Final Scientific Technical Report

DRILLING AND PRODUCTION TESTING THE METHANE HYDRATE RESOURCE POTENTIAL ASSOCIATED WITH THE BARROW GAS FIELDS

DOE Project Number: DE-FC26-06NT42962

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Awarded to

North Slope Borough, Alaska

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ABSTRACT

In November of 2008, the Department of Energy (DOE) and the North Slope Borough (NSB) committed funding to develop a drilling plan to test the presence of hydrates in the producing formation of at least one of the Barrow Gas Fields, and to develop a production surveillance plan to monitor the behavior of hydrates as dissociation occurs. This drilling and surveillance plan was supported by earlier studies in Phase 1 of the project, including hydrate stability zone modeling, material balance modeling, and full-field history-matched reservoir simulation, all of which support the presence of methane hydrate in association with the Barrow Gas Fields. This Phase 2 of the project, conducted over the past twelve months focused on selecting an optimal location for a hydrate test well; design of a logistics, drilling, completion and testing plan; and estimating costs for the activities. As originally proposed, the project was anticipated to benefit from industry activity in northwest Alaska, with opportunities to share equipment, personnel, services and mobilization and demobilization costs with one of the then-active exploration operators. The activity level dropped off, and this benefit evaporated, although plans for drilling of development wells in the BGF's matured, offering significant synergies and cost savings over a remote stand-alone drilling project. An optimal well location was chosen at the East Barrow #18 well pad, and a vertical pilot/monitoring well and horizontal production test/surveillance well were engineered for drilling from this location. Both wells were designed with Distributed Temperature Survey (DTS) apparatus for monitoring of the hydrate-free gas interface. Once project scope was developed, a procurement process was implemented to engage the necessary service and equipment providers, and finalize project cost estimates. Based on cost proposals from vendors, total project estimated cost is $17.88 million dollars, inclusive of design work, permitting, barging, ice road/pad construction, drilling, completion, tie-in, long-term production testing and surveillance, data analysis and technology transfer. The PRA project team and North Slope have recommended moving forward to the execution phase of this project.

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1.0 Executive Summary

In November 2008, The Department of Energy (DOE) and the North Slope Borough (NSB) committed funding to develop a drilling plan to test the presence of hydrates in the producing formation of at least one of the Barrow Gas Fields, and to develop a production surveillance plan to monitor the behavior of hydrates while it dissociated. This commitment was based on results of work completed in Phase I of this project, including methane hydrate stability modeling, material balance modeling, and full field history-matched reservoir simulation, all of which support the presence of methane hydrate in association with the Barrow Gas Fields.

This report and accompanying appendices represent the deliverables of the work that was conducted over the last 12 months to find an optimal location, design the drilling and logistics plans, and develop a detailed cost estimate to execute the plan. The results of this work have led to the following conclusions:

- The project budget would not support the drilling at both East Barrow and Walakpa. The recommended plan is to drill a vertical observation well at the crest of the East Barrow reservoir, and a horizontal producer down-dip in the free gas leg.
- After analyzing all sub-surface and surface information, including log analysis, seismic coverage, well control, surface conditions, hook-up costs, logistics constraints, and drilling costs, the optimal drilling location was found to be at the EB18 pad in the East Barrow gas field.
- The vertical observation well (Savik No. 1) will be cored with oil-based coring fluid, and logged, to measure the properties of the Upper and Lower Barrow sandstones, which are believed to contain hydrates at the crest of the structure.
- The observation well and horizontal producer will be equipped with Distributed Temperature Survey (DTS) to measure the temperature of the hydrate/reservoir interval as the zone is being depressured through production. A cooling effect, indicative of the endothermic nature of dissociation, will show that hydrates are dissociating and contributing to commercial production at this field. Production surveillance, including temperature monitoring, pressure monitoring, and analysis of produced fluids, will continue several years after the wells are drilled and completed.
- The point forward cost to conduct the planned operations is predicted to be $16,030,442, broken down as follows:

	Gross Cost	DOE Share
Total, Fixed Costs:	$11,990,580	
25% Cost Share to Hydrate Project:	**$2,997,645**	**$2,398,116**
Savik No. 1 Well Cost:	$6,626,341	
Savik No. 2 Well Cost:	$4,222,436	
Project Engineering/Management:	$1,784,000	
PEM/DTS/Production Surveillance:	$400,000	
Drilling, Flowline Costs:	**$13,032,777**	**$10,426,222**
Point Forward Total Cost of Project:	**$16,030,422**	**$12,824,338**
Budget Period 3 Monies:	$1,850,000	**$1,480,000**
Total Project Budget:	**$17,880,422**	**$14,304,338**

- Including the Phase II funding consumed between December 2008 and November 2009, the total cost of the project is predicted to be $17,880,422. The DOE share of the project gross cost is predicted to be $14,304,338.
- Project scope has been refocused on East Barrow, with no Walakpa option, but with significant enhancements. There are opportunities to reduce scope and cut costs, if required.

This project represents a special opportunity to measure the properties of the postulated hydrate interval, and if present, monitor its behavior over time, as it contributes to commercial production and provide gas and power for the community of Barrow. By combining this project with the re-development project at Walakpa that the NSB intends to conduct, the hydrate project can be conducted at a significant cost savings to a standalone project, in any other year. The estimated cost if there were no synergies with the NSB project has been estimated at $27MM. The proposed project, if conducted in 2010-2011, represents a 37% cost saving to a standalone project.

For many reasons, including the need to understand the depletion mechanism at the East Barrow gas field, the unique opportunity to monitor the behavior of hydrates under continuous dissociation, and the cost savings that can be captured by sharing resources with the NSB, it is recommended that this project be approved and moved into Budget Period 4, commencing December 1, 2009.

2.0 Selection of Optimal Drilling Locations - Summary

In March of 2009, an interim topical report was submitted to the DOE that documented the work that led to the selection of the optimal well locations at East Barrow, to achieve program objectives. Discussed below are a brief summary of the work, and a description of the proposed drillsite at East Barrow.

2.1 Fine-Grid Reservoir Modeling

At the East Barrow Field, two potential locations were evaluated as hydrate test well sites; based on geoscience data, reservoir issues, surface constraints, and logistical considerations. Both candidates would result in vertical holes that are expected to penetrate hydrates within the Barrow sandstone, and both are located near seismic lines. As shown in Figure 1, these two primary candidate areas are 1.) at the crest of the structure near well No. 19, and 2.) near the crest of the structure adjacent to wells No. 18 and No. 21.

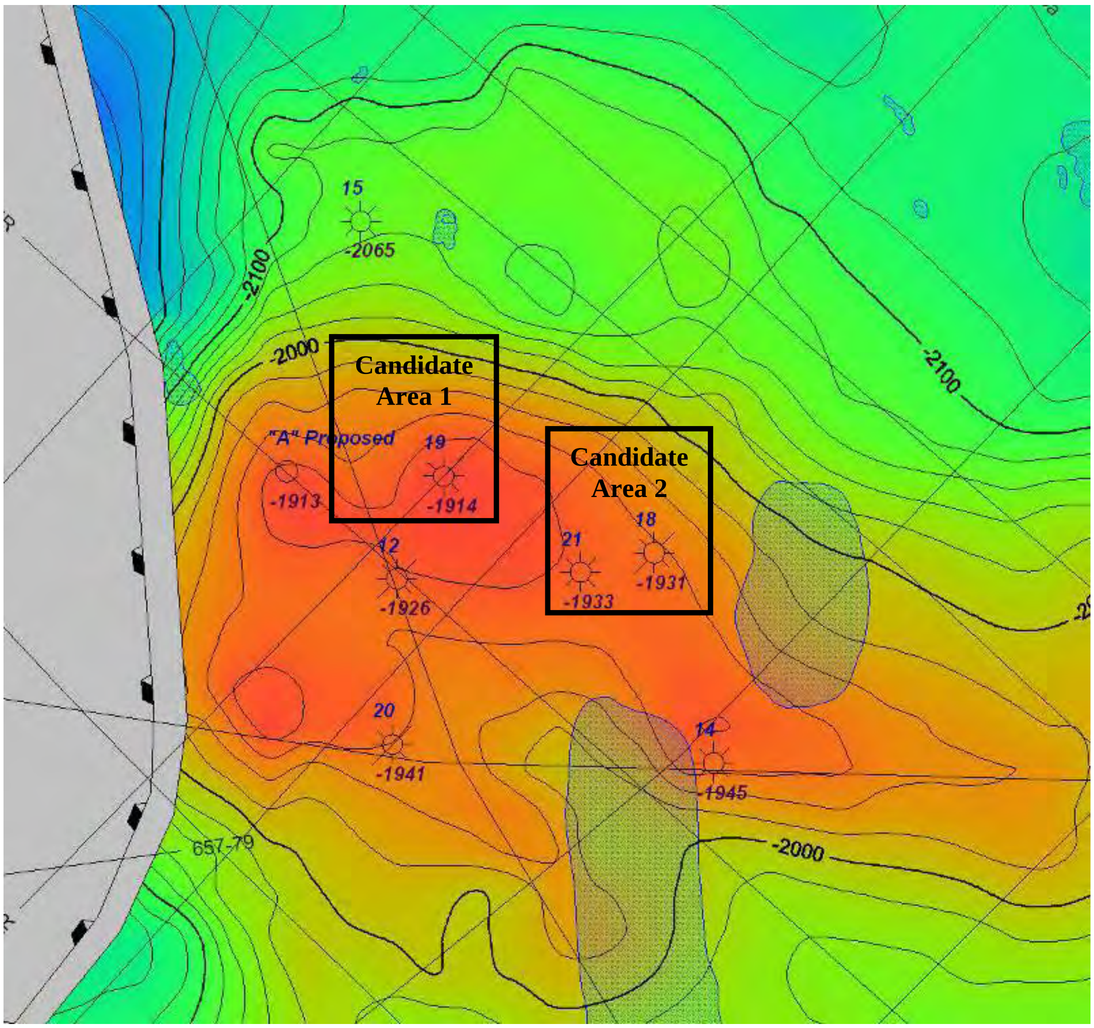

Figure 1. Map of East Barrow Gas Field with Candidate Hydrate Test Well Locations

One of the major factors to consider when determining where to place the observation well and producer wells is: what changes are expected to occur within the hydrate interval over the course of the production test. To answer this question, a fine-gridded reservoir model was developed over one of the areas to predict how the hydrate zone would dissociate due to downdip free-gas production and depressurization. The model was then modified to include a monitoring well at the crest, and a horizontal well in the free gas leg. The fine-gridded model with the new wells is shown below in Figure 2.

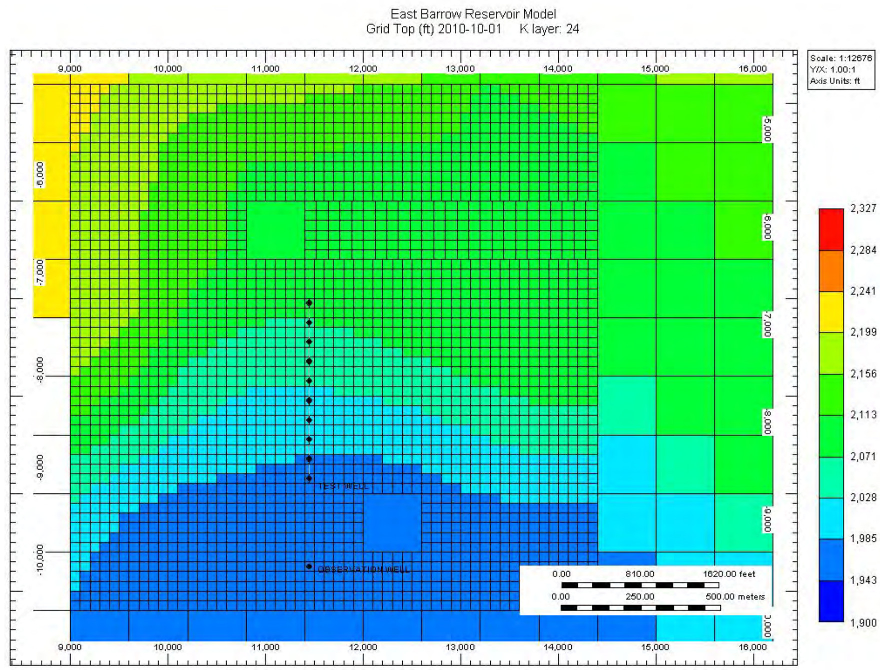

Figure 2: Plan View showing Observation Well and High Angle Producer

The model was then run over a span of 5 years with a production rate of 1MMscfpd produced from the horizontal test well to observe how the hydrate layer behaves. The character of the hydrate layer at year 0, 3 and 5 are shown in Figures 3, 4, and 5 below.

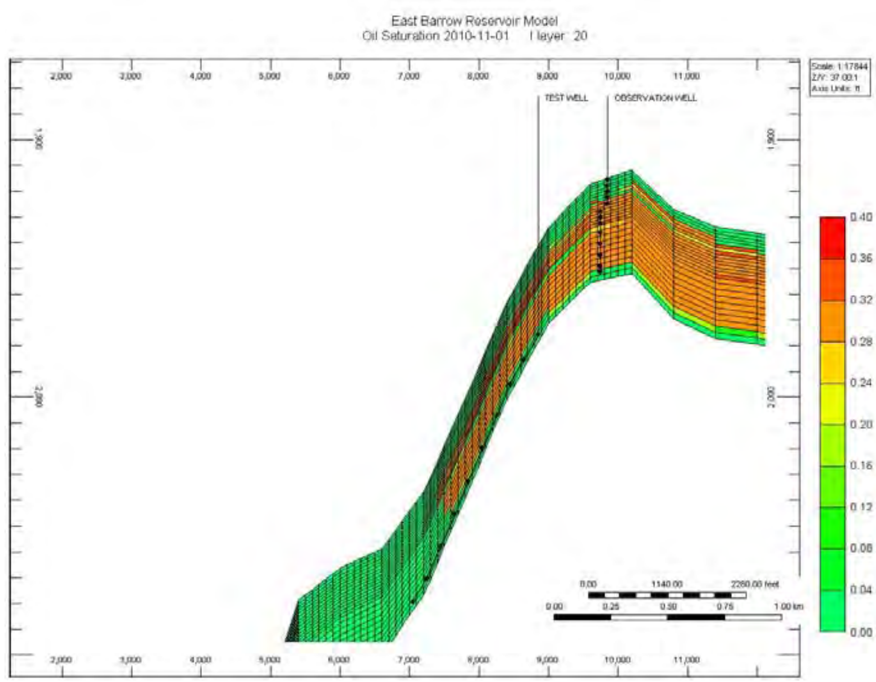

Figure 3: Observation Well and High Angle Producer, Current Time

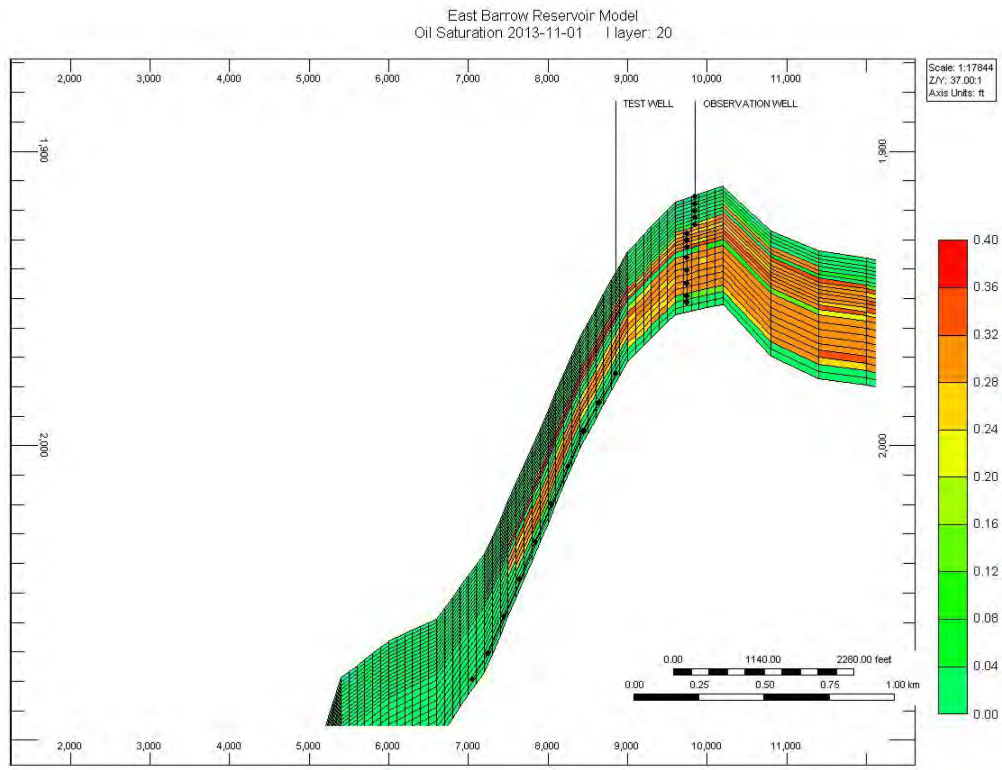

Figure 4: Observation Well and High Angle Producer, After 3 years of Production

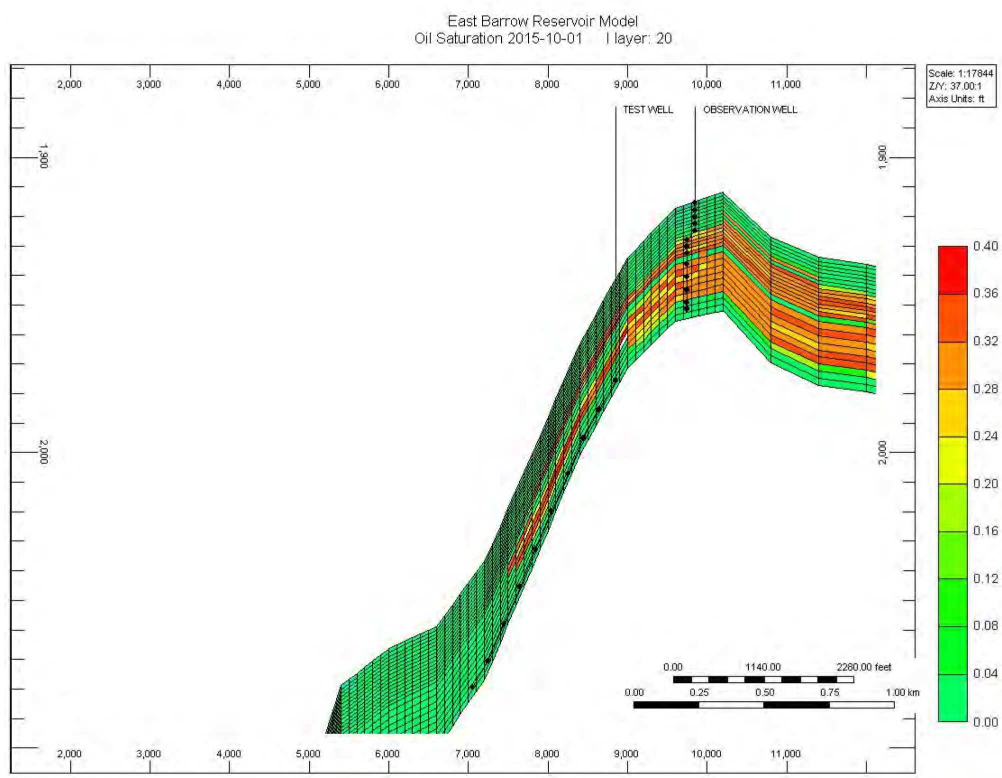

Figure 5: Observation Well and High Angle Producer, After 5 years of Production

As a result of the reservoir simulation work that was performed to predict the current status of the hydrate layer, and how the current hydrate interval is expected to change over 5 years of production, several observations and conclusions can be drawn, as listed below:

- The expected case shows hydrate decomposition occurs from below (from the original free gas/hydrate interface), and away from the overburden and underburden. At the time the observation well is drilled, at least one interface is expected.
- As a practical matter, other possible scenarios may be found at the observation well including 2.) A full column of hydrate, with no interface. Or, 3.) Very little to no hydrate.
- Uncertainty surrounding the actual location of hydrates and the exact depth of the hydrate/free-gas interface must be acknowledged and considered when choosing the optimal location of the wells, and how decisions will be made once the observation well is drilled.
- This work suggests that an observation well near the crest of the structure is a good location and is expected to see adequate hydrate and an interface to monitor.
- This work suggests that a horizontal well in the free gas leg, producing at 1 MMscfpd, will cause enough pressure drop to cause hydrates at the observation well to dissociate.

2.2 Temperature Modeling

The fine-grid simulation has determined that if a hydrate column is present near the crest of the structure, there will be dissociation of hydrates at the location of an observation well due to production from a downdip high angle producer. The question then becomes, what measurements can be taken to prove that dissociation is occurring, and, and what can be done to measure hydrate behavior over time. Given the endothermic nature of hydrate dissociation, it was postulated that continuous monitoring of temperature could be used to meet these objectives. To test this theory, the temperature of the grid-blocks at the wellbore was recorded over time. The result is the plot shown in Figure 6 below.

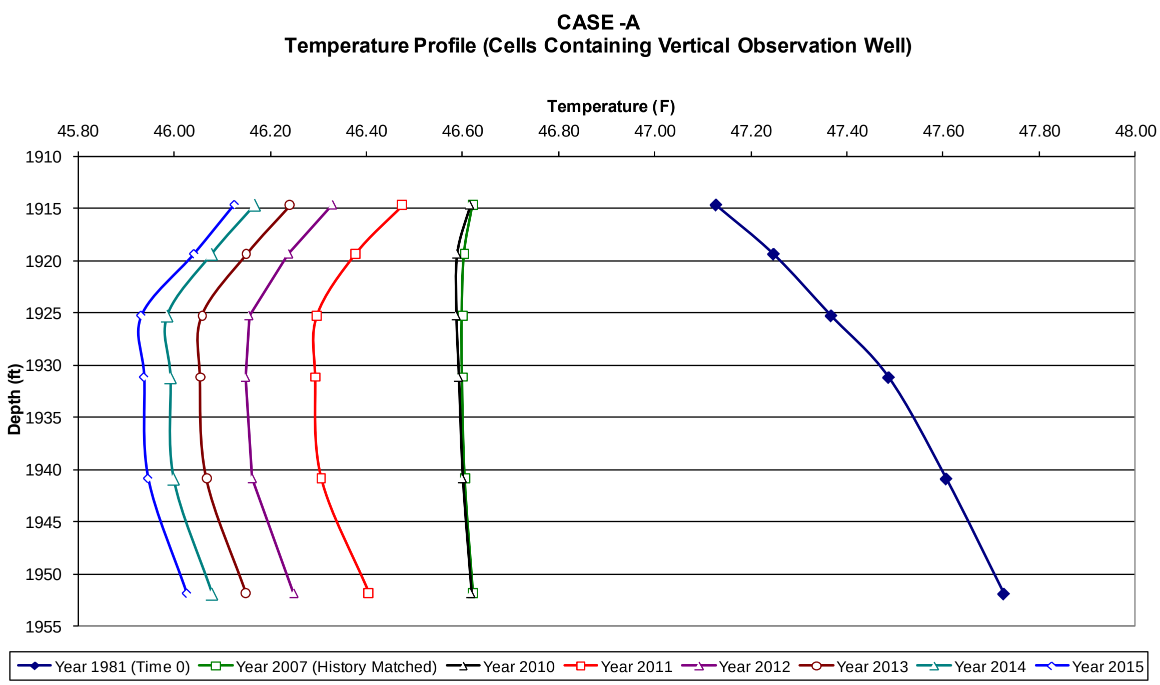

Figure 6: Simulated Temperature Response over Barrow Sand, span of 5 years of production

The results of this work indicate that continuous temperature monitoring with distributed temperature survey (DTS) will be an acceptable way of proving that hydrates are present, and that hydrates are dissociating due to downdip production and resulting depressurization.

2.3 Selection of Optimal Drilling Locations

Encouraged by results of production and temperature modeling that a well near the crest of the structure and a downdip producer would provide proof of concept, the focus turned to picking the exact surface and subsurface locations of the observation well and producer well. Given all the subsurface and surface constraints, a number of competing factors had to be considered to arrive at an optimal location. The analysis found that the area around abandoned well No. 18 had the most advantages and least disadvantages. A summary of the pros and cons of this location is given below.

Pros:

1. Surface conditions are favorable. A road and gravel pad will allow adequate access to the drillsite, as shown in Figure 7 below.
2. Sub-surface conditions are favorable. An observation well could be drilled at the crest, where hydrates are expected as shown in Figure 8 below.
3. Well log analysis of Wells No. 18 and No. 21 indicate that hydrates were present when the wells were originally drilled.
4. A high angle producer drilled from a surface location immediately adjacent to the observation well will intersect a relatively steep flank, allowing for maximum vertical relief which has a high chance of intersecting the free gas-hydrate interface.
5. Fine grid simulation modeling indicates that these two wells would provide proof of concept, provided a hydrate zone is found to be present.
6. Seismic control is very good, as the heel of the horizontal well is on a seismic line, as shown in Figure 9.
7. Well control is good, particularly on the crest of the structure, with nearby wells No. 18 and 21.
8. Given the departure from the surface location to the heel, the build rate of this well would be slightly less aggressive (8.0 deg/100’ vs. 8.9 deg.100’) than the well near EB 19, as shown in Figure 10.

Cons

1. The gravel pad at EB18 is too small to support a drilling rig operation, so ice would have to be constructed alongside the existing gravel pad to conduct operations.

