ORISE
OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION
Managed by ORAU for the U.S. Department of Energy

April 9, 2012

Mr. John Hickman
Mail Stop: T-E18
Division of Waste Management
U.S. Nuclear Regulatory Commission
11545 Rockville Pike
Rockville, MD 20852

SUBJECT: FINAL REPORT—CONFIRMATORY SURVEY OF THE FUEL OIL TANK AREA, HUMBOLDT BAY POWER PLANT, EUREKA, CALIFORNIA
DCN: 5167-SR-01-0

Dear Mr. Hickman:

The Oak Ridge Institute for Science and Education (ORISE) performed confirmatory radiological survey activities on the former Fuel Oil Tank Area and other portions of the Humboldt Bay Power Plant as requested by the U.S. Nuclear Regulatory Commission (NRC) site representative. These survey activities were conducted during the period of February 14 and 15, 2012. Enclosed is the final report that summarizes ORISE's survey procedures and provides the results of the ORISE radiological survey activities. The surveys included gamma walkover scans, gamma direct measurements, and soil sampling.

My contact information is listed below, or you may contact Erika Bailey at 865.576.6659 or Tim Vitkus at 865.576.5073, should you require any additional information.

Sincerely,

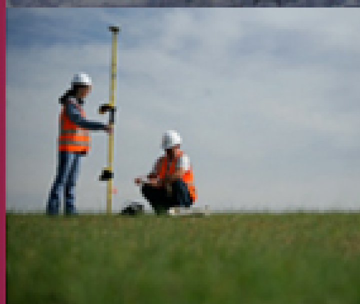
Wade C. Adams
Project Manager/Health Physicist
Independent Environmental Assessment
and Verification

WCA:fr

Enclosure

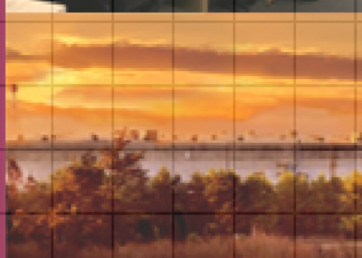
c:	G. Schlapper, NRC Region IV T. Carter, NRC HQ	R. Evans, NRC Region IV File 5167
electronic:	S. Roberts, ORISE/IEAV E. Bailey, ORISE/IEAV	T. Vitkus, ORISE/IEAV A. Hood, ORISE/IEAV

Telephone: 865.576.0065 Fax: 865.241.3497 E-mail: Wade.Adams@orau.org
P.O. Box 117 | Oak Ridge, TN 37831 | www.orise.orau.gov

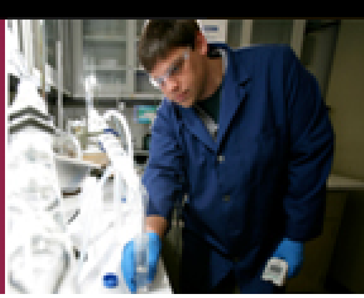
CONFIRMATORY SURVEY OF THE FUEL OIL TANK AREA HUMBOLDT BAY POWER PLANT EUREKA, CALIFORNIA

W. C. Adams



Prepared for the
U.S. Nuclear Regulatory Commission


ORISE



Approved for public release; further dissemination unlimited.

NOTICES

CONFIRMATORY SURVEY OF THE FUEL OIL TANK AREA
HUMBOLDT BAY POWER PLANT
EUREKA, CALIFORNIA

Prepared by

W. C. Adams

ORISE

Independent Environmental Assessment and Verification Program
Oak Ridge Institute for Science and Education
Oak Ridge, Tennessee 37831-0017

Prepared for the
U.S. Nuclear Regulatory Commission

FINAL REPORT

APRIL 2012

This report is based on work performed by the Oak Ridge Institute for Science and Education under contract number DE-AC05-06OR23100 with the Department of Energy.

Prepared by the Oak Ridge Institute for Science and Education, under interagency agreement (NRC FIN No. F1008) between the U.S. Nuclear Regulatory Commission and the U.S. Department of Energy.

THIS PAGE LEFT BLANK INTENTIONALLY

CONFIRMATORY SURVEY OF THE FUEL OIL TANK AREA
HUMBOLDT BAY POWER PLANT
EUREKA, CALIFORNIA

Prepared by: ______________________ Date: 4/9/12
W. C. Adams, Health Physicist/Project Manager
Independent Environmental Assessment
and Verification Program

Reviewed by: ______________________ Date: 4/9/2012
T. J. Vitkus, IEAV Survey Operations Director
Independent Environmental Assessment
and Verification Program

Reviewed by: ______________________ Date: 4/9/12
W. P. Ivey, Laboratory Group Manager
Independent Environmental Assessment
and Verification Program

Reviewed by: ______________________ Date: 4/9/2012
P. H. Benton, Quality Assurance Specialist
Independent Environmental Assessment
and Verification Program

Approved for release by: ______________________ Date: 4/9/2012
E. N. Bailey, Survey Projects Manager
Independent Environmental Assessment
and Verification Program

THIS PAGE LEFT BLANK INTENTIONALLY

CONTENTS

FIGURES

TABLES

ACRONYMS

CFR	Code of Federal Regulations
cpm	counts per minute
CSPW	Characterization Survey Planning Worksheet
DCGL	derived concentration guideline level
DQO	data quality objectives
ESI	Enercon Services, Incorporated
FOTA	Fuel Oil Tank Area
FSS	final status survey
GPS	global positioning system
GWS	gamma walkover scans
HBPP	Humboldt Bay Power Plant
HBRP	Humboldt Bay Repowering Project
IEAV	Independent Environmental Assessment and Verification
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	minimum detectable concentration
MeV	million electron volts
MWe	megawatt electric
NORM	naturally occurring radioactive material
NRC	U.S. Nuclear Regulatory Commission
OOL	Open Outside (of RCA) Land Area
ORAU	Oak Ridge Associated Universities
ORISE	Oak Ridge Institute for Science and Education
pCi/g	picocuries per gram
PG&E	Pacific Gas & Electric Company
RCA	radiological control area
RER	Replicate Error Ratio
ROC	radionuclide of concern
SAFSTOR	cold shutdown and safe storage
SOR	Sum-of-Ratios
SPCS	State Plane Coordinate System
SU	survey unit

THIS PAGE LEFT BLANK INTENTIONALLY

CONFIRMATORY SURVEY OF THE FUEL OIL TANK AREA HUMBOLDT BAY POWER PLANT EUREKA, CALIFORNIA

1. INTRODUCTION AND SITE HISTORY

The Pacific Gas & Electric Company (PG&E) operated the Humboldt Bay Power Plant (HBPP) Unit 3 nuclear reactor near Eureka, California under U.S. Atomic Energy Commission provisional license number Demonstration Power Reactor license DPR-7. HBPP Unit 3 achieved initial criticality in February 1963 and began commercial operations in August 1963. Unit 3 was a natural circulation boiling water reactor with a direct-cycle design. This design eliminated the need for heat transfer loops and large containment structures. Also, the pressure suppression containment design permitted below-ground construction. Stainless steel fuel claddings were used from startup until cladding failures resulted in plant system contamination—zircaloy-clad fuel was used exclusively starting in 1965 eliminating cladding-related contamination. A number of spills and gaseous releases were reported during operations resulting in a range of mitigative activities (see ESI 2008 for details).

In July 1973, Unit 3 was shut down for annual refueling and seismic modifications. However, by December 1980 it was concluded that completing the required upgrades and restarting Unit 3 would be cost prohibitive. PG&E decided in June 1983 to decommission Unit 3, received a possession-only license amendment, and placed the unit into cold shutdown and safety storage (SAFSTOR). Unit 3 is currently undergoing decommissioning. Decommissioning activities have also been completed on the adjacent fossil fuel Units 1 and 2, with all materials being removed to ground level. As part of the Humboldt Bay Repowering Project (HBRP), PG&E has built ten new fossil fuel units (16.3 MWe [megawatt electric] each) on the site in the vicinity of Unit 3.

Currently, PG&E has demolished the Fuel Oil Tank and has performed final status surveys (FSS) on the former Fuel Oil Tank Area (FOTA) soils. Hence, the U.S. Nuclear Regulatory Commission's (NRC's) Headquarters and Region IV Offices have requested that the Independent Environmental Assessment and Verification (IEAV) Program of the Oak Ridge Institute for Science and Education (ORISE) perform confirmatory surveys of the former FOTA excavation. Due to the small footprint of the site, the licensee has found it necessary to conduct surveys of the decontaminated survey areas and then backfill and/or pave those areas to allow for further decommissioning work. Therefore, the NRC requested that ORISE perform confirmatory surveys coincident with the licensee's surveys and soil sampling prior to backfilling. During the ORISE survey activities, the NRC also requested additional radiological survey activities consisting of gamma walkover scans (GWS) of the newly paved road along the north and east side of the site, the Unit 1 and Unit 2 concrete pads and the Northeast Laydown Area.

2. SITE DESCRIPTION

The HBPP site, owned by PG&E, consists of 143 acres on the southern edge of Humboldt Bay four miles southwest of the town of Eureka, in Humboldt County, in the State of California (Fig. A-1). PG&E maintains ten new operating electric generating units at the HBPP site (in the New Generation Footprint Area) that run on fossil fuels, two non-operating fossil fuel units (Units 1 and 2) and one non-operational nuclear unit (Unit 3). Units 1 and 2, which were recently decommissioned to ground level, were interconnected with and west of Unit 3 (ESI 2008). The remaining property includes mostly open areas and protected wetlands.

2.1 Fuel Oil tank Area (FOTA)

The FOTA, pictured in Figs. A-2 and A-3, covers approximately 6,500 square meters (m^2) and is located in the northwest section of the HBPP to the west of Units 1 and 2, north of the Intake Canal and south of the Independent Spent Fuel Storage Installation. Within the FOTA is a bermed soil area that contains some asphalt roadway on portions of the berm and concrete pads, which are positioned between an access ramp and metal stairs. With the exception of the areas that were remediated from under the tank and immediately adjacent to the tank due to hydrocarbon contamination, the soil remains at the level that existed when the fuel oil tank was present. FSS activities were performed on a section of the FOTA so that a portion of the FOTA could be used for a soil pile. ORISE did not perform any confirmatory activities of that portion of the FOTA. The FOTA is identified as an Open Outside (of the Radiological Control Area) Land Area (OOL) by PG&E. The survey unit (SU) designation is OOL10.

2.2 Unit 1 and Unit 2 Concrete Pads

The Unit 1 and Unit 2 concrete pads are located east of the FOTA and west of the Unit 3 (the Reactor Building). These were where the fossil fuel units once stood (Fig. A-2). Portions of these pad areas were in use for radiological waste container storage and as material laydown areas and these portions were therefore inaccessible.

2.3 NORTHEAST LAYDOWN AREA

The Northeast Laydown Area is located northeast of Unit 3 and the curve of the New Asphalt Roadway and west of the Discharge Canal (Fig. A-2). The area has been repaved with asphalt and at the time of the GWS, a portion of the area was inaccessible due to radiological waste containers and other radiological waste storage bins.

2.4 NEW ASPHALT ROADWAY

The New Asphalt Roadway stretches from an east/west direction at the northern portion of the site and curves to a north/south direction along the eastern portion of the site just east of Unit 3 and west of the Discharge Canal (Fig. A-2).

