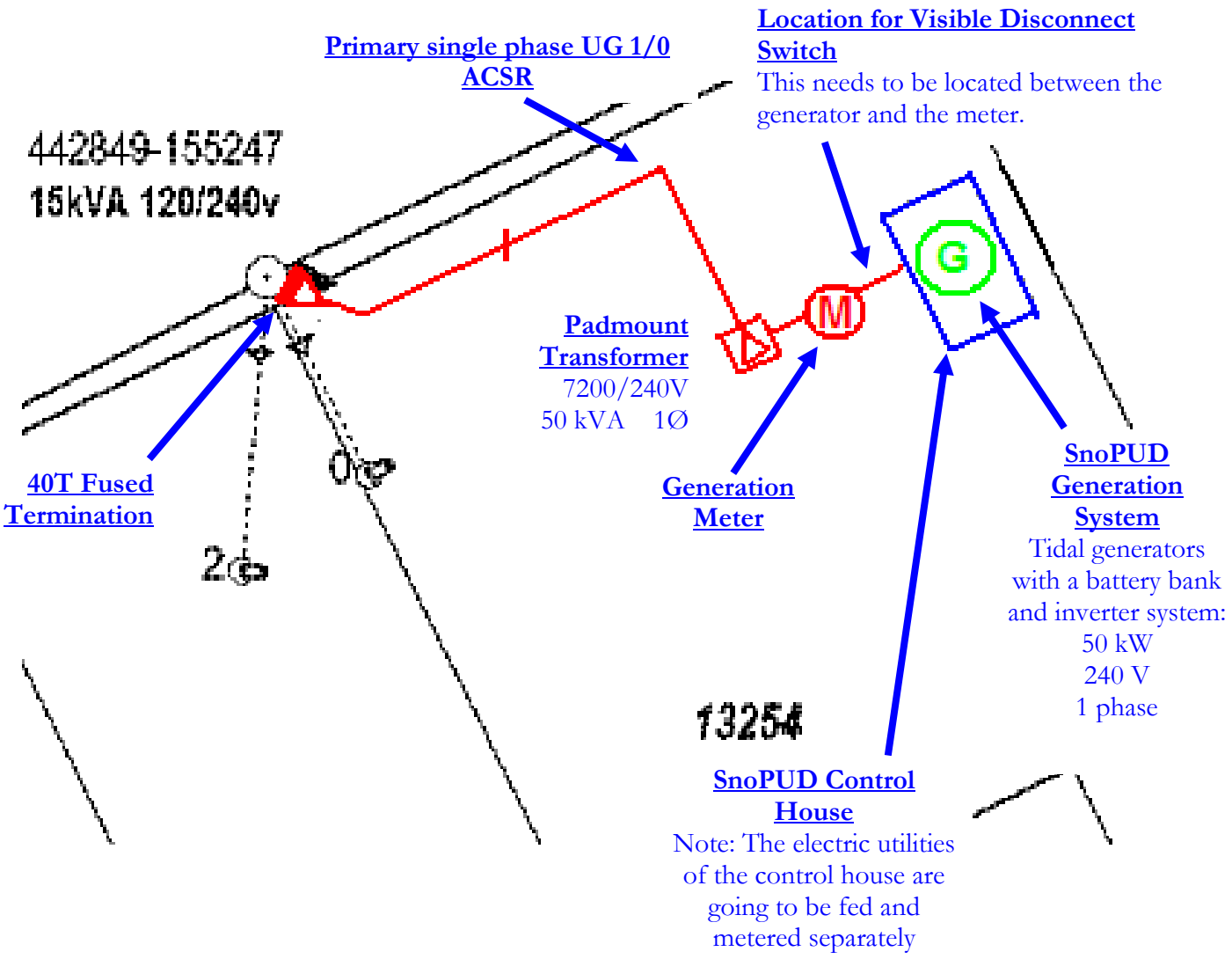


EXHIBIT C: COST ESTIMATE

Cost Estimate for PSE's Interconnection with SnoPUD's Tidal Generation.

Item	Fully Burdened Costs		
Cable, 1-phase, 1/0, Install	$ 2300		
Conduit < 6", DB	$ 1300		
Vault, 1-phase	$ 5700		
Xfmr, 1-phase	$ 9800		
Termination Pole, 1 ph, includes riser	$ 3200		
Protection, 40T fused cutout	$ 4700		
Traffic Control Plans	$ 400		
Flagging	$ 900		
S/T Contracted Line Work		$ 28,300	
Meter	$ 700		
PSE Servicemen	$ 400		
PSE Station Inspector	$ 800		
S/T PSE Directs		$ 1,900	
Survey	$ 1,900		
Right-Of-Way Evaluation	$ 600		
R/W Application	$ 1,300		
S/T Right or Way Permit		$3,800	
JA Account Fee		$ 5,000	
Testing and Commissioning Allowance		$3,000	
Contingency		$7,000	
CIAC Allowance		$11,000	
TOTAL PROJECT			$60,000