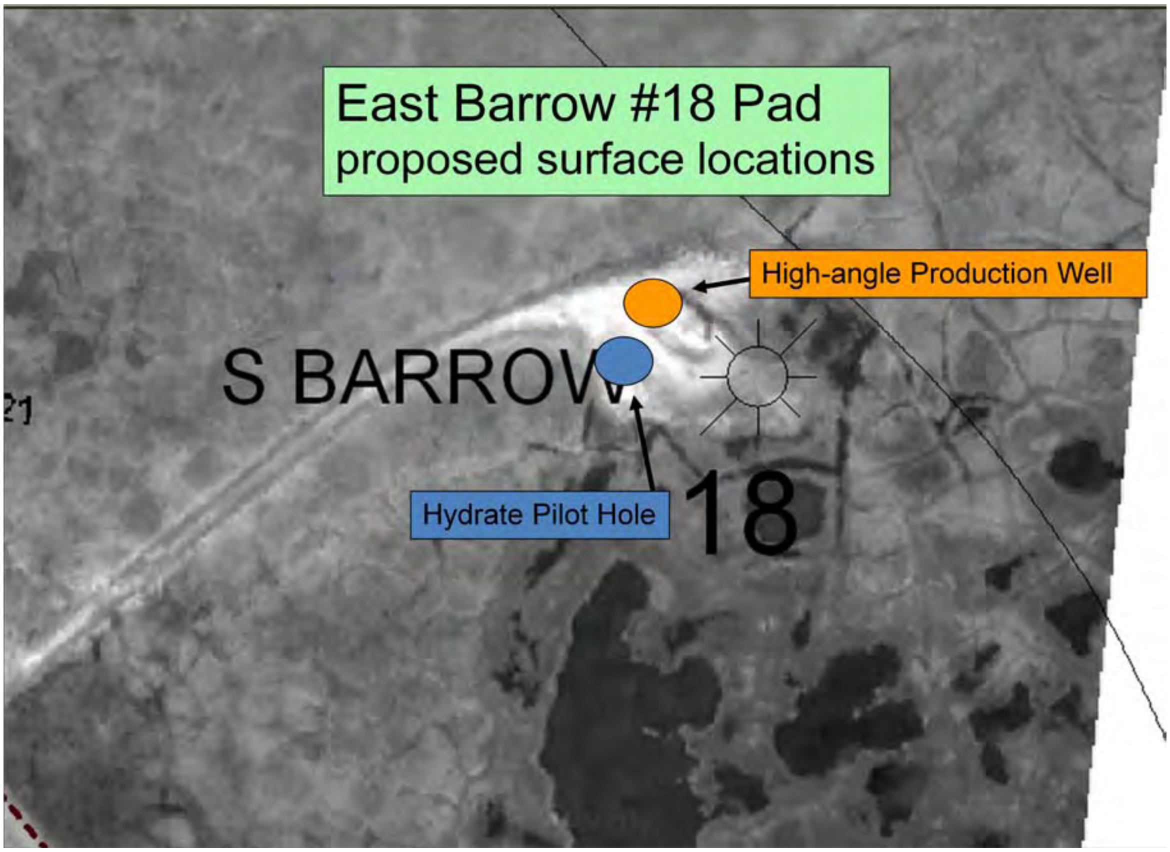

Figure 7: Surface Locations of Wells drilled from Well No. 18 Pad

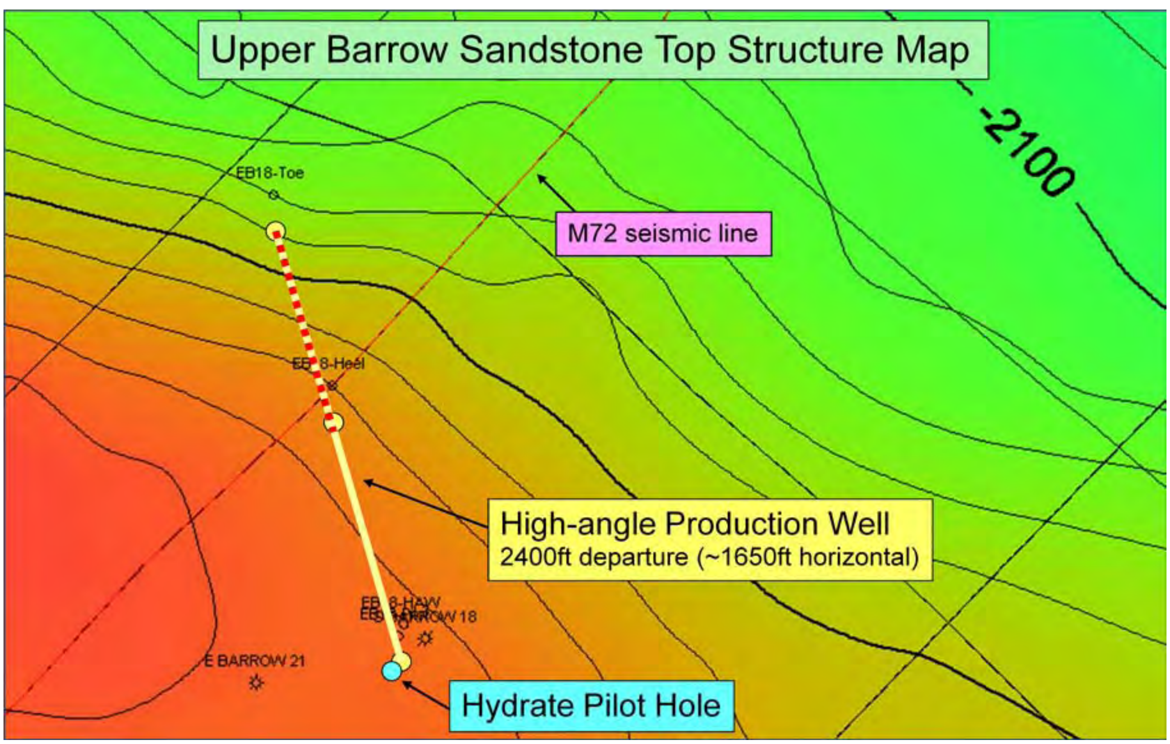

Figure 8: Heel and Toe Location on Structure Map

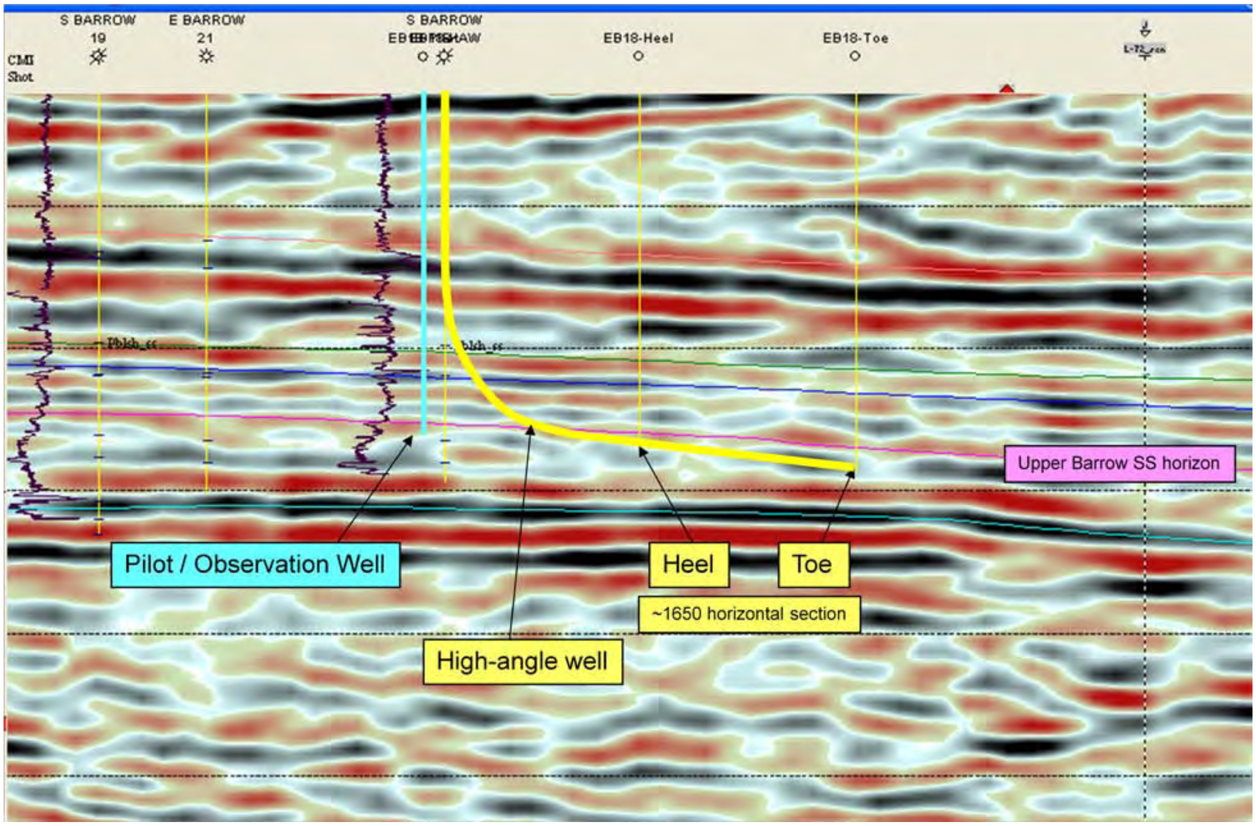

Figure 9: Observation Well and Horizontal Well on Seismic Cross Section

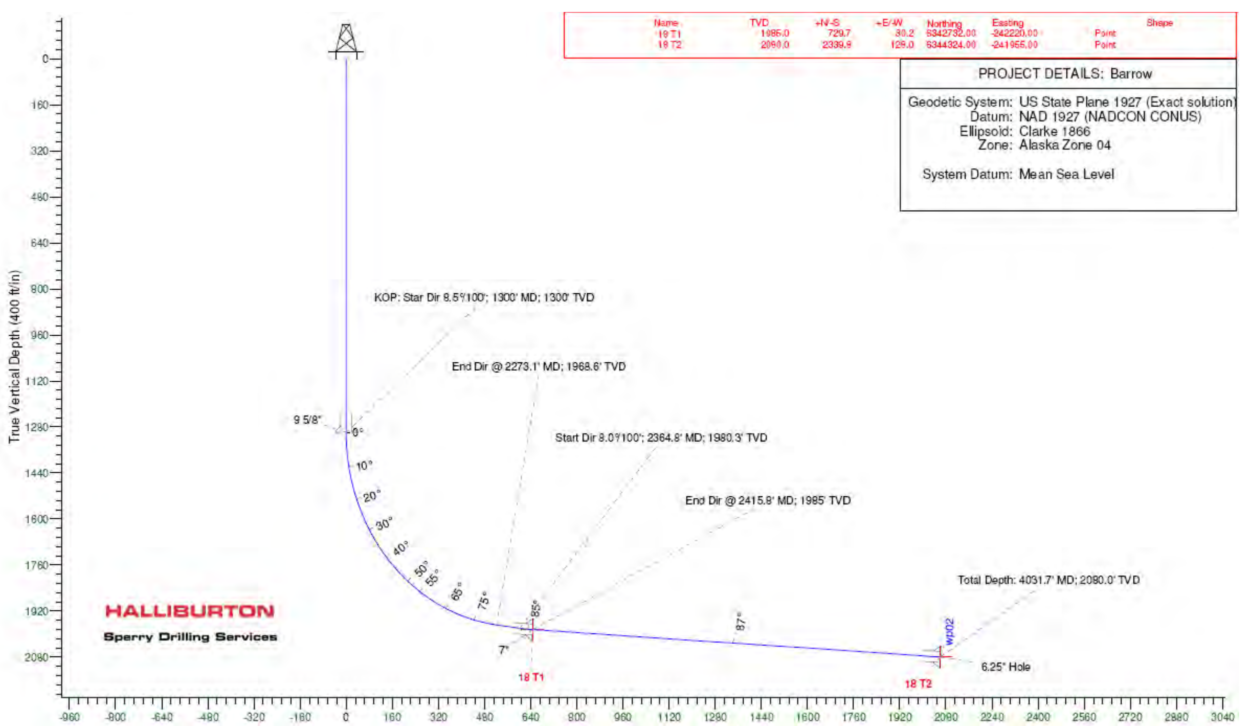

Figure 10: Directional Plan of Horizontal Producer

2.4 Summary – Selection of Optimal Location at East Barrow Field

A fine-grid model, and a time lapse simulation, was performed to understand the behavior of a hydrate interval, as the reservoir is de-pressured with down-dip, free gas production. An exhaustive analysis was then performed that weighed surface issues, subsurface issues, log analysis, seismic control, and well control to select the optimal location of the vertical observation well and high angle producer.

The results indicate that the pad at EB 18 is the optimal location to drill the vertical observation well (Savik No. 1) and the high angle (horizontal) producer (Savik No. 2).

3.0 Overview – Plan of Operations

Once the well objectives were defined, and the optimal drilling locations had been selected, the focus of the project team turned to planning the operation. Because the DOE work will be conducted concurrent with the re-development work for the NSB, the "project" and basis for the work plan includes all work associated with both projects. A comprehensive Plan of Operations was written in May 2009. A copy of that Plan of Operations is given in Appendix A.

A summary of the Plan of Operations is provided below:

- The plan includes a background discussion of the project.
- Section 2 includes a discussion of the logistical challenges of this project, including a description of the five distinct operational phases, as follows:
  - Barging of equipment spread from Prudhoe West Dock to Barrow – July 2010
  - Mobilization of equipment spread from NARL staging pad to the East Barrow Field and drilling of two wells at East Barrow.
  - Mobilization of equipment spread to Walakpa and the drilling of up to four development wells
  - Mobilization of equipment spread back to NARL staging pad at Barrow
  - Barging of equipment from Barrow to West Dock – July 2011
- Section 3 gives an overview of the well designs and data acquisition program of the hydrate test wells at East Barrow, and the development wells at Walakpa.
  - Included are well schematics and preliminary directional plans of the type wells.
  - Also included are discussions of drilling rig requirements, hole size, casing design, mud program, and drilling practices.
- Included in the appendix of the Plan of Operations are the following documents:
  - Preliminary barge load-out list
  - List of proposed permitted lakes for Temporary Water Use
  - Rolling Stock and operating spread for ice road & pad construction, and maintenance
  - Existing pipeline network at Walakpa
  - Well Schmatics for East Barrow and Walakpa

4.0 Overview – Well Plans

Well plans, outlining how the wells will be drilled, have been drafted for the hydrate observation well, Savik No. 1, and the hydrate production test well, Savik No. 2. A brief discussion of the well design and a brief drilling procedure is given below for each well. Included in Appendix B and C are the Savik No. 1 and Savik No. 2 well plans.

Well design summary and brief drilling procedure – Savik No. 1

Savik No. 1 is a vertical well, drilled near the crest of the structure, that is intended to core and log the hydrate interval of the Barrow gas sands. The well will be completed with DTS to monitor its temperature behavior over time. An abbreviated drilling procedure is given below.

1. Move in and rig up drilling unit.
2. Install Mud Chiller & Generator, Coring and Lab Trailer and Geo Shack, MWD/LWD/Mud Logging unit, Wireline unit – for core retrieval.
3. Take on water and build spud mud.
4. Function test 21-1/2" 2M Hydril Diverter System.
5. MU BHA #1: 12-1/4" Tricone drill bit on packed rotary assembly and drill to 300'-. POOH.
6. MU BHA #2: 12-1/4" packed rotary assembly w/ MWD collars – test MWD collars below 13 3/8" conductor. Drill 12-1/4" surface hole to +/- 1520-ft. md tvd/rkb. Maintain drilling fluid temperature at +/- 40 - 60 deg. F with dilution.
7. Circulate and condition 12-1/4" surface hole section for casing.
8. Run 9-5/8", 40#, L-80 BTC-M casing to TD @ +/- 1520 tvd/md rkb.
9. Cement 9-5/8", 40#, L-80 BTC-M casing – bump plug with MOBM Coring Fluid. ND diverter system, install wellhead and NU 11 5M BOPE – test BOPE.
10. Clean Pits, plug all water sources and take on (cold) MOBM.
11. Plumb in Mud Chiller per DrillCool and test.
12. MU BHA #3 w/ 8 ¾" bit. RIH to 1400-ft and test casing to 1500 psi.
13. Drill out shoe track, floats and 20-ft of formation to 1540-ft tvd/md rkb.
14. POOH to 1400-ft and perform FIT to 0.67 psi/ft equivalent (12.9 ppg).
15. Drill 8 ¾" hole section with BHA #3 (MWD/GR/RES) to Walakpa Sands core point at 1700-ft tvd/ss = 1728-ft tvd/md rkb. – POOH. Core point to be picked by well-site geologist.
16. M/U BHA #4, 7-7/8" CORION wire line retrievable coring assembly with coring insert. RIH to core point at +/-1728-ft tvd/md rkb per onsite geologists.
17. Core Walakpa Sands interval (48 ft total) from 1728-ft tvd/md rkb to 1776-ft tvd/md rkb. Two each 24 ft core sections will be acquired through the Walakpa Sands interval. Wire line retrieve each 24 ft Walakpa sands core section to surface.
18. POOH with BHA #4.
19. MU BHA #5 – 7 7/8" bit w/ packed BHA assembly (MWD/GR/RES) – drill 7 7/8" hole section to Upper Barrow Sands core point at +/- 1925-ft tvd/ss = 1953-ft tvdmd rkb per onsite geologists.
20. POOH – MU BHA #6 ; 7-7/8" CORION wire line retrievable coring assembly with coring insert. RIH to core point at 1953-ft tvd/md rkb.
21. Core Upper and Lower Barrow Sands interval (+/-120 ft total) from 1953-ft tvd/md rkb to 2073-ft tvd/md rkb. Five each 24 ft core sections will be acquired through the Upper and Lower Barrow Sands interval. Wire line retrieve each 24 ft Upper and Lower Barrow sands core section to surface.
22. POOH w/ BHA #6, L/D same. MU BHA #7 – 8 ¾" hole opener assembly. RIH to 1728-ft tvd/md rkb - open 7 7/8" (120 ft) cored & drilled interval (1953 – 2073 ft tvd/md rkb) to 8 ¾" OD. POOH.

23. MU BHA #8 - 8 ¾" bit w/ packed BHA assembly (MWD/GR/RES) – drill 8 ¾" hole section to well TD at 2174 ft md/tvd rkb. POOH – stand back BHA #9.
24. R/U E-line.
25. RIH w/ formation evaluation logging suites: 3 logging runs.
26. P/U BHA #8 – RIH . Perform clean out run to +/- 2174-ft md/tvd rkb. POOH, L/D BHA #8.
27. RU to run 7" casing with DTS strapped to exterior of pipe. RIH. Cement to surface.
28. ND tree, NU x-mas tree. RD, MO.

Well design summary and brief drilling procedure – Savik No. 2

Savik No. 2 is a horizontal well, drilled down dip from Savik No. 1, which is intended to penetrate the Barrow sandstone above the base hydrate stability zone (BHSZ), drill within the Barrow Sandstone in a down dip direction to intersect the free gas bearing interval, and produce from the free gas leg. The well will be completed with DTS to monitor its temperature behavior over time. An abbreviated drilling procedure is given below.

1. Move in and rig up drilling unit.
2. Install MWD/LWD and Wireline unit.
3. Take on water and build spud mud. PU 4 ½" DP (approx. 80 jts, R2)
4. Function test 21-1/2" 2M Hydril Diverter System.
5. MU BHA #1: 12-1/4" Tricone drill bit on packed rotary assembly and drill to 300'-. POOH.
6. MU BHA #2: 12-1/4" packed rotary assembly w/ LWD collars – test LWD collars below 13 3/8" conductor. Drill 12-1/4" surface hole to +/- 1028ft. md tvd/rkb.
7. Circulate and condition 12-1/4" surface hole section for surface 9 5/8' 40# L80 BTC-Mcasing.
8. Run 9-5/8", 40#, L-80 BTC-M casing to TD @ +/- 1028 tvd/md rkb.
9. Cement 9-5/8", 40#, L-80 BTC-M casing – bump plug. ND diverters system, install Vetco Grey 5M wellhead , NU DSA and 11 5M BOPE – test BOPE, choke manifold, stand pipe & surface IBOP's and safety valves.
10. MU BHA #3 w/ 8-1/2" bit, directional assembly w/ LWD/GR/RES/NEU/DEN. RIH to 900-ft rkb and test surface 9-5/8" casing to 2500 psi. Record test on Barton recorder and submit with daily IADCC report.
11. Drill out shoe track, floats and 20-ft of formation to 1050-ft tvd/md rkb.
12. POOH to 1000-ft and perform FIT to 0.67 psi/ft equivalent (12.8 ppg).
13. Drill 8-1/2" hole section with BHA #3 (MWD/GR/RES/NEU/DEN) to 7" 26# L80 intermediate casing point at 2382-ft md/2004-ft tvd.
14. Circulate 8-1/2" wellbore, short trip to 9 5/8" 40# shoe @ 1028 –ft tvd/md rkb , prep rig for running 7" 26# L80 intermediate casing. POOH with BHA #3
15. Run 7" intermediate casing. Land 7" 26# L80 casing hanger in casing head of Vetco Grey 5M well head. RILDS to energize pickoffs. Test Vetco Grey 5M wellhead to 3500 psi.
16. PU 60 jts of 4" DP – position on set back area.
17. MU BHA #4 – 6 1/8" bit w/ directional assembly (LWD/GR/RES/NEU/DEN). RIH, test 7" 26# L80 BTC-M casing to 3500 psi.
18. Drill 6-1/8" horizontal hole section to 4026-ft md/2110-ft tvd rkb. Wellbore to be directionally constrained to the Upper Barrow Gas Sand interval. Short trip 6-1/8" horizontal hole section, circulate annulus 2x. Back ream as required through tight hole sections.
19. POOH w/ BHA #4. Prep rig to run 4 ½" 12.6# L80 EUE-8rd slotted liner with 2 7/8" 6.5# L80 completion assembly.
20. RIH w/ 4-1/2" 12.6# L80 EUE-8rd slotted liner on 2-7/8" 6.5# L80 completion assembly w/ 7" x 2 7/8" production packer. Distributed temperature survey (DTS) equipment to be affixed to the external O.D. of the 2-7/8" completion tubing and 4-1/2" production slotted liner.

5.0 Overview of Logistics Costs including Transportation, Supply Chain, Ice, etc.

Once proposals were received from all sub-contractors who submitted bids, the project team normalized the bids, evaluated and ranked the proposals, and selected the winning proposal based on cost and project performance. Using the detailed cost data in the winning proposer's bid package, the project team then, developed a comprehensive, detailed cost estimating spreadsheet for "fixed cost" portion of the project, and the cost of each well.

The fixed cost portion of the project includes all costs to mobilize equipment, keep the equipment at Barrow until the following barge season, and other logistics and supply chain costs to support the drilling operation. Given below is a summary of the fixed cost portion of the project, and the hydrate project's share based on a 25/75 split.

Category	Program Cost
Pad Lease	$280,000
Barging	$2,667,885
Air Cargo	$606,064
Air Passenger	$1,348,160
Heavy Haul	$168,300
Mob, DeMob, Standby	$6,920,171
Total, Fixed Costs:	$11,990,580
25% Cost Share to Hydrate Project:	**$2,997,645**

6.0 Overview of Well Cost Estimates for Savik No. 1 and No. 2

Using the detailed cost data in the winning proposers bid package, and very granular time estimate of each operation, broken down by phase, hole section, and task, the project team developed a detailed cost estimating spreadsheet for Savik No. 1 and Savik No. 2. A line-itemized cost summary of the two wells is given below.

<u>Savik No. 1 Detailed Cost Estimate</u>

LEASE:	East Pool, South Barrow Field	WELL Nbr.:	Savik No. 1	WELL TYPE:	Gas, Dev.
LOCATION:		COUNTY:	North Slope Borough	STATE:	Alaska
FIELD/PROSPECT:	South Barrow, East Pool	FORMATION:	Upper/Lower Barrow Ss	Proj. TVD:	2200
DESCRIPTION:	Vertical Methane Hydrate Monitoring Well				

Cost			**Total Cost**	**$6,626,341**
Code	**CATEGORY**	**Adder, this Sheet**	**Other Sheets**	**Well**
101	**CAMP AND CATERING**	$0	$252,072	$252,072
102	**CASING RUNNING TOOLS & SERVICE**	$0	$16,700	$16,700
103	**CEMENTING**	$0	$136,145	$136,145
104	**COMMUNICATIONS**	$0	$29,400	$29,400
105	**CONDUCTOR INSTALLATION**	$0	$68,044	$68,044
106	**CORE BITS, CORING TOOLS**	$0	$756,911	$756,911
107	**CORE HANDLING & ANALYSIS**	$0	$114,186	$114,186
108	**CUTTINGS AND WASTE MANAGEMENT**	$0	$232,872	$232,872
109	**DIESEL FUEL**	$0	$917,947	$917,947
111	**DOWNHOLE DRILLING TOOLS**	$0	$235,491	$235,491
112	**DRILL BITS**	$0	$35,050	$35,050
113	**DRILLING RIG CONTRACT**	$0	$901,536	$901,536
114	**DRILLING FLUIDS**	$0	$1,102,607	$1,102,607
115	**FISHING TOOLS**	$0		$0
116	**FORMATION EVALUATION**	$0	$582,558	$582,558
	Mud Logging	$0	$79,500	
	E-Line	$0	$503,058	
117	**ICE & LOCATION BUILDING**	$0		
118	**OTHER WELL SUPPORT SERVICES**	$0	$117,200	$117,200
119	**RENTAL EQUIPMENT, ROLLING STOCK**	$0	$172,137	$172,137
120	**SUPERVISION**	$0	$138,400	$138,400
121	**SUPPLY CHAIN & LOGISTICS MANAGEMENT**	$0	$67,200	$67,200
	Highway Truck Transportation	$0		
200	**TANGIBLES**	$0	$449,885	$449,885
201	**Tubulars, OCTG**	$0		
202	**Downhole Completion Equip, Packers, DTS**	$0	$102,073	
203	**Artificial Lift, Downhole Treatment**	$0		
204	**Surface Monitoring, DTS**	$0	$153,615	
205	**Wellhead, X-mas Tree**	$0	$41,435	
206	**Wellhouses**	$0		$300,000
207	**Flowlines**	$0		
208	**Miscellaneous Tangible Material**	$0		

Savik No. 2 Detailed Cost Estimate

LEASE:	East Pool, South Barrow Field	WELL Nbr.:	Savik No. 2	WELL TYPE:	Gas, Dev.
LOCATION:		COUNTY:	North Slope Borough	STATE:	Alaska
FIELD/PROSPECT:	South Barrow, East Pool	FORMATION:	Upper/Lower Barrow Ss	Proj. TVD:	4100
DESCRIPTION:	Horizontal Hydrate Test Well				

Cost Code	CATEGORY	Adder, this Sheet	Total Cost Other Sheets	$4,222,435 Well
101	CAMP AND CATERING	$0	$252,117	$252,117
102	CASING RUNNING TOOLS & SERVICE	$0	$19,638	$19,638
103	CEMENTING	$0	$136,545	$136,545
104	COMMUNICATIONS	$0	$27,000	$27,000
105	CONDUCTOR INSTALLATION	$0	$68,044	$68,044
106	CORE BITS, CORING TOOLS	$0	$0	$0
107	CORE HANDLING & ANALYSIS	$0	$0	$0
108	CUTTINGS AND WASTE MANAGEMENT	$0	$196,797	$196,797
109	DIESEL FUEL	$0	$789,959	$789,959
111	DOWNHOLE DRILLING TOOLS	$0	$265,691	$265,691
112	DRILL BITS	$0	$50,500	$50,500
113	DRILLING RIG CONTRACT	$0	$751,280	$751,280
114	DRILLING FLUIDS	$0	$35,502	$35,502
115	FISHING TOOLS	$0		$0
116	FORMATION EVALUATION	$0	$0	$0
	Mud Logging	$0	$0	
	E-Line	$0	$0	
117	ICE & LOCATION BUILDING	$0		
118	OTHER WELL SUPPORT SERVICES	$0	$106,000	$106,000
119	RENTAL EQUIPMENT, ROLLING STOCK	$0	$156,062	$156,062
120	SUPERVISION	$0	$120,000	$120,000
121	SUPPLY CHAIN & LOGISTICS MANAGEMENT	$0	$56,000	$56,000
	Highway Truck Transportation	$0		
200	TANGIBLES	$0	$541,301	$541,301
201	Tubulars, OCTG	$0		
	13-3/8" 70.67# L-80 Conductor	$0	$7,685	
	9-5/8" 40# L-80 Surface	$0	$49,360	
	7" 26# L-80 Intermediate	$0	$107,526	
	4-1/2" 12.6# L-80 Production	$0	$36,400	
202	Downhole Completion Equip, Packers, DTS	$0	$145,281	
203	Artificial Lift, Downhole Treatment	$0		
204	Surface Monitoring, DTS	$0	$153,615	
205	Wellhead, X-mas Tree	$0	$41,435	
206	Wellhouses	$0		$400,000
207	Flowlines	$0		$250,000
208	Miscellaneous Tangible Material	$0		

7.0 Production Surveillance Program

Following the drilling of the two wells, a production surveillance program will be established to monitor the pressure and temperature behavior of the two wells, and to measure the chemistry of the produced fluids. Since these efforts will be similar, and conducted alongside, activities required to survey the NSB production, the incremental surveillance costs are not expected to be significant.

Assuming temperature data is the primary focus, supported by periodic pressure surveys and geochemisty analysis of the produced fluids, the monthly cost of a production engineer, allocated to the hydrate project is estimated at $10,000 per month. Combined with wellsite equipment and support for the gathering of samples, the final budget period for the project, from June 2012 to November of 2013 is estimated at $400,000.

8.0 Authority for Expenditure (AFE) Cost Summary

Shown below is a summary of the costs to mobilize equipment to Barrow, and drill the two wells at East Barrow field to test the presence of hydrates, monitor temperature and pressure, and monitor the water chemistry of the produced fluids. Shown in Appendix

Cost Summary: Total Program Costs, DOE share at 80%

Category	Program Cost	DOE Share
Pad Lease	$280,000	
Barging	$2,667,885	
Air Cargo	$606,064	
Air Passenger	$1,348,160	
Heavy Haul	$168,300	
Mob, DeMob, Standby	$6,920,171	
Total, Fixed Costs:	$11,990,580	
25% Cost Share to Hydrate Project:	**$2,997,645**	**$2,398,116**
Savik No. 1 Well Cost:	$6,626,341	
Savik No. 2 Well Cost:	$4,222,436	
Project Engineering/Management:	$1,784,000	
PEM/DTS/Production Surveillance:	$400,000	
Drilling, Flowline Costs:	**$13,032,777**	**$10,426,222**
Point Forward Total Cost of Project:	**$16,030,422**	**$12,824,338**
Budget Period 3 Monies:	$1,850,000	**$1,480,000**
Total Project Budget:	**$17,880,422**	**$14,304,338**

9.0 Monthly Point Forward Cash Flow Projections

Given the cost totals described in previous sections, the project team built a monthly budget for budget periods 3, 4, and 5. This spend profile is shown below.