3. OBJECTIVES

The objective of the confirmatory side-by-side survey was to generate independent radiological data for use by the NRC in evaluating the adequacy and accuracy of the licensee's radiological soil sampling results from the FOTA. Data collected by ORISE and the licensee were reviewed to assess whether classifications based on the *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)* (NRC 2000) were appropriate; whether radionuclides of concern (ROCs) were detected above historically low levels in the HBRP footprint (i.e., averaged 0.38 picocuries per gram [pCi/g] for cesium-137 [Cs-137] and non-detected for all other ROCs); and, whether data quality were sufficient for comparison to generic NRC screening values and FOTA-specific derived concentration guideline levels (DCGLs).

During the ORISE confirmatory survey activities for the FOTA, the NRC site representative also tasked ORISE with performing GWS of three additional areas as stated in Section 1.

4. DOCUMENT REVIEW

ORISE has reviewed PG&E's *Characterization Survey Planning Worksheet* (CSPW) (PG&E 2012). Since the FOTA was classified as Class 3 SU as described in Section 5, it was PG&E's intention to use the data as FSS data in the event that the characterization survey findings met the classification criteria for a Class 3 SU. The characterization plan worksheet was specifically reviewed for historical information and to identify the ROCs and the applicable DCGLs for the FOTA. ORISE also reviewed preliminary FSS data for the soil pile area within the FOTA. The purpose of these reviews was to ensure that regulatory requirements were being met by PG&E and to develop the confirmatory survey plan. ORISE also ensured that the current FSS activities within the area were adequate and appropriate, taking into account any supporting documentation and MARSSIM guidance (NRC 2000).

5. DATA QUALITY OBJECTIVES

The ORISE independent confirmatory survey planning relies on the Data Quality Objectives (DQO) process to design and implement the confirmatory activities planned for the HBPP site. The DQO process includes the following seven steps:

- Step 1: State the problem
- Step 2: Identify the decisions
- Step 3: Identify inputs to the decisions
- Step 4: Define the study boundaries
- Step 5: Develop a decision rule
- Step 6: Specify the decision errors
- Step 7: Optimize the survey design

The confirmatory DQO steps for the HBPP site were as follows:

- Step 1, problem: The confirmatory survey must assess the reliability and adequacy of the HBPP FSS results.

- Step 2, decisions: Are HBPP procedures sufficiently robust to identify residual material with concentrations that exceed the DCGLs for the ROCs, and are the residual concentrations of the primary ROC, Cs-137, sufficiently low (at background levels)?

- Step 3, decisions inputs: The decision inputs included: 1) gamma walkover scan results, and 2) soil sample results and comparison of ORISE and PG&E soil sample concentrations.

- Step 4, study boundaries: The former FOTA is the study boundary.

- Step 5, decision rules: There were two decision rules. The first was based on the comparison of the confirmatory soil sample results to the HBPP FSS results and to the site cleanup goals. The second rule was based on surface scan and judgmental sample results to determine whether any residual "hot spots" were present and if the FOTA had been classified appropriately as Class 3.

- Step 6, decision errors: The gamma walkover scans and side-by-side split soil sample results should be in good agreement and soil sample results for the MARSSIM Class 3 Survey Unit should be at or near background levels and all ROCs below the CSPW survey design release criteria.

- Step 7, survey design optimization: The survey design was optimized to collect the appropriate data based on the procedures detailed below.

6. CONFIRMATORY RADIOLOGICAL SURVEY PROCEDURES

To expedite the survey process, ORISE coordinated and worked with the NRC site representative as the licensee planned their survey activities. This assured that ORISE would complete side-by-side confirmatory surveys at such a time as the licensee determined the probability of satisfying the FSS DQOs was high.

ORISE personnel visited the HBPP site from February 14 to 15, 2012 to perform visual inspections and independent measurements and sampling. The radiological survey activities were conducted in accordance with a project-specific plan submitted to and approved by the NRC, the ORISE *Survey Procedures Manual* and the Oak Ridge Associated Universities (ORAU) *Quality Program Manual* (ORISE 2012, 2008 and ORAU 2011).

6.1 Survey Unit Classification

PG&E classifies SUs in accordance with MARSSIM guidance (NRC 2000) with three classifications for impacted areas, based on contamination potential—as either Class 1, 2, or 3. The FOTA has been classified by PG&E as a Class 3 SU and the historical documentation supports this classification. Class 3 area are designated as any impacted areas that are not expected to contain residual contamination, or are expected to contain levels of residual contamination at a small fraction of the DCGL.

Although the FOTA is a Class 3 SU, ORISE confirmatory survey activities coverage within the FOTA SU were conservative and on the same order of rigor as the PG&E CSPW (PG&E 2012). The PG&E CSPW called for 100% gamma scan coverage of the FOTA. Also, a portion of the

FOTA had already been surveyed and soil samples had been collected by the licensee. This was done so that a dirt pile could be placed in this portion of the FOTA SU.

6.2 Reference System

Global positioning system (GPS) coordinates were used for referencing measurement and sampling locations. The specific reference system used by the licensee was the California State Plane Coordinate System (SPCS FIPS 0401 US Survey feet; North American Datum 83).

6.3 Surface Scans

High-density gamma radiation surface scans were conducted over the soil, concrete, and asphalt surfaces within the FOTA, the area of interest for this survey report (Fig. A-3). Surface scans were performed using sodium iodide thallium-activated (NaI[Tl]) scintillation detectors coupled to ratemeter-scalers with audible indicators. Detectors were also coupled to global positioning systems (GPSs) that enabled real-time gamma count rate and position data capture. Field personnel relied on the audio output to identify and mark any locations of elevated direct gamma radiation for further investigations that might suggest the presence of residual contamination.

6.4 Gamma Direct Measurements

A one-minute static gamma count rate measurement was performed at each of the twelve remaining characterization soil sample locations determined per PG&E for the FOTA (Fig. A-4). After each soil sample was collected, a post-sample one-minute static gamma count rate was performed. Pre- and post-sample gamma direct measurements were also performed at judgmentally-selected locations exhibiting elevated gamma radiation level as determined by surface scans (Fig. A-5).

6.5 Soil Sampling

6.5.1 Systematic Sample Locations

Twelve duplicate systematic surface samples, 0 to 15 cm each, were collected from the FOTA at locations predetermined in the PG&E CSPW (Fig. A-4). Although ORISE collected one of the duplicate samples in conjunction with PG&E personnel, the final number of soil samples retained for confirmatory analysis depended upon the ORISE gamma direct measurement results and/or the PG&E preliminary gamma spectroscopy analyses of the ORISE samples. Based on the ORISE review of the aforementioned data, four of the twelve systematic soil sample duplicates were retained for radiological analyses (PG&E samples OOL10-1, 2, 7, and 11 which corresponded to ORISE samples S001, 2, 7, and 11, respectively). Refer to Figs. A-4 and A-5, and Table B-1.

6.5.2 Judgmentally-Selected Sample Locations

Judgmental surface soil samples were collected at six locations of suspected elevated gamma radiation detected during the ORISE GWS of the FOTA surfaces (Fig. A-5). Since these were judgmental samples, ORISE requested each of these samples for independent analyses. These were ORISE samples S016 to S021 (Refer to Fig. A-5 and Table B-1).

6.6 INTERLABORATORY COMPARISON ANALYSES

Since some areas within the FOTA were covered with clean fill prior to ORISE gaining access, thus precluding direct confirmatory surveys for the soil pile area, ORISE requested that the three samples previously collected by PG&E (PG&E samples OOL10-4, 9, and 15, which were ORISE samples S004, 9, and 15, respectively) be provided to ORISE for interlaboratory comparison analysis.

7. ADDITIONAL RADIOLOGICAL SURVEY PROCEDURES

At the request of the NRC site representative, ORISE also performed limited, low-density radiological GWS of three other areas: the Unit 1 and Unit 2 remaining concrete pads (Fig. A-6), the Northeast Laydown Area (Fig. A-7), and the newly paved asphalt haul road (Fig. A-8). The additional surveys were to provide radiological scan data to ensure that radiological contamination was not being spread by continuing decommissioning activities of the Unit 3 reactor on previously released site surfaces as per the *Cross Contamination Prevention and Monitoring Plan* (CCPMP) (PG&E 2008).

8. RADIONUCLIDES OF CONCERN

The major ROC identified in the FOTA was Cs-137. A complete listing of ROCs and associated generic NRC Screening Values and FOTA-specific DCGLs are provided in Table 1. The soil DCGLs are reported in units of picocuries per gram (pCi/g).

Table 1. Derived Concentration Guideline Levels for Surface Soil Radionuclides of Concern Humboldt Bay Power Plant Eureka, California

Nuclide	NRC Screening Value DCGLs (pCi/g)[a]	FOTA-Specific DCGLs (pCi/g)[b]
Easy to Detect – Gamma Spectroscopy[c]		
Co-60	3.8	1.9
Nb-94	5.8	2.9
I-129	0.5	0.25
Cs-137	11	5.5
Eu-152	8.7	4.35
Eu-154	8	4
Np-237	—[d]	115
Hard to Detect – Wet Chemistry[e]		
H-3	110	55
C-14	12	6
Ni-59	5,500	2,750
Ni-63	2,100	1,050
Sr-90	1.7	0.85
Tc-99	19	9.5
Pu-238	2.5	1.25
Pu-239	2.3	1.15
Pu-240	—	1,240
Pu-241	72	36
Am-241	2.1	1.05
Cm-243	3.2	1.6
Cm-244	—	2,200
Cm-245	—	276
Cm-246	—	1,190

[a]Derived concentration guideline levels from NUREG-1757, Volume 1, Revision 1 Table B-2 (NRC 2003)
[b]DCGLs applied under the *Characterization Survey Planning Worksheet* for the HBPP FOTA correspond to the lesser of either an annual dose of 15 mrem/y (the 25 mrem/y DCGL adjusted to an assumed California Department of Toxic Substance Control risk-based release of 15 mrem/y) or 50% of the NRC Screening Values (PG&E 2012)
[c]Easy-to-detect radionuclide concentrations determined via gamma spectroscopy
[d]NRC Screening Value not provided
[e]Hard-to-detect radionuclide concentrations may be determined with wet chemistry analytical procedures based on the gamma spectroscopy results and with guidance from the NRC site representative

9. SAMPLE ANALYSIS AND DATA INTERPRETATION

Samples and data were returned to the ORISE laboratory in Oak Ridge, Tennessee for analysis and interpretation. Sample analyses were performed in accordance with the ORISE Laboratory Procedures Manual (ORISE 2011). Soil samples were analyzed by gamma spectroscopy with the primary ROC being Cs-137; however, spectra were also reviewed for other gamma-emitting radionuclides (i.e., fission and activation products) associated with the HBPP. After reviewing the gamma spectroscopy results, wet chemistry analyses for additional radionuclides such as Ni-63, Sr-90, and transuranics were deemed not necessary.

Soil sample results were reported in units of pCi/g. Gamma count rate measurement results were reported in units of counts per minute (cpm). The data generated were compared with the PG&E analytical results (specifically for Cs-137) and then with the CSPW survey design release criteria established for the primary site-specific ROC for the FOTA. All sample results were compared with the FOTA-specific applicable DCGL and MARSSIM guidance to determine if the FOTA Class 3 designation was appropriate. Additional information regarding instrumentation and procedures may be found in Appendices C and D.

10. FINDINGS AND RESULTS

The results for each radiological survey procedure component are discussed in the following sections.