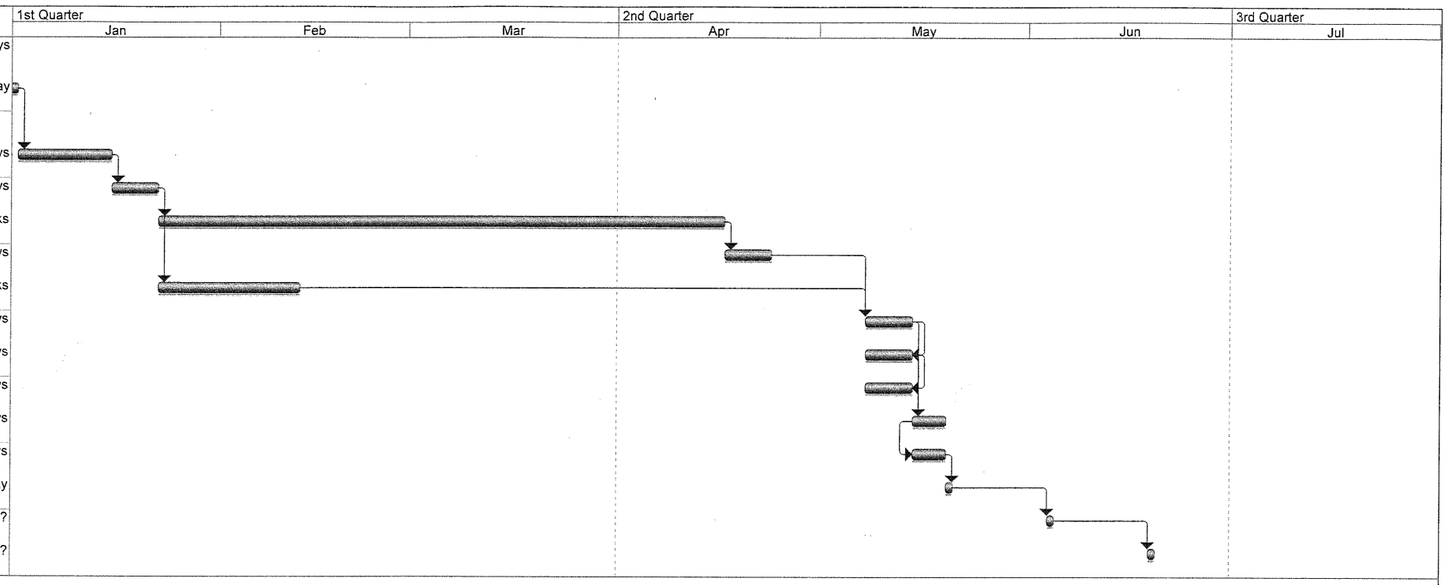
Cost Estimate Assumptions:

- This estimate is only for the connection of the generation service. The cost of the facility service connection can be provided separately.
- Based on discussion with SnoPUD, assumed conduit and cable length is 200 ft.
- The circuit feed is assumed to be rated at 200 amps.
- Since the site is on SR 20, flaggers and a right-of-way review and permit will be required. Flagging assumes two flaggers subcontracted for two 8-hour days
- Decommissioning costs are not included in this estimate.
- Due to the size of the project, standard communication equipment will be installed for metering. These costs will be captured in the metering cost estimate.
- Due to the size of the project, no additional relaying is necessary and conventional fusing will be used. A 40T overhead fused cutout will be installed on the termination pole.
- CICA Allowance is periodically adjusted and may change at time of construction.

EXHIBIT D: SCHEDULE

(Assumes arbitrary start date of 01/01/2014)

ID	Task Name	Duration
1	**Snohomish PUD Tidal Generation**	0 days
2	SnoPud -PSE Notice to Proceed	1 day
3		
4	PSE designs interconnection	10 days
5	PSE applies for R/W Permit	5 days
6	WSDOT Review of R/W Application	12 wks
7	Receive and reviews R/W Permit	5 days
8	Easement Finalized	3 wks
9	SnoPUD Completes Trench	5 days
10	SnoPud Installs Meter Base	5 days
11	SnoPud Installs Disconnect Sw	5 days
12	PSE Installs Conduit and Terminates Cable	3 days
13	PSE Installs Transformer	3 days
14	PSE Installs Meter	1 day
15	SnoPUD Test & Comm Notifiication	1 day?
16	PSE Witness Test and Commission	1 day?



Project: SnoPUD Tidal Generation Prc
Date: Fri 5/10/13

Task — Progress — Summary — External Tasks — Deadline
Split — Milestone — Project Summary — External Milestone

Page 1

Exhibit E: COMMISSIONING AND TESTING PROCEDURES

The commissioning of customer-owned protection systems is to follow the standard process outlined in this exhibit. This provides a structured and consistent approach so that the expectations of both parties can be managed and PSE's requirements clearly communicated and established early in the process.

The process outlined is linear, in that each step must be completed prior to moving on to the next. Each step has a specific deliverable to document that step. Until this deliverable is executed, that specific step is not considered complete. Specific description of each step will be provided soon after Facility Study completion.

The steps are:

1. Design review
2. Test plan review
3. Customer testing and commissioning
4. PSE witnessing