Month	Budget Period	Total PEM Spend	Hydrate PEM Split	Hydrate Project PEM Spend	Hyd.Program Spend	Budget Phase Cumulative
Dec-09	4	$100,000	40%	$40,000	$73,000	$73,000
Jan-10	4	$140,000	40%	$56,000	$365,000	$438,000
Feb-10	4	$160,000	40%	$64,000	$146,000	$584,000
Mar-10	4	$160,000	40%	$64,000	$73,000	$657,000
Apr-10	4	$180,000	40%	$72,000	$109,500	$766,500
May-10	4	$180,000	40%	$72,000	$146,000	$912,500
Jun-10	4	$180,000	40%	$72,000	$365,000	$1,277,500
Jul-10	4	$200,000	40%	$80,000	$547,500	$1,825,000
Aug-10	4	$200,000	40%	$80,000	$438,000	$2,263,000
Sep-10	4	$200,000	40%	$80,000	$219,000	$2,482,000
Oct-10	4	$220,000	70%	$154,000	$255,500	$2,737,500
Nov-10	4	$240,000	80%	$192,000	$912,500	**$3,650,000**
Dec-10	5	$280,000	75%	$210,000	$6,589,232	$6,589,232
Jan-11	5	$280,000	60%	$168,000	$3,354,518	$9,943,750
Feb-11	5	$280,000	30%	$84,000	$1,317,846	$11,261,597
Mar-11	5	$280,000	20%	$56,000	$119,804	$11,381,401
Apr-11	5	$240,000	10%	$24,000	$119,804	$11,501,205
May-11	5	$200,000	10%	$20,000	$119,804	$11,621,009
Jun-11	5	$120,000	10%	$12,000	$83,863	$11,704,872
Jul-11	5	$120,000	10%	$12,000	$59,902	$11,764,774
Aug-11	5	$120,000	25%	$30,000	$59,902	$11,824,677
Sep-11	5	$100,000	25%	$25,000	$47,922	$11,872,598
Oct-11	5	$60,000	25%	$15,000	$23,961	$11,896,559
Nov-11	5	$10,000	100%	$10,000	$11,980	$11,908,539
Dec-11	5	$10,000	100%	$10,000	$11,980	$11,920,520
Jan-12	5	$10,000	100%	$10,000	$11,980	$11,932,500
Feb-12	5	$10,000	100%	$10,000	$11,980	$11,944,481
Mar-12	5	$10,000	100%	$10,000	$11,980	$11,956,461
Apr-12	5	$10,000	100%	$10,000	$11,980	$11,968,442
May-12	5	$10,000	100%	$10,000	$11,980	**$11,980,422**
Jun-12	6	$10,000	100%	$10,000	$20,000	$20,000
Jul-12	6	$10,000	100%	$10,000	$20,000	$40,000
Aug-12	6	$10,000	100%	$10,000	$20,000	$60,000
Sep-12	6	$10,000	100%	$10,000	$20,000	$80,000
Oct-12	6	$10,000	100%	$10,000	$16,000	$96,000
Nov-12	6	$10,000	100%	$10,000	$16,000	$112,000
Dec-12	6	$10,000	100%	$10,000	$16,000	$128,000
Jan-13	6	$10,000	100%	$10,000	$16,000	$144,000
Feb-13	6	$10,000	100%	$10,000	$16,000	$160,000
Mar-13	6	$10,000	100%	$10,000	$16,000	$176,000
Apr-13	6	$10,000	100%	$10,000	$16,000	$192,000
May-13	6	$10,000	100%	$10,000	$16,000	$208,000
Jun-13	6	$10,000	100%	$10,000	$16,000	$224,000
Jul-13	6	$10,000	100%	$10,000	$16,000	$240,000
Aug-13	6	$10,000	100%	$10,000	$16,000	$256,000
Sep-13	6	$10,000	100%	$10,000	$16,000	$272,000
Oct-13	6	$10,000	100%	$10,000	$16,000	$288,000
Nov-13	6	$10,000	100%	$10,000	$16,000	$304,000
Dec-13	6	$10,000	100%	$10,000	$16,000	$320,000
Jan-14	6	$10,000	100%	$10,000	$16,000	$336,000
Feb-14	6	$10,000	100%	$10,000	$16,000	$352,000
Mar-14	6	$10,000	100%	$10,000	$16,000	$368,000
Apr-14	6	$10,000	100%	$10,000	$16,000	$384,000
May-14	6	$10,000	100%	$10,000	$16,000	**$400,000**
Totals: Point Forward:		$4,550,000		$1,992,000	**$16,030,422**	

10.0 Incremental Cost to Move and Drill at Walakpa, after E. Barrow

The original project scope included in the proposal incorporated an option to drill a methane hydrate test well at the Walakpa Gas Field, if hydrates were not encountered in East Barrow. This option was based on the assumption that exploration activity in western NPRA would provide synergies in logistics and considerable cost sharing opportunities to reduce the burden of mobilization of rig and equipment to Barrow. Subsequent to the drafting of that proposal, two significant factors have impacted the cost estimates of this project. Firstly, exploration activity in western NPRA has completely dried up, and there are no exploration companies operating in the Barrow area in the foreseeable future, thus negating the opportunity to share costs for mobilization. Secondly, the scope of the project at East Barrow was enhanced significantly, with plans to drill an instrumented vertical observation well and a horizontal production test well replacing a single wellbore in the original plan. Even though the hydrate project would only bear the burden of 25% of the fixed costs, including mobilization of the rig and equipment to Walakpa, the overall project budget could not cover the base plan (East Barrow) and the backup plan (Walakpa). To complete the commercial analysis and cost estimate for the project, the incremental cost to mobilize to Walakpa and drill, complete and tie-in a pair of hydrate wells (observation and production test wells) after drilling one well at East Barrow was calculated. The cost of this additional work is given in the table below:

Incremental Cost, and Total Cost to Drill at Walakpa, and East Barrow

Category	Program Cost		DOE Share
Ice Road, Pads at Walakpa	$7,000,000		
Total, Fixed Costs:	$7,000,000		
25% Cost Share to Hydrate Project:	**$1,750,000**		**$1,400,000**
Walakpa No. 15 Well Cost:	$6,626,341		
Walakpa No. 16 Well Cost:	$4,222,436		
Flowline, Power:	$5,000,000		
Project Engineering/Management:	$450,000		
DTS/Prod. Surveillance:	$0		
Drilling, Hookup Program Costs:	**$16,298,777**		**$13,039,022**
Point Forward Total Cost to DOE:	**$18,048,777**		**$14,439,022**
Budget Period 3 Monies:	$1,850,000		**$1,480,000**
Incremental Cost:	**$19,898,777**	*	**$15,919,022**
Monies spent to Drill Savik No. 1:	$11,957,986		
Total Cost to drill E. Barrow and Walakpa:	**$31,856,763**		

11.0 Summary – Coring Plans

In addition to the Plan of Operations, Well Plans, and Cost Estimates that were prepared as part of Phase II of this project, a three volume coring manual was written to establish procedures to acquire, handle, and analyze the core. Discussed below is a brief description of the documents. Volumes 1, 2, and 3 of the Coring Manual are posted separately on the DOE-NETL website. These documents are as follows:

- ***Volume 1 – Core Acquisition***
  Discusses pre-well planning and coring operations up through core laydown
- ***Volume 2 – Core Handling, On-site Analysis***
  Discusses core handling, sub-sampling, preservation, and transportation
- ***Volume 3 – Post-Field Core Analysis***
  Discusses off-site core analysis tests and methods conducted by the Science Party
- ***Volume 4 - Decision Criteria to Complete Well (Not yet written)***
  Discusses the test results that will trigger a decision to complete or abandon the well

Lessons learned from previous hydrate-bearing cored wells, including the Mallik (1998 and 2002), Hot Ice (2004), and Mt. Elbert (2007) arctic onshore wells, and certain offshore research programs are incorporated into these documents where applicable.

The program has been designed to deliver the key objectives identified by the Gas Hydrate project research team and the Barrow Field development team including members of DOE, USGS, NSB, PRA, and supporting service companies. This document will be reviewed and refined through a number of meetings leading up to well spud, including a coring workshop once final preparations begin. All four volumes of this manual will then be used as an on-site policy and procedures manual to guide all aspects of the coring program. It is also intended to serve as the all-encompassing master reference document for all interested stakeholders.

12.0 Summary – Phase II Work Effort

This document and its appendices, along with the interim report submitted in March and the Technology Status Assessment submitted in February, represent the deliverables of Phase II of DOE Project Number: DE-FC26-06NT42962.

The project team has completed the well design work and planning necessary to deliver an AFE quality cost estimate and proceed to the execution phase. Cost estimates and monthly estimated cash flows have been submitted as part of this document.

This project represents a rare opportunity to measure the behavior of methane hydrate, as it is being produced in a commercial setting. In addition to the tremendous impact on the global methane hydrate research effort, this work will help the North Slope Borough better understand the recovery mechanism of the East Barrow Gas Field, which will potentially have very significant positive impact on a critical rural energy resource.

While the cost estimates have come in above estimates submitted in the project proposal, the scope of the project has been enhanced significantly, with more focus on East Barrow, and an overall better fit with DOE research objectives.

The project team recommends continuing to the next budget period (BP4), commencing December 1, 2009, and ending November 30, 2010, including further detailed design and logistics planning, award of contracts to chosen vendors, acquisition of all required permits, and mobilization of drilling rig and equipment from West Dock to Barrow.

PLAN OF OPERATIONS

Methane Hydrates Production Test Well and
The Barrow Gas Fields Critical Upgrades and
Modernization Gas Well Drilling Project
Barrow, Alaska

2010-2011

CIP No. 68-070 and 68-063

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Appendix A : Preliminary Inventory / Barging West Dock Prudhoe Bay – Barrow
Appendix B : Permitted Lakes Temporary Water Use
Appendix C : Road/Pad & Maintenance Operating Kit
Appendix D : Walakpa #3 – Pipeline Route / Field Access
Appendix E : Well Schematics

1.0 Overview

Commencing in the 3rd. quarter of 2010, equipment and service personnel required to support; well construction, ice pad & ice road construction, logistics and maintenance will be mobilized via barging from West Dock, Prudhoe Bay to Barrow, Alaska. The initial program objective, operationally situated in the East Pool of the South Barrow Gas field will be to characterize and quantify the presence of a postulated methane hydrate interval overlying and interfaced with free gas in the Barrow gas sands. The methane hydrate resource evaluation will require the drilling, coring and logging of a vertical monitoring well to be followed by the drilling and completion of an offsetting horizontal producer - referenced as the production test well.

The methane hydrate program joint funding principles are ; the Department of Energy (DOE), with federal funding through DOE funding opportunity : DE-FC26-06NT42962 and the North Slope Borough (NSB) with funding allocated through the NSB's capital improvements program CIP No: 68-070 " Methane Hydrates Production Test Well".

Following the completion of the project scope of work to support the DOE and NSB methane hydrates program objectives – there will exist an operations transition to a new phase of project work scope and deliverables. Independently funded through the NSB's CIP No: 68-063 " Barrow Gas Fields Critical Upgrades and Modernization, 2010-2011 Gas Well Drilling Project" – a total of 4 horizontal gas producers completed in the Walakpa gas sand interval, along with production lines, well houses and surface facilities upgrades will be constructed.

The new horizontal gas producer wells along with the upgraded surface production infrastructure at Walakpa will significantly increase the proven gas reserves and supply resource potential available to the NSB.

2.0 Drilling Logistics, Drilling and Well Completions

a. Logistics Planning : Phases I - V

Program logistics planning and integrated supply chain management required to support the East Pool and Walakpa gas fields well work and facilities upgrades will require proper resourcing and management of six individual logistics phases. The logistics phases are determined by: weather/temperature seasonal profiles, operations sequence and equipment mobilization management issues. A listing of the key logistics phase(s) and associated management points are provided below.

Phase I: Initial Mobilization West Dock, Prudhoe Bay to Barrow, NSB / Stage Operations spread at Barrow

- Establish communications protocols between all elements of the logistics supply chain and field supervisory personnel.
- Finalize the barge(s) load out schedule, barge cycle time and Beaufort Sea transit plan.
- Ensure delivery and manifesting of all program equipment and consumables through inventory management controls.
- Manage Conflict Avoidance Agreement issues arising from bow head whale migration.
- Monitor seasonal weather systems (July - August 2010) occurring offshore in the Beaufort Sea that could impact safe barge transiting to Barrow. A push-forward mobilization date could occur should weather patterns and severity dictate.
- Establish HSE procedures for the loading and offloading of equipment onto barges.
- Manage and coordinate pre-mobilization rig start up and systems functional integrity approvals.
- Manage inter-field transit of drilling equipment from point of FOB (Deadhorse,Ak.) to West Dock.
- Coordinate service company equipment, consumables and personnel.

- Document service company effective equipment and personnel start date.
- Manage barge offloading of service equipment and well construction consumables at Barrow.
- De-mob barges
- De-mob West Dock barging load out equipment and service personnel.
- Rationalize barging mobilization and load out equipment/personnel costs vs. AFE.
- Stage and secure operating spread at Barrow. (NARL Beach)
- Rationalize service co. personnel compliment to ensure equipment & materials security and function.

Phase II: Build Ice Pad Adjacent to EB 18 Pad, Drill Savik #1 and Savik #2

- Install snow fences at Savik #1 and Savik #2 pad locations.
- Position temperature thermistors at Savik locations to monitor seasonal thaw zone.
- Commence snow pre packing with ATV – tucker snow cats at -5 C (23 F) at 18" penetration.
- Manage ingress issues from Barrow to Savik drillsite.
- Install 16" conductors and cellars at Savik #1 and Savik #2 surface locations.
- Mobilize operating spread from Barrow to EB#18 and EB#21 surface locations.
- Drill/Core/Log – Methane Hydrate monitor well – Savik No.1.
- Drill/Log – Methane Hydrate production test well – Savik No.2.

Phase III: Mobilization

- Mob operating spread from East Barrow to Walakpa – drill Walakpa development wells.
- Pre-pak ice road from South Barrow Field to Walakpa.
- Construct ice road from South Barrow Field to Walakpa.
- Construct 4ea snow pak/ice pads in Walakpa: 2 ea. drilling / 2 ea. staging
- Mobize Rig,Camp & Operating spread from Barrow to Walakpa
- Rig up rig / camp and service co. spread on first development gas well surface location.
- Drill/Complete 4 ea. Walakpa horizontal production wells.
- Manage seasonal temperature trends and implications to C-Plan egress plan.
- Prep rig/camp – operating spread for demobilization

Phase IV: Demobilize to Barrow
- Demobilize rig/camp – operating spread from Walakpa to Barrow.
- Stage and secure operating spread at Barrow. (Utilidor Plant)
- Rationalize air transport of service co. equipment from Barrow to Deadhorse – per logistics plan.

Phase V: Barge Operating Spread from Barrow to West Dock
- De-mob rig/camp – operating spread assets from Barrow to West Dock. Dependant on Beaufort Sea open water/sea ice condition.
- Manage rig/camp – operating spread equipment offloading at West Dock.
- Release barging assets & service company barging offload equipment.
- Close out West Dock offload area.

Table 1 : Logistics Plan and Schedule

Program Logistics Plan : East Barrow - MH Monitor/Test Walakpa - Gas Development Wells					
Phase Description	**From**	**To**	**Start Date**	**End Date**	**Duration (days)**
Phase I					***158***
Staging / Initial Mobilization	West Dock	West Dock	7/1/2010	7/31/2010	30
Barging	West Dock	Barrow	8/1/2010	8/31/2010	30
STAND-BY : Staging - Operating Spread / NARL	Barrow	Barrow	9/1/2010	12/1/2010	91
Mobilize - Operating Spread	Barrow	East Barrow Gas Field	12/2/2010	12/9/2010	7
Phase II					***45***
MIRU - Operating Spread Build Ice Pad. Mobilize Rig & Operating Spread	East Barrow Gas Field	East Barrow Gas Field	12/10/2010	12/15/2010	5
Drill/Evaluate : Methane Hydrates Monitor & Test Well	East Barrow Gas Field	East Barrow Gas Field	12/16/2010	1/25/2011	40
Phase III					***92***
Prep-Mobilization	East Barrow Gas Field	East Barrow Gas Field	1/26/2011	1/31/2011	5
Mobilize - Operating Spread	East Barrow Gas Field	Walakpa	2/1/2011	2/15/2011	14
MIRU - Operating Spread	Walakpa	Walakpa	2/16/2011	2/21/2011	5
Drill/Complete : 4 ea. Horizontal Gas Development Wells	Walakpa	Walakpa	2/22/2011	5/1/2011	68
Phase IV					***79***
Prep-Mobilization	Walakpa	Walakpa	5/2/2011	5/7/2011	5
Mobilize - Operating Spread	Walakpa	Barrow - NARL	5/8/2011	5/22/2011	14
STAND-BY : Operating Spread / NARL	Barrow -NARL	Barrow - NARL	5/23/2011	7/22/2011	60
Phase V					***38***
De-mobilization - Operating Spread	Barrow -NARL	West Dock	7/23/2011	8/23/2011	31
Equipment Return : Supplier Point of Origin	West Dock	West Dock	8/24/2011	8/31/2011	7
Total Program Term :					**412**

Figures 1 and 2, Barrow Gas Field (BGF) - North Slope Borough (NSB) and Logistics phase(s) I – V Central Arctic North Slope respectively are provided to illustrate the scale of the logistics and supply chain management challenges. Table 1, above, provides a timings schedule of program operations milestones including mob/de-mob, pad/road and staging area construction requirements.

Figure 1 : Barrow Gas Field (BGF) - North Slope Borough (NSB)

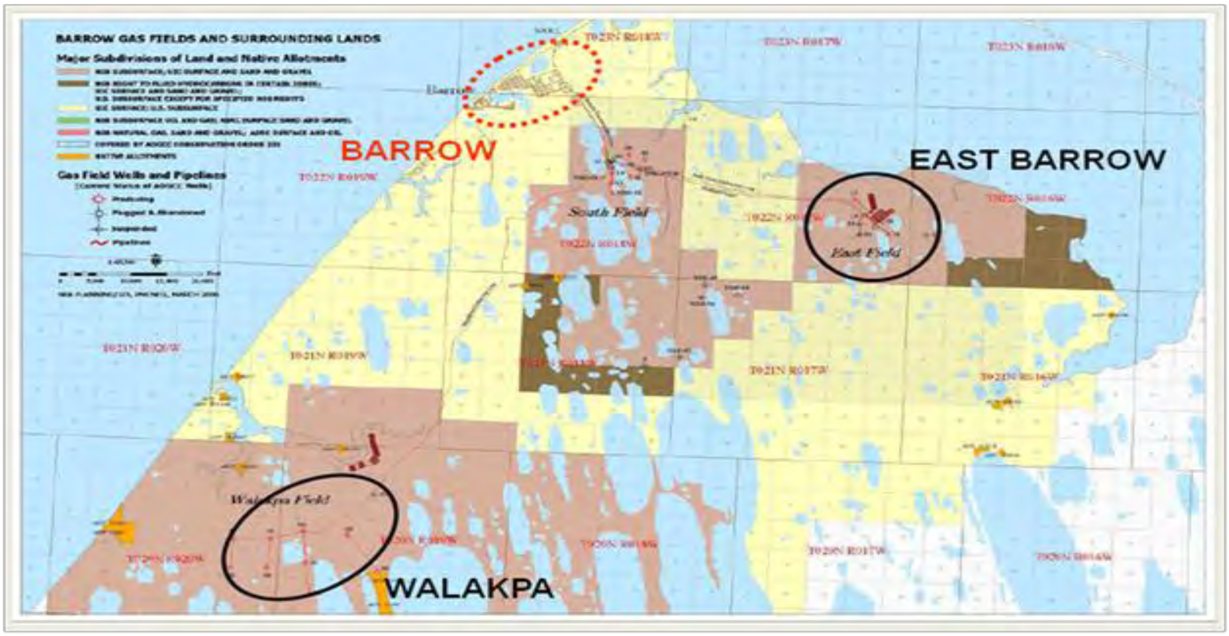
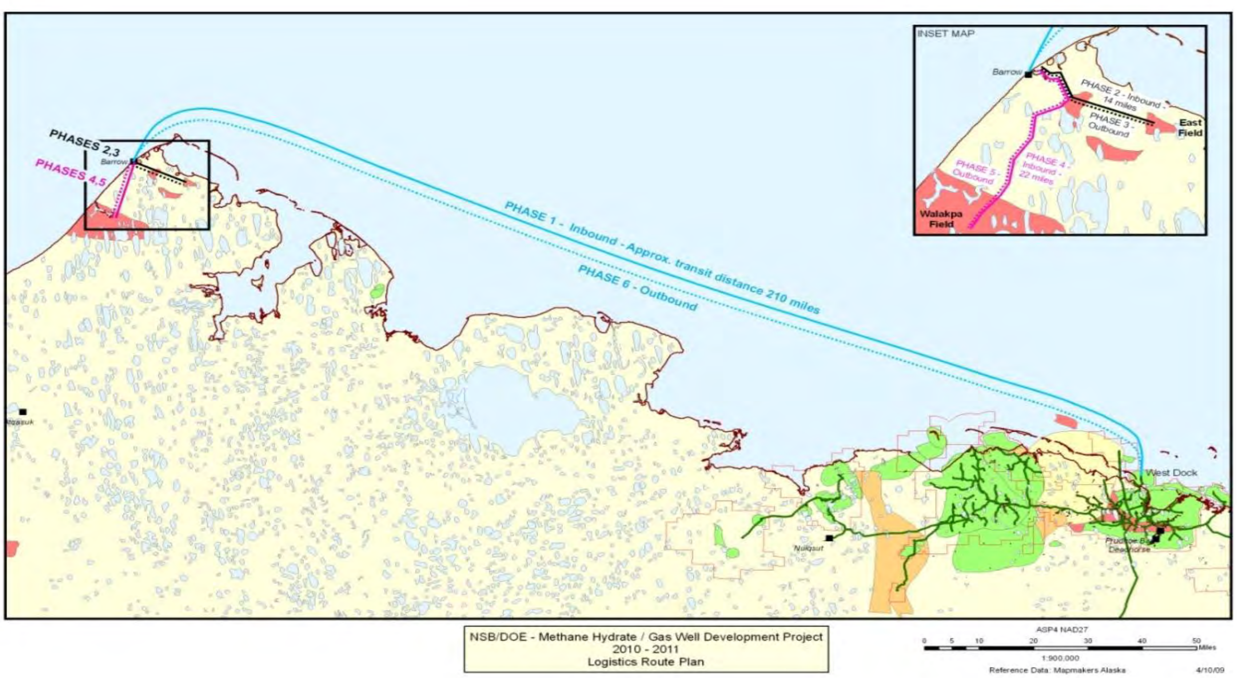


Figure 2 : Logistics phase(s) I – V Central Arctic North Slope.



b. Barging Plan

Service and surface facilities construction equipment along with pad/ice road construction and maintenance equipment are planned to be staged at West Dock Causeway, Prudhoe Bay in summer of 2010. Initial barging load outs will occur in mid to late July, utilizing barges with comparable deadweight tonnage loading and draft characteristics as represented in Figure #3. Tug requirements will be in the nominal 1000 hp range, allowing for barge average transiting speeds of 6-7 knots. The 210 mile distance between West Dock and Barrow is estimated to take 32 hours. A fully loaded barge is expected to have a 72 hour cycle time from departing West Dock to its arrival back to West Dock to begin its next loading cycle. It is estimated that a period of 4-6 weeks will be required to transit the entire operating spread to Barrow from West Dock, with final barging operations ending in the last week of August 2010.

Load out operations at the West Dock Causeway will utilize a certified crane for placement of deck cargo on the barge – if required. Barge load outs will be pre-planned and manifested to optimize barge deck space utilization and offloading efficiencies. Barge(s) stability criteria : vertical (vcg) ,transverse (tcg) and longitudinal (lcg) centers of gravity will be determined and managed within the barges operating stability guidelines. Offloading of equipment in Barrow will be performed with forklifts, accessing equipment by way of deck offloading corridors. Barge offloading ramps supported by rig mats and minor gravel placements will be used to move deck cargo from the barge deck to an intermediate staging location. The NSB, Dept. of Public Works, CIPM Division will be made aware of barge deck space back hauling opportunities from Barrow to West Dock.

A preliminary inventory listing of equipment to be transported to Barrow from West Dock is provided in **Appendix A : " Preliminary Inventory /Barging West Dock, Prudhoe Bay – Barrow : Quarter 3 - 2010".** In addition, the anticipated equipment inventory to be used for ice or snow pak pad/ road construction, pad and maintenance as well as rig move and rig operations support is provided in **Appendix C : "Road/Pad & Maintenance Operating Kit".**

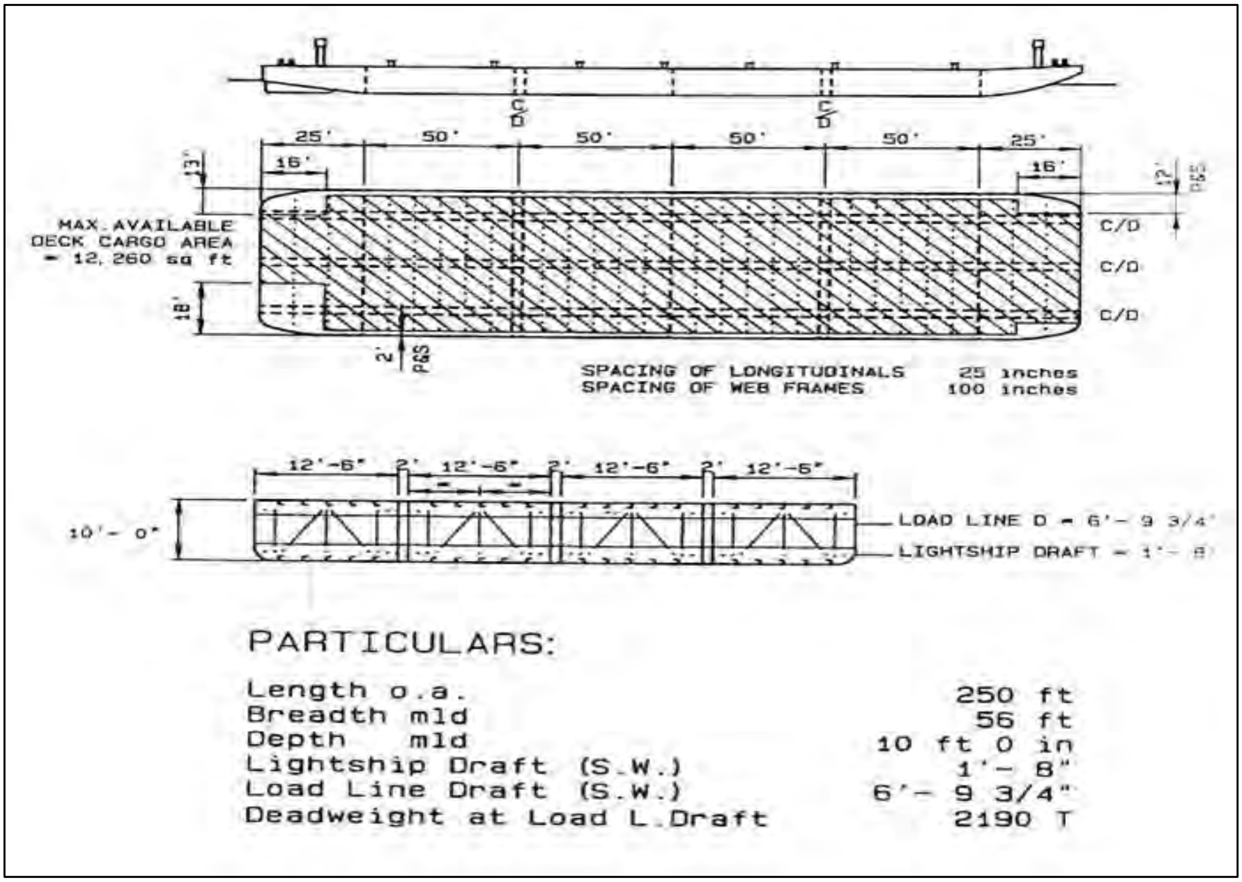
b.1 Federal Regulatory and Subsistence Authorizations

The barging routes used for open water crossings of the Beaufort Sea will be located within the habitat of marine mammals regulated by the National Marine Fisheries Service (NMFS). The marine mammals list includes: Western Arctic Bowhead whales, beluga whales, ringed, spotted and bearded seals. Only the bowhead whale is listed as endangered under the Endangered Species Act (ESA) and designated as "depleted" under the Marine Mammals Protection Act (MMPA).

The program logistics plan will begin mobilization of equipment in July 2010 and make every effort to avoid interference with the bowhead whale fall westward migration and subsistence activities. The logistics plan calls for completion of barging activities by September 1, 2010. Weather and operating conditions may possibly extend the barging window beyond the planned completion date. In the event that a late season barging effort is required, then a Conflict Avoidance Agreement (CAA) will be sought between the Alaska Eskimo Whaling Commission (AEWC), Whaling Captains Association and the North Slope Borough (NSB) and Department of Energy (DOE). The CAA would allow for late season barging to occur between the dates of September 1, 2010 and October 15, 2010.