10.1 DOCUMENT REVIEW

The ORISE reviews of PG&E's CSPW and preliminary radiological data indicated that the procedures and methods implemented were appropriate for the FOTA (PG&E 2012).

10.2 SURFACE SCANS

Gamma radiation surface scans identified six areas of elevated gamma radiation, primarily along the excavation trenches used to drain standing water from the site, along other surface water runoff areas, and at the asphalt entrance at the northeast corner of the berm. The gamma scan paths and the normalized count rate in cpm are provided in Fig. A-3. The gamma scans ranged from less than 3,800 to 11,390 cpm. Figure A-9 is the frequency histogram of the normalized walkover gamma count rate data population for the FOTA; the histogram indicates a normal distribution typical of the background concentrations associated with those areas. ORISE did observe slightly elevated gamma radiation levels over the ground surface where the standing water excavation trench dirt was piled. Further investigation indicated a natural soil strata layer deposit. The dark lines in the trench pictures (Fig. A-10) indicate the locations where the elevated gamma radiations were in the southern portion of the FOTA near where the former fuel tank used to be located.

The ORISE GWS data indicates that the low gamma radiation levels associated with the Class 3 SU is typical of background levels that ranged from 3,200 to 5,400 cpm over the various surfaces (soil, asphalt and concrete) within the FOTA.

10.3 Gamma Direct Measurements

Gamma direct measurements were performed at each soil sample location. The results indicated that gamma radiation levels were at or near background levels (3,500 cpm). ORISE selected soil samples from locations that exhibited the highest gamma radiation levels even though those locations were slightly above background levels.

10.4 Radionuclide Concentrations in Confirmatory Soil Samples

The summary data for the FOTA systematic and judgmental soil samples are presented in Table 2. The data for the radionuclide concentrations in individual samples are provided in Table B-1. All soil results for Cs-137 were less than the respective FOTA CSPW designed release criteria for each individual soil sample. Total uranium concentrations, as a naturally occurring radioactive material (NORM), are provided to account for the elevated gamma radiation levels determined by the GWS in the FOTA.

Table 2. Radionuclide Concentrations in FOTA Soil Samples Summary Results

Soil Sample Summary	Radionuclide Concentrations (pCi/g)				
	Cs-137	Co-60	U-235	U-238	Total U[a]
Systematic	0.03 to 0.37	-0.02 to 0.01	0.04 to 0.16	0.15 to 0.69	0.34 to 1.48
Mean Concentration	***0.26***	***0.00***[b]	***0.07***	***0.45***	***0.97***
Judgmental	-0.01 to 0.51	-0.01 to 0.01	-0.02 to 0.08	0.28 to 1.84	0.60 to 3.75
Mean Concentration	***0.14***	***0.00***	***0.04***	***0.82***	***1.69***

[a]Total U = U-238 * 2 + U-235
[b]Zero values due to rounding

ORISE also performed a comparison of the ORISE and PG&E soil samples results (Table B-2). PG&E's Cs-137 results, for those sample locations where both ORISE and PG&E provide analytical data, are in good agreement and indicate that the FOTA Cs-137 concentrations are at background levels.

10.5 Radionuclide Concentrations in Interlaboratory Comparison Analyses Soil Samples

The results of the interlaboratory comparison soil samples indicate that the ORISE and PG&E radiological soil sample results are in good agreement. The comparison soil sample results are presented in Table B-3.

11. COMPARISON OF RESULTS WITH RELEASE CRITERIA

The applicable site-specific soil DCGLs for the ROCs are provided in Table 1 and have been approved by the NRC (ESI 2007). The primary ROC for the FOTA, as designated by the CSPW, was Cs-137. To demonstrate compliance with the Table 1 FOTA-specific criteria, each radionuclide concentration should be less than its respective DCGL—with consideration for small areas of elevated activity—as well as application of the unity rule (Sum-of-Ratios [SOR]). The unity rule requires that the sum of the concentration of each contaminant divided by the respective guideline be less than one.

$$SOR = \frac{Conc_1}{DCGL_1} + \frac{Conc_2}{DCGL_2} + \cdots + \frac{Conc_n}{DCGL_n} \leq 1$$

Cs-137 and Co-60 were the only identified ROCs in the ORISE-analyzed soil samples. ORISE also reported the uranium concentrations to determine the natural concentrations associated with the NORM soil strata determined in the FOTA. Radionuclide concentrations in soil samples were directly compared with the Cs-137 DCGLs provided in Table 1. ORISE did not apply the unity rule/SOR in the activity calculations for each of the soil samples since the primary ROC, Cs-137, was well below the release criteria and a review of the gamma spectroscopy data did not indicate any other easy-to-detect ROC other than Co-60. Each of the 13 soil samples analyzed by ORISE was below the individual Cs-137 FOTA-specific release criteria.

12. ADDITIONAL RADIOLOGICAL SURVEY ACTIVITIES

12.1 Unit 1 and Unit 2 - Gamma Walkover Scans

GWS over the Unit 1 and Unit 2 concrete pads indicated a gamma count rate range from less than 3,300 to approximately 13,000 cpm. The elevated gamma radiation levels were determined to be from shine when the surveyor was in the proximity of radiological waste containers and the radwater waste treatment facility. Elevated gamma radiation levels were not found on the portion of the concrete pads that were scanned. The GWS results are presented in Fig. A-6 and the GWS frequency histogram is provided in Fig. A-11.

12.2 Northeast Laydown Area - Gamma Walkover Scans

GWS over the Northeast Laydown Area asphalt pad indicated a gamma count rate range from less than 3,000 to approximately 21,000 cpm. The elevated gamma radiation levels were determined to be from shine when the surveyor was in the proximity of radiological waste containers and other wrapped radiological waste. The highest count rate was on a piece of equipment that had been determined to an X-bar equipment lift; this piece of equipment was determined to not be tagged with a radiological identification tag). Elevated gamma radiation levels were not found on the portion of the Northeast Laydown Area asphalt pad that was scanned. The GWS results and a picture of the X-bar are presented in Fig. A-7 and the GWS frequency histogram is provided in Fig. A-12.

12.3 New Asphalt Roadway - Gamma Walkover Scans

GWS over the new asphalt roadway indicated a gamma count rate range from less than 3,400 to approximately 11,000 cpm. The elevated gamma radiation levels were determined to be from shine when the surveyor was in the proximity of radiological waste containers and the radiological cleanup work associated with the reactor decommissioning. Elevated gamma radiation levels were not found on the portion of the asphalt roadway that was scanned. The GWS results are presented in Fig. A-8 and the GWS frequency histogram is provided in Fig. A-13.

13. SUMMARY

During the period of February 14 to 15, 2012, ORISE performed radiological confirmatory survey activities for the former FOTA and additional radiological surveys of portions of the HBPP site in Eureka, California. The radiological survey results demonstrate that residual surface soil contamination was not present significantly above background levels within the FOTA. Therefore, it is ORISE's opinion that the radiological conditions for the FOTA surveyed by ORISE (refer to Tables 2 and B-1) are commensurate with the site release criteria for final status surveys as specified in PG&E's *Characterization Survey Planning Worksheet* (PG&E 2012). In addition, the confirmatory results indicated that the ORISE FOTA SU Cs-137 mean concentrations results compared favorably with the PG&E FOTA Cs-137 mean concentration results, as determined by ORISE from the PG&E characterization data (refer to Table B-2). The interlaboratory comparison analyses of the three soil samples analyzed by PG&E's onsite laboratory and the ORISE laboratory indicated good agreement for the sample results and provided confidence in the PG&E analytical procedures and FSS soil sample data reporting (Table B-3).

10. REFERENCES

Enercon Services, Inc. (ESI) 2007. *Site Characterization Plan – Humboldt Bay Power Plant*. HBPP-PP-003, Rev. 0. July 16.

ESI 2008. *Historical Site Assessment*, prepared for the Humboldt Bay Power Plant Pacific Gas & Electric Company, Eureka, California. Draft. September.

Pacific Gas & Electric Company (PG&E) 2008. *Cross Contamination Prevention and Monitoring Plan*. Prepared for the Humboldt Bay Power Plant, Pacific Gas & Electric Company, Eureka, California. HBAP C-220. October 14.

PG&E 2012. *Characterization Survey Planning Worksheet*. Prepared for the Humboldt Bay Power Plant, Pacific Gas & Electric Company, Eureka, California. Draft; Revision 3. February 9.

Oak Ridge Associated Universities (ORAU) 2011. *Quality Program Manual for the Independent Environmental Assessment and Verification Program.* Oak Ridge, Tennessee. December 1.

Oak Ridge Institute for Science and Education (ORISE) 2008. *Survey Procedures Manual for the Independent Environmental Assessment and Verification Program*. Oak Ridge, Tennessee. May 1.

ORISE 2010. *Radiation Protection Manual.* Oak Ridge, Tennessee. June 3.

ORISE 2011. *Laboratory Procedures Manual for the Independent Environmental Assessment and Verification Program.* Oak Ridge, Tennessee. December 1.

ORISE 2012. *Final Project-Specific Plan for the Independent Confirmatory Survey of the Former Fuel Oil Tank Area at the Humboldt Bay Power Plant, Eureka, California*. DCN: 5167-PL-01-0. Oak Ridge, Tennessee. February 9.

U.S. Nuclear Regulatory Commission (NRC) 2000. *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), NUREG-1575; Revision 1*. Washington, DC. August.

NRC 2003. *Consolidated NMSS Decommissioning Guidance: Decommissioning Process for Materials Licensees. NUREG-1757; Volume 1, Revision 1*. Washington, DC. September.

