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April 1, 2020

PG&E Letter HBL-20-007

ATTN: Document Control Desk
U.S Nuclear Regulatory Commission
Washington, DC 20555-0001

Docket No. 50-133, License No. DPR-7
Humboldt Bay Power Plant, Unit 3
Final Status Survey Report for the Humboldt Bay Power Plant Reactor Caisson Survey Units

References:

1. PG&E Letter HBL-20-004, "Revision 13 to the Defueled Safety Analysis Report, Revision 3 of the License Termination Plan, and Revisions 37, 38, and 39 to the Humboldt Bay Quality Assurance Plan," dated February 24, 2020.

2. PG&E Letter HBL-16-008, "Request for Partial Release of Humboldt Bay Power Plant Unit 3 Property from the Part 50 Site," dated November 9, 2016.

3. NRC Letter to PG&E, "Humboldt Bay Power Plant Unit 3 – Request for Partial Site Release from Part 50 License (CAC No. L53153)," dated January 5, 2018.

Dear Commissioners and Staff:

On February 24, 2020, Pacific Gas & Electric Company (PG&E) submitted PG&E Letter HBL-20-004 (Reference 1), which included Revision 3 of the License Termination Plan (LTP). Section 1.2 of the LTP describes a phased decommissioning approach to accomplish site release for unrestricted use and license termination.

The first phase consisted of a partial site release of an area south of King Salmon Avenue. In Reference 2, PG&E submitted a request for the partial site release of this area. Reference 2 included a Final Status Survey (FSS) Report for the survey units within the area proposed to be released. The release was approved by the NRC in Reference 3.

In the subsequent phases, PG&E will submit FSS reports for the remaining survey units as they are completed. Upon completion of FSS reports, PG&E will request the site be released from the 10 CFR Part 50 license.

The Enclosure to this letter contains the FSS Report for the Reactor Caisson. The FSS Report demonstrates that the aggregate of the radiological data provides sufficient confidence to ensure that this area meets the release criteria in accordance with the Humboldt Bay Power Plant, Unit 3 LTP. This is based on a review of the design methodology, surveys, and sample results in reference to the site-specific derived concentration guideline level. The FSS Report concludes that the survey area surveyed and sampled during the FSS should be released from further radiological controls. Therefore, the FSS Report supports the regulatory decision to terminate the 10 CFR Part 50 license for this survey area.

PG&E requests that the NRC review the enclosed information and concur that this area meets the LTP release criteria.

There are no new or revised regulatory commitments (as defined in NEI 99-04) in this letter.

If you have any questions or require additional supporting documentation for this submittal, please contact Mr. William Barley at (707) 444-0856.

Sincerely,

/Maureen Zawalick for James Welsch

James M. Welsch
Senior Vice President, Generation and Chief Nuclear Officer

Enclosure
cc: HBPP Humboldt Distribution
cc/enc: John B. Hickman, NRC Project Manager
Scott A. Morris, NRC Region IV Administrator

Humboldt Bay Power Plant

Final Status Survey Report

Reactor Caisson

Pacific Gas and Electric Company®

HUMBOLDT BAY POWER PLANT
FINAL STATUS SURVEY REPORT

Reactor Caisson

Final Status Survey Report for Survey Units:

HBPP-FSSP-NOL01-09

HBPP-FSSP-NOL01-09-FSR

Report Prepared by: _____ Date: 3-17-20
Gordon Madison, CHP - FSS Engineer

Technical Review: _____ Date: 3-17-20
Marshall Blake - FSS Engineer

Initial Report Approval: _____ Date: 3-17-2020
Kris Rowberry, MHP, AHP - Expert Site Closure Specialist

Final Report Approval: WH BARLEY / WH Barley Date: 3-17-20
William Barley, CHP - Site Closure Manager

EXECUTIVE SUMMARY

In accordance with the provisions of the Humboldt Bay License Termination Plan (LTP), Rev. 2 (Ref. 1), Survey Units NOL01-09 and NOL01-09-FSR were Final Status Surveyed (FSS) for phased release from the site's 10CFR50 license. This report was prepared to demonstrate that the designated survey units satisfy the radiological release criteria.