Additionally, due to the physical presence of barging operations ongoing in the Beaufort Sea, there could exist the potential for disturbance to marine mammals by visual ,acoustic or other cues. The NSB/DOE will jointly seek the issuance of a Incidental Harassment Authorization (IHA) from the NMFS. The IHA will be supported by the mitigating measures set forth in the CAA which will include monitoring and reporting requirements, a Plan of Cooperation and a Barging Operations Schedule.

Figure #3



c. Pad ,Roads and Staging Area Developments & Well Locations

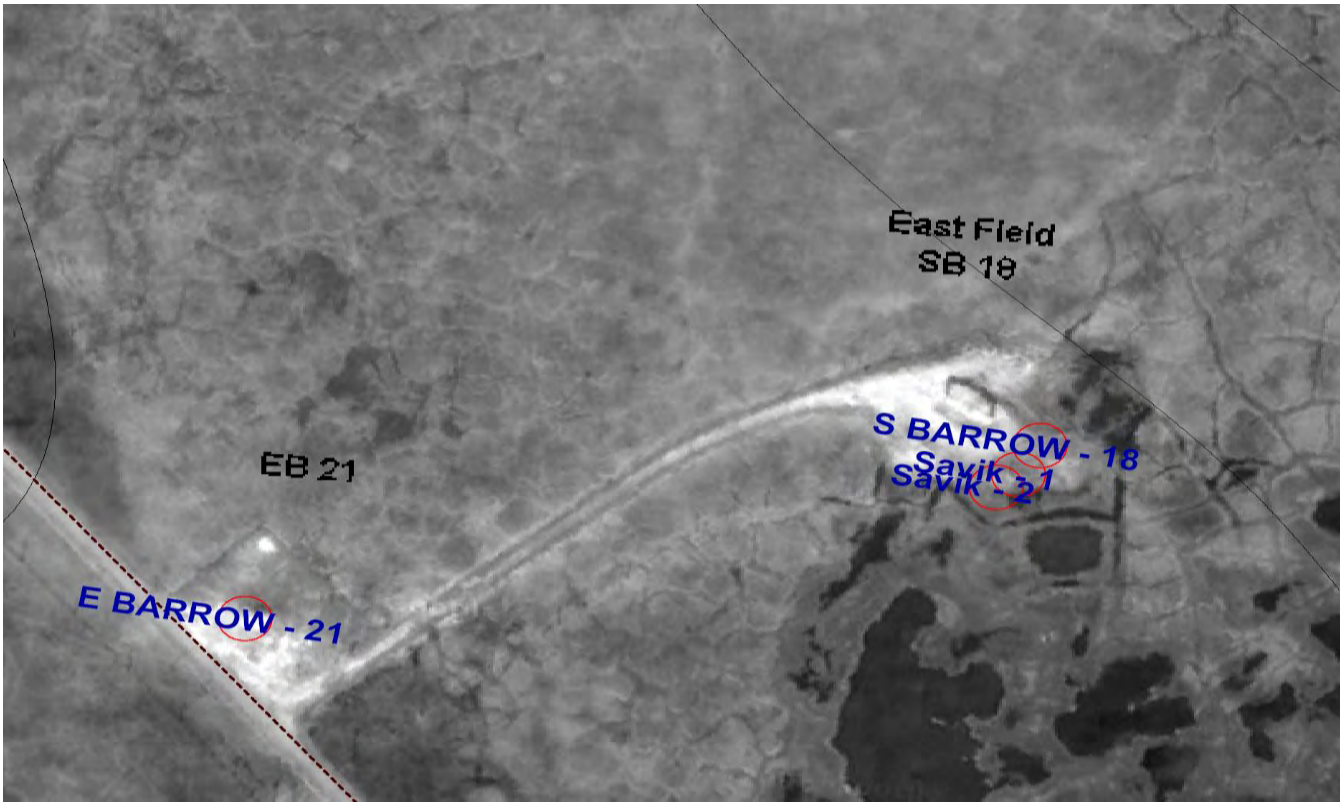
c.1 East Barrow

The drilling rig and service company support equipment required to drill and complete the methane hydrate monitor and horizontal test wells will be moved from the Barrow staging area to the Savik drill pad on or around December 1st, 2010. The rig camp and its sanitation unit along with service company bulk materials and sundry well construction consumables will immediately follow and be located on the Savik staging pad location. The distance between the two pad locations is approximately 1/10 mile. Ingress from Barrow to the East Barrow gas field surface locations will be via Cakeater Rd, an existing gravel road, which may require improvements to accept rig module and service company equipment loads. Electrical power line drops originating from utility poles, along the Cakeater Rd access route will need to be temporarily disconnected to allow rig passage. Surveillance of this approximately 14 mile transit route will be undertaken during the 2009 Summer Studies program; a list of road access deficiencies and power utility obstructions will be noted and corrected prior to the planned December 2010 mobilization.

In middle October 2010, approximately 1 month after the arrival and staging of the operations spread in Barrow, snow fences will be positioned upwind of the Savik drill pad and staging area surface locations. The snow fences will serve to accumulate snow in the general pad areas. Pre-packing operations will begin with ATV equipment (Tucker Snow Cats) to arrest the snow accumulations and begin the process of building the pad locations by periodic snow pre packing operations. Intermittent side casting of water (0.6 gallons/sq.ft) will be used as part of the pad construction process. Figure #4 below, provides satellite imagery of the Savik #1 and Savik # surface locations. Note, that part of the planned Savik pad surface location is situated on the existing

EB #18 gravel location with the majority supported by a temporary ice pad. The Savik staging pad will be constructed of ice.

Figure #4



c.2 Walakpa

Mobilization of well construction and surface facility upgrade equipment and supplies will commence following the completion of the methane hydrates well work in the East Pool of the Barrow Gas Fields (BGF). The planned operating spread mobilization date is expected to occur in the 3rd. week of January 2011 . A period of 14 days is planned for the complete mobilization to Walakpa, with a five day period provided for preparing the drilling rig, rig camp and support elements to begin well construction operations.

Figure #5, below, illustrates the intended ice/snow pack access route to the Walakpa Gas field from Barrow. A ½ mile corridor on each side of the Walakpa gas pipeline has previously been permitted by Conoco Phillips in support of their 2007 Intrepid winter exploration program. In addition; archeological assessments, lake studies, river crossing information and native allotment issues have all been assessed by Conoco Phillips and shared with the PRA project team.

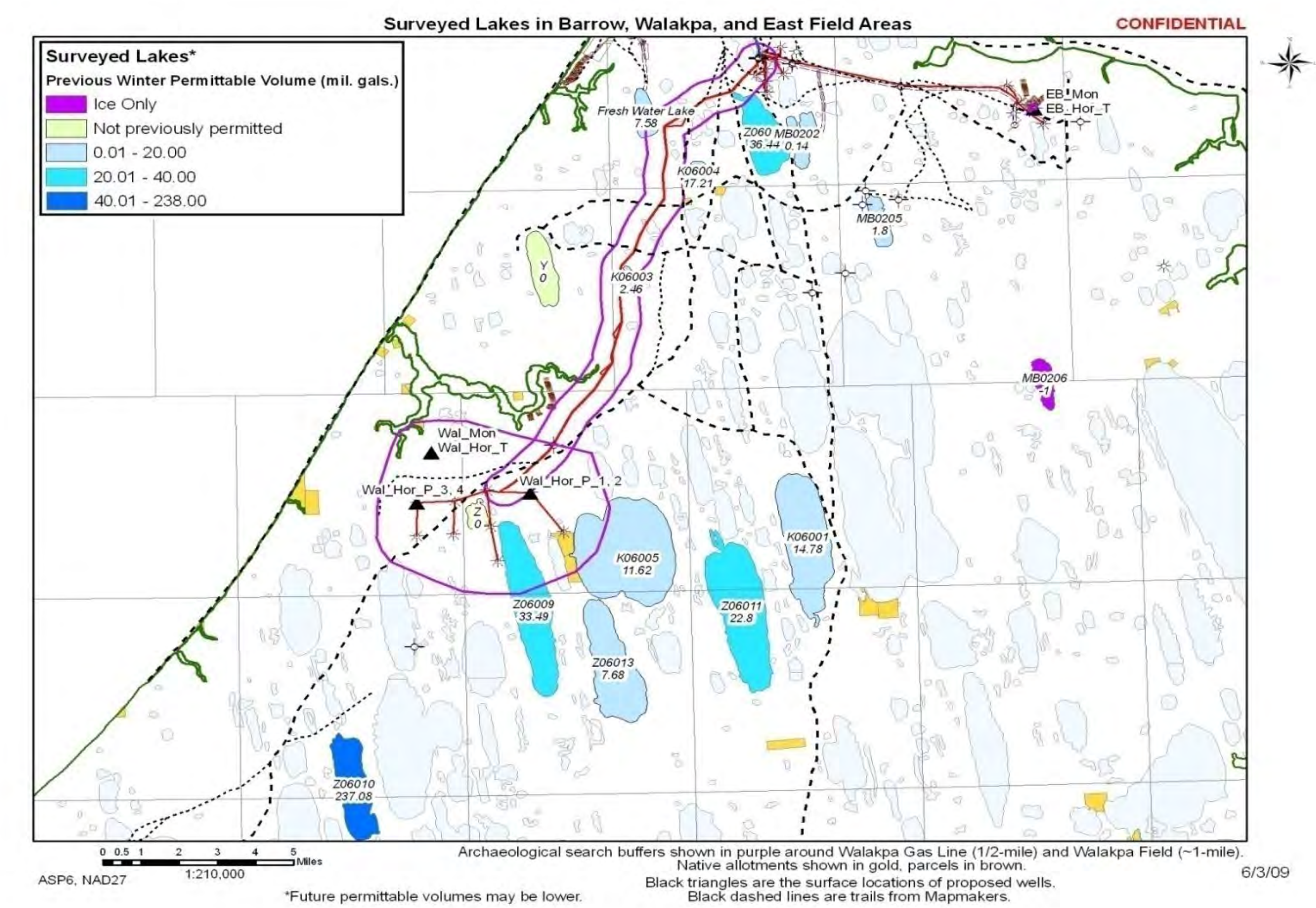
The Barrow-Walakpa winter 2011 route will be located within the ½ mile corridor on the east side of the north-south transecting gas pipeline. The This route will provide better access to lake water resources, river crossing management and is in general more favorable from a terrain/topographical standpoint. Ice/snow pak road will be constructed with nominal dimension of : 30 ft. wide x 6" thickness.

Similar to the ice/snow pad and staging areas developed at the East Barrow Gas field locations:, snow fences will also be utilized to capture snow accumulations at staked drill pads and staging areas. The periodic pre-packing of snow accumulations with approved tundra travel vehicles (ATV) will expedite the construction of the route to Walakpa as well as drill pads and staging areas. Permitted winter fresh water lake withdrawals normally required for ice road and ice pad construction will be reduced.

Walakpa and East Barrow gas field summer studies programs are scheduled for August of 2009. The summer studies programs will be conducted to provide necessary environmental permitting information as well as information to support non-environment permitting requirements. The summer studies scope of work will include :

- Archeological assessments
- River Crossing information (Walakpa Creek)
- Pad & Staging Area staking by licensed and bonded survey crews
- Route staking & Walakpa inter-field transit options
- Lake studies and lake access staking
- Native allotment assessments (USS 11784)

Figure #5



c.3 Water Requirements : East Barrow & Walakpa Gas Fields

A fresh lake water resource assessment was undertaken to ensure the adequate provision of water for both the East Barrow and Walakpa gas field programs. Table 2 – Summary of Project Water Requirements documents water resource allocations.

Table 2: Summary of Project Water Requirements

Proposed Use	SOURCE NAME	SOURCE LOCATION (Umiat Meridian)	QUANTITY (Gal)	TIMING (seasons and duration)
Drilling operations			6,000,000	DAILY. 40000 gals/day, 150 days, during drilling operations
P&A operations			600,000	DAILY. 10000 gals/day, 60 days, during P&A operations
Snow/Ice **Pad** Construction			10,000,000	Early winter withdrawal to build ice pads to support drilling and P&A operations
Snow/Ice **Road** Construction			40,000,000	Early winter withdrawal to build ice roads to support drilling and P&A operations
Snow/Ice **Road/Pad** Maintenance			15,000,000	DAILY. 100,000 gals/day, 150 days, during drilling and P&A operations to maintain ice roads and pad
Total, Project			**71,600,000**	**Project Total**

Ice road , pad and staging area construction water resource usage could be significantly reduced if snow fall is sufficient to allow snow pre-packing and snow pak road construction. A .6 gallon/sq.ft water allocation is an established norm for maintaining snow pak road surface integrity for high traffic, high loading occurrences. This water application is normally administered 3-4 times to the snow pak road, through the project term.

Appendix B – Permitted Lakes – Temporary Water Use, provides a permitted lake roster, in the East Barrow and Walakpa areas. The table lists permitted lakes used by CP in their Intrepid 2007 winter exploration season along with allowable winter withdrawal volumes.

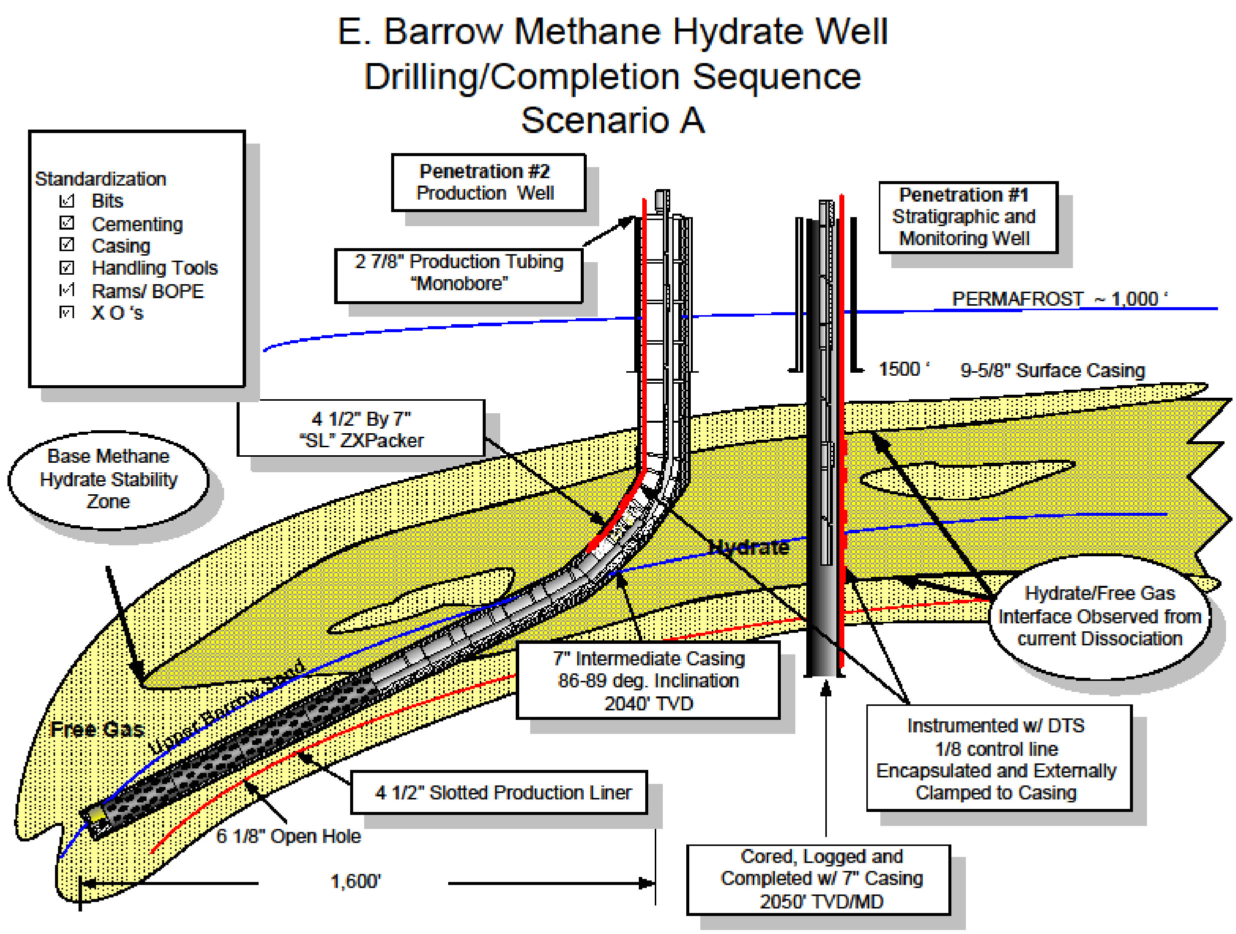
3.0 Well Design

a. Design Objectives: East Barrow/Walakpa : Methane Hydrates Monitor & Horizontal Test Well

The methane hydrates test programmed for the East Pool of the Barrow Gas Field will be conducted by design with the twinning of two wells. The initial well, designated as the monitoring well will be paired with a second well designated as the horizontal test well. The design objective of the twinned wells is to characterize and quantify the postulated presence of a methane hydrate interval overlying and in contact with free gas contained in the upper Barrow gas sand. The characterization and quantification of the methane hydrate interval will be principally determined by its in-situ depressurization and disassociation occurring by way of free gas production through the horizontal test well. Distributed temperature survey (DTS) instrumentation will be affixed to the external surface of the production casing on both the monitoring well and horizontal test well. The DTS data, recorded over time, will provide empirical evidence by way of endothermic cooling, caused by depressurization and disassociation of methane hydrates in contact with free gas present in the upper Barrow gas sand.

Figures # 6 below represent well design illustrations of the monitoring and horizontal test wells programmed for East Barrow Gas Field.

Figure #6



a.1 Coring – East Barrow Methane Hydrate Monitor Well

Core Acquisition

Description

Since the recovery of a core with hydrate (or definitive evidence of hydrates) is the only direct way to ascertain the presence of hydrate, it will be a critical aspect of this project. A wellbore will be designed and drilled to capture and preserve a core in a way that confirms hydrates are or were present, or, proves they were never present. In addition, experiments will be conducted on the core to study the rock, fluid, and hydrate properties to better understand its characteristics and how it reacts to depressurization.

Coring is planned in the stratigraphic test well at East Barrow. The core will be captured with wireline retrievable coring tools to recover and inspect the core as quickly as possible.

Functional Specification

- Approximately 100’ of core will be acquired in the East Barrow well. The depth of the core is approximately 1900’ to 2000’ TVD.
- The well should be vertical or near vertical.
- A 3” core is to be captured with a 7-7/8” core bit.
- An mineral oil-based drilling fluid will be used to conduct coring operations.
- A system that allows timely inspection and analysis of the core, once at the surface is required.

Core Handling, Core Analysis

Description

The primary purpose of obtaining core is to confirm or deny the existence of hydrates. The secondary purpose is to measure reservoir properties and reduce subsurface uncertainties so a better reservoir and hydrate recovery model can be built. To accomplish these goals, the Barrow Gas Field on-site sub-sampling and core analysis objectives are summarized below:

- Confirm gas hydrate and reservoir characterization interpretation.
- Sample gas hydrate and pore-water geochemical and microbiological properties to understand when and if hydrates were present, and if so, the origin and nature of gas hydrate and implications for continued recharge of free gas zone.
- Obtain whole-round cores for subsequent measurements of porosity, permeability, and fluid saturations for log model calibrations, and future resource assessments.
- Sample mineralogy and lithology for log model calibration, and to better understand formation physical and mechanical properties.

a.2 Logging – East Barrow Methane Hydrate Monitor & Horizontal Test Well(s)

Wireline Logging

Description

A fundamental objective of the stratigraphic test well is to acquire high-quality wireline logging measurements across the suspected hydrate bearing intervals. Because gas hydrates are naturally unstable at surface conditions and have different properties than in-situ, considerable emphasis and care will be placed on the downhole logging program to gather data in its native state.

Functional Specification

- Wireline (Electric Line) logging is required on, the stratigraphic test well at East Barrow.
- Wireline logs will be run from the base of surface casing (approximately 1500' TVD) to TD (approximately 2200') in the East Barrow Well.

Logging Requirements

- Array resistivity (ranging from deep to shallow measurements)
- Dipole acoustic logging (P-wave velocity,Vp and Shear-wave velocity, Vs)
- Quadrupole acoustic logging (Vp and Vs), if available
- Spectral gamma ray
- Gamma-gamma density
- Neutron density, porosity
- NMR proton logging (T2 relaxation times, porosity, etc)
- Formation electrical imaging

a.3 Completion

Downhole Completion Equipment, Distributed Temperature Survey (DTS)

Description

The downhole completion design is a critical element to meeting the objectives of the various types of wells planned for the hydrate test program and well upgrade program. The hydrate observation well and horizontal producer will be equipped with DTS cable. The development wells at Walakpa will be completed as conventional horizontal producers. The specifications and bid instruction for DTS are given under separate cover in the category of DTS.

Functional Specification

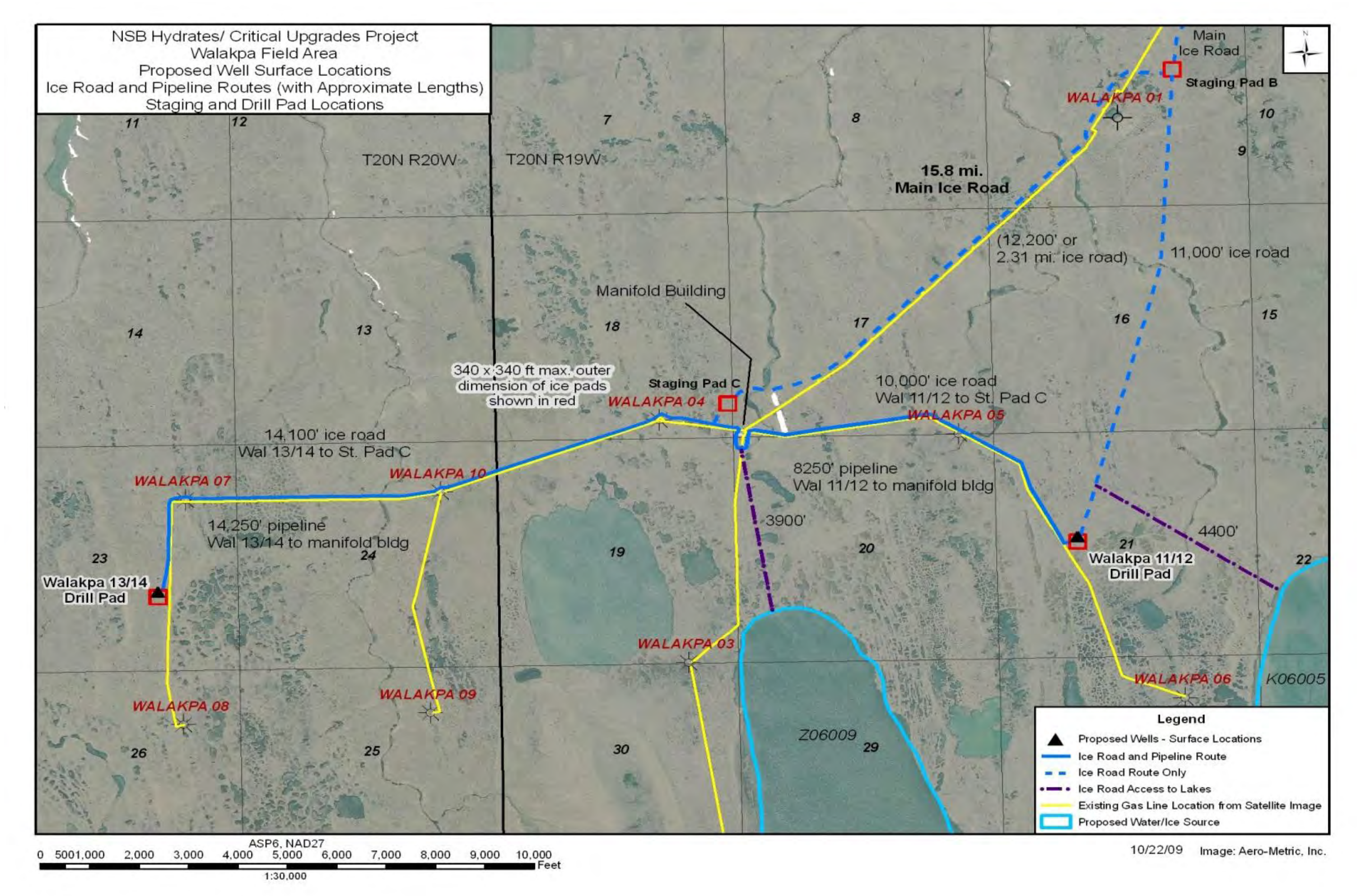
- If hydrates are found at the East Barrow Gas field, the observation well and horizontal producer well will be completed with DTS cable. The vertical observation well will be completed with 7' production casing, cemented to surface, with no production tubing. DTS would be strapped to the outside of the 7" casing in this well.

- The horizontal hydrate test well producer will be completed to place DTS across the slots of a slotted liner. This will be accomplished with 4-1/2” slotted liner with a packer and cross-over to 2-7/8” tubing back to surface, with a packer pass through for DTS cable.
- The horizontal development wells at Walakpa will be completed with a 4-1/2” slotted liner, a production packer and 2 7/8” tubing to surface.

b. Well Delivery : East Barrow / Walakpa

The Walakpa Gas field critical upgrades and modernization gas well drilling program funded under CIPM 68-063 includes the drilling and completion of 4ea horizontal gas development wells. The well construction start date is scheduled to begin in the 2nd week of February2011, as shown in Table #1 above, and continue until the 4th horizontal well is drilled and completed around May 1st, 2011. An estimated 20 days of rig operating time is assigned to each horizontal production well. Figure #7, below, shows satellite imagery of the Walakpa Gas field.

Figure #7

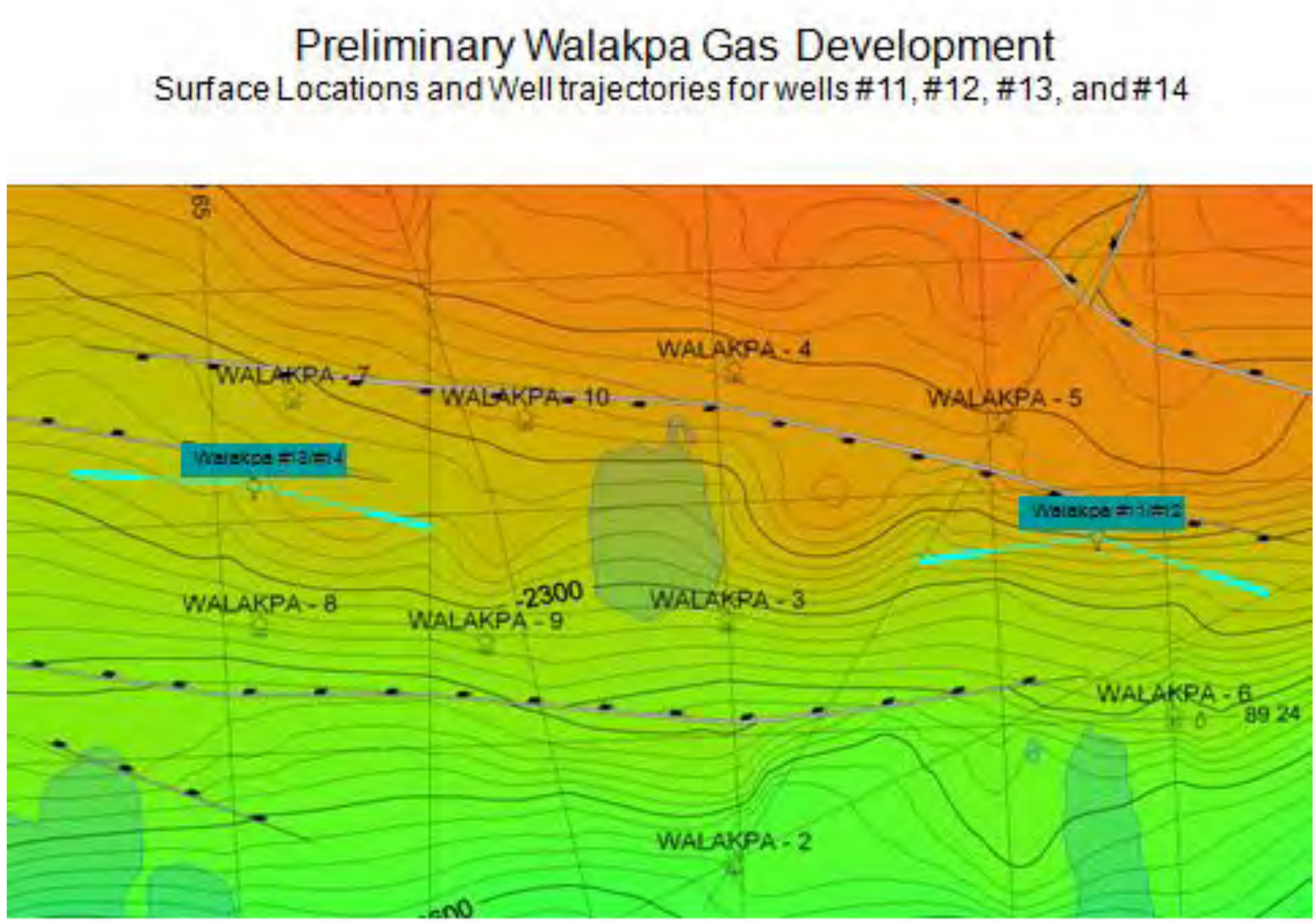


Reservoir drainage area optimization, well deliverability, gas production redundancy and production hydrate mitigation by reduced drawdown were key topics of analysis in arriving at the decision to drill horizontal producer wells. Principally, the analysis developed by M.Dunn – Gas Rate Modelling, Walakpa Field, March 2009, suggests :

- Horizontal wells can deliver much higher rates than its equivalent vertical well.
- Horizontal wells can drain a much larger area than its equivalent vertical well, thus reducing the number of wells required to to drain the same field area.
- Horizontal wells can deliver the equivalent rate of a vertical well, with much less pressure drawdown at the sand face, and thus minimize the risk of hydrate formation at the reservoir.