THIS PAGE LEFT BLANK INTENTIONALLY

APPENDIX A
FIGURES

THIS PAGE LEFT BLANK INTENTIONALLY

Fig. A-1. Site Location Map – Humboldt Bay Power Plant, Eureka, California

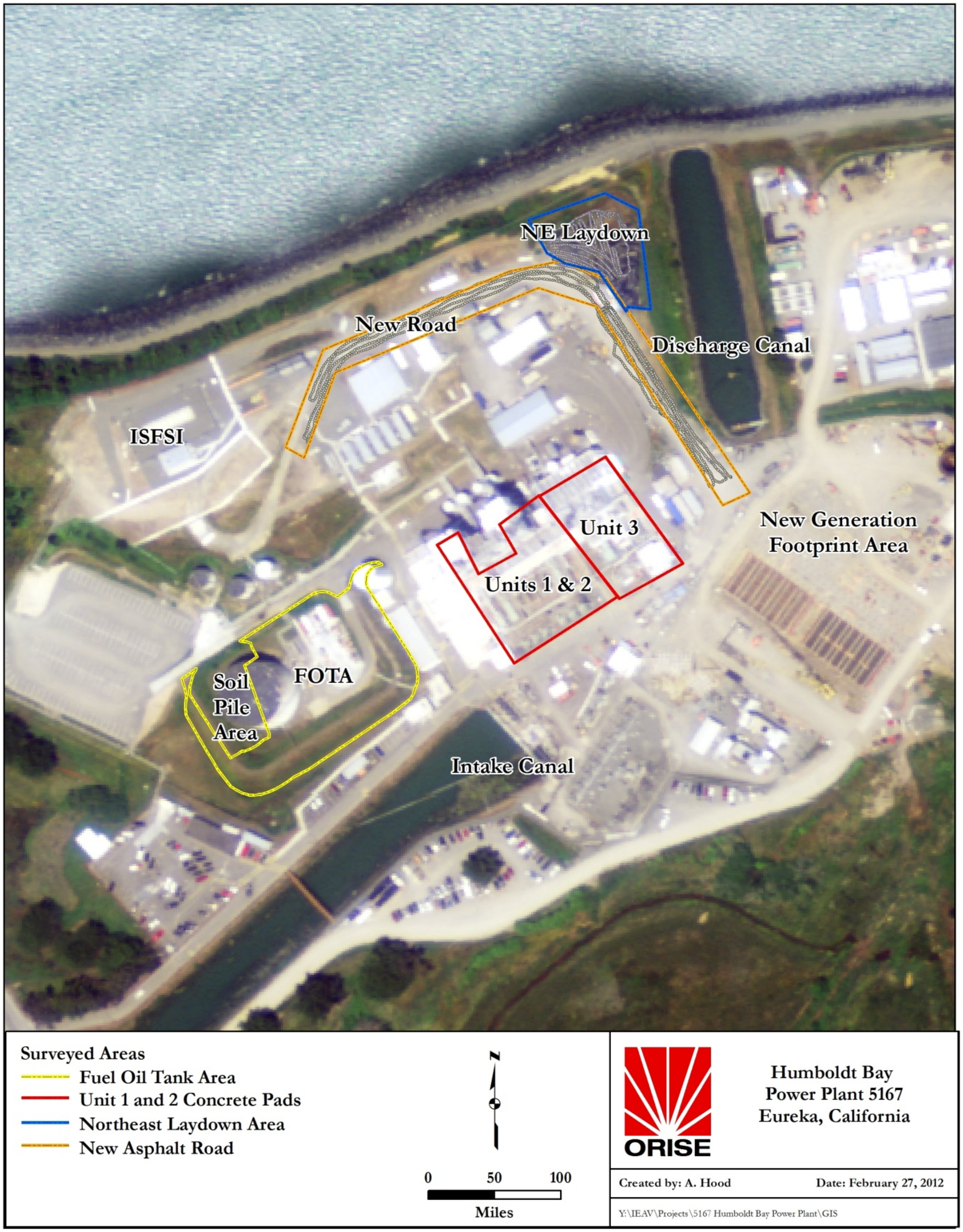


Fig. A-2. Humboldt Bay Power Plant – Site Overview of Surveyed Areas

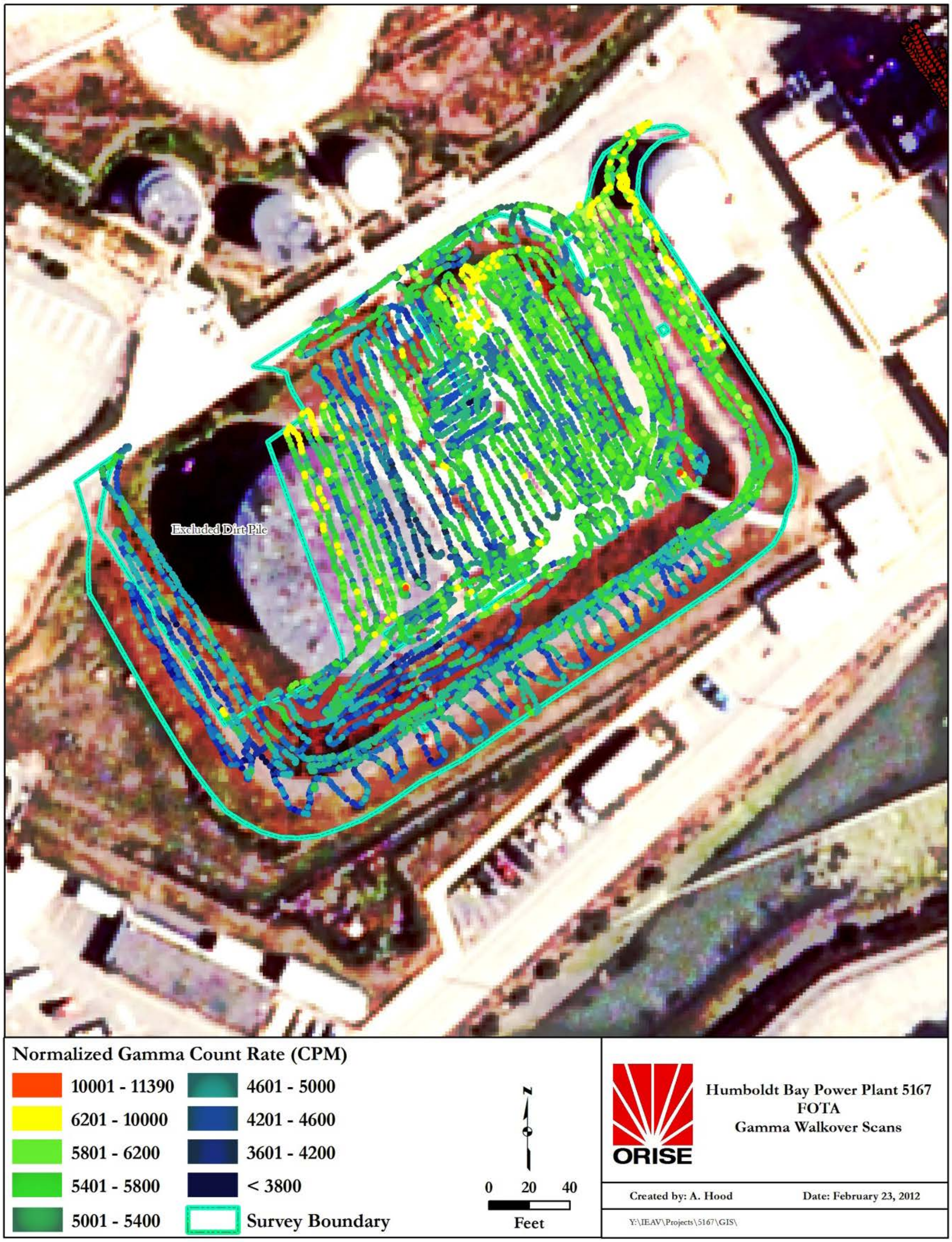