The areas under consideration consist of the open land area inside the restricted area Caisson Removal Excavation footprint, and the Final Site Restoration (FSR) of the Caisson Removal footprint, which includes the area covering the Cutter Soil Mix (CSM) Wall with at least two feet of backfilled onsite-approved reuse soil. Additional discussion regarding the CSM Wall is provided in NRC Inspection Report 050-00133/16-001 (Ref. 21). The Caisson Removal Excavation footprint formerly contained below grade sections of the Refuel Building and included the dry well and liner, activated concrete around the core region, embedded piping systems and associated drains, suppression chamber and remaining downcomer piping, spent fuel pool (SFP) walls, sheet piles around the SFP, timber piles, access shaft, radwaste and off-gas tunnels, emergency escape hatch, valve gallery and associated piping system, sumps and concrete tremie seal. The Caisson Removal Excavation footprint included only the excavated bottom surface area excluding the dewatering wells.

The Caisson FSR area includes backfilled reuse material consisting of rubblized concrete surveyed via the Multi-Agency Radiation Survey and Assessment of Materials and Equipment (MARSAME) process from various locations on site and soils certified in accordance with the Technical Basis Document (TBD) for the Gamma Radiation Detection and In-Container Analysis (GARDIAN) bulk assay system. It should be noted that the Caisson FSR survey unit is larger than the Caisson FSS survey unit due to inclusion of the CSM wall footprint in the survey area design. The total footprint areas of the two open land survey units are approximately 884 square meters (m^2) and 1,351 m^2 for NOL01-09 and NOL01-09-FSR respectively. NOL01-09 is bounded on all sides by the CSM wall with the exception of the West side which is bounded by OOL03-02. NOL01-09-FSR is bounded by survey unit NOL01-05 to the north, on the west by Survey Unit OOL03-02, on the east by Survey Unit NOL01-04, and on the south by NOL01-07. It should be noted that NOL01-09-FSR overlaps with Survey Unit OOL03-02 on the west side. See Executive Summary Tables for details of each survey unit.

The survey unit areas are designated as Class 1 land areas in the LTP, indicating that the areas are impacted areas expected to have, or have had prior to remediation, a potential for radioactive contamination in excess of the Derived Concentration Guideline Levels (DCGLs).

Extensive radiological remediation within the Caisson Removal Excavation footprint was necessary during decommissioning to satisfy the radiological release criteria. Additionally, as described later in this report, one of four dewatering wells required radiological remediation to satisfy the radiological release criteria.

The surveys performed included a total of fifty-five (55) samples. Each of the statistical sample locations was selected based on a random start, systematic grid placement using the Visual Sample Plan (VSP) software program. Sample locations were confirmed by a high precision Total Position Station (TPS) or Global Positioning System (GPS) for survey units NOL01-09 and NOL01-09-FSR/CSM Wall respectively. The sampling effort

included thirty (30) statistical samples, four (4) split-samples, fifteen (15) biased samples, three (3) investigation samples, and three (3) Oak Ridge Institute for Science and Education (ORISE) split samples in NOL01-09.

Additionally, four sample recounts were taken for quality assurance purposes. No Quality Assurance (QA) related discrepancies were noted that could impact the overall confidence in the results or conclusions of the FSS.

Accessible survey areas were also 100% scanned with a gamma-sensitive Sodium-Iodide (NaI) detector system. There were three instances where scan investigation criteria were exceeded as noted in Survey Unit NOL01-09, each requiring an investigation sample. There were no investigation samples collected for survey unit NOL01-09-FSR.

The maximum hypothetical dose, from all sources, including groundwater, to a future resident farmer was determined to be less than 8.0 millirem per year (mrem/yr) and less than 0.9 mrem/yr for survey units NOL01-09 and NOL01-09-FSR respectively. It should be noted that the total dose calculated for NOL01-09 includes overestimates from the CSM Wall and Dewatering Well Characterization Plans as described later in this report. The report concludes that the survey units have met the FSS data quality objectives and each meet the regulatory release criteria of less than 25 mrem/yr to the average member of the critical group plus ALARA (As Low As Reasonably Achievable).