Figure #8, below, illustrates horizontal well placements (heel-toe: 1600ft) , flanking the east and west periphery of the reservoir. Continuing refinements to drill pad requirements has reduced the number of drill pads to two for the horizontal producer wells. Two wells would be drilled from each pad either in a “down-dip” or along “strike” direction.

Figure #8

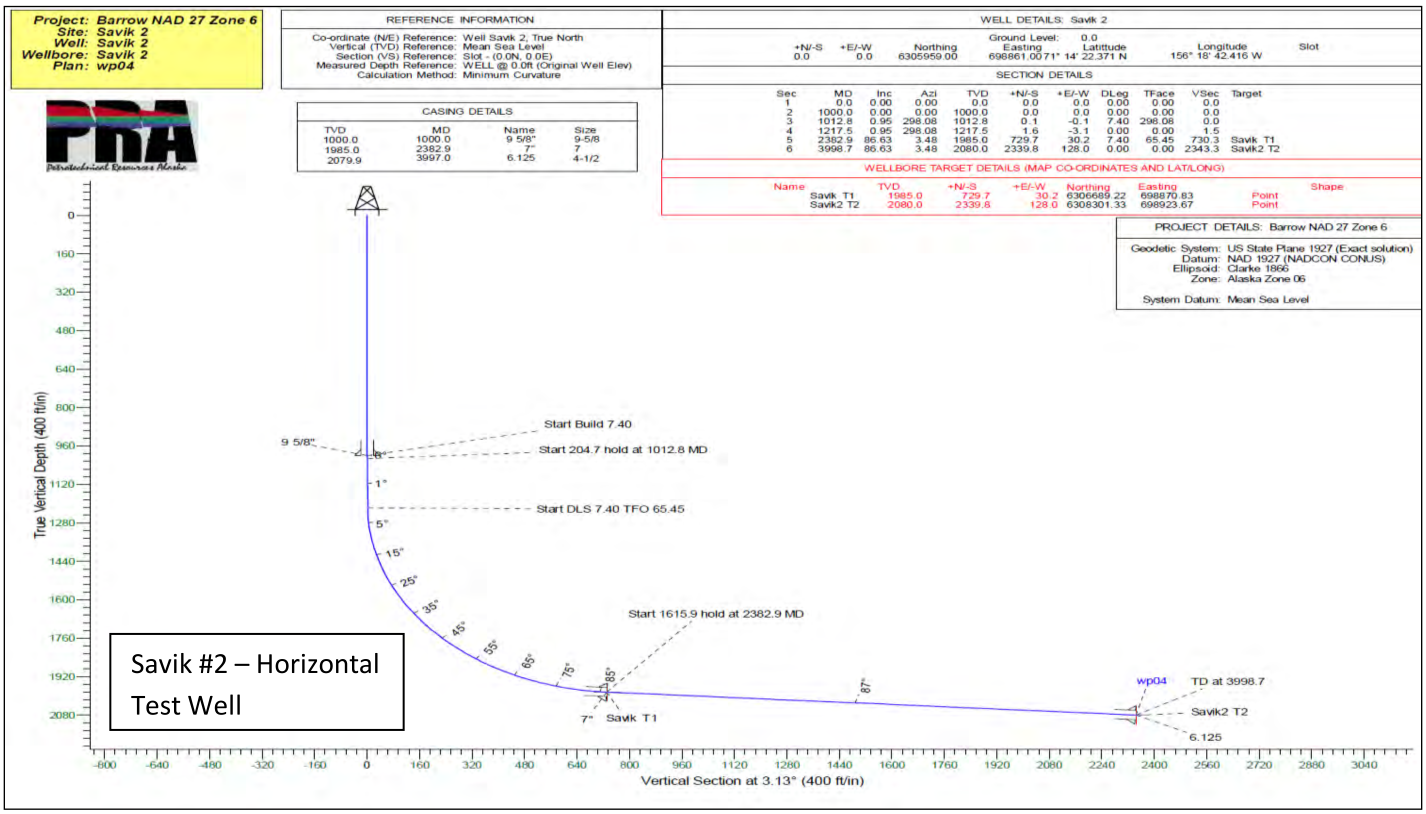


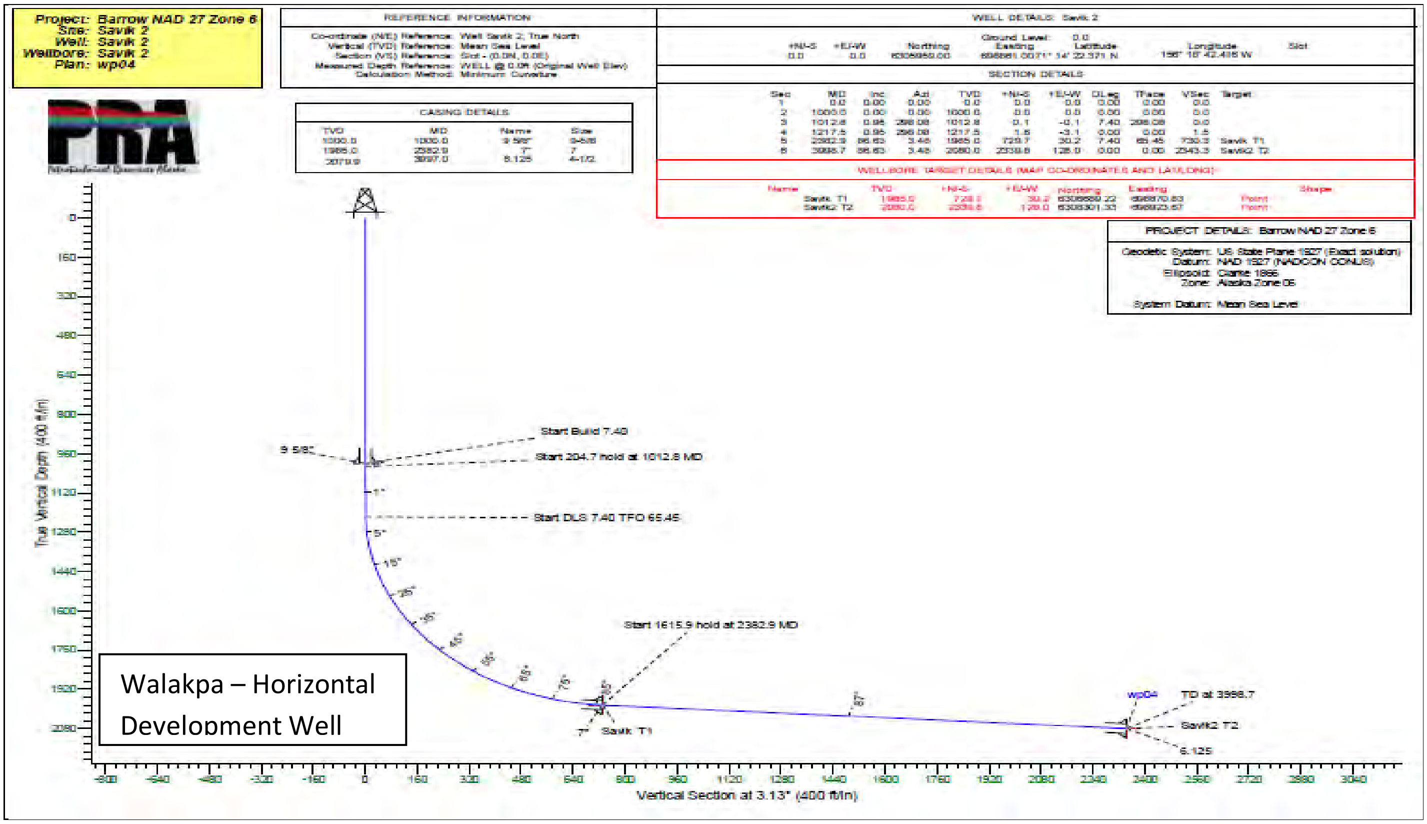
b. 1 Directional Wellbore Design

Well directional profiles were developed to determine wellbore geometry parameters such as; torque & drag measurements, dog leg severity, kick off point optimization, vertical section length and heal-toe horizontal distance. The current horizontal well directional profile includes:

- Kickoff point at 1000 ft. md/tvd – below 9-5/8 surface casing shoe
- Build rate of 7 deg./100 to inclination of 75 deg.
- Build rate of 3 deg/100 to inclination of 80 deg. – top setting Walakpa gas sand
- Run and cement 7" intermediate casing at 2025' tvd.
- Drill and build inclination to 88 deg to a final well measured depth of 4936' with 1600 ft of heal to toe distance.

Figure 9: Directional Profiles : East Barrow/Savik#2 & Walakpa Horizontal Development Well





b.2 Surface Wellhead Spacing and Drilling Rig Footprint

All wells, including hydrate monitor and production test wells, and the Walakpa development wells, will be designed with up to 2 wells per pad. Wells will be drilled on 15 - 30-ft surface wellhead spacing to minimize the footprint of the pad. The exact drilling rig footprint will not be known until the drilling contractor has been selected and final drilling plans have been completed. The footprint shown is adequate for showing the surface requirements necessary to support the drilling operations.

b.3 Drilling Rig Capacity and Rig Camp

To ensure adequate drilling efficiency and safety, the drilling rig will have the necessary horsepower, hook-load pull capacity, and manpower to drill the wells and complete them with the proposed tubular program. Given the depth, departure, and horizontal length of these wells, the drilling rig will be rated to a minimum nominal drill depth rating of 10,000’. Such a rig will need at least 500 hp drawworks capability, 300 hp top drive/rotary table capability, and a pull capacity of at least 400,000 pounds.

The rig camp necessary to support this type of drilling operation will be likely be a 30 to 60-person drilling rig camp to house drilling, supervisory, and HSE personnel necessary to carry out the operations in a safe, responsible manner. The camp will be located a minimum distance of 250 feet from the nearest well, as determined by the State of Alaska Fire Marshal. This distance has been determined to be a safe distance while allowing for demobilization of rig components in the event of an emergency. Final approval and an occupancy permit will be obtained from the Fire Marshal before the camp is placed on the gravel pad.

b.4 Well Control

The weight of the drilling fluid will serve as the primary well control mechanism for the drilling program. Offset well data from previous wells in the area will be used to estimate the necessary fluid weight. This area is known to have a normal pressure gradient equivalent to salt water, and there are numerous wells drilled in the area to support this belief. In case an unexpected influx of reservoir fluids does occur ("kick"), blowout prevention equipment (BOPE) will be used to control the well while heavier mud weight is circulated into the well

Experienced company representatives and drilling contractor personnel will be well control certified in accordance with all Alaska Oil and Gas Conservation Commission (AOGCC) regulations and will follow formal procedures to address any well-control issues. Well control procedures that will be used on the Barrow Upgrade Project wells are similar to methods used on other North Slope directional wells. There are no known hydrocarbon intervals above the Barrow sandstone in the East Barrow field, or above the Walakpa sand in the Walakpa field.

b.5 Well Construction – East Barrow / Casing Design

The casing design for the straight hole monitoring well is as follows:

- 80' of 13-3/8" 72 ppf L-80 conductor casing
- 1500' of 9-5/8" 40 ppf L-80 surface casing
- +/- 2200' MD of 7" 26 ppf L-80 production casing.

The casing design for the offsetting horizontal production well is as follows:

- 80' of 13-3/8" 72 ppf L-80 conductor casing
- 1000' of 9-5/8" 40 ppf L-80 surface casing
- +/- 1900' TVD, +/-2400' MD of 7" 26 ppf L-80 intermediate casing
- 4-1/2" 12.6 ppf slotted liner across the Barrow Sandstone

b.6 Well Construction – Walakpa / Casing Design

Up to four horizontal development wells are planned at Walakpa to increase well deliverability and overall field reliability. These wells are planned to drain virgin reservoir outboard of existing wells, with some overlap within the drainage area of existing wells.

The casing design for the Walakpa development wells is as follows:

- 80' of 13-3/8" 72 ppf L-80 conductor casing
- 1000' of 9-5/8" 40 ppf L-80 surface casing
- +/- 1900' TVD, +/-2400' MD of 7" 26 ppf L-80 intermediate casing
- 4-1/2" 12.6 ppf slotted liner across the Barrow Sandstone

The completion design for the producers is based on simplicity, fit-for-purpose, maximum reservoir efficiency, and low cost. The proposed production scheme for all producer wells is a 4-1/2-inch slotted liner run across the producing interval of each well. This design eliminates the need for liner cementing and perforating of a long horizontal section. The well will then be completed with a production packer or polished bore receptacle in the top of the liner to accept the tubing string and seal the annulus. Allowances for downhole methanol injection will be made. All completion and wellhead/Xmas tree equipment will be rated to 5,000 psi.

b.7 Drilling Fluids Program

All wells will have a similar drilling fluids program, as shown in Table 6.2. Standard North Slope water-based mud systems will be used to drill the entire section of the horizontal producer wells. For the vertical hydrate monitoring well, water-based mud will be used to drill to the surface casing point. After surface casing is set, the well will be displaced with oil-based coring fluid.

The freshwater-based mud will be made on-site. The surface hole will be drilled with a freshwater spud mud with the required viscosity for effective hole cleaning. The fluid to drill the reservoir interval will be based on a study of fluid compatibility and on the final well completion requirements. During drilling, mud processing equipment will be used to adjust as necessary the weights and other properties for all drilling fluids.

Table 6.2A: Barrow Drilling Fluids Program - Properties

HOLE SECTION	DENSITY (POUNDS PER GAL)	FUNNEL VISCOSITY (SECOND)	PV	YP
Spud to Base Permafrost	8.5 – 9.2	200 – 300	8 – 15	30 – 60
Base Permafrost to TD of Surface Hole	9.2 – 9.4	150 – 100	12 – 24	25 – 35
Base of Surface Casing to Intermediate	9.1 – 9.5	55 – 80	10 – 26	9 – 18
Production Hole	9.0 – 9. 5	55 – 80	10 – 26	9 – 18

Table 6.2B: Barrow Drilling Fluids Program - Formulation

PRODUCT	CONCENTRATION
Bentonite Gel	20 – 25 ppb
Soda Ash, Caustic	0.25 ppb
Viscosifier	1.0 – 2.0 ppb
Fluid Loss Control	1.0 – 2.0 ppb
Barite	As needed
4 – 6% KCl	For clay control, as needed
Lubricant	As needed for torque/drag

b.8 Data Acquisition

Logging while drilling (LWD) tools will be used to obtain subsurface well data while the wells are being drilled. Electric line logs will be run on the monitor wells to gather a complete data set of logs over the postulated hydrate zone. Full cores will be taken in the postulated hydrate zones of the monitor wells.

Savik #1

Methane Hydrate Monitoring Well

East Pool - South Barrow Gas Field

Rig : Kuukpik #5

AFE Number: **AFE Amount:** **Days:**

Estimated Spud: 8, December 2010 **Prepared By: PRA Drilling Team**

Prepared by:____________________
M.R. Cook

Reviewed by:__________________
M.D. Dunn

NSB Project Administrator Date

DOE Project Administrator Date

Distribution:	**19 Copies, 1 original**
Kuupik #5	8 copies
Robert Vagnetti	1 copy
Ray Boswell	1 copy
Tim Collett	1 copy
Steve McRae	1 copy
Matt Dunn	1 copy
Kurt Thomas	1 copy
Tom Walsh	1 copy
Mike Dunn	1 copy
Mike Cook	1 copy
Pete Stokes	1 copy

Contact List - example

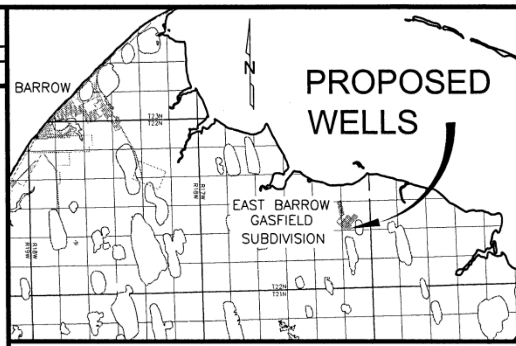
Contacts	Role/ Function	Name	Work	Cell	Home
Accounting Lead					
Anchorage Operations					
AOGCC					
Baker Hughes	Fishing				
Bariod Anchorage	Drill Fluids				
Baroid Rig					
Conam Construction	Wellhouse/ Flowline				
Ice Road/Pad Construction Suprv.					
Expeditor – on site					
Geologist					
GCI Telecom					
Halliburton					
Kuukpik - Anchorage					
Kuukpik Rig #5					
Logistics Lead					
NSB SPOC					
Peak Field Supervisor					
Reservoir Engineer					
Rig Camp					
Schlumberger					
Sperry Directional/MWD Anchorage					
Sperry Rig					
Toolpusher					
UIC Fuel Supervisor					
Umiaq					
Well Site Supervisor					

DATE: 08-20-09	SCALE: 1" = 100'	SHEET: 1 OF 1

REV	DATE	DESCRIPTION	REV	DATE	DESCRIPTION
1	8-21-09	WELL NAMES			

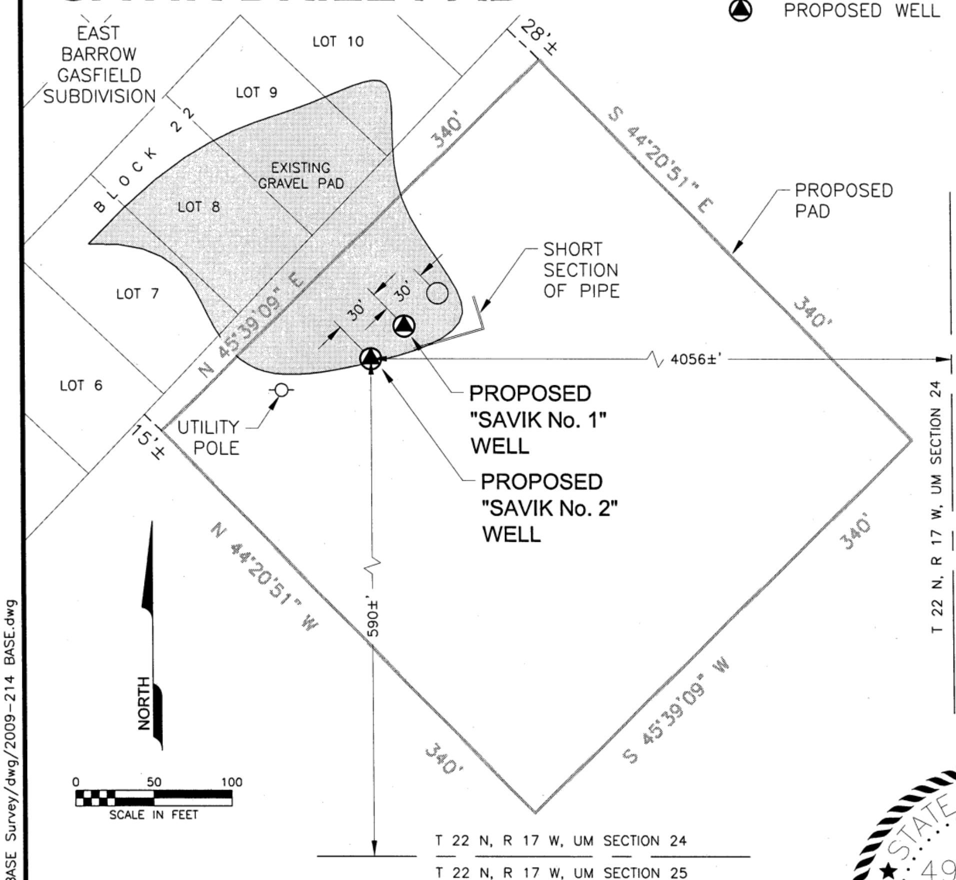
NOTES:

1. COORDINATES SHOWN HEREON BASED UPON AUTONOMOUS GPS OBSERVATIONS AND ARE APPROXIMATE ONLY.
2. AS-STAKED SURVEY CONDUCTED AUG. 5, 2009 - AUG. 6, 2009
3. ALL DISTANCES ARE IN U.S. SURVEY FEET
4. PROTRACTED SECTION LINES SHOWN HEREON ARE APPROXIMATE AND FOR REFERENCE ONLY



VICINITY MAP - NOT TO SCALE

AS-STAKED SAVIK DRILL PAD



LEGEND

○ EXISTING WELL

▲ PROPOSED WELL

PROPOSED "SAVIK-1" WELL LOCATED WITHIN T. 22 N., R. 17 W., U.M., SECTION 24
NAD 27, ZONE 6
LAT: 71°14'22.57" N LONG: 156°18'41.73" W N = 6,305,980 E = 698,883
NAD 83, ZONE 6*
LAT: 71°14'21.09" N LONG: 156°18'54.20" W N = 6,305,667 E = 1,838,887
PROPOSED "SAVIK-2" WELL LOCATED WITHIN T. 22 N., R. 17 W., U.M., SECTION 24
NAD 27, ZONE 6
LAT: 71°14'22.37" N LONG: 156°18'42.40" W N = 6,305,959 E = 698,861
NAD 83, ZONE 6*
LAT: 71°14'20.89" N LONG: 156°18'54.88" W N = 6,305,646 E = 1,838,865
*CONVERTED BY NAD CON

SURVEYORS CERTIFICATE

I HEREBY CERTIFY THAT I AM PROPERLY REGISTERED AND LICENSED TO PRACTICE LAND SURVEYING IN THE STATE OF ALASKA AND THAT THIS AS-STAKED EXHIBIT REPRESENTS A SURVEY MADE BY ME OR UNDER MY DIRECT SUPERVISION AND THAT ALL DIMENSIONS AND OTHER DETAILS ARE CORRECT AS OF AUGUST 6, 2009

STATE OF ALASKA
49TH
8-21-09
KENNETH J. PINARD
No. 11545
REGISTERED PROFESSIONAL LAND SURVEYOR

PRA PETROTECHNICAL RESOURCES ALASKA

LCMF LLC
615 EAST 82 AVENUE SUITE 200, ANCH., AK 99518
an Ukpeagvik Inupiat Corporation Company

DRAWN BY: LHH	CHECKED BY: KJP	W.O. No: 2009-214

DWG LOCATION: S:/2009214 PRA BASE Survey/dwg/2009-214 BASE.dwg

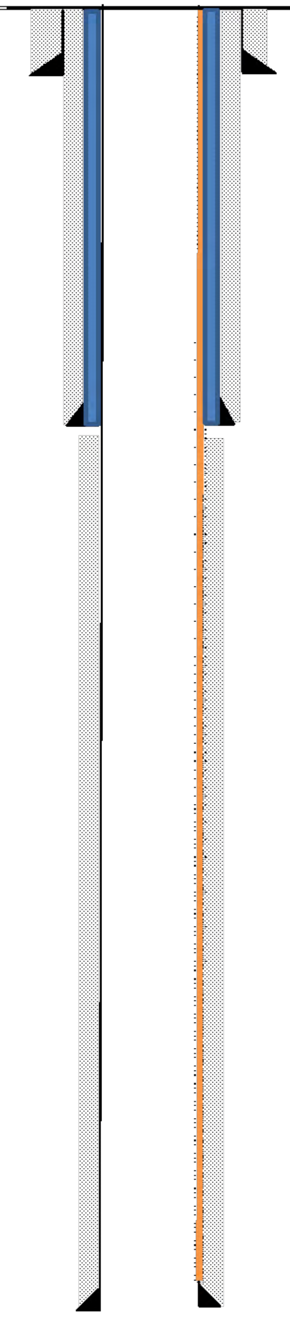
THE ONLY U.S. NATIONAL LABORATORY DEVOTED TO FOSSIL ENERGY TECHNOLOGY

North Slope Borough

Field :
Elevation : GL = 7ft above Sea level

East Barrow : Methane Hydrates Monitor Well

Engineer: M.Cook
Rig:
RKB elev. : est. 20ft above Pad elev.

DIR/LWD MWD	OH LOGS	FORM	DEPTH - (rkb) MD	DEPTH - (rkb) TVD	Savik #1	HOLE SIZE	CASING SPECS	MUD INFO CEM INFO	INFO
NONE	NONE	Permafrost	100	100		16"	13-3/8 in. 72 lb/ft L80 Welded/Insulated		Well Head : 11" 3M/5M
MWD/GR/ RES - Gyro		Base of Permafrost : Casing Point	950 ss 1500 ss	950 ss 1500 ss		12-1/4"	**Surface Casing** 9-5/8" 40 lbs/ft L80 BTC-M Internal Yield : 5750 psi Collapse : 3090 psi	Spud Mud **Lead Cement - Lite** BOC: 1000 ft. Density : 10.7 ppg Cement Excess : 150 % **Tail Cement** TOC: 1000 ft. Density : 15.8 ppg Cement Excess : 150 %	Test Casing to : 1500 psi /2500 psi Freeze Protection : Annuli 7"x 9-5/8" Arctic Pak - Gelled Diesel
MWD/GR/ RES Neu/Den Gyro		Pebble Shale **Core Point**	1360 ss 1925 ss	1360 ss 1925 ss		8-1/2"	**Production Casing** 7" 26 lbs/ft L80 BTC-M Internal Yield : 7240 psi Collapse : 6000 psi	LSND/KCL Polymer	MH -Surveillance Distributed Temp. Survey (DTS)
	Note #1	Top : Upper Barrow Gas Sand Top : Lower Barrow Gas Sand Base: Lower Barrow Gas Sand **TD**	1935 ss 2015 ss 2035 ss **2145 ss**	1935 ss 2015 ss 2035 ss **2145 ss**		7-7/8" 8-1/2"		MOBM **Cement** TOC: 1550 Density : 12.5 ppg Cement Excess : 30%	Note #1: Array Resistivity Dipole acoustic Quadrapole acoustic Spectral Gamma Ray Gamma Gamma Density Neutron Density Porosity NMR proton logging Formation Electric logging TD : Base of Lower Barrow Gas Sand

Date	Rev by	Comments
10/20/2009	M.Cook	Preliminary Well Planning

STATE OF ALASKA
ALASKA OIL AND GAS CONSERVATION COMMISSION

PERMIT TO DRILL

20 AAC 25.005

1a. Type of Work:	1b. Current Well Class:	1c. Specify if well is proposed for:
Drill [x] Redrill [ ] Re-entry [ ]	Exploratory [ ] Development Oil [ ] Stratigraphic Test [x] Service [ ] Development Gas [ ] Multiple Zone [ ] Single Zone [ ]	Coalbed Methane [ ] Gas Hydrates [x] Shale Gas [ ]

2. Operator Name: North Slope Borough - Barrow, Alaska	5. Bond: Blanket [x] Single Well [ ] Bond No. CD 17430	11. Well Name and Number: Savik #1
3. Address: Dept. Public Works, 1689 Okpik St., Barrow, AK 99723	6. Proposed Depth: MD: 2174 ft. TVD: 2174 ft.	12. Field/Pool(s): East Pool of the South Barrow Gas Field
4a. Location of Well (Governmental Section): Surface: 4035' FEL, 612' FSL, T22N,R17W, UM Sect. 24	7. Property Designation: South Barrow Gas Field - East Pool	
Top of Productive Horizon: 4035' FEL, 612' FSL, T22N,R17W, UM Sect. 24	8. Land Use Permit:	13. Approximate Spud Date: Dec. 7, 2010
Total Depth: 4035' FEL, 612' FSL, T22N,R17W, UM Sect. 24	9. Acres in Property: 21,120	14. Distance to Nearest Property: 11,200 ft.
4b. Location of Well (State Base Plane Coordinates): Surface: x 698883 y- 6305980 Zone- 6 (NAD 27)	10. KB Elevation (Height above GL): 21 feet	15. Distance to Nearest Well Within Pool: 30 ft. - EB 18
16. Deviated wells: Kickoff depth: none feet Maximum Hole Angle: zero deg. degrees	17. Maximum Anticipated Pressures in psig (see 20 AAC 25.035) Downhole: 950 psig Surface: 760 psig	

18. Casing Program:

Hole	Casing	Weight	Grade	Coupling	Length	Top (rkb) MD	Top (rkb) TVD	Setting Depth - Bottom (rkb) MD	Bottom (rkb) TVD	Cement Quantity, c.f. or sacks (including stage data)
16	13 3/8"	72#	L80	Weld	80	21	21	101	101	Single Stage: 111 sxs.
12 1/4"	9 5/8"	40#	L80	BTC-M	1500	20	20	1520	1520	Lead: 161 sxs , Tail: 352 sxs
8 1/2"	7"	26#	L80	BTC-M	2155	19	19	2174	2174	Single Stage: 94 sxs.