Fig. A-3. HBPP Fuel Oil Tank Area – Gamma Walkover Scans

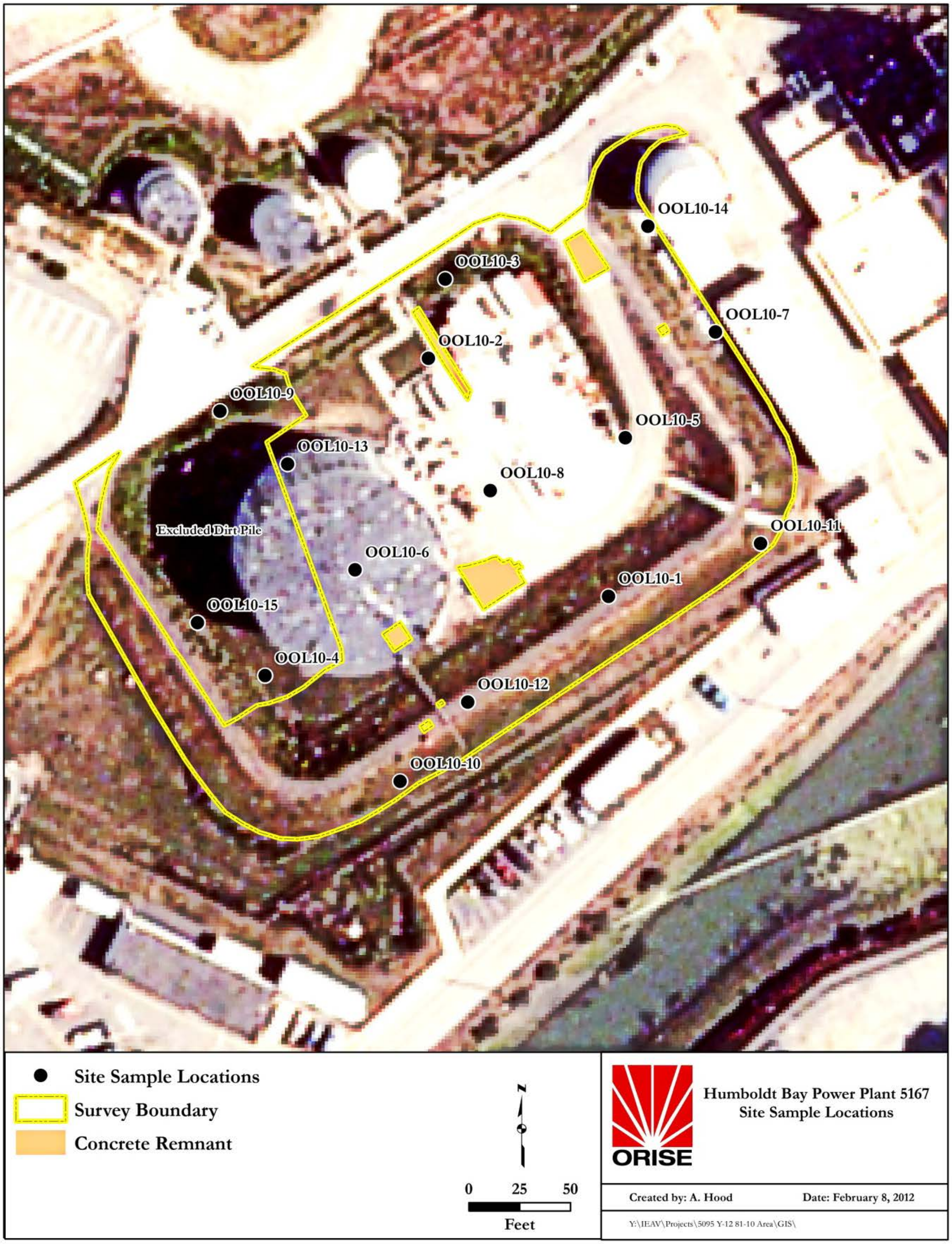


Fig. A-4. HBPP FOTA - PG&E Systematic Soil Sample Locations

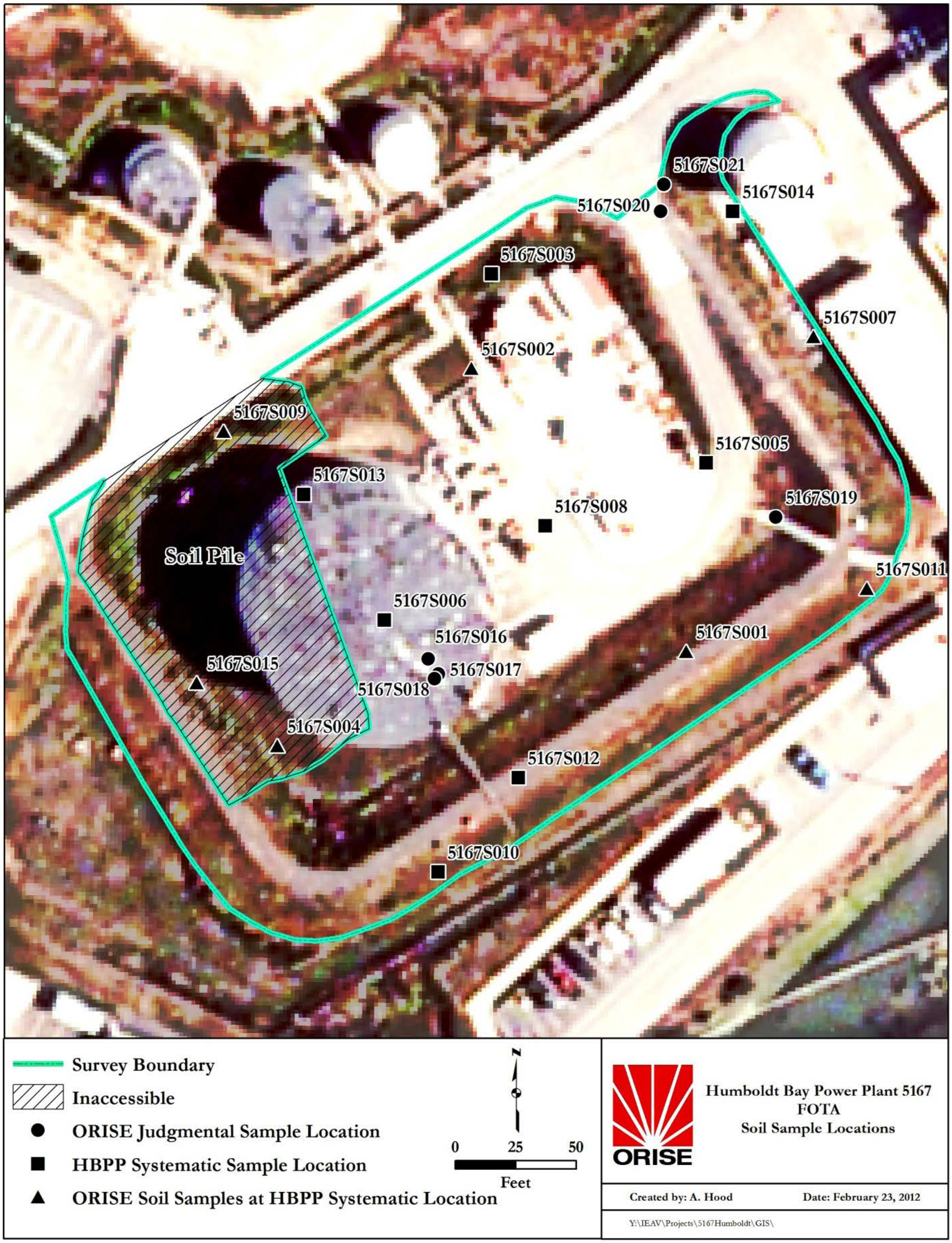


Fig. A-5. HBPP FOTA - Confirmatory Soil Sample Locations

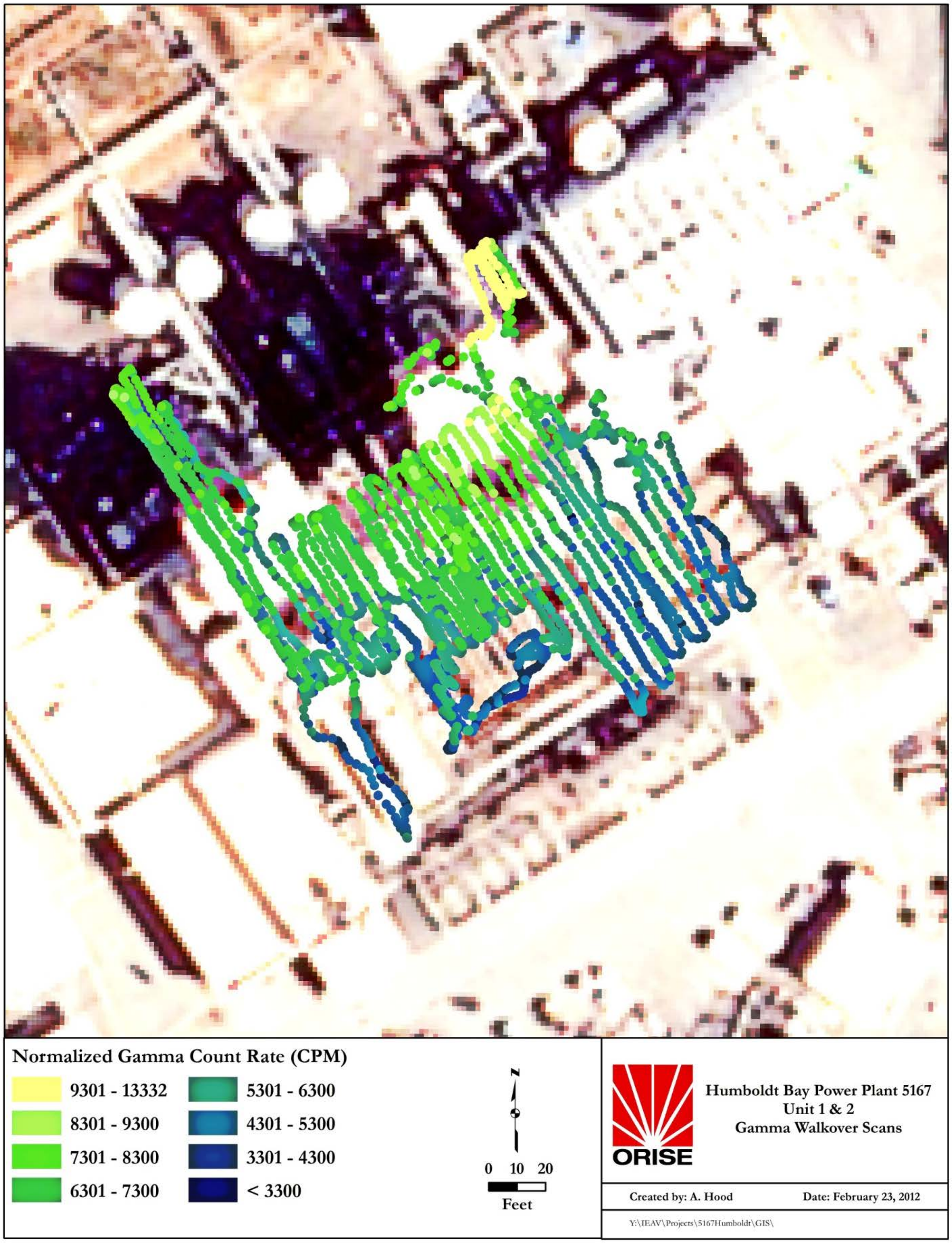