Table ES.1 - Synopsis of NOL01-09

Feature	Design Criteria		Comment
Survey Unit Land Area	884 m^2 (1)		Footprint area based on AutoCAD
Classification	Class 1		Based on the HBPP LTP Rev. 2
Final Status Survey Plan No.	HBPP-FSSP-NOL01-09-01		HBPP Procedure RCP FSS-2 Attachment 9.1
Grid Spacing	8.25 m		HBPP Procedure RCP FSS-2 Attachment 8.2
DCGLs	23.6 pCi/g(2)Am-241 5.94 pCi/g C-14 3.58 pCi/g Co-60 7.45 pCi/g Cs-137	9.43 pCi/g Eu-152 8.87 pCi/g Eu-154 1.41 pCi/g Sr-90	Scaled to reflect 23.58 mrem/yr TEDE(3) due to resultant dose of 1.42 mrem/yr from Cs-137 dose contribution from CSM(4) wall as listed in HBPP-FSSP-NOL01-09-00.
Scan Survey Area Coverage	Approximately 100%		Table 5-4 of the HBPP LTP requires 100% of area coverage for Class 1 survey units
Number of Measurements	15 Soil Samples (non-parametric test)		15 required per LTP Section 5.3.3.3.1 using Table 5-5 of MARSSIM for relative shift of 2
Min. Value	3.75E-02		Based on Unity
Max. Value	1.63E-01		Based on Unity
Mean	1.08E-01		Based on Unity
Median	1.14E-01		Based on Unity
Std. Dev.	3.31E-02		Based on Unity
No. of Split Measurements	2 Soil Samples		1 required per HBAP C-202
No. of Bias Measurements	5 Biased Samples Soil Collected		Judgmental locations selected by FSS Engineer (4 of 5 located near each of 4 dewatering wells)
No. of Recount Measurements	2 Soil Samples		1 required per HBAP C-202
Maximum Hypothetical Dose	7.88E+00 mrem/yr (2.69E+00 mrem/yr Survey unit dose plus 2.21E+00 mrem/yr CSM wall dose plus 2.97E+00 mrem/yr NE(5) Dewatering Well dose)		Meets FSS data quality objectives and regulatory release criteria of 25 mrem/yr TEDE

Note (1): meters Squared

Note (2): pico-curies per gram

Note (3): Total Effective Dose Equivalent

Note (4): Cutter Soil Mix

Note (5): Northeast

Table ES.2 - Synopsis of NOL01-09-FSR

Feature	Design Criteria	Comment
Survey Unit Land Area	1,351 m^2 (1)	Footprint area based on AutoCAD
Classification	Class 1	Based on the HBPP LTP Rev. 2
Final Status Survey Plan No(s).	HBPP-FSSP-NOL01-09-FSR-00	HBPP Procedure RCP FSS-2 Attachment 9.1
Grid Spacing	10 m	HBPP Procedure RCP FSS-2 Attachment 8.1
DCGL	7.65 pCi/g(2) Cs-137	Scaled to reflect 24.21 mrem/yr TEDE(3) due to resultant dose of 0.79 mrem/yr TEDE from deselected HTD radionuclides listed in HBPP-FSSP-NOL01-09-FSR-00.
Scan Survey Area Coverage	Approximately 100%	Table 5-4 of the HBPP LTP requires 100% of area coverage for Class 1 survey units
Number of Measurements	15 Soil Samples (non-parametric test)	15 required per LTP Section 5.3.3.3.1 using Table 5-5 of MARSSIM for relative shift of 2
Min. Value	-1.34E-02	pCi/g Cs-137
Max. Value	6.97E-02	pCi/g Cs-137
Mean	2.62E-02	pCi/g Cs-137
Median	3.33E-02	pCi/g Cs-137
Std. Dev.	2.39E-02	pCi/g Cs-137
No. of Split Measurements	2 Soil Samples	1 required per HBAP C-202
No. of Bias Measurements	None	N/A
No. of Recount Measurements	2 Soil Samples	1 required per HBAP C-202
Maximum Hypothetical Dose	8.80E-01 mrem/yr	Meets FSS data quality objective and regulatory release criteria of 25 mrem/yr TEDE