19. **PRESENT WELL CONDITION SUMMARY** (To be completed for Redrill and Re-Entry Operations)

Total Depth MD (ft):	Total Depth TVD (ft):	Plugs (measured):	Effect. Depth MD (ft):	Effect. Depth TVD (ft):	Junk (measured):

Casing	Length	Size	Cement Volume	MD	TVD
Conductor/Structural					
Surface					
Intermediate					
Production					
Liner					

Perforation Depth MD (ft): Perforation Depth TVD (ft):

20. Attachments: Filing Fee [x] BOP Sketch [x] Drilling Program [x] Time v. Depth Plot [x] Shallow Hazard Analysis [x]
Property Plat [x] Diverter Sketch [x] Seabed Report [ ] Drilling Fluid Program [x] 20 AAC 25.050 requirements [x]

21. Verbal Approval: Commission Representative: Date

22. I hereby certify that the foregoing is true and correct. Contact

Printed Name ______ Title ______

Signature Phone Date

Commission Use Only

Permit to Drill Number:	API Number: 50-	Permit Approval Date:	See cover letter for other requirements.

Conditions of approval: If box is checked, well may not be used to explore for, test, or produce coalbed methane, gas hydrates, or gas contained in shales [ ]

Other: Samples req'd: Yes [ ] No [ ] Mud log req'd: Yes [ ] No [ ]
H_2S measures: Yes [ ] No [ ] Directional svy req'd: Yes [ ] No [ ]

APPROVED BY THE COMMISSION

DATE: , COMMISSIONER

Well Name:	Savik #1

Drill, Core & Evaluate Summary

Type of Well (service / producer / injector):	Methane Hydrate – Monitoring Well

Surface Location:	Located within : T.22 N., R. 17 W., U.M. Section 24 NAD 27 ZONE 6 : LAT: 71 14'22.57" N LONG: 156 18' 41.73" W N = 6,305,980 E= 698,883
TOP - core point Walakpa Sands	T.22 N., R. 17 W., U.M. Section 24 NAD 27 ZONE 6 : LAT: 71 14'22.57" N LONG: 156 18' 41.73" W N = 6,305,980 E= 698,883 TVD/SS: 1700-ft
BOTTOM – core point Walakpa Sands	T.22 N., R. 17 W., U.M. Section 24 NAD 27 ZONE 6 : LAT: 71 14'22.57" N LONG: 156 18' 41.73" W N = 6,305,980 E= 698,883 TVD/SS: 1748-ft
TOP – core point Upper Barrow Gas Sand	T.22 N., R. 17 W., U.M. Section 24 NAD 27 ZONE 6 : LAT: 71 14'22.57" N LONG: 156 18' 41.73" W N = 6,305,980 E= 698,883 TVD/SS:1925-ft
BOTTOM - core point Lower Barrow Gas Sand	T.22 N., R. 17 W., U.M. Section 24 NAD 27 ZONE 6 : LAT: 71 14'22.57" N LONG: 156 18' 41.73" W N = 6,305,980 E= 698,883 TVD/SS:2045-ft

Insert SOR table

AFE Number:		**Rig:**	Kuukpik #5

Estimated Start Date:	Dec. 8th, 2010	**Operating days to complete:**	22

MD:	2174	**TVD:**	2174	**Max Inc:**	0	**KOP:**	vert	**KBE(GL):**	21 ft.

Well Design (conventional, slimhole, etc.):	Conventional : drill/core/evaluate/instrument

Objective:	Gas Hydrates – presence determination/core acquisition/core analysis/instrument as methane hydrate monitor well

Drilling Fluid Program:

12-1/4-in Surface Hole Fluid Properties:				Spud – LSND Freshwater Mud		
Density (ppg)	**Funnel Vis**	**YP**	**HTHP**	**pH**	**API Filtrate**	**LG Solids**
8.6 – 9.2	75 – 150	25 – 60	N/A	9.0 – 9.5	< 12	< 6.5
7 7/8" - 8 ¾" Coring / Production Hole Fluid Properties:				MOBM – Coring Fluid		
Density (ppg)	*PV*	**YP**	**HTHP**	**pH**	**API Filtrate**	**LG Solids**
8.8 – 10.2	10 – 20	25 – 30	10 - 11	9.0 – 9.5	< 6	< 15

Waste Disposal: RCRA Exempt – Class II Wastes
Drilling fluid : ANNULAR INJECTION in permitted East Barrow/Walakpa annuli or existing well.
Drill Cuttings disposal :
Option #1 : beneficial reuse; transported to Barrow Municipal Landfill
Option #2 : stored/barged to G&I Facility (PRB) disposal site.
Waste Disposal: RCRA Exempt – Class I Wastes
Option #1 : disposed of locally - Barrow Municipality

Casing/Tubing Program

Hole Size	Csg / Tbg O.D.	Wt/Ft	Grade	Conn	Length	Top MD / TVDrkb	Bottom MD / TVDrkb
16 0-in	13.375-in	72#	L-80	Welded	80-ft	21-ft	101-ft
12.25-in	9.625-in	40#	L-80	BTC-M	1500-ft	20-ft	1520-ft
8.5-in	7.0-in	26#	L-80	BTC-M	2155-ft	19-ft	2174-ft

Cement Program:

Casing Size	9-5/8", 40 ppf, L-80 BTC	
Type:	Surface Casing to 1500' md/tvd	
Basis for Calculation	Shoe depth: 1520 ft-md/tvd (rkb) : 80-ft. shoe joints, 150% in permafrost (12-1/4" hole), and cement to surface. Lead : Type L Permafrost Tail : Type C Permafrost	
Cement Volume:	Spacer	5 bbl of water, 10 bbl CW 100 and 40 bbl Mud Push
	Lead (BOC @ 1000 ft.)	Density: 10.7, Yield: 4.15 cu.ft/sk, Mix Water: 19.5 gal/sk Sxs : 161
	Tail (TOC @ 1000 ft.)	Density: 15.6, Yield: 0.95 cu.ft/sk, Mix Water:3.83 gal/sk Sxs : 352
	Temp	36 deg. F @ 1500 ft. tvd/md

Casing Size	7", 26 ppf, L-80 BTC-M	
Type:	Production Casing (long string) : 2174 ft. md/tvd (rkb)	
Basis for Calculation	Shoe depth: 2174 ft-md/tvd (rkb), 120-ft. shoe joints, 30% excess in open hole. Single Stage : ArcticCem LT	
Cement Volume:	Wash	5 bbl water, 10 bbl CW 100
	Spacer	30 bbl Mud Push
	Tail	Density: 12.5, Yield: 2.36 cu.ft/sk, Mix Water: 13 gal/sk Sxs : 94
	Temp	57deg. F @ 2174 ft. tvd/md.

Evaluation Program

12.250-in Surface Hole:	
Core Program: Open Hole Logs:	• None • MWD: Directional/Gamma/Resistivity
8.5-in Production Hole:	
Coring Program: Open Hole Logs:	• **Run 1 :** Core : Wireline retrieved from Top of Walakpa Sands to base of Lower Barrow Gas Sands MWD: Directional/Gamma/Resistivity • **Run 1 :** 1600 – 2174' – **Walakpa Sand Interval** ▪ Electromagnetic Propagation Tool Log (EPT) ▪ RT Scanner • **Run 2 :** 1600 – 2174' – **Walakpa Sand Interval** ▪ Dipole Shear Imager Log ▪ OBMI ▪ Gamma Ray Log • **Run 3 :** 1600 – 2174'- **Barrow Sand Interval** ▪ CMR – Combinable Magnetic Resonance ▪ NGT – Spectral Gamma Ray Log ▪ ECS – Elemental Capture Sonde
Cased Hole Logs:	• **Run 1 :** No cased hole logs required

Formation Markers

Formation	Est. Formation Tops (TVDss)	Uncertainty (feet)	Commercial Hydrocarbon Bearing (Yes/No)	Est. Pore Press. (Psi)	Est. Pore Press. (ppg EMW)
Base of Permafrost	950	+/- 100'	no	412	8.34
Top HRZ/Pebble Shale	1360	+/- 25'	no	590	8.34
Base HRZ	1380	+/- 25'	no	n/a	n/a
9-5/8 csg pt (500'MD below BPF)	1500	+/- 25'	n/a	n/a	n/a
Walakpa SS	1715	+/- 25'	no	797	8.9
LCU/Kingak Shale	1725	+/- 25'	no	798	8.9
Top Upper Barrow SS	1935	+/- 25'	yes	966	9.6
Top Lower Barrow SS	2015	+/- 25'	yes	1006	9.6
Base Lower Barrow SS	2035	+/- 25'	yes	1015	9.6
Hydrate Stability Zone	2050	+/- 25'	n/a	n/a	n/a
TD (within Kingak Shale)	2145	+/- 25'	no	1070	9.6
(TD: 110'md below base Lower Barrow)					

Recommended BHA / Bit Program

BHA	Hole Size	Hole Section	Depth (MD-rkb)	Footage	Bit Type	TFA	GPM
1	12-1/4”	Surface	100-ft – 300-ft	200-ft		.84	675
2	12-1/4”	Surface	300-ft – 1520-ft	1220-ft			675
3	8-3/4”	Production	1520-ft - 1728-ft	208-ft			375-450
4	7-7/8” Core Bit	Walakpa Core Interval	1728-ft – 1776-ft	48-ft			
5	7-7/8” Bit	Production	1776-ft – 1953-ft	177-ft			375-450
6	7-7/8” Core Bit	Barrow Gas Sands Core Interval	1953-ft – 2073-ft	120-ft			
7	8-3/4”	Hole Opener & Bit Run	1953-ft - 2073-ft	120-ft			375-450
8	8-3/4”	Production	2073-ft - 2174-ft	101-ft			375-450

Well Control

Surface Interval – 12.25”

BOPE	21 ¼ ” 2M MSP
Maximum anticipated BHP	650-psi (8.35-lb/gal @ 1500-ft TVD)
Maximum surface pressure	500-psi (0.1-psi/ft gas gradient to surface)
Planned BOP test pressure	21-1/4” MSP 2M – test to 1000 psi

Production Interval – 7 7/8” – 8 ¾”

BOPE	11”, 5M, Double ram with annular (Hydril - GL)
Maximum anticipated BHP	960-psi (9.6-lb/gal @ 1935-ft TVDss – top Upper Barrow Sandstone)
Maximum surface pressure	860-psi (0.1-psi/ft gas gradient to surface)
Kick tolerance and integrity	Infinite kick tolerance with 12.9-lb/gal FIT.
Planned BOP test pressure	Rams test to 2,500-psi/250-psi. Annular test to 1,500-psi/250-psi
Casing Test Pressure (7”)	3,500-psi
Planned completion fluids	MOBM

Drilling Hazards & Contingencies:

- Hydrates will be present from the base of the permafrost to approximately 2174’ TVD/rkb.
- Mud system chemistry and temperature and drilling mechanics will be optimized to minimize hydrate sublimation while maintaining primary well control.
- Sticky clays may be present from the lower permafrost on down to total depth.
- Potential for packing off/stuck pipe, tight hole, and swabbing exists.
- Free gas saturation in zones expected to be hydrates.

Lost Circulation

- Loss circulation is possible throughout the entire 8-1/2” (1500’ – 2174’) production hole section.
- Pebble Shale : loss circulation events.

Swabbing

- Corion – core barrel; monitor trip tank when wirelining core barrel, and/or tripping coring assembly.

Expected Pressures

- The Upper and Lower Barrow gas sands are geo-pressured. DST formation pressure data indicate the upper Barrow gas sand at 966 psi @ 1963 ft-tvd (9.6 ppg equivalent).

Hydrocarbons:

- Hydrocarbons in the form of Methane Hydrates are expected from the base of the permafrost to TD, and are possible through the base of the hydrate stability zone. Free gas may be present.

Faults

- No fault intersections are expected in this vertical wellbore.

Hydrogen Sulphide

- The East Barrow gas field is not designated as H2S area. H2S is not expected.

Anti-Collision Issues

- The EB-18 well.

Distance to Nearest Well:

- The EB-18 well – 30 ft. at surface.

DRILLING PROCEDURE:

Pre-Rig Operations:

1. Survey in ice road and pad.
2. Construct ice road and pad.
3. Drill and set 13-3/8" 72 # L80 conductor casing and well cellar. Install braden head.
4. N/U 21 ¼" 2M Diverter system prior to MIRU.
5. Hold pre-spud meeting in Anchorage and at NSB Base Camp.

Drilling, Coring and Evaluation:

1. Move in and rig up drilling unit.
2. Install Mud Chiller & Generator, Coring and Lab Trailer and Geo Shack, MWD/LWD/Mud Logging unit, Wireline unit – for core retrieval.
3. Take on water and build spud mud.
4. Function test 21-1/2" 2M Hydril Diverter System.
5. MU BHA #1: 12-1/4" Tricone drill bit on packed rotary assembly and drill to 300'-. POOH.
6. MU BHA #2: 12-1/4" packed rotary assembly w/ MWD collars – test MWD collars below 13 3/8" conductor. Drill 12-1/4" surface hole to +/- 1520-ft. md tvd/rkb. Maintain drilling fluid temperature at +/- 40 - 60 deg. F with dilution.
7. Circulate and condition 12-1/4" surface hole section for casing.
8. Run 9-5/8", 40#, L-80 BTC-M casing to TD @ +/- 1520 tvd/md rkb.
9. Cement 9-5/8", 40#, L-80 BTC-M casing – bump plug with MOBM Coring Fluid. ND diverters system, install wellhead and NU 11 5M BOPE – test BOPE.
10. Clean Pits, plug all water sources and take on (cold) MOBM.
11. Plumb in Mud Chiller per DrillCool and test.
12. MU BHA #3 w/ 8 ¾" bit. RIH to 1400-ft and test casing to 1500 psi.
13. Drill out shoe track, floats and 20-ft of formation to 1540-ft tvd/md rkb.
14. POOH to 1400-ft and perform FIT to 0.67 psi/ft equivalent (12.9 ppg).
15. Drill 8 ¾" hole section with BHA #3 (MWD/GR/RES) to Walakpa Sands core point at 1700-ft tvd/ss = 1728-ft tvd/md rkb. – POOH. Core point to be picked by well-site geologist.
16. M/U BHA #4, 7-7/8" CORION wire line retrievable coring assembly with coring insert. RIH to core point at 1728-ft tvd/md rkb.
17. Core Walakpa Sands interval (48 ft total) from 1728-ft tvd/md rkb to 1776-ft tvd/md rkb. Two each 24 ft core sections will be acquired through the Walakpa Sands interval. Wire line retrieve each 24 ft Walakpa sands core section to surface.
18. POOH with BHA #4.
19. MU BHA #5 – 7 7/8" bit w/ packed BHA assembly (MWD/GR/RES) – drill 7 7/8" hole section to Upper Barrow Sands core point at 1925-ft tvd/ss = 1953-ft tvdmd rkb.
20. POOH – MU BHA #6 ; 7-7/8" CORION wire line retrievable coring assembly with coring insert. RIH to core point at 1953-ft tvd/md rkb.
21. Core Upper and Lower Barrow Sands interval (120 ft total) from 1953-ft tvd/md rkb to 2073-ft tvd/md rkb. Five each 24 ft core sections will be acquired through the Upper and Lower Barrow

Sands interval. Wire line retrieve each 24 ft Upper and Lower Barrow sands core section to surface.

22. POOH w/ BHA #6, L/D same. MU BHA #7 – 8 ¾” hole opener assembly. RIH to 1728-ft tvd/md rkb - open 7 7/8” (120 ft) cored & drilled interval (1953 – 2073 ft tvd/md rkb) to 8 ¾” OD. POOH.
23. MU BHA #8 - 8 ¾” bit w/ packed BHA assembly (MWD/GR/RES) – drill 8 ¾” hole section to well TD at 2174 ft md/tvd rkb. POOH – stand back BHA #9.
24. R/U E-line.
25. RIH w/ formation evaluation logging suites: 3 logging runs.
26. P/U BHA #8 – RIH .
27. Perform clean out run to +/- 2174-ft md/tvd rkb.
28. POOH, L/D BHA #8.

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PROCEDURE

MOVE RIG; Step: 1, Phase: PRE, Task: MOB

Prior to moving rig onto location, complete a pre-rig inspection with Rockford pad operator. Ensure that the landing ring has been welded on the 16" conductor and check the height of the conductor for correct space out for the rig and diverter line.

Nipple up 21-1/4" 2,000-psi diverter system with 16" outlet on existing 20" landing ring. Ensure diverter setup conforms to diagram posted with AOGCC, and that any flowlines that may be in the path of the diverter are protected. Function test diverter, and record it on the IADC and morning report. Notify AOGCC 24-hr prior to conducting the function test on the diverter and provide them with a written copy of the test after it is completed.

RIG UP; Step: 2, Phase: PRE, Task: RIGU

MIRU drilling rig. Load pipe shed. Conduct and evacuation drill.

The DrillCool Mud Chiller will need to be bermed and contained near the rock washer along with the mud chiller power unit (generator). The core processing trailers will be rigged up adjacent the rig, with the Corion (cold) tailer requiring intrinsically safe heat and lights, communications (Gaitronics), and compressed air. The coring shack (warm) will require heat, lights and communications.

DRILL SURFACE HOLE; Step: 3, Phase: SURF, Task: DRILL

1. PU Corion 5" DP and 5" HWDP as needed to drill to 1520-ft md/tvd rkb. Corion DP will be used for the drilling of all hole sections in the well. The Corion 5" DP has been manufactured with an oversized bore to facilitate the wireline retrievable coring system.
2. MU BHA #1 12-1/4" Bit/Packed rotary assembly. Drill out conductor and 12-1/4" surface hole to 300-ft per directional driller to get MWD collar outside the conductor on the next run. POOH.
3. Make up BHA #2, 12-1/4" packed rotary assembly w/ MWD (DIR/GR/RES). Drill to approximately 1520-ft md/tvd rkb per directional driller. Casing point will be picked by the wellsite geologist in the shale section below the base of permafrost and above the hydrate zone.

   - Hydrates are not expected in this interval however monitor flowline and pits for signs of gas bubbles and/or gas influx.
   - Gravel is expected in the surface hole. Generally the gravel is smaller ad wells have handled them with initial funnel viscosities of 90 sec/qt. Be prepared to raise funnel viscosities to 250-300 sec/qt in the event of tight hole or excessive gravel returns across the shale shakers.
   - Maintaining the mud temperature at +/- 60 F or colder is always beneficial for wellbore stability in the permafrost section. Keep the mud as cool as practical with cold water dilutions.
   - High/Low viscosity sweeps (25 bbls-low/25bbls-high) should be circulated prior to short tripping. Circulation rates should be maintained between 450-550 gpm, unless hole conditions dictate otherwise.

CASE/CEMENT SURFACE HOLE; Step: 4, Phase: SURF, Task: CASE

1. At TD, circulate at least 2 bottoms-ups. Continue circulating until the hole is clean. Pump out to HWDP at full drilling flow rate. RIH to TD. Condition mud to run casing while circulating an additional BU. Pull out of hole and lay down BHA.
2. Rig up 9-5/8" casing running equipment including fill up tool. Ensure that a cross-over with safety valve is on the rig and has been function-tested (9-5/8" BTC x 2.0" swage with 2.0" full open valve attached. Run casing to TD as follows:

Size	Section	Length	Weight	Grade	Coupling	Drift
9-5/8"	Surf – 1520ft	1500-ft	40 lb/ft	L-80	BTC-M	8.75

   a. First two joints with straight bladed centralizer per joint.
   b. Float equipment on top of second joint, Baker-locked on top and bottom. Insure that float equipment is 36-40#.
   c. Place on straight bladed centralizer per joint for the next *24 joints* without stop collars.

3. Run casing to TD wash last joint in and land casing using fill up tool.
4. Circulate and condition the mud to cement casing – YP 15-20. Circulate at least one bottoms up with fill up tool prior to installing cement head.
5. RU (Cementing Co.) and test lines. Mix and pump the Lead and Tail cement slurries as per Cement program. Follow the recommended pump schedule to ensure that the anticipated formation fracture pressure is not exceeded. Drop wiper plug and chase with Mineral Oil-Based Coring Fluid, charging the rig pumps from a Vac Truck. (Insure mud is as cool as possible, 40 deg. F = target). This will allow us to clean pits and take on additional coring fluid while WOC, also chilled mud will reduce the time required for chilling. Bump plug with 1,000 psi over circulating pressure. Check the floats to ensure they hold.

Wash & Spacer	5 bbl water and 10 bbl CW 100 40 bbl of MudPush
Lead	Type L Permafrost: 10.7 ppg and 4.15 ft3/sxs
Tail	Type C Permafrost: 15.6 ppg and 0.95 ft3/sxs
Temp	Casing Point BHST : 36 deg F (estimated)

6. Nipple down riser and install the Vetco Grey Uni-bore wellhead system (11" 5K Gen.5 wellhead flange). Will need 13-5/8" x 11" adapter for BOPE. Have service hand on location to supervise installation and testing of wellhead. Test the wellhead system per Vetco Grey guidelines and procedures. Check with Rockford operations superintendent for wellhead orientation specifications.
7. Nipple up 13-5/8" 5M BOPE and test to 250/3000 psi and record on chart and on the IADC report.
8. MU BHA #3 with 8-3/4" milled tooth bit w/ MWD/GR/RES. RIH to 1400-ft md/tvd rkb and test casing to 2000 psi. Drill out float equipment and 20 ft of new hole.
9. POOH to 1400-ft md/tvd rkb. Perform FIT to 0.67 psi/ft equivalent (12.9 ppg). Record FIT with a chart recorder. Report results on IADC and morning report. POOH. If Leak Off occurs at less than 12.9 ppg EMW, discuss options with Anchorage operations team prior to proceeding.

DRILL PRODUCTION HOLE 1 (8 ¾" – 7 7/8") ; Step: 5, Phase: PROD, Task: DRILL/

1. Drill 8 ¾" hole section with BHA #3 (MWD/GR/RES) to Walakpa Sands core point at approximately 1700-ft tvd/ss = 1728-ft tvd/md rkb. Core point to be picked by Well Site Geologist. POOH w/ BHA #3.
2. Prep rig floor to PU 7 7/8" CORION Coring BHA #4. RIH to Walakpa Sands core point.
3. **CORING** operations will proceed per the CORION representative. Detailed coring,core handling/retreival and core evaluation procedures are presented in the **CORING MANUAL** – procedures will be reviewed with copies to be distributed to all key personnel prior to coring operations. Normal operating parameters for coring operations include:
   a. Circulation rate: 200-225 gpm
   b. WOB: 4,000 – 10,000 lbs (may require minimal WOB to core hydrates)
   c. Rotary speed: 60-90 rpm
   d. The plan is to core (48 ft) from 1728 – 1776 ft tvd/md rkb of Walakpa Sands. Instantaneous ROP's may be very high in hydrates. CORION advises allowing these "breaks" to drill off in order to avoid jams.
   e. Coring should require 2 runs. The installation and removal of the coring sleeve inserts will proceed as described in the Coring Procedure Manual – Volume #1 . If gas is observed the lubricator procedure will be adopted for removing and deploying coring inserts. Decision to employ the lubricator method will rest 100% with the Wellsite Supervisor.
   f. Prior to coring and prior to retrieving coring inserts, flow check for 5-minutes. While pulling core, watch for signs of swabbing.
   g. Circulate 1 x BU drilling rate as dictated by hole conditions. Pump out to the shoe monitoring hole conditions. If hole conditions are satisfactory, POOH. If tight hole or excessive drag is encountered, TIH and circulate an additional BU. POOH. Flow check well for 10 minutes.
   h. L/D CORION BHA #4 and rig down wireline equipment.
4. MU BHA #5 (MWD/GR/RES) and RIH. Drill 7 7/8" hole section with BHA #5 (MWD/GR/RES) to Upper and Lower Barrow gas sands core point at approximately 1925-ft tvd/ss = 1953-ft tvd/md rkb. Core point to be picked by Well Site Geologist. POOH w/ BHA #6.
5. Prep rig floor to PU 7 7/8" CORION Coring BHA #6. RIH to Upper and Lower Barrow gas sands core point.
   a. The plan is to core (approx 120 ft) from 1953-ft –2073-ft tvd/md rkb of Upper and Lower Barrow gas sands . Instantaneous ROP's may be very high in hydrates. CORION advises allowing these "breaks" to drill off in order to avoid jams.
   b. Coring should require 5 ea. 24-ft core sections, each wire line retrieved to surface for evaluation. The installation and removal of the coring sleeve inserts will proceed as described in the Coring Procedure Manual – Volume 1. If gas is observed, the lubricator procedure will be adopted for removing and deploying coring inserts. Decision to employ the lubricator method will rest 100% with the Wellsite Supervisor.
   c. Prior to coring and prior to retrieving coring inserts, flow check for 5-minutes. While pulling core, watch for signs of swabbing.
   d. Circulate 1 x BU drilling rate as dictated by hole conditions. Pump out to the shoe monitoring hole conditions. If hole conditions are satisfactory, POOH. If tight hole or excessive drag is encountered, TIH and circulate an additional BU. POOH. Flow check wellf or 10 minutes.
   e. L/D CORION BHA #6 and rig down wireline equipment.
6. **Hole-Opener Run #2 (8 3/4") -** 7-7/8" Hole to 8-3/4" (approx :1728 – 2073 ft tvd/md (350 ft.))

   - PU Hole Opener BHA #8 per on site representative and RIH.
   - Open cored hole to 8-3/4".
   - At TD, circulate 3 x BU. If hole conditions are good, POOH. If not, RIH to TD and circulate 3 x BU. Repeat cycle until hole is clean. POOH, stand back 5" DP
   - Note: The Hole Opener is preferred over reaming to bottom with an 8-3/4" bit due to the potential for inadvertently sidetracking the well.

7. MU BHA #9 (MWD/GR/RES) and RIH. Drill 8 ¾" hole section with BHA #9 (MWD/GR/RES) to TD at 2174 ft tvd/md rkb.
   a. Circulate 2 x BU drilling rate as dictated by hole conditions. Pump out to the shoe monitoring hole conditions. If hole conditions are satisfactory, POOH. If tight hole or excessive drag is encountered, TIH and circulate an additional BU. POOH. Flow check wellf or 10 minutes.
   b. Utilize the TESCO top drive to back ream tight hole intervals. Hole sections exhibiting PU weights in excess to 40k - 50k over normal – should be targeted for back reaming.

<u>LOG PRODUCTION HOLE; Step: 6, Phase: PROD, Task: LOG</u>

1. Obtaining high-quality logging data across the hydrate zone is the primary objective of this well. The evaluation phase should go as follows:

   E-Line Logging (Approximately 20 hrs)

   - Rig up SLB e-line for 3 logging runs.
     - Run #1 – PEX, EPT and RT Scanner. Estimated Duration: 6 hours
     - Run #2 – DSI, GR, OBMI. Estimated Duration: 6 hours
     - Run #3 – CMR, NGT, ECS. Estimated Duration: 8 hours

   After completion of Logging run #3, RD SLB e-line. PU 8-3/4" BHA and TIH breaking circulation every 250-ft. At TD, circulate 3 x BU. Pump out to the shoe. If hole conditions are good, POOH. If tight, TIH to TD and circulate 2 x BU and repeat. POOH and lay down BHA. Flow check for 10 minutes.

<u>CASE PRODUCTION CASING #1; Step: 7, Phase: COMP, Task: CASE</u>

1. After logging is complete, RIH with an 8-3/4" cleanout BHA and circulate and condition hole for running casing. POH, laying down.