Fig. A-6. HBPP Unit 1 and Unit 2 Concrete Pads – Gamma Walkover Scans

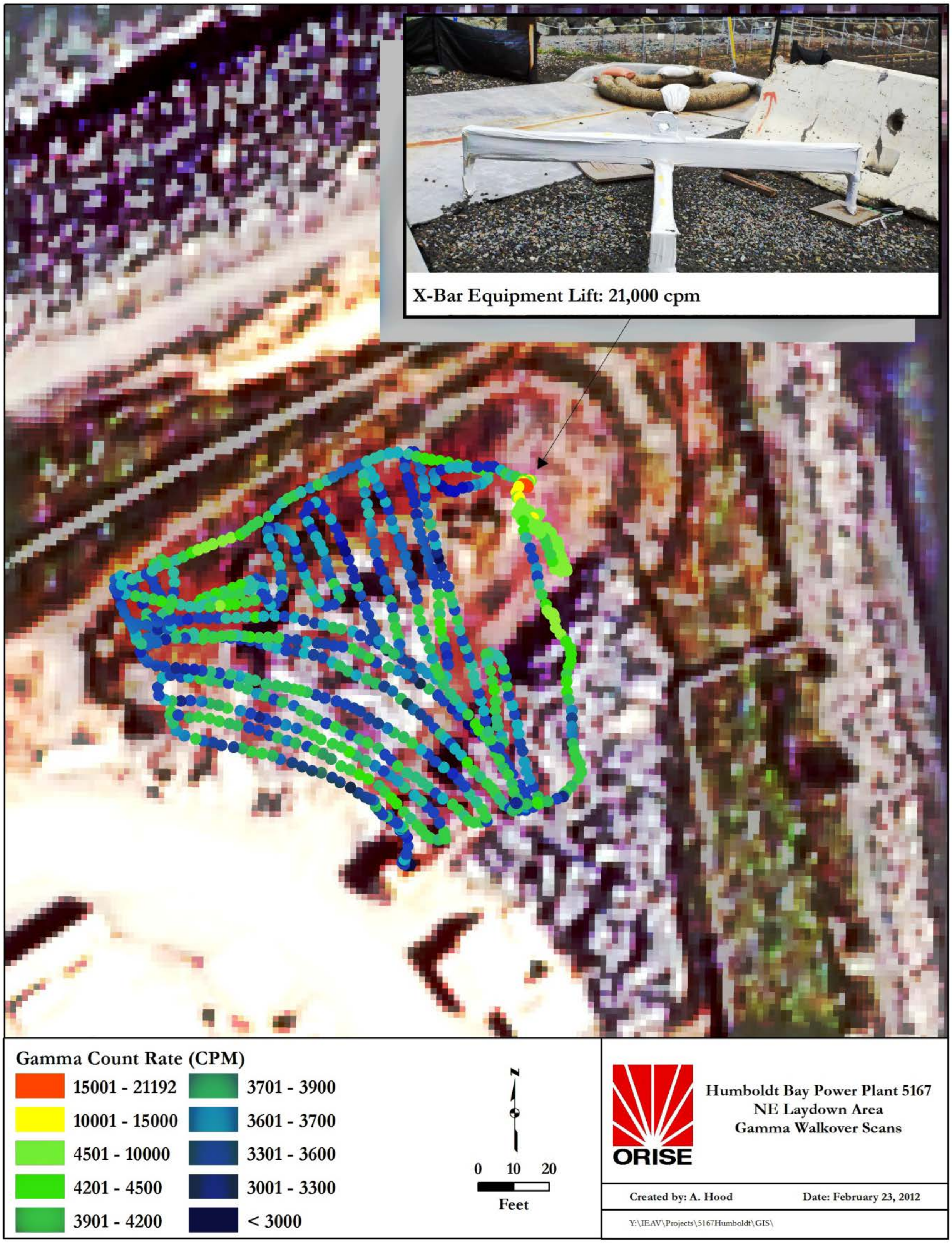


Fig. A-7. HBPP Northeast Laydown Area – Gamma Walkover Scans

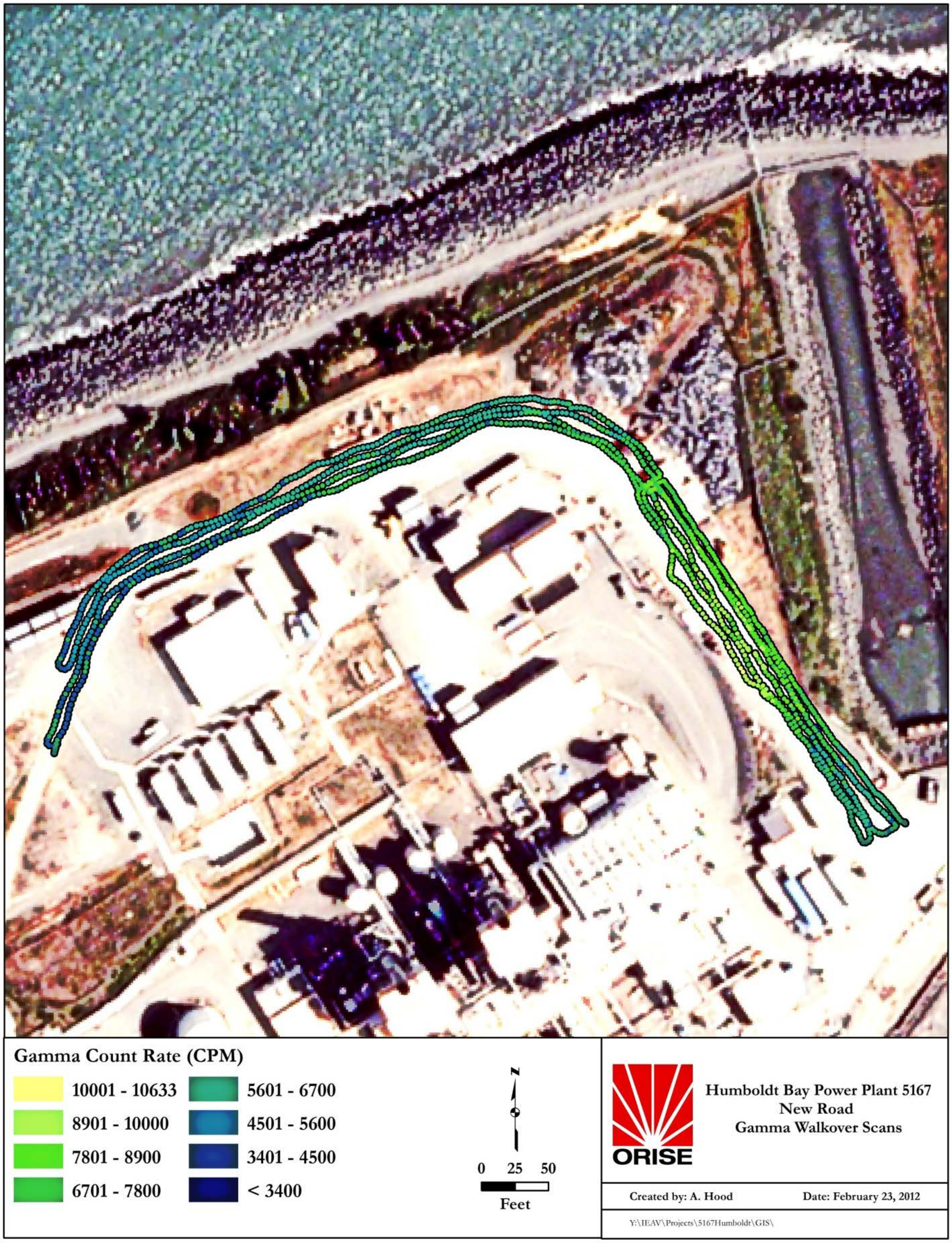
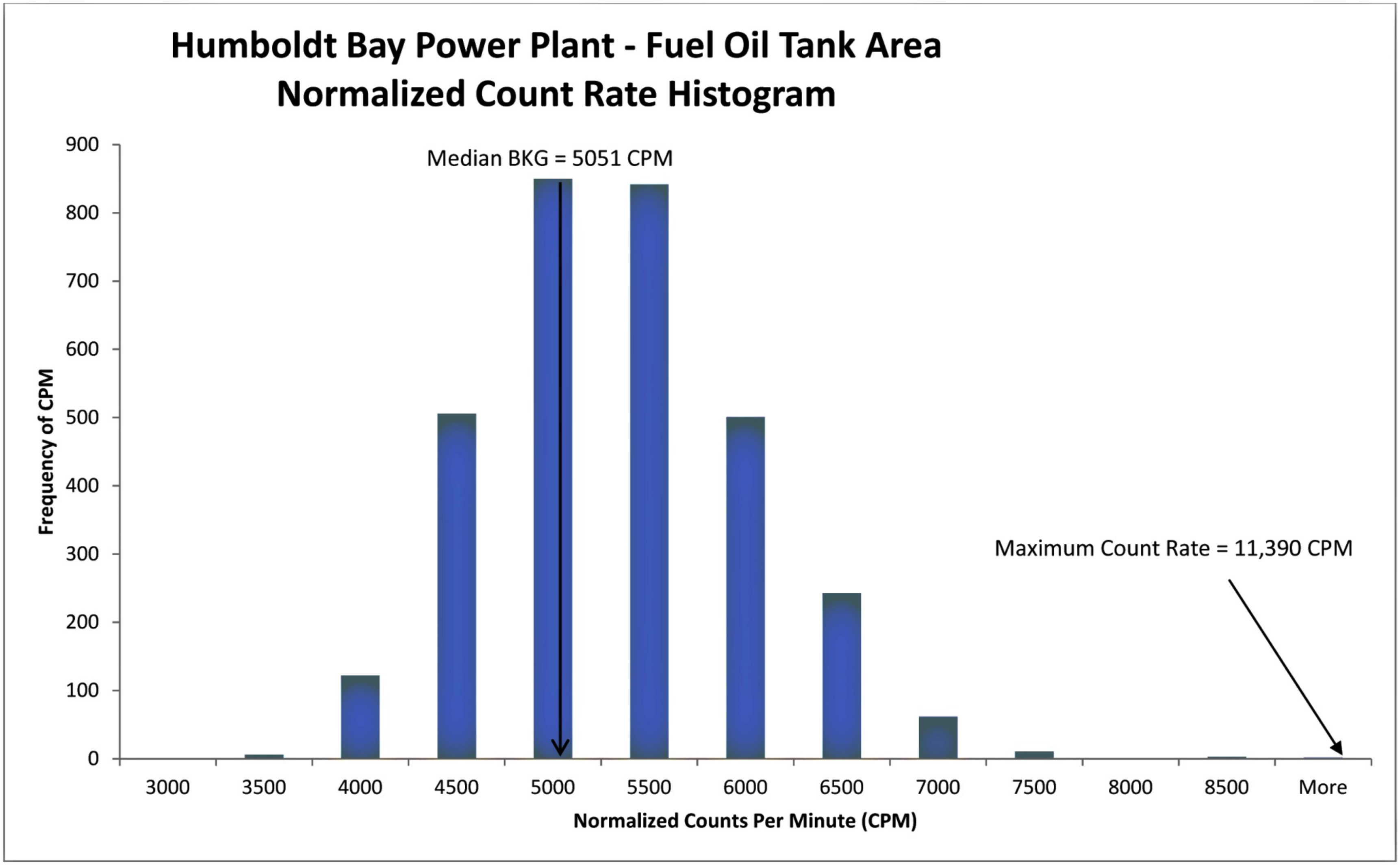


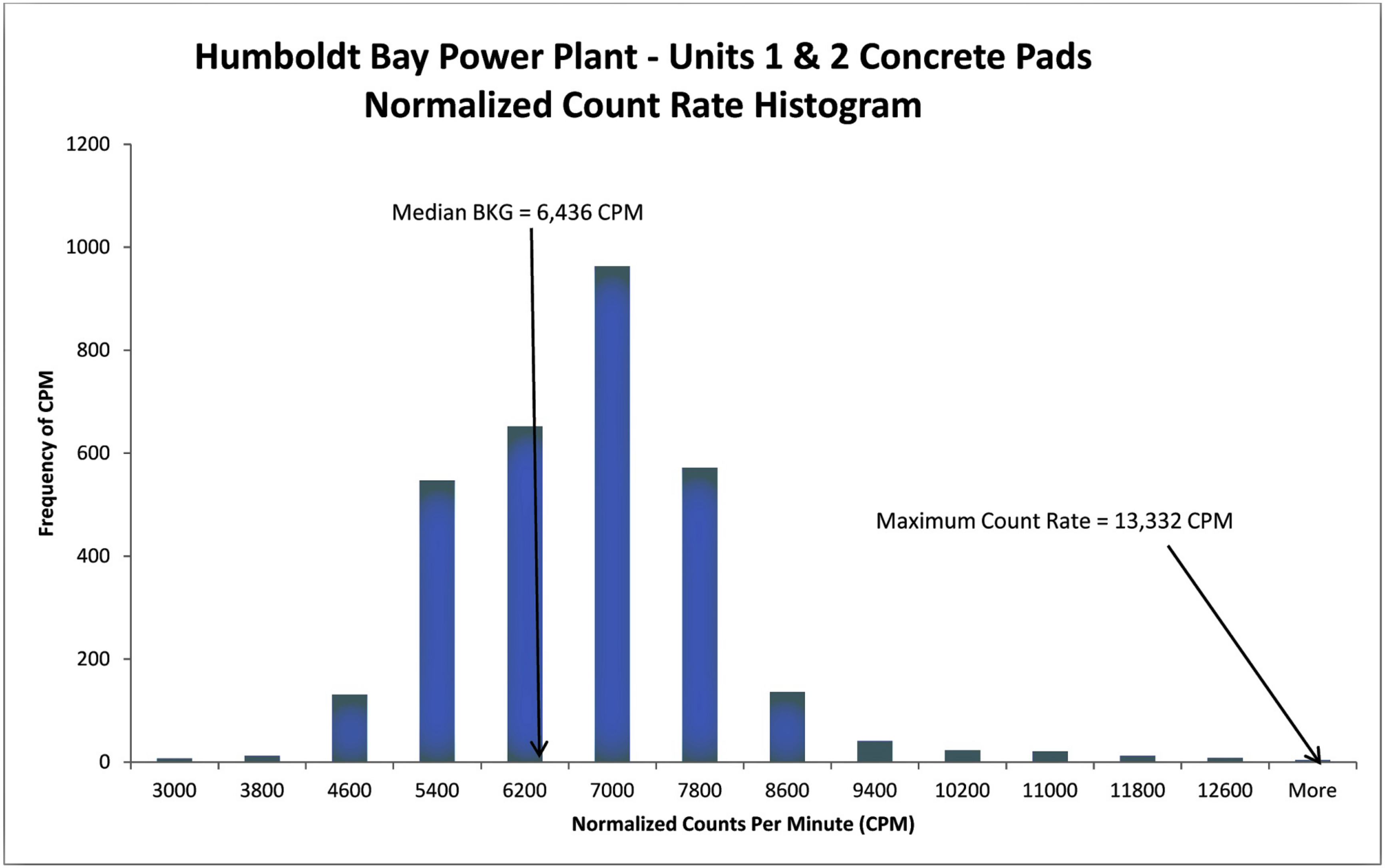
Fig. A-8. HBPP New Asphalt Roadway – Gamma Walkover Scans