Note (1): meters Squared

Note (2): pico-curies per gram

Note (3): Total Effective Dose Equivalent

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1.0 INTRODUCTION

This radiological FSS Report documents the radiological status of a small portion of the Humboldt Bay Power Plant (i.e., the Site) in Eureka, CA. Presently, the 1000 King Salmon Ave, Eureka, CA site is subject to U.S. Nuclear Regulatory Commission (NRC) Radioactive Materials License No. DPR-7 (Ref. 4). The long-term objective of the licensee, Pacific Gas and Electric Company (PG&E), is to decommission the Site such that it will meet the criteria for unrestricted use as specified in the License Termination Rule at 10 CFR Part 20, Subpart E and to terminate NRC Facility Operating License No. DRP-7. This FSS Report documents the final condition of the following FSS Areas: NOL01-09 –NOL Open Land Area Inside the RA (Caisson), and NOL01-09-FSR Caisson (Final Site Restoration) in preparation for license termination. This report documents the final radiological status of the outlined area in Figure 1.1, along with other report submittals, serves collectively to demonstrate that the criteria for unrestricted use have been met, and serves to support the regulatory decision to terminate the license.

Figure 1.1 - Overview of Surveyed Area Extents

May 2016 Image

1.1 PHASED RELEASE AREA DESCRIPTION

As described in the LTP, PG&E has performed a partial site release of the site south of King Salmon Avenue to the Humboldt Bay Harbor District. The remaining site land areas are to the north (site east) of King Salmon Avenue. Figure 1.2 depicts an aerial overview that indicates the current extents remaining to be released. The most recent version of the LTP stipulates that if an additional phased release is done the Phased Release Area map will be updated.

Figure 1.2 – Current Phase Release Area

Photo taken June 2011

The following figures, Figure 1.3 and Figure 1.4, are aerial photographs of Survey Units NOL01-09 Caisson Removal Excavation area and Caisson FSR area respectively.

Figure 1.3 – Aerial Photo of Survey Units NOL01-09 and CSM-RC Extents

Undated Aerial Photo taken from Google Earth

Figure 1.4 – Aerial Photo of Survey Unit NOL01-09-FSR Extents

Undated Aerial Photo taken from Google Earth

1.2 SURVEY UNIT DESIGNATION

In accordance with Humboldt Bay Power Plant (HBPP) RCP FSS-1, Survey Units NOL01-09 and NOL01-09-FSR are designated as Class 1 Survey Units per the HBPP Historical Site Assessment (HSA) (Ref. 2) and were confirmed by subsequent reviews.

1.3 SURVEY UNIT DESCRIPTIONS

Both of the Survey Units described in this report are part of Survey Area NOL01. A summary of each specific survey unit is provided below.

Survey Unit NOL01-09

Survey Unit NOL01-09 is approximately 884 m^2 of surface area. The survey unit is an excavation of the Caisson to remove below grade sections of the Refuel Building and included the dry well and liner, activated concrete around the core region, embedded piping systems and associated drains, suppression chamber and remaining downcomer piping, spent fuel pool (SFP) walls, sheet piles around the SFP, timber piles, access shaft, emergency escape hatch, valve gallery and associated piping system, sumps and concrete tremie seal. The unit is bounded by the CSM Wall on all sides with the exception of the West side which is bounded by OOL03-02. (See Figure 1.5). It should be noted that NOL01-09-FSR overlaps with Survey Unit OOL03-02 on the west side. As part of the Caisson Removal project, there were four dewatering wells installed to facilitate decommissioning activities. Survey Unit NOL01-09 also includes the following support structure characterization survey units needed for Caisson demolition:

- CHAR-CSM-RC

  Survey Unit CHAR-CSM-RC consists of eleven 80' soil borings collected prior to construction of the CSM Wall. During the construction of the CSM wall, soils within the wall footprint were used as part of the wall construction. The CSM Wall contains a footprint of approximately 467 m^2 with NOL01-09 bounding on the inside of the wall, and on the outside wall by Survey Units NOL01-05 to the north, on the west by Survey Unit OOL03-02, on the east by Survey Unit NOL01-04, and on the south by NOL01-07.