2. Change the bottom set of BOP rams to 7". Pull wear bushing. Rig up GBR casing running equipment and crew to run 7" casing. Ensure casing is drifted to 6.151" drift I.D. Verify that all LDS pins are retracted on the well head.

3. Calculate land out with to insure that the space out will include the following:
   - Pup used under the hanger.
   - 7" hanger
   - 7" hanger landing sub
   - Landing joint long enough to reach RKB +6 for safe working conditions.
   - Perform dummy run with 7" casing hanger and landing joint prior to running casing.
   - Have hanger and landing joint made up and on the cat walk.

   - Verify land out with RKB measurement and verify land out is accurate by looking for mark on casing thru the casing valve. Stand aside or lay down during casing running job.

4. M/U and run 7", 26#, L-80, BTC-M casing to TD as follows:
(Note: Float equipment will be bucked onto casing joints prior to arrival on location.)

- 7" float shoe
- 2 joints 7" casing
- 7" float collar
- 7" casing to surface
- 7" casing hanger
- 7" landing joint

Rig up Halliburton/Well Dynamics DTS spooler w/ ¼" control line with DTS. Run and strap DTS line per detailed DTS running procedure.

- Attach two (2) bow-spring centralizers with stop collars to each of the bottom two (2) joints of casing (the shoe track). The remainder of the centralizers will be placed every third joint in this straight hole.
- Baker-Lock all float equipment and bottom four (4) joints of casing.
- Verify floats are working and RIH with the casing, filling every five (5) joints.
- M/U casing hanger and landing joint on last joint of casing.
- R/U cementing head and test head and lines to 500/3,000 psi. Circulate and condition the hole for cementing while reciprocating the casing. Annular velocity should match that used for drilling the hole. Circulate a minimum of two (2) casing volumes.
- Reciprocate the casing throughout the cement job if possible, using 30' strokes at one stroke per minute.
- While reciprocating the casing, pump cement as follows,carefully monitoring up/down weights and flow rates while reciprocating. (Note: Adjust volume of lead slurry to account for actual length of hole drilled. Allow for 30% excess in the open hole.)
- Mix and pump cement as per Halliburton Cement program. Follow the recommended pump schedule to ensure not to exceed anticipated formation fracture pressure. Bump the plug with 1,000-psi over circulating pressure. Check float equipment to make sure that it holds.

Casing Size	7", 26 ppf, L-80 BTC-M	
Type:	Production Casing (long string) : 2174 ft. md/tvd (rkb)	
Basis for Calculation	Shoe depth: 2174 ft-md/tvd (rkb), 120-ft. shoe joints, 30% excess in open hole. Single Stage : ArcticCem LT	
Cement Volume:	Wash	5 bbl water, 10 bbl CW 100
	Spacer	30 bbl Mud Push
	Tail	Density: 12.5, Yield: 2.36 cu.ft/sk, Mix Water: 13 gal/sk Sxs : 118
	Temp	57deg. F @ 2174 ft. tvd/md.

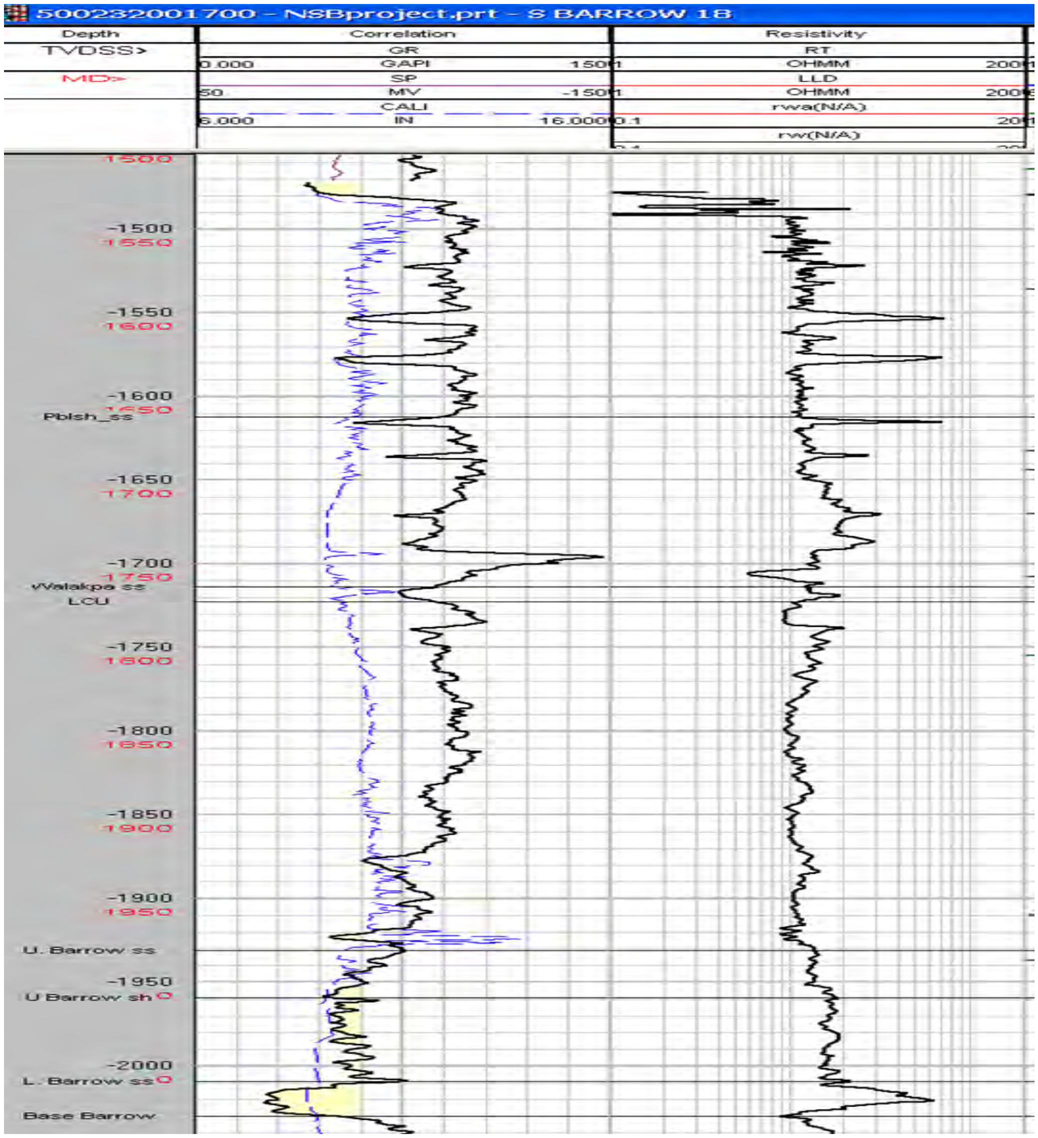
- Drop top plug and displace with 79 bbls of 10 ppg MOBM at 8 bbl/min.
- Slow pumps down to 3 bbls/min 15 bbls short of the top plug locating in the landing collar.
- Continue reciprocating casing as long as possible with casing at TD at the bottom of the down-stroke.
- Land casing hanger in wellhead before bumping plug or if reciprocation becomes

difficult. Verify land out with mark on pipe that was made during the dummy run of the hanger before running casing.

- Bump plug with 500 psi with casing positioned at the bottom of the down-stroke. Hold pressure for 2 minutes. Bleed off and ensure floats are holding. Note: If plug bump is not observed, do not over-displace by more than half the shoe track volume.
- P/U packoff and packoff running tool. Verify land out mark and measure for proper landing of packoff. Grease the ID and OD seals of the packoff. Record all part and serial numbers from the packoff. If the pack off does not land according to the mark, pick up and verify seals are in good working order and re-land. ,If it does not land apply weight of the block not to exceed 15,000 lbs to over come the o-rings.
- After landing, run in lower LDS to engage the pack off. Test void to 5,000 psi to verify the seals are operating correctly for 15 minutes.
  If good test is achieved un-J the pack off running tool and bring to floor.
- Rig down cementers and clean up. Clear rig floor.
- Test 7-in casing to 3,500 psi for 30-min and record on chart and IADC.
- WOC for 4 hours.
- PU BHA (7” 26# L80 drift = 6.151”) w/ csg scraper. RIH to top of cement, test 7” 26# L80 casing to 3,500 psi for 30-min and record on chart and IADC.
- Circulate hole (long way) with 9.5lb/gal NaCl completion brine. POOH – L/D drill pipe.

RIG DOWN AND RELEASE RIG; Step: 8, Phase: COMP, Task: RIGD

1. Install TWC and test to 2,500-psi. ND 11” 5K BOPE.
2. NU lock down flange, tubing head adapter and Vetco Grey 5M XMAS tree. Pressure test tubing head adapter and tree to 5,000-psi for 15 min.
3. RD Rig. Skid Rig to Savik #2 location. Pull TWC.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Correlation
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SP
50 MV -150
CALI
6.000 IN 16.000
Resistivity
RT
OHMM 200
LLD
OHMM 200
rwa(N/A)
0.1 20
rw(N/A)
-1500
-1550
-1600
Pblsh_ss
-1650
-1700
Walakpa ss
LCU
-1750
-1800
-1850
-1900
U. Barrow ss
-1950
U Barrow sh
-2000
L. Barrow ss
Base Barrow

Savik #2

Methane Hydrate Horizontal Test Well
East Pool - South Barrow Gas Field
Rig : Kuukpik #5

AFE Number: **AFE Amount:** **Days:**

Estimated Spud: 8, December 2010 **Prepared By: PRA Drilling Team**

Prepared by:____________________
M.R. Cook

Reviewed by:__________________
M.D. Dunn

NSB Project Administrator Date

DOE Project Administrator Date

Distribution:	**19 Copies, 1 original**
Kuupik #5	8 copies
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Contact List - example

Contacts	Role/ Function	Name	Work	Cell	Home
Accounting Lead					
Anchorage Operations					
AOGCC					
Baker Hughes	Fishing				
Bariod Anchorage	Drill Fluids				
Baroid Rig					
Conam Construction	Wellhouse/ Flowline				
Ice Road/Pad Construction Suprv.					
Expeditor – on site					
Geologist					
GCI Telecom					
Halliburton					
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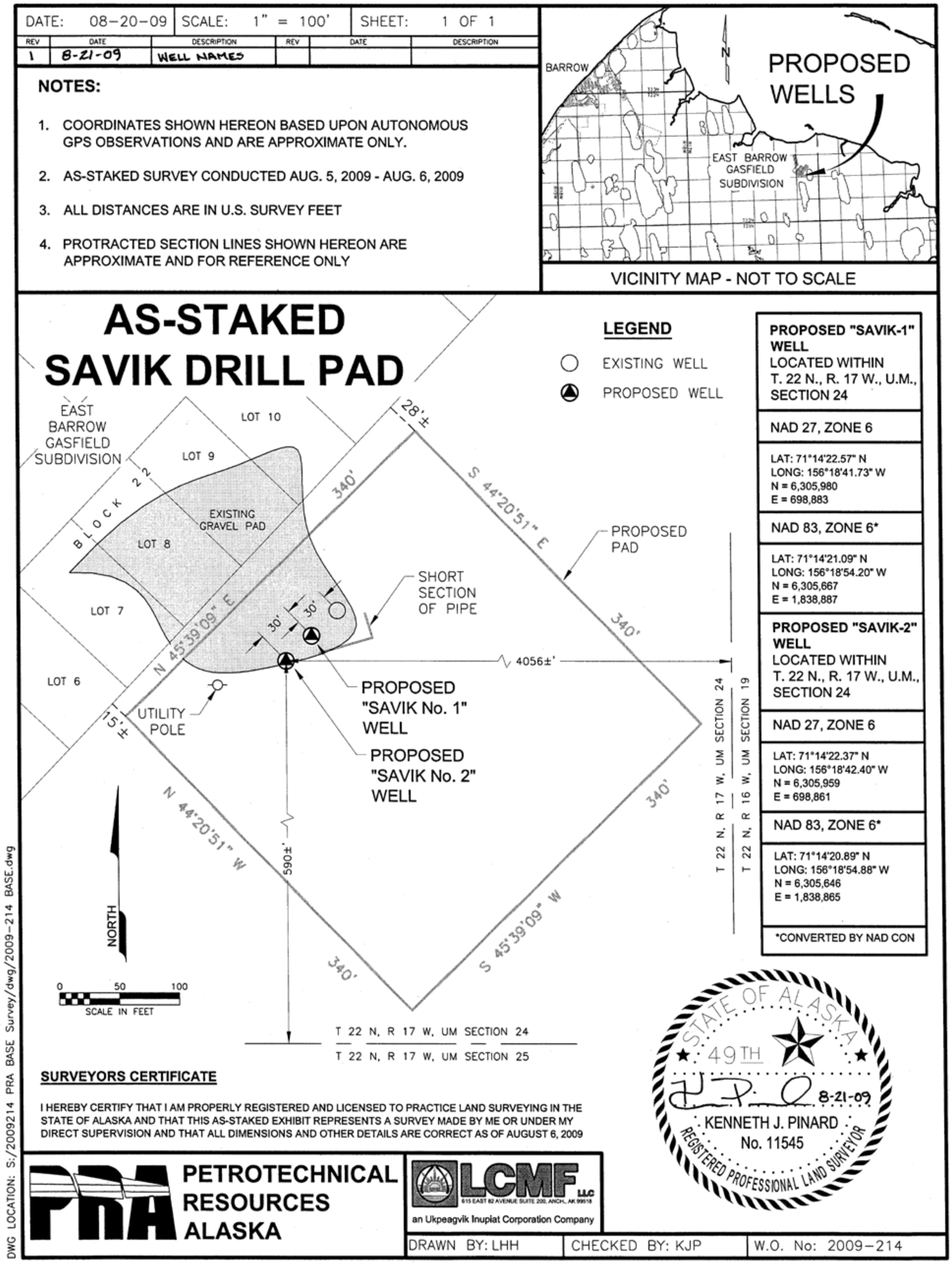
NSB SPOC					
Peak Field Supervisor					
Reservoir Engineer					
Rig Camp					
Schlumberger					
Sperry Directional/MWD Anchorage					
Sperry Rig					
Toolpusher					
UIC Fuel Supervisor					
Umiaq					
Well Site Supervisor					


DATE: 08-20-09
SCALE: 1" = 100'
SHEET: 1 OF 1
REV DATE DESCRIPTION REV DATE DESCRIPTION
1 8-21-09 WELL NAMES
NOTES:
1. COORDINATES SHOWN HEREON BASED UPON AUTONOMOUS GPS OBSERVATIONS AND ARE APPROXIMATE ONLY.
2. AS-STAKED SURVEY CONDUCTED AUG. 5, 2009 - AUG. 6, 2009
3. ALL DISTANCES ARE IN U.S. SURVEY FEET
4. PROTRACTED SECTION LINES SHOWN HEREON ARE APPROXIMATE AND FOR REFERENCE ONLY
BARROW
PROPOSED WELLS
EAST BARROW GASFIELD SUBDIVISION
VICINITY MAP - NOT TO SCALE
AS-STAKED SAVIK DRILL PAD
LEGEND
EXISTING WELL
PROPOSED WELL
PROPOSED "SAVIK-1" WELL LOCATED WITHIN T. 22 N., R. 17 W., U.M., SECTION 24
NAD 27, ZONE 6
LAT: 71°14'22.57" N
LONG: 156°18'41.73" W
N = 6,305,980
E = 698,883
NAD 83, ZONE 6*
LAT: 71°14'21.09" N
LONG: 156°18'54.20" W
N = 6,305,667
E = 1,838,887
PROPOSED "SAVIK-2" WELL LOCATED WITHIN T. 22 N., R. 17 W., U.M., SECTION 24
NAD 27, ZONE 6
LAT: 71°14'22.37" N
LONG: 156°18'42.40" W
N = 6,305,959
E = 698,861
NAD 83, ZONE 6*
LAT: 71°14'20.89" N
LONG: 156°18'54.88" W
N = 6,305,646
E = 1,838,865
*CONVERTED BY NAD CON
EAST BARROW GASFIELD SUBDIVISION
LOT 10
LOT 9
LOT 8
LOT 7
LOT 6
BLOCK 22
EXISTING GRAVEL PAD
28'±
340'
S 44°20'51" E
PROPOSED PAD
SHORT SECTION OF PIPE
30'
30'
N 45°39'09" E
4056±'
340'
PROPOSED "SAVIK No. 1" WELL
PROPOSED "SAVIK No. 2" WELL
UTILITY POLE
15'±
T 22 N, R 17 W, UM SECTION 24
T 22 N, R 16 W, UM SECTION 19
N 44°20'51" W
590±'
340'
S 45°39'09" W
340'
NORTH
0 50 100
SCALE IN FEET
T 22 N, R 17 W, UM SECTION 24
T 22 N, R 17 W, UM SECTION 25
SURVEYORS CERTIFICATE
I HEREBY CERTIFY THAT I AM PROPERLY REGISTERED AND LICENSED TO PRACTICE LAND SURVEYING IN THE STATE OF ALASKA AND THAT THIS AS-STAKED EXHIBIT REPRESENTS A SURVEY MADE BY ME OR UNDER MY DIRECT SUPERVISION AND THAT ALL DIMENSIONS AND OTHER DETAILS ARE CORRECT AS OF AUGUST 6, 2009
STATE OF ALASKA
49TH
8-21-09
KENNETH J. PINARD
No. 11545
REGISTERED PROFESSIONAL LAND SURVEYOR
PETROTECHNICAL RESOURCES ALASKA
LCMF LLC
an Ukpeagvik Inupiat Corporation Company
DRAWN BY: LHH
CHECKED BY: KJP
W.O. No: 2009-214
DWG LOCATION: S:/2009214 PRA BASE Survey/dwg/2009-214 BASE.dwg

STATE OF ALASKA
ALASKA OIL AND GAS CONSERVATION COMMISSION

PERMIT TO DRILL

20 AAC 25.005

1a. Type of Work: Drill [x] Redrill [ ] Re-entry [ ]

1b. Current Well Class: Exploratory [ ] Development Oil [ ] Stratigraphic Test [x] Service [ ] Development Gas [ ] Multiple Zone [ ] Single Zone [ ]

1c. Specify if well is proposed for: Coalbed Methane [ ] Gas Hydrates [x] Shale Gas [ ]

2. Operator Name: North Slope Borough - Barrow, Alaska

5. Bond: Blanket [x] Single Well [ ] Bond No. CD 17430

11. Well Name and Number: Savik #2

3. Address: Dept. Public Works, 1689 Okpik St., Barrow, AK 99723

6. Proposed Depth: MD: 3998 ft. TVD: 2080 ft.

12. Field/Pool(s): East Pool of the South Barrow Gas Field

4a. Location of Well (Governmental Section):
Surface: 4056' FEL, 590' FSL, T22N,R17W, UM Sect. 24
Top of Productive Horizon: 4029' FEL, 1320' FSL, T22N,R17W, UM Sect. 24
Total Depth: 3937' FEL, 2930' FSL, T22N,R17W, UM Sect. 24

7. Property Designation: South Barrow Gas Field - East Pool

8. Land Use Permit:

13. Approximate Spud Date: Dec. 7, 2010

9. Acres in Property: 21,120

14. Distance to Nearest Property: 11,200 ft.

4b. Location of Well (State Base Plane Coordinates): Surface: x 698861 y 6305959 Zone- 6 (NAD 27)

10. KB Elevation (Height above GL): 21 feet

15. Distance to Nearest Well Within Pool: 30 ft. - EB 18

16. Deviated wells: Kickoff depth: none feet; Maximum Hole Angle: zero deg. degrees

17. Maximum Anticipated Pressures in psig (see 20 AAC 25.035) Downhole: 950 psig Surface: 760 psig

18. Casing Program:

Hole	Casing	Weight	Grade	Coupling	Length	Top (rkb) MD	Top (rkb) TVD	Bottom (rkb) MD	Bottom (rkb) TVD	Cement Quantity, c.f. or sacks (including stage data)
16	13 3/8"	72#	L80	Weld	80	21	21	101	101	Single Stage: 111 sxs.
12 1/4"	9 5/8"	40#	L80	BTC-M	1000	20	20	1028	1028	Lead: 80 sxs , Tail: 352 sxs
8 1/2"	7"	26#	L80	BTC-M	2300	19	19	2328	2004	Single Stage: 118 sxs.
6 1/8"	4 1/2"	12.6#	L80	EUE 8-rd	1850	2178	1964	4026	2110	production - slotted liner

19. **PRESENT WELL CONDITION SUMMARY** (To be completed for Redrill and Re-Entry Operations)

Total Depth MD (ft):	Total Depth TVD (ft):	Plugs (measured):	Effect. Depth MD (ft):	Effect. Depth TVD (ft):	Junk (measured):

Casing	Length	Size	Cement Volume	MD	TVD
Conductor/Structural					
Surface					
Intermediate					
Production					
Liner					

Perforation Depth MD (ft):

Perforation Depth TVD (ft):

20. Attachments: Filing Fee [x] BOP Sketch [x] Drilling Program [x] Time v. Depth Plot [x] Shallow Hazard Analysis [x] Property Plat [x] Diverter Sketch [x] Seabed Report [ ] Drilling Fluid Program [x] 20 AAC 25.050 requirements [x]

21. Verbal Approval: Commission Representative: Date

22. I hereby certify that the foregoing is true and correct. Contact

Printed Name Title

Signature Phone Date

Commission Use Only

Permit to Drill Number:	API Number: 50-	Permit Approval Date:	See cover letter for other requirements.

Conditions of approval: If box is checked, well may not be used to explore for, test, or produce coalbed methane, gas hydrates, or gas contained in shales [ ]

Other:

Samples req'd: Yes [ ] No [ ] Mud log req'd: Yes [ ] No [ ]

H_2S measures: Yes [ ] No [ ] Directional svy req'd: Yes [ ] No [ ]

APPROVED BY THE COMMISSION

DATE: , COMMISSIONER

Well Name:	**Savik #2**

Drill & Evaluate Summary

Type of Well (service / producer / injector):	Methane Hydrate – Horizontal Test Well

Surface Location:	Located within : 4056' FEL 590' FSL T.22 N., R. 17 W., U.M. Section 24 NAD 27 ZONE 6 : N = 6,305,959 E= 698,861
Target Savik T1 – (Heel) Upper Barrow Gas Sand	4029' FEL 1320' FSL T.22 N., R. 17 W., U.M. Section 24 NAD 27 ZONE 6 : N = 6306689.22 E= 698870.83 TVD/SS: 1985-ft
Target Savik T2 – (Toe) Upper Barrow Gas Sand	3937' FEL 2930' FSL T.22 N., R. 17 W., U.M. Section 24 NAD 27 ZONE 6 : N = 6308301.33 E= 698923.67 TVD/SS: 2080-ft

AFE Number:	

Rig:	Kuukpik #5

Estimated Start Date:	Dec. 30th, 2010

Operating days to complete:	22

MD:	4026 (rkb)	**TVD:**	2110 (rkb)	**Max Inc:**	87	**KOP:**	1012	**KBE(GL):** **SS - GL**	21 ft. 7 ft.

Well Design (conventional, slimhole, etc.):	Methane Hydrate Horizontal Test Well

Objective:	Gas Hydrates – Drill horizontal test well to produce "free gas" in the Upper Barrow Gas Sand – below base of methane hydrate stability zone.

Drilling Fluid Program:

12-1/4-in Surface Hole Fluid Properties:				Spud – LSND Freshwater Mud		
Density (ppg)	**Funnel Vis**	**YP**	**HTHP**	**pH**	**API Filtrate**	**LG Solids**
8.6 – 9.2	75 – 150	25 – 60	N/A	9.0 – 9.5	< 12	< 6.5
8-1/2" Intermediate Hole Fluid Properties:				Polymer-KCL / LSND		
Density (ppg)	*PV*	**YP**	**HTHP**	**pH**	**API Filtrate**	**LG Solids**
8.8 – 10.2	10 – 20	25 – 30	10 - 11	9.0 – 9.5	< 6	< 15
6-1/8" Production Hole Fluid Properties:				Polymer-KCL / LSND		
Density (ppg)	*PV*	**YP**	**HTHP**	**pH**	**API Filtrate**	**LG Solids**
8.8 – 10.4	10 – 20	25 – 35	10 - 11	9.0 – 9.8	< 6	< 10

Waste Disposal: RCRA Exempt – Class II Wastes
Drilling fluid : ANNULAR INJECTION in permitted East Barrow/Walakpa annuli or existing well.
Drill Cuttings disposal :
Option #1 : beneficial reuse; transported to Barrow Municipal Landfill
Option #2 : stored/barged to G&I Facility (PRB) disposal site.
Waste Disposal: RCRA Exempt – Class I Wastes
Option #1 : disposed of locally - Barrow Municipality

Casing/Tubing Program

Hole Size	Csg / Tbg O.D.	Wt/Ft	Grade	Conn	Length	Top MD / TVDrkb	Bottom MD / TVDrkb
16 0-in	13.375-in	72#	L-80	Welded	80-ft	21-ft	101-ft
12.25-in	9.625-in	40#	L-80	BTC-M	1000-ft	20-ft	1028-ft
8.5-in	7.0-in	26#	L-80	BTC-M	2300-ft	19-ft	2328-ft/2004-ft
6.125-in	4.5-in	12.6#	L-80	EUE-8rd	1850-ft	2178-ft/1964	4026-ft/2110-ft

Cement Program:

Casing Size	9-5/8”, 40 ppf, L-80 BTC	
Type:	Surface Casing to 1500’ md/tvd	
Basis for Calculation	Shoe depth: 1520 ft-md/tvd (rkb) : 80 -ft. shoe joints, 150% in permafrost (12-1/4” hole), and cement to surface. Lead : Type L Permafrost Tail : Type C Permafrost	
Cement Volume:	Spacer	5 bbl of water, 10 bbl CW 100 and 40 bbl Mud Push
	Lead (BOC @ 1000 ft.)	Density: 10.7, Yield: 4.15 cu.ft/sk, Mix Water: 19.5 gal/sk Sxs : 80
	Tail (TOC @ 1000 ft.)	Density: 15.6, Yield: 0.95 cu.ft/sk, Mix Water:3.83 gal/sk Sxs : 352
	Temp	36 deg. F @ 1500 ft. tvd/md

Casing Size	7", 26 ppf, L-80 BTC-M	
Type:	Production Casing (long string) : 2174 ft. md/tvd (rkb)	
Basis for Calculation	Shoe depth: 2174 ft-md/tvd (rkb), 120-ft. shoe joints, 30% excess in open hole. Single Stage : ArcticCem LT	
Cement Volume:	Wash	5 bbl water, 10 bbl CW 100
	Spacer	30 bbl Mud Push
	Tail	Density: 12.5, Yield: 2.36 cu.ft/sk, Mix Water: 13 gal/sk Sxs : 118
	Temp	57deg. F @ 2174 ft. tvd/md.

Evaluation Program

12.250-in Surface Hole:	
Open Hole Logs:	• Logging while drilling (LWD) with directional will be utilized in lieu of open hole e-line formation evaluation logging runs. • LWD Directional/Gamma/Resistivity/Neutron/Density/Gyro
8.5-in Intermediate Hole:	
Open Hole Logs:	• LWD Directional/Gamma/Resistivity/Neutron/Density/Gyro
6.125 Production Hole:	
Open Hole Logs:	• LWD Directional/Gamma/Resistivity/Neutron/Density/Gyro
Cased Hole Logs:	• not required

Formation Markers

Formation	*Est. Formation Tops (TVDss)*	*Uncertainty (feet)*	*Commercial Hydrocarbon Bearing (Yes/No)*	*Est. Pore Press. (Psi)*	*Est. Pore Press. (ppg EMW)*
Base of Permafrost	950	+/- 100'	no	515	9.6
Top HRZ/Pebble Shale	1360	+/- 25'	no	720	9.6
Base HRZ	1380	+/- 25'	no	n/a	n/a
9-5/8 csg (500'MD below BPF)	1450	+/- 25'	n/a	n/a	n/a
Walakpa SS	1740	+/- 25'	no	910	9.6
LCU/Kingak Shale	1750	+/- 25'	no	915	9.6
Upper Barrow SS	1960	+/- 25'	yes	1019	9.6
Upper Barrow SS (target heel)	1985	+/- 25'	yes	1032	9.6
Hydrate Stability Zone (est.)	2050	n/a	n/a	n/a	n/a
Upper Barrow SS (target toe)	2080	+/- 25'	yes	1079	9.6

Recommended Bit Program

BHA	Hole Size	Depth (MD)	Bit Type	Nozzle/Flow rate
1	12.5-in	0-ft – 1000-ft	Hughes MX-C1	3-15 & 1-10
2	8.5-in	1000-ft – 2300-ft	Smith FGXiCPS	3-15 & 1-10
3	6.125-in	2300-ft – 4026-ft TD	Security FM2643	3-12

Well Control

Surface Interval – 12.25”

BOPE – Surface Interval – 12.25”	21 ¼ ” 2M MSP
Maximum anticipated BHP	433-psi (8.35-lb/gal @ 1000-ft TVD)
Maximum surface pressure	390-psi (0.1-psi/ft gas gradient to surface)
Casing Test Pressure : 9 5/8” 40# L80 BTC-M	2,500-psi

BOPE – Intermediate/Production – 8.5” /6.125”	11”, 5M, Double ram with annul ar (Hydril - GL)
Maximum anticipated BHP	960-psi (9.4-lb/gal @ 1960-ft TVD/SS – top Upper Barrow Sandstone)
Maximum surface pressure	760-psi (0.1-psi/ft gas gradient to surface)
Kick tolerance and integrity	Infinite kick tolerance with 12.9-lb/gal FIT.
Planned BOP test pressure	Rams test to 2,500-psi/250-psi. Annular test to 1,500-psi/250-psi
Casing Test Pressure : 7” 26# L80 BTC-M	3,500-psi
Planned drilling fluid:	Polymer/KCL - LSND

Drilling Hazards & Contingencies:

- Hydrates will be present from the base of the permafrost to approximately 1990’ TVD/rkb. – top of Upper Barrow Sandstone @ 1960-ft ss + 28-ft (GL+rkb)
- Mud system chemistry and temperature and drilling mechanics will be optimized to minimize hydrate sublimation while maintaining primary well control.
- Sticky clays may be present from the lower permafrost on down to total depth.
- Potential for packing off/stuck pipe, tight hole, and swabbing exists.
- Free gas saturation in zones expected to be hydrates.