BKG = background

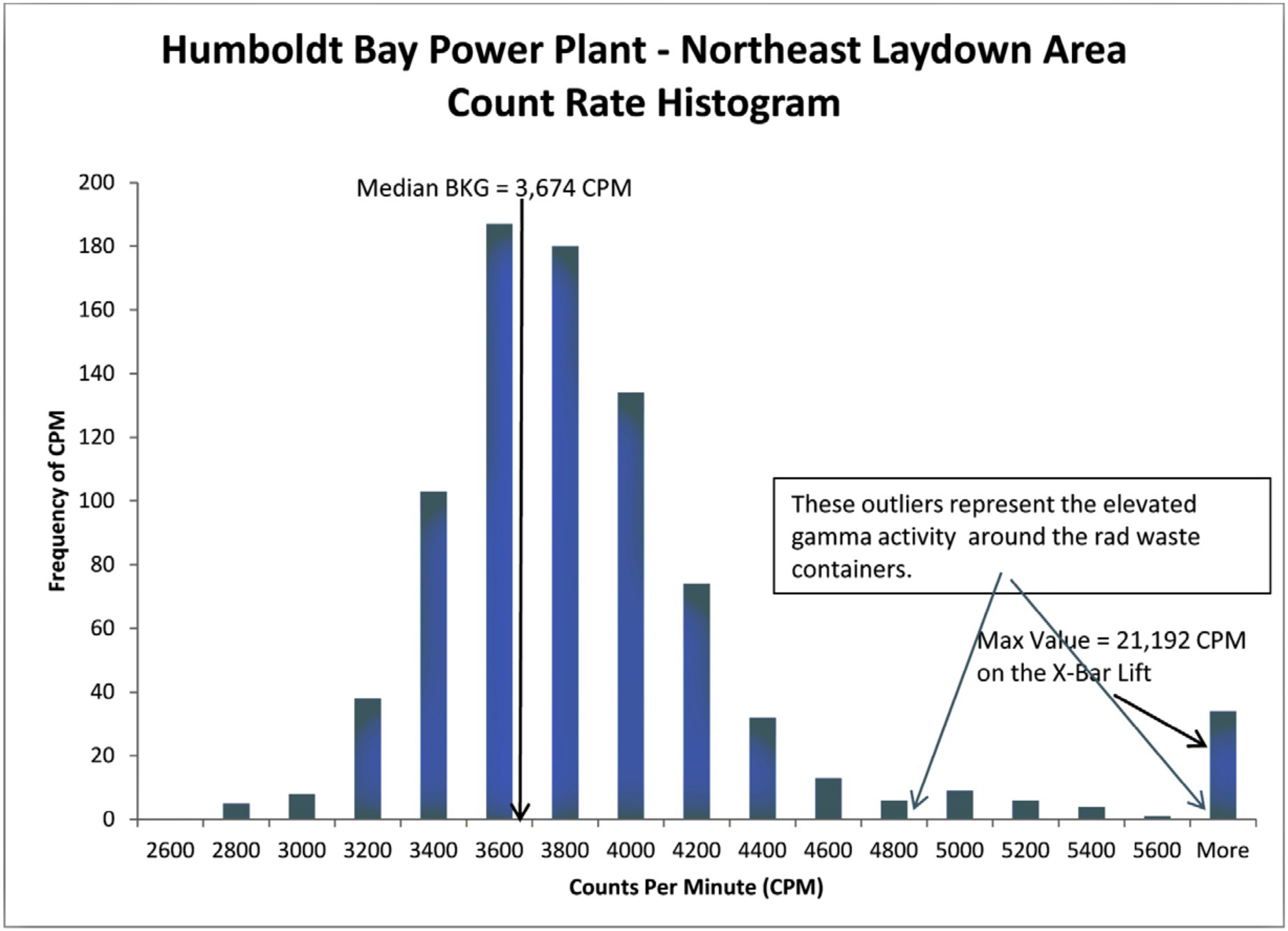
Fig. A-9. HBPP Fuel Oil Tank Area – Gamma Scan Count Rate Distribution

Fig. A-10. Fuel Oil Tank Area – Pictures of the Natural Strata Layer that Exhibited Elevated Gamma Radiation Levels



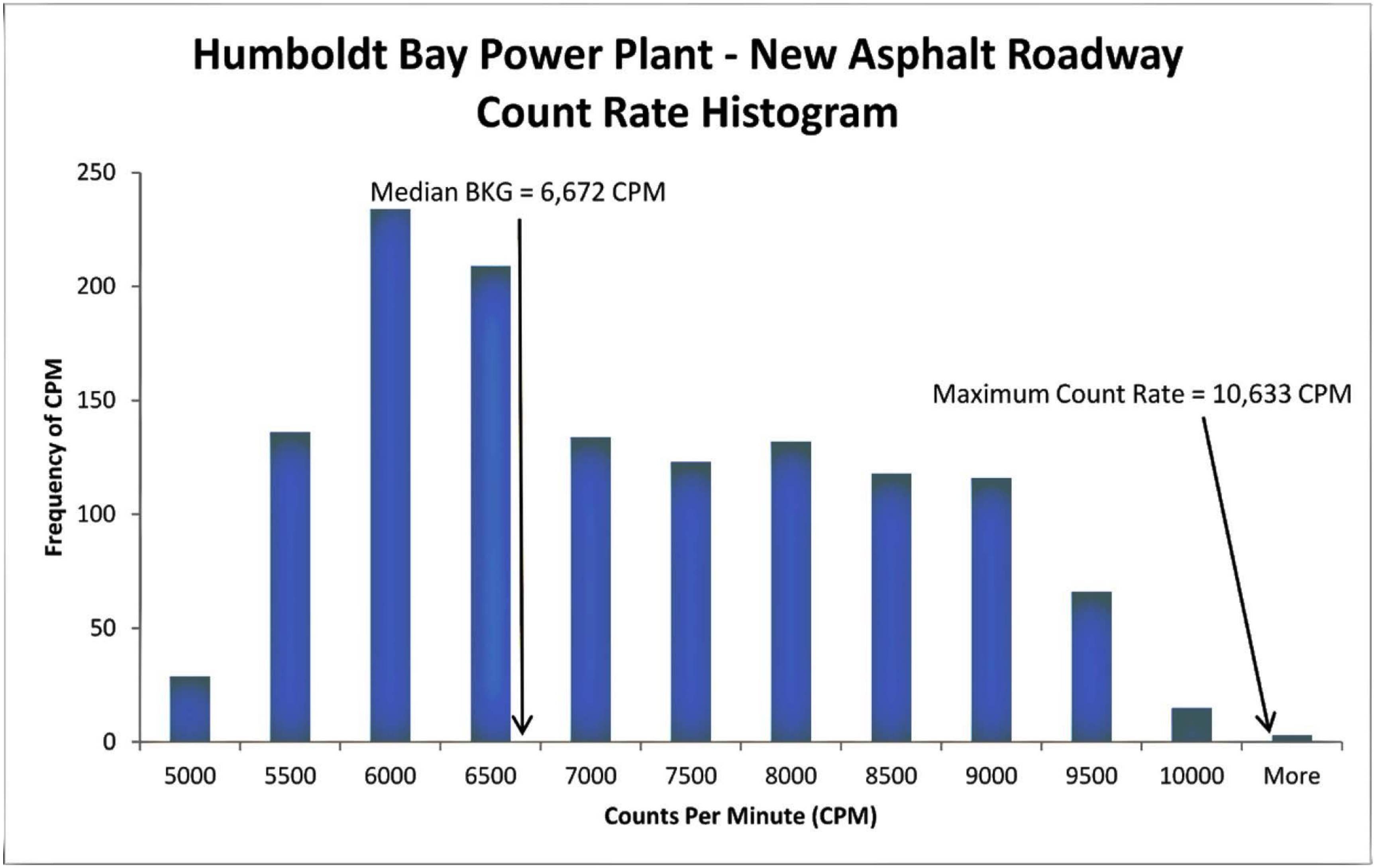
BKG = background

Fig. A-11. HBPP Units 1 & 2 Concrete Pads – Gamma Scan Count Rate Distribution



BKG = background

Fig. A-12. HBPP Northeast Laydown Area Asphalt Pad – Gamma Scan Count Rate Distribution



BKG = background

Fig. A-13. HBPP New Asphalt Roadway – Gamma Scan Count Rate Distribution

THIS PAGE LEFT BLANK INTENTIONALLY

APPENDIX B
TABLES

THIS PAGE LEFT BLANK INTENTIONALLY

Table B-1. Radionuclide Concentrations in ORISE Soil Samples
Confirmatory Survey Activities for the Fuel Oil Tank Area
Humboldt Bay Power Plant
Eureka, California

Sample ID[a]	East (ft)	North (ft)	Cs-137	Co-60	U-235	U-238	Total U[b]
Humboldt Bay Systematically-Selected Soil Sample Locations							
S001	5949071	2160777	0.03 ± 0.02[c]	-0.01 ± 0.04	0.07 ± 0.06	0.26 ± 0.28	0.59 ± 0.56
S002	5948982	2160894	0.30 ± 0.04	0.01 ± 0.04	0.05 ± 0.14	0.52 ± 0.32	1.09 ± 0.66
S004	5948902	2160738	0.25 ± 0.04	0.00[d] ± 0.04	0.04 ± 0.08	0.24 ± 0.33	0.52 ± 0.66
S007	5949124	2160907	0.37 ± 0.04	0.00 ± 0.03	0.06 ± 0.11	0.67 ± 0.33	1.40 ± 0.67
S009	5948880	2160868	0.20 ± 0.02	0.01 ± 0.03	0.16 ± 0.11	0.59 ± 0.21	1.34 ± 0.43
S011	5949146	2160803	0.34 ± 0.04	0.00 ± 0.04	0.10 ± 0.08	0.69 ± 0.32	1.48 ± 0.64
S015	5948869	2160764	0.35 ± 0.04	-0.02 ± 0.04	0.04 ± 0.11	0.15 ± 0.36	0.34 ± 0.73
FOTA Average			*0.26*	*0.00*	*0.07*	*0.45*	*0.97*
FOTA Standard Deviation			*0.12*	*0.01*	*0.04*	*0.22*	*0.47*
ORISE Judgmental Soil Sample Locations							
S016	5948965	2160774	0.02 ± 0.01	0.00 ± 0.03	0.08 ± 0.06	0.72 ± 0.30	1.52 ± 0.60
S017	5948969	2160768	0.00 ± 0.03	0.00 ± 0.04	0.08 ± 0.06	1.11 ± 0.34	2.30 ± 0.68
S018	5948967	2160766	-0.01 ± 0.03	0.01 ± 0.05	0.07 ± 0.09	1.84 ± 0.42	3.75 ± 0.84
S019	5949108	2160832	0.29 ± 0.03	-0.01 ± 0.03	-0.02 ± 0.13	0.58 ± 0.24	1.14 ± 0.50
S020	5949061	2160958	0.01 ± 0.02	0.00 ± 0.03	0.04 ± 0.09	0.28 ± 0.23	0.60 ± 0.47
S021	5949062	2160970	0.51 ± 0.05	0.00 ± 0.04	-0.01 ± 0.12	0.41 ± 0.27	0.81 ± 0.55
Judgmental Average			*0.27*	*0.00*	*0.04*	*0.82*	*1.69*

[a]Refer to Figs. A-4 and A-5
[b]Total Uranium calculations for natural uranium were 2*U-238 + U-235
[c]Uncertainties represent the 95% confidence level, based on total propagated uncertainties
[d]Zero values are due to rounding

Table B-2. Fuel Oil Tank Area Comparison Data
Confirmatory Survey Activities for the Fuel Oil Tank Area
Humboldt Bay Power Plant
Eureka, California

ORISE Sample ID[a]	PG&E Sample ID[b]	East (ft)	North (ft)	Cs-137 Concentrations (pCi/g)		Relative Error Ratio (RER)[d]
				ORISE	PG&E[c]	
Humboldt Bay Systematically-Selected Soil Sample Locations						
S001	OOL10-1	5949071	2160777	0.03 ± 0.02[e]	<0.120	—[f]
S002	OOL10-2	5948982	2160894	0.30 ± 0.04	0.322 ± 0.080	0.25
S003	OOL10-3	5948991	2160933	— ± —	0.353 ± 0.096	—
S004	OOL10-4	5948902	2160738	0.25 ± 0.04	0.193 ± 0.053	0.86
S005	OOL10-5	5949079	2160855	— ± —	<0.099	—
S006	OOL10-6	5948946	2160790	— ± —	<0.094	—
S007	OOL10-7	5949124	2160907	0.37 ± 0.04	0.313 ± 0.082	0.62
S008	OOL10-8	5949013	2160829	— ± —	<0.106	—
S009	OOL10-9	5948880	2160868	0.20 ± 0.02	0.195 ± 0.057	0.08
S010	OOL10-10	5948969	2160686	— ± —	<0.179	—
S011	OOL10-11	5949146	2160803	0.34 ± 0.04	0.317 ± 0.088	0.24
S012	OOL10-12	5949002	2160725	— ± —	0.350 ± 0.076	—
S013	OOL10-13	5948913	2160842	— ± —	<0.088	—
S014	OOL10-14	5949087	2160957	— ± —	<0.129	—
S015	OOL10-15	5948869	2160764	0.35 ± 0.04	0.345 ± 0.083	0.05
FOTA Average				*0.26*	*0.30*	*0.30*
FOTA Standard Deviation				*0.12*	*0.07*	*0.32*