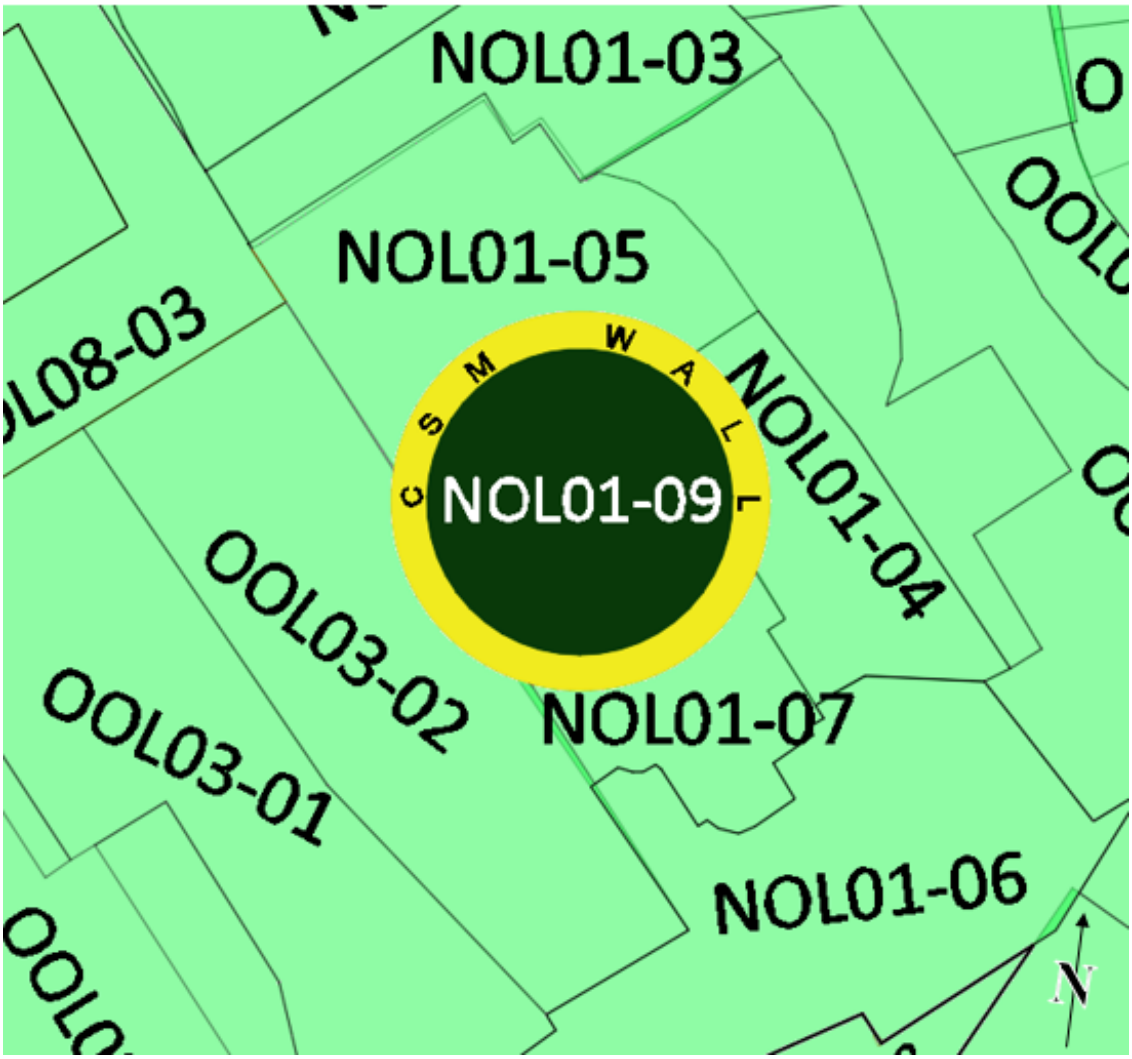
- CHAR-CAISSON-DW

  Survey Unit CHAR-CAISSON-DW consists of the Caisson Dewatering Wells, all located within the footprint of NOL01-09. Each well casing was estimated to be 31' long with a diameter of 12", for a total casing inside surface area of 36 m^2.

Survey Unit NOL01-09-FSR

Survey Unit NOL01-09-FSR (the Caisson Final Site Restoration area) is approximately 1,351 m^2 of surface area. The survey unit contains backfilled materials consisting of rubblized concrete and remediated soil from various locations on-site. The Survey Unit is bounded by survey unit NOL01-05-FSR to the north, on the west by Survey Unit OOL03-02-FSR, on the east by Survey Unit NOL01-04-FSR, and on the south by NOL01-07-FSR. (See Figure 1.5).