Lost Circulation

- Loss circulation is possible throughout the entire 8-1/2” (1000’ – 2300’) intermediate hole section.

Expected Pressures

- The Upper and Lower Barrow gas sands are geo-pressured. DST formation pressure data indicate the upper Barrow gas sand at 960 psi @ 1960 ft-tvd (9.4 ppg equivalent).

Hydrocarbons:

- Hydrocarbons in the form of Methane Hydrates are expected from the base of the permafrost to TD, and are possible through the base of the hydrate stability zone. Free gas may be present.

Faults

- No fault intersections are expected in this vertical wellbore.

Hydrogen Sulphide

- The East Barrow gas field is not designated as H2S area. H2S is not expected.

Anti-Collision Issues

- The EB-18 well.

Distance to Nearest Well:

- The EB-18 well – 30 ft. at surface.

Drilling and Evaluation:

1. Move in and rig up drilling unit.
2. Install MWD/LWD and Wireline unit.
3. Take on water and build spud mud. PU 4 ½" DP (approx. 80 jts, R2)
4. Function test 21-1/2" 2M Hydril Diverter System.
5. MU BHA #1: 12-1/4" Tricone drill bit on packed rotary assembly and drill to 300'-. POOH.
6. MU BHA #2: 12-1/4" packed rotary assembly w/ LWD collars – test LWD collars below 13 3/8" conductor. Drill 12-1/4" surface hole to +/- 1028ft. md tvd/rkb.
7. Circulate and condition 12-1/4" surface hole section for surface 9 5/8' 40# L80 BTC-Mcasing.
8. Run 9-5/8", 40#, L-80 BTC-M casing to TD @ +/- 1028 tvd/md rkb.
9. Cement 9-5/8", 40#, L-80 BTC-M casing – bump plug. ND diverters system, install Vetco Grey 5M wellhead , NU DSA and 11 5M BOPE – test BOPE, choke manifold, stand pipe & surface IBOP's and safety valves.
10. MU BHA #3 w/ 8 1/2" bit, directional assembly w/ LWD/GR/RES/NEU/DEN. RIH to 900-ft rkb and test surface 9 5/8" casing to 2500 psi. Record test on Barton recorder and submit with daily IADCC report.
11. Drill out shoe track, floats and 20-ft of formation to 1050-ft tvd/md rkb.
12. POOH to 1000-ft and perform FIT to 0.67 psi/ft equivalent (12.8 ppg).

13. Drill 8 1/2" hole section with BHA #3 (MWD/GR/RES/NEU/DEN) to 7" 26# L80 intermediate casing point at 2382-ft md/2004-ft tvd.
14. Circulate 8 ½" wellbore, short trip to 9 5/8" 40# shoe @ 1028 –ft tvd/md rkb , prep rig for running 7" 26# L80 intermediate casing. POOH with BHA #3
15. Run 7" intermediate casing. Land 7" 26# L80 casing hanger in casing head of Vetco Grey 5M well head. RILDS to energize pickoffs. Test Vetco Grey 5M wellhead to 3500 psi.
16. PU 60 jts of 4" DP – position on set back area.
17. MU BHA #4 – 6 1/8" bit w/ directional assembly (LWD/GR/RES/NEU/DEN). RIH, test 7" 26# L80 BTC-M casing to 3500 psi.
18. Drill 6 1/ 8" horizontal hole section to 4026-ft md/2110-ft tvd rkb. Wellbore to be directionally constrained to the Upper Barrow Gas Sand interval. Short trip 6 1/8" horizontal hole section, circulate annulus 2x. Back ream as required through tight hole sections.
19. POOH w/ BHA #4. Prep rig to run 4 ½" 12.6# L80 EUE-8rd slotted liner with 2 7/8" 6.5# L80 completion assembly.
20. RIH w/ 4 ½" 12.6# L80 EUE-8rd slotted liner on 2-7/8" 6.5# L80 completion assembly w/ 7" x 2 7/8" production packer. Distributed temperature survey **(DTS)** equipment to be affixed to the external O.D. of the 2 7/8" completion tubing and 4 ½" production slotted liner.

DRILLING PROCEDURE:

Pre-Rig Operations:

1. Survey in ice road and pad.
2. Construct ice road and pad.
3. Drill and set 13-3/8” 72 # L80 conductor casing and well cellar. Install braden head.
4. N/U Drillling Diverter system prior to MIRU.
5. Hold pre-spud meeting in Anchorage and at NSB Base Camp.

PROCEDURE

MOVE RIG; Step: 0, Phase: PRE, Task: MOB

Prior to moving rig onto location, complete a pre-rig inspection with Rockford pad operator. Ensure that the landing ring has been welded on the 13-3/8”” conductor and check the height of the conductor for correct space out for the rig and surface BOPE (21 ¼” 2 M MSP), bell nipple, flowline, diverter line.

RIG UP; Step: 1, Phase: PRE, Task: RIGU

MIRU drilling rig. Load pipe shed. Conduct and evacuation drill.

Nipple up 21-1/4” 2M diverter system with 16” outlet on existing landing ring. Ensure diverter setup conforms to diagram posted with AOGCC, and that any flowlines that may be in the path of the diverter are protected. Function test diverter, and record it on the IADC and morning report. Notify AOGCC 24-hr prior to conducting the function test on the diverter and provide them with a written copy of the test after it is completed.

DRILL SURFACE HOLE; Step: 2, Phase: SURF, Task: DRILL

1. Conduct spud meeting and HSE compliance briefing with all personnel on rig.
2. PU enough 4-1/2”-in drill pipe to drill to 1028-ft MD/TVD rkb
3. PU 12 ¼ ” bit and BHA (MWD/GR/RES/NEU/DEN). Drill as per mud and directional plans to **1028-ft MD/TVD rkb**.
   - Light to moderate hydrates were encountered on previous East Barrow wells drilled through the surface hole section. No drilling problems related to the hydrates were reported. Be prepared.
   - Watch flowline temperatures and dilute as necessary to keep temperatures low.

CASE/CEMENT SURFACE HOLE; Step: 3, Phase: SURF, Task: CASE

1. Circulate at least 3 bottoms-up or until hole is clean. Pump out to HWDP at full drilling flow rate. RIH to TD. Circulate at least 3 bottoms-up or until hole is clean. Condition mud to run casing during circulation. Pump out of hole at full drilling flow rate. LD BHA.
2. Rig up 9 5/8" casing running equipment. Ensure that a cross-over with safety valve is on the rig floor and has been function tested.
3. Run 9 5/8" 40-lb/ft, L-80, BTC-M surface casing to total depth as per attached casing program.
4. Circulate and condition the mud to cement casing – YP 15-20. Circulate at least 3 bottoms-up or until hole is clean.
5. Mix and pump two-stage cement job as per Cement program. Follow the recommended pump schedule to ensure that the anticipated formation fracture pressure is not exceeded. Bump each plug with 1,000-psi over circulating pressure. Check float equipment to ensure that it holds.
6. Nipple down diverter system, pick up and install Vetco Grey 20" x 11" 5M Gen 5 wellhead system with 11" x 11" tubing spool. Have Vetco Grey service hand on location to supervise installation and testing of wellhead. Test wellhead system as per Vetco Grey test procedures. **Check with Rockford Well ops for wellhead orientation.**
7. Nipple up 13 -5/8" 5M BOPE and test rams to 250-psi low and 2500-psi high as per drilling permit. Test annular to 250-psi low and 1,500 psi high and record on chart and IADC.
8. PU 8.5-in bit, bent housing motor and BHA (MWD/GR/Res/Neu/Den). RIH and tag float collar. Test 9 5/8"-in casing to 2,500-psi for 30-min. Record test on chart and IADC.
9. Drill cement, float collar and float shoe, cement below shoe if any, and <u>20-ft of new hole</u>. Circulate cement and cuttings out of hole.

Perform Formation Integrity Test (**F.I.T.)**. to 12.8-<u>lb/gal</u> EMW. (***Call Drilling Superintendent if less than 12.8-lb/gal***). Record F.I.T. with chart recorder. Report results on IADC and morning report.

DRILL INTERMEDIATE HOLE; Step: 4, Phase: INT1, Task: DRILL

1. Drill 8.5-in intermediate hole section as per mud and directional plans to TD at **<u>±2328-ft MD, 2004-ft TVD</u>** as per geologist.
   - Planned KOP below surface 9 5/8" csg @ 1028 –ft md/tvd rkb.
   - Build and turn at 7.4°/100-ft to end of build at 2328-ft md with wellbore inclination of 87° deg.
   - LWD/GR/RES/NEU/DEN – sensor offset from bit should be minimized to allow for Upper Barrow Sandstone marker identification.
   - 8 ½" well bore to intersect top of Upper Barrow sandstone with prognosed 7-in 26# L80 shoe placement at 10-ft tvd below top of Upper Barrow sandstone formation.

CASE/CEMENT INTERMEDIATE HOLE; Step: 5, Phase: COMP, Task: CASE

1. Circulate / condition mud to run casing. Circulate at least 3 bottoms-up or until hole is clean. Pump out to casing shoe at full drilling rate. Perform a wiper trip if required. POOH, L/D 4 ½" DP.

2. Change the bottom set of BOP rams to 7". Pull wear bushing. Rig up GBR

casing running equipment and crew to run 7” casing. Ensure casing is drifted to 6.151” drift I.D. Verify that all LDS pins are retracted on the well head.

3. Calculate land out with to insure that the space out will include the following:
   - Pup used under the hanger.
   - 7 hanger
   - 7 hanger landing sub
   - Landing joint long enough to reach RKB +6 for safe working conditions.
   - Perform dummy run with 7” casing hanger and landing joint prior to running casing.
   - Have hanger and landing joint made up and on the cat walk.
   - Verify land out with RKB measurement and verify land out is accurate by looking for mark on casing thru the casing valve. Stand aside or lay down during casing running job.

4. M/U and run 7”, 26#, L-80, BTC-M casing to TD as follows:
   (Note: Float equipment will be bucked onto casing joints prior to arrival on location.)
   - 7” float shoe
   - 2 joints 7” casing
   - 7” float collar
   - 7” casing to surface
   - 7” casing hanger
   - 7” landing joint
   - Attach two (2) bow-spring centralizers with stop collars to each of the bottom three (3) joints of casing (the shoe track). The remainder of the centralizers will be placed as needed through the zone(s) of interest and doglegs as indicated by the directional survey.
   - Baker-Lock all float equipment and bottom four (4) joints of casing.
   - Verify floats are working and RIH with the casing, filling every five (5) joints.
   - M/U casing hanger and landing joint on last joint of casing.
   - R/U cementing head and test head and lines to 500/3,000 psi. Circulate and condition the hole for cementing while reciprocating the casing. Annular velocity should match that used for drilling the hole. Circulate a minimum of two (2) casing volumes.
   - Reciprocate the casing throughout the cement job if possible, using 30’ strokes at one stroke per minute.
   - While reciprocating the casing, pump cement as follows,carefully monitoring up/down weights and flow rates while reciprocating. (Note: Adjust volume of lead slurry to account for actual length of hole drilled. Allow for 30% excess in the open hole.)
   - Mix and pump cement as per Halliburton Cement program. Follow the recommended pump schedule to ensure not to exceed anticipated formation fracture pressure. Bump the plug with 1,000-psi over circulating pressure. Check float equipment to make sure that it holds.

Casing Size	7”, 26 ppf, L-80 BTC-M	
Type:	Production Casing (long string) : 2174 ft. md/tvd (rkb)	
Basis for Calculation	Shoe depth: 2174 ft-md/tvd (rkb), 120-ft. shoe joints, 30% excess in open hole. Single Stage : ArcticCem LT	
Cement Volume:	Wash	5 bbl water, 10 bbl CW 100
	Spacer	30 bbl Mud Push
	Tail	Density: 12.5, Yield: 2.36 cu.ft/sk, Mix Water: 13 gal/sk Sxs : 118
	Temp	57deg. F @ 2174 ft. tvd/md.

- Drop top plug and displace with bbls of 10 ppg at 8 bbl/min.
- Slow pumps down to 3 bbls/min 15 bbls short of the top plug locating in the landing collar.
- Continue reciprocating casing as long as possible with casing at TD at the bottom of the down-stroke.
- Land casing hanger in wellhead before bumping plug or if reciprocation becomes difficult. Verify land out with mark on pipe that was made during the dummy run of the hanger before running casing.
- Bump plug with 500 psi with casing positioned at the bottom of the down-stroke. Hold pressure for 2 minutes. Bleed off and ensure floats are holding. Note: If plug bump is not observed, do not over-displace by more than half the shoe track volume. Shoe track volume = 4.6 bbls.
- P/U packoff and packoff running tool. Verify land out mark and measure for proper landing of packoff. Grease the ID and OD seals of the packoff. Record all part and serial numbers from the packoff. If the pack off does not land according to the mark, pick up and verify seals are in good working order and re-land. ,If it does not land apply weight of the block not to exceed 15,000 lbs to over come the o-rings.
- After landing run in lower LDS to engage the pack off. Test void to 5,000 psi to verify the seals are operating correctly for 15 minutes.
  If good test is achieved un-J the pack off running tool and bring to floor.
- Rig down cementers and clean up. Clear rig floor.
- Test 7-in casing to 3,500 psi for 30-min and record on chart and IADC.
- PU BHA (7” 26# L80 drift = 6.151”) w/ csg scraper. RIH to top of cement, test 7” 26# L80 casing to 3,500 psi for 30-min and record on chart and IADC.

DRILL PRODUCTION HOLE #1 ; Step: 6, Phase: PROD1, Task: DRILL

1. Drill 6.125-in horizontal hole as per onsite geologist to a maximum total depth of **±4026-ft MD, 2110-ft.**
   - 6.125 wellbore inclination to be maintained at 87deg to end of hole section. (Base of Upper Barrow sandstone)
   - Max flowrate: 285-gpm as per 4.75-in MWD tool restriction.
   - Min flowrate: 220-gpm as per HES hole cleaning modeling.

CASE/PRODUCTION HOLE; Step: 7, Phase: COMP, Task: CASE
4.5-in Slotted Liner in Upper Barrow Gas Sand

1. RU to run 4-1/2" slotted liner as follows:

   a) 4-1/2" float shoe Bakerlok pin thread
   b) Slotted liner 4-1/2" 12.6-lb/ft L-80 (no centralizers on first 2 joints)
   c) Blank liner 4-1/2" 12.6-lb/ft L-80 Box x Pin to give a **150-ft liner lap**
   d) HES Liner Hanger and liner top packer with C-2 setting sleeve and 6' tieback extension
   e) **Liner running tool**
   f) 4.0-in drill pipe
   g) If required, use stands of two drill collars plus one joint of HWDP to provide additional weight when the liner reaches the open hole.

   - **Centralization:** Run two (2) 4-1/2" x 5.75-in rigid straight blade centralizers per joint with a welded stop collar between for the open hole section. Centralizers should be attached to float across half the length of the joint. These centralizers are to help combat differential sticking. This centralizer placement proposal is subject to change depending on hole conditions.

2. Run liner in hole on 4" drill string. Running speed should not exceed 90-ft/min to minimize surge pressure on the formation. **Set liner hanger +/-150-ft above the 7"** casing shoe such that hanger is not set in a severe dogleg or in the previous casing float collar.

RUN COMPLETION; Step: 8, Phase: COMP, Task: RUNCOM

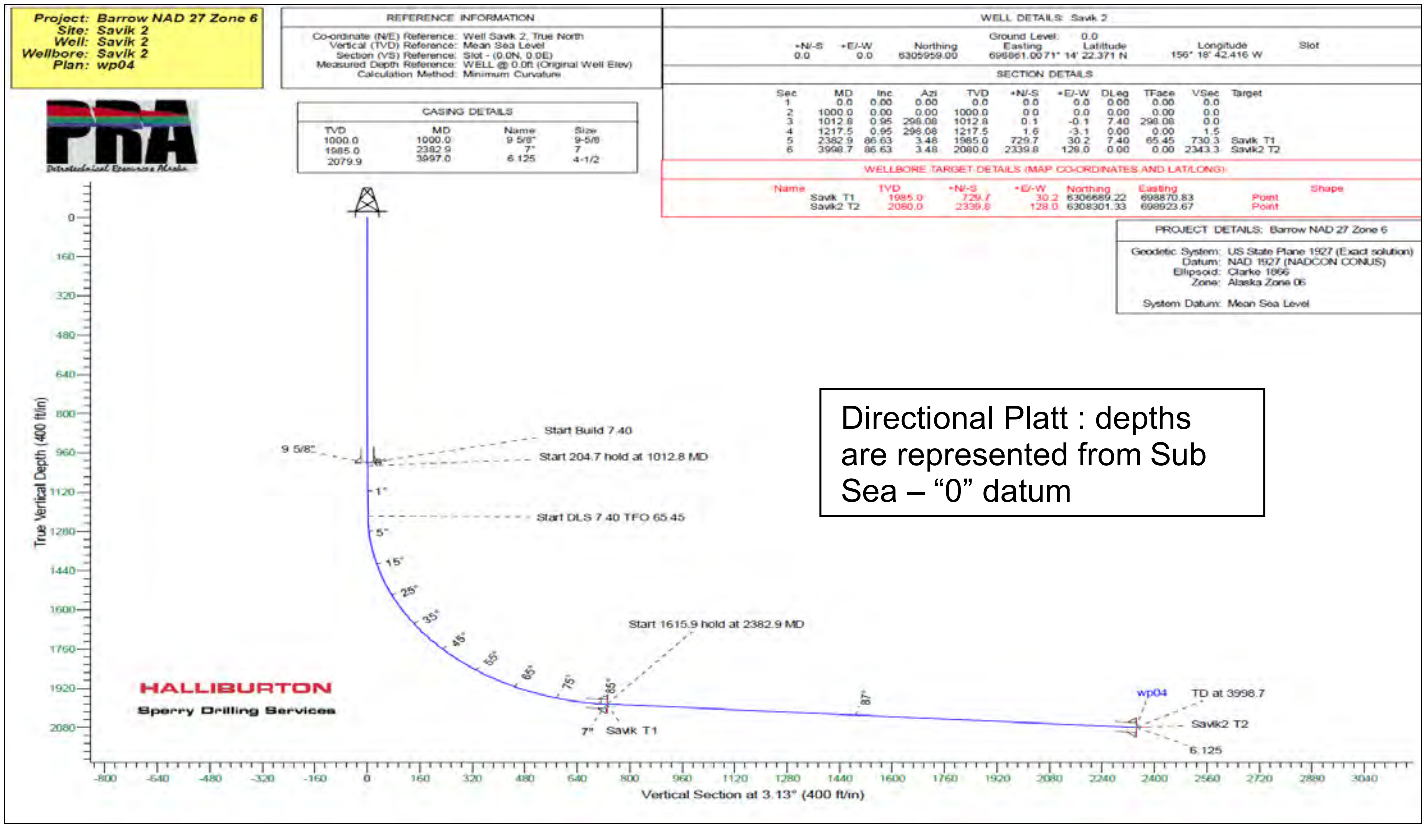
1. Rig up for running 2.875-in completion..
2. Run the following 2.875-in Completion: Reference ***<u>Running an DST Completion</u>*** RP.

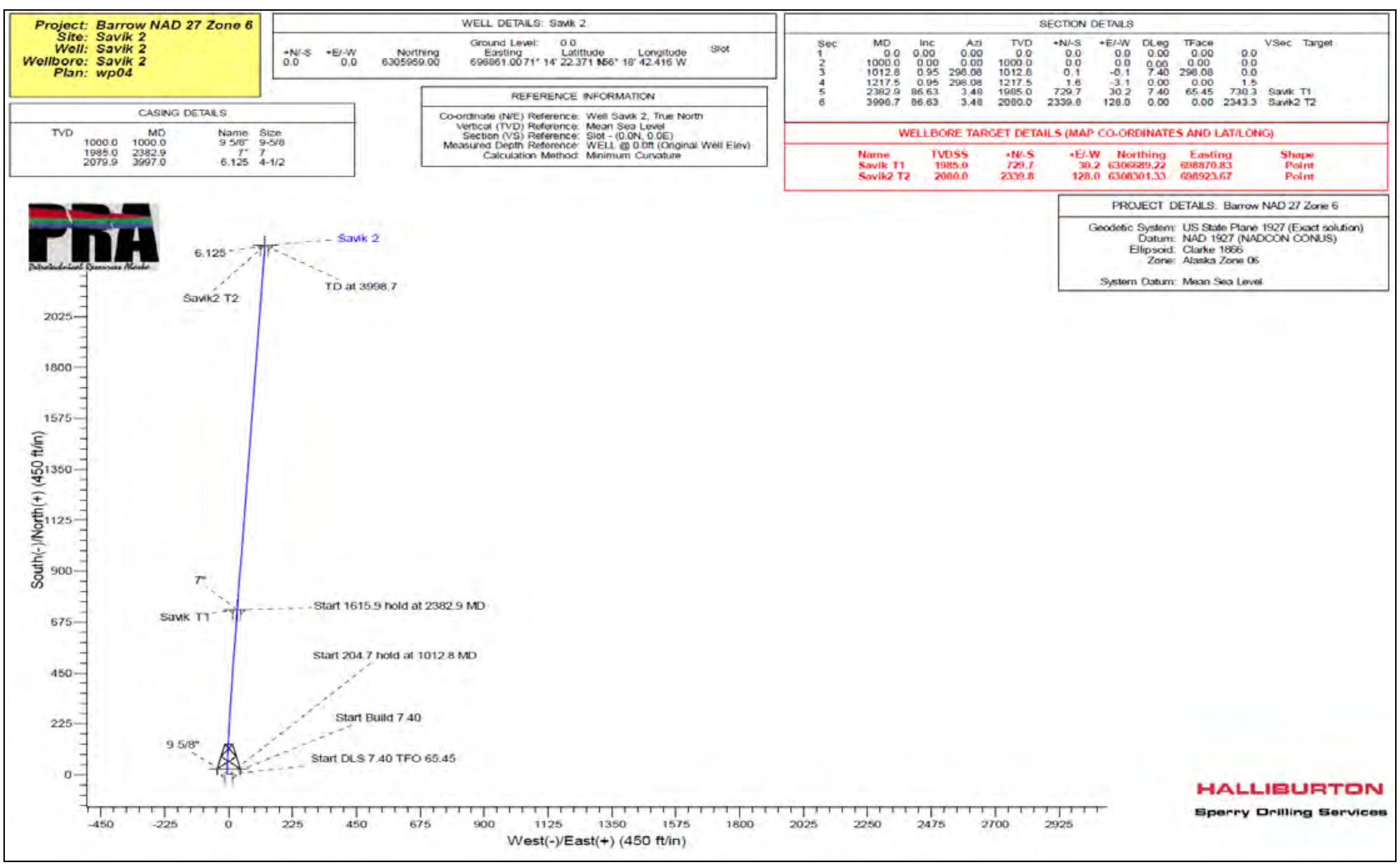
   - WLEG, 2-7/8” 6.5#, L-80
   - 10’ 2-7/8” 6.5#, L-80 Pup Joint
   - 1 Joint 2-7/8” 6.5#, L-80 EUE 8rd
   - XN Nipple (2.25” ID)
   - 2 Joint 2-7/8” 6.5#, L-80 EUE 8rd tubing
   - 10’ 2-7/8” 6.5#, L-80 Pup Joint
   - GLM 2-7/8” x 1” Side Pocket KBMM
   - 10’ 2-7/8” 6.5#, L-80 Pup Joint
   - 2-7/8” 6.5#, L-80 EUE 8rd tubing
   - 10’ 2-7/8” 6.5#, L-80 Pup Joint
   - GLM 2-7/8” x 1” Side Pocket KBMM
   - 10’ 2-7/8” 6.5# L-80 Pup Joint
   - 2-7/8” 6.5# L-80 EUE 8rd tubing
   - 2-7/8” 6.5# L-80 Pup Joints
   - Tubing Hanger

   A. Use Best-O-Life 2000 pipe dope for the non-premium threads, i.e. Buttress, EUE 8 round or EUE A/B MOD.
   B. The make up torque values for 2-7/8" L-80 6.5# EUE 8rd tubing are:
   Minimum: 1,730 ft-lb, Optimum: 2,300 ft-lb, and maximum: 2,800 ft-lb.
   C. The 2-7/8" L-80 6.5# EUE 8rd tubing performance properties are:
   Body Yield: 145,000#, Burst: 10,570 psi, Collapse: 11,160 psi.
3. Record PU and SO weights before landing hanger and record on daily operations report.

<u>RIG DOWN AND RELEASE RIG; Step: 14, Phase: COMP, Task: RIGD</u>

1. Install TWC and test to 2,500-psi. ND BOPE and NU lock down flange, tubing head adapter and Vetco Grey 5K carbon tree. Pressure test tubing head adapter and tree to 5,000-psi.
2. Pull TWC with lubricator. Set BPV.
3. Freeze protect well to 500-ft.
4. Freeze protect the 7-in x 9 5/8”-in casing down to 2,000-ft MD.
5. Complete a post -rig inspection with the Rockford Operation representative prior to the rig moving off the well.


Project: Barrow NAD 27 Zone 6
Site: Savik 2
Well: Savik 2
Wellbore: Savik 2
Plan: wp04
REFERENCE INFORMATION
Co-ordinate (N/E) Reference: Well Savik 2, True North
Vertical (TVD) Reference: Mean Sea Level
Section (VS) Reference: Slot - (0.0N, 0.0E)
Measured Depth Reference: WELL @ 0.0ft (Original Well Elev)
Calculation Method: Minimum Curvature
WELL DETAILS: Savik 2
CASING DETAILS
SECTION DETAILS
WELLBORE TARGET DETAILS (MAP CO-ORDINATES AND LAT/LONG)
PROJECT DETAILS: Barrow NAD 27 Zone 6
Geodetic System: US State Plane 1927 (Exact solution)
Datum: NAD 1927 (NADCON CONUS)
Ellipsoid: Clarke 1866
Zone: Alaska Zone 06
System Datum: Mean Sea Level
Directional Platt : depths are represented from Sub Sea – "0" datum
Start Build 7.40
Start 204.7 hold at 1012.8 MD
Start DLS 7.40 TFO 65.45
Start 1615.9 hold at 2382.9 MD
TD at 3998.7
Savik T1
Savik2 T2
wp04
HALLIBURTON
Sperry Drilling Services
True Vertical Depth (400 ft/in)
Vertical Section at 3.13° (400 ft/in)


Project: Barrow NAD 27 Zone 6
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Wellbore: Savik 2
Plan: wp04
WELL DETAILS: Savik 2
CASING DETAILS
REFERENCE INFORMATION
SECTION DETAILS
WELLBORE TARGET DETAILS (MAP CO-ORDINATES AND LAT/LONG)
PROJECT DETAILS: Barrow NAD 27 Zone 6
Savik 2
TD at 3998.7
Savik2 T2
Savik T1
Start 1615.9 hold at 2382.9 MD
Start 204.7 hold at 1012.8 MD
Start Build 7.40
Start DLS 7.40 TFO 65.45
HALLIBURTON
Sperry Drilling Services
South(-)/North(+) (450 ft/in)
West(-)/East(+) (450 ft/in)