Table B-2. Fuel Oil Tank Area Comparison Data
Confirmatory Survey Activities for the Fuel Oil Tank Area
Humboldt Bay Power Plant
Eureka, California

ORISE Sample ID[a]	PG&E Sample ID[b]	East (ft)	North (ft)	Cs-137 Concentrations (pCi/g)		Relative Error Ratio (RER)[d]
				ORISE	PG&E[c]	
ORISE Judgmental Soil Sample Locations						
S016	OOL10-20	5948965	2160774	0.02 ± 0.01	<0.084	—
S017	OOL10-21	5948969	2160768	0.00[g] ± 0.03	<0.082	—
S018	OOL10-22	5948967	2160766	-0.01 ± 0.03	<0.108	—
S019	OOL10-23	5949108	2160832	0.29 ± 0.03	0.318 ± 0.074	0.35
S020	OOL10-24	5949061	2160958	0.01 ± 0.02	<0.077	—
S021	OOL10-25	5949062	2160970	0.51 ± 0.05	0.621 ± 0.096	1.03
Judgmental Average[h]				*0.40*	*0.47*	*0.69*

[a]Refer to Figs. A-4 and A-5
[b]PG&E Sample ID provided by PG&E
[c]PG&E Cs-137 concentrations from PG&E-provided gamma spectroscopy reports
[d]Relative Error Ratio (RER) was calculated based on the formula in the DOE's Quality Systems for Analytical Services and provides a way to determine if analytical results of duplicates (in this case, split samples) are in agreement. A RER < 3 means the samples are in agreement at the 99% confidence level.
[e]Uncertainties represent the 95% confidence level, based on total propagated uncertainties
[f]Measurement or analysis not performed
[g]Zero values are due to rounding
[h]Calculated using concentrations that were greater than the minimum detectable concentration (MDC); ORISE samples used were S019 and S021

Table B-3. Radionuclide Concentrations in Interlaboratory Comparison Soil Samples
Confirmatory Survey Activities for the Fuel Oil Tank Area
Humboldt Bay Power Plant
Eureka, California

ORISE Sample ID[a]	PG&E Sample ID[b]	Cs-137 Concentrations (pCi/g)		Relative Error Ratio (RER)[c]
		ORISE	PG&E[c]	
S004	OOL10-4	0.25 ± 0.04[c]	0.19 ± 0.05	0.9
S009	OOL10-9	0.20 ± 0.02	0.20 ± 0.06	0.1
S015	OOL10-15	0.35 ± 0.04	0.35 ± 0.08	0.1

[a]Refer to Figs. A-4 and A-5
[b]PG&E sample identification and sample Cs-137 concentrations provided by PG&E
[c]Relative Error Ratio (RER) was calculated based on the formula in the DOE's Quality Systems for Analytical Services and provides a way to determine if analytical results of duplicates (in this case, split samples) are in agreement. A RER < 3 means the samples are in agreement at the 99% confidence level.
[d]ORISE uncertainties represent the 95% confidence level, based on total propagated uncertainties

APPENDIX C
MAJOR INSTRUMENTATION

THIS PAGE LEFT BLANK INTENTIONALLY

The display of a specific product is not to be construed as an endorsement of the product or its manufacturer by the author or his employer.

C.1 SCANNING AND MEASUREMENT INSTRUMENT/DETECTOR COMBINATIONS

C.1.1 Gamma

Ludlum NaI Scintillation Detector Model 44-10, Crystal:2 in x 2 in
coupled to:
Ludlum Ratemeter-scaler Model 2221
(Ludlum Measurements, Inc., Sweetwater, TX)
coupled to:
Trimble GeoXH Receiver and Data Logger
(Trimble Navigation Limited, Sunnyvale, CA)

C.1.2 Laboratory Analytical Instrumentation

High Purity Extended Range Intrinsic Detector
CANBERRA/Tennelec Model No: ERVDS30-25195
(Canberra, Meriden, CT)
Used in conjunction with:
Lead Shield Model G-11
(Nuclear Lead, Oak Ridge, TN) and
Multichannel Analyzer
Canberra's Apex Gamma Software
Dell Workstation
(Canberra, Meriden, CT)

High Purity Extended Range Intrinsic Detector
Model No. GMX-45200-5
(AMETEK/ORTEC, Oak Ridge, TN)
used in conjunction with:
Lead Shield Model SPG-16-K8
(Nuclear Data)
Multichannel Analyzer
Canberra's Apex Gamma Software
Dell Workstation
(Canberra, Meriden, CT)

High-Purity Germanium Detector
Model GMX-30-P4, 30% Eff.
(AMETEK/ORTEC, Oak Ridge, TN)
Used in conjunction with:
Lead Shield Model G-16
(Gamma Products, Palos Hills, IL) and
Multichannel Analyzer
Canberra's Apex Gamma Software
Dell Workstation
(Canberra, Meriden, CT)

THIS PAGE LEFT BLANK INTENTIONALLY

APPENDIX D
SURVEY AND ANALYTICAL PROCEDURES

THIS PAGE LEFT BLANK INTENTIONALLY

D.1 PROJECT HEALTH AND SAFETY

The proposed survey and sampling procedures were evaluated to ensure that any hazards inherent to the procedures themselves were addressed in current Job Hazard Analyses (JHA). All survey and laboratory activities were conducted in accordance with ORISE health and safety and radiation protection procedures (ORISE 2008 and 2010).

Pre-survey activities included the evaluation and identification of potential health and safety issues. Survey work was performed per the ORISE generic health and safety plans and a site-specific Integrated Safety Management (ISM) pre-job hazard checklist. PG&E personnel also provided site-specific safety awareness training. An ORISE safety walkdown of the site indicated that the land clearing activities and restoration activities by PG&E personnel left uneven terrain in some areas typical for outdoor survey activities, steep inclines on the berms, and standing water and thick mud in a portion of the FOTA.

D.2 CALIBRATION AND QUALITY ASSURANCE

Calibration of all field and laboratory instrumentation was based on sources/standards, traceable to the National Institute of Standards and Technology (NIST).

Analytical and field survey activities were conducted in accordance with procedures from the following ORAU and ORISE documents:

- Survey Procedures Manual (May 2008)
- Laboratory Procedures Manual (December 2011)
- Quality Program Manual (December 2011)

The procedures contained in these manuals were developed to meet the requirements of 10 Code of Federal Regulations (CFR) 830 Subpart A, *Quality Assurance Requirements*, Department of Energy Order 414.1C *Quality Assurance*, and the U.S. Nuclear Regulatory Commission *Quality Assurance Manual for the Office of Nuclear Material Safety and Safeguards* and contain measures to assess processes during their performance.

Quality control procedures include:

- Daily instrument background and check-source measurements to confirm that equipment Operation is within acceptable statistical fluctuations.

- Participation in Mixed-Analyte Performance Evaluation Program (MAPEP), NIST Radiochemistry Intercomparison Testing Program (NRIP), and Intercomparison Testing Program (ITP) Laboratory Quality Assurance Programs.

- Training and certification of all individuals performing procedures.

- Periodic internal and external audits.

D.3 SURVEY PROCEDURES

D.3.1 SURFACE SCANS

A NaI(Tl) scintillation detector was used to scan for elevated gamma radiation. Identification of elevated radiation levels was based on increases in the audible signal from the recording and/or indicating instrument. Additionally, the detectors were coupled to GPS units with data loggers enabling real-time recording in one-second intervals of both geographic position and the gamma count rate. Positioning data files were downloaded from field data loggers for plotting using commercially available software (http://trl.trimble.com/docushare/dsweb/Get/Document-261826/GeoExpl2005_100A_GSG_ENG.pdf). Position and gamma count rate data files were transferred to a computer system, positions were differentially corrected, and the results were plotted on geo-referenced aerial photographs. Positional accuracy was within 0.5 meters at the 95th percentile.

ORISE Survey Procedures (ORISE 2008) require a minimum scan speed of 0.5 to 1 meter per second (m/s) based on the site contaminant and the DCGL for the primary contaminant of concern. A review of the gamma walkover scan data points relative to the scan area coverage indicate that the scan speed was less than 0.5 m/s. The scan minimum detectable concentrations for the NaI scintillation detectors was 6.6 pCi/g for Cs-137, the primary radionuclide of concern as provided in NUREG-1507 (Table 6.4). Any audible increase in radiation levels were investigated by

ORISE. It is standard procedure for the ORISE staff to pause and investigate any locations where gamma radiation is distinguishable from background levels.

D.3.2 Soil Sampling

Approximately 0.5 to 1 kg of soil was collected at each sample location. Collected samples were placed in a Marinelli jar, sealed, and labeled in accordance with ORISE survey procedures. The systematic soil samples were collected as split soil samples with PG&E personnel from the systematically-selected soil sample locations as determined by PG&E. The judgmental samples were collected as split samples with PG&E personnel from locations of elevated gamma radiation levels as determined by the ORISE gamma walkover scans.

D.4 RADIOLOGICAL ANALYSIS

D.4.1 Gamma Spectroscopy

Samples of soil were dried, mixed, crushed, and/or homogenized as necessary, and a portion sealed in a 0.5-liter Marinelli beaker or other appropriate container. The quantity placed in the beaker was chosen to reproduce the calibrated counting geometry. Net material weights and volumes were determined and the samples counted using intrinsic germanium detectors coupled to a pulse height analyzer system. Background and Compton stripping, peak search, peak identification, and concentration calculations were performed using the computer capabilities inherent in the analyzer system. All total absorption peaks (TAP) associated with the radionuclides of concern (ROCs) were reviewed for consistency of activity. TAPs used for determining the activities of ROCs and the typical associated minimum detectable concentration (MDCs) for a one-hour count time were:

Radionuclide	TAP[a] (MeV)	MDC (pCi/g)
Co-60	1.173	0.06
Cs-137	0.661	0.05
U-235	0.143	0.24
U-238 by Th-234	0.063	0.75

[a]Spectra were also reviewed for other identifiable easy-to-detect TAPs that would not be expected at this site.

D.4.2 UNCERTAINTIES

The uncertainties associated with the analytical data presented in the tables of this report represent the total propagated uncertainties for that data. These uncertainties were calculated based on both the gross sample count levels and the associated background count levels.

D.4.3 DETECTION LIMITS

Detection limits, referred to as minimum detectable concentrations, were based on 3 plus 4.65 times the standard deviation of the background count $[3 + (4.65\ (BKG)^{1/2})]$. Because of variations in background levels, measurement efficiencies, and contributions from other radionuclides in samples, the detection limits differ from sample to sample and instrument to instrument.