Figure 1.5 – Map View of the FSS Area Location Relative to Surrounding Survey Units



1.3.1 HISTORICAL SITE ASSESSMENT (HSA) EVENTS

Within the HSA, there was a history of fuel cladding failures associated with the use of stainless-steel clad fuel in its initial core loadings. The history of fuel failure, along with more than 13 years of commercial operation, led to the accumulation of fission, activation, and transuranic (TRU) products in the piping, in nuclear plant system components, the SFP and on concrete surfaces (Ref. 2). In 1965, the stainless steel-clad fuel was replaced with zircaloy-clad fuel. In 1975, a fuel assembly was dropped into the SFP cask loading pit, separating several fuel rods from the assembly. Additionally, the reference mentions that in March 1966, it was discovered that a leak in the spent fuel storage pool liner had developed. At the time there was no evidence of contamination from this event in the Reactor Caisson sump. However, one test well drilled north of the spent fuel storage pool (between the pool and the bay) revealed evidence of contamination, a factor of 100 below the allowable drinking water limits.

The LTP mentions that in July 2005, the resin transfer line from the SFP demineralizer (through the offgas tunnel) to the resin disposal tank was found to be blocked, leading to resin fines in the offgas tunnel in the sump near the offgas filter. Additionally, the reference states that there was a history of the Liquid Radwaste concentrator overflow and steam condensate leakage to the Concentrated Waste Tank Vault and the radwaste tankage sump.

1.3.2 SCOPING SURVEYS

According to the 2008 Characterization report, (Ref. 5) Scoping Surveys of buildings and structures residing above the Caisson footprint were not performed due to spent fuel movement operations and availability of data collected by the Radiation Protection (RP) Department.

1.3.3 CHARACTERIZATION

During the construction of the CSM wall, soils within the wall footprint were used as part of the wall construction. Subsequently, the HBPP Site Closure Group was tasked with the characterization of the soils that would be contained in the wall. A characterization survey plan was developed (Humboldt Bay Power Plant CSM Wall Characterization Plan, December 17, 2014) utilizing a semiparametric logistic regression sampling model with a graded methodological progression. The survey methodology used an in situ geotechnical push-probe approach designed to assess horizontal stratigraphically stationed activity concentrations. The constraint of penetration for the sample, as well as the gradient of ingress was relayed to the probe operator prior to performing the sampling to ensure that the focal intention of the characterization plan was followed correctly and safely. The mechanical penetrometer samples were homogenized, composited individually and assayed by the HBPP onsite laboratory personnel for plant-related radionuclides. The data acquired from the sampling regime were used to determine the radiological sub-surface strata status of the CSM wall. It should be noted at the time of the Caisson FSS, the FSS Plan only considered the CSM Wall Characterization dose contribution from Cesium-137 (Cs-137), as the nuclide was the only nuclide identified during sample analysis. Of eleven boring samples collected from the CSM Wall, only one sample was analyzed for Hard to Detect (HTD) radionuclides, with the exception of Tritium (H-3) and Strontium-90 (Sr-90). Table 1.1 below provides a summary of boring samples from the CSM Wall analyzed at the HBPP Laboratory.

Table 1.1 - Summary of Soil Boring Sample Results for the CSM Wall

Boring Number	Sample Number	Description	Cs-137 pCi/g	H-3 pCi/g	Sr-90 pCi/g	Sample Purpose
CSM-RC-01	2015-2055	Soil at 0 to 80 ft.	**1.45E+00**	N/A	N/A	CHAR
CSM-RC-01S	2015-2056	Soil at 0 to 80 ft.	**1.75E+00**	N/A	N/A	CHAR
CSM-RC-02	2015-3337	Soil at 0 to 80 ft.	1.20E-02	N/A	N/A	CHAR
CSM-RC-03R	2015-3701	Soil at 0 to 80 ft.	2.35E-02	N/A	N/A	CHAR
CSM-RC-04	2015-1643	Soil at 0 to 80 ft.	1.25E-02	-1.00E-02	-7.90E-02	CHAR
CSM-RC-05	2015-1839	Soil at 0 to 80 ft.	-2.58E-03	-3.00E-02	7.20E-02	CHAR
CSM-RC-05S	2015-1840	Soil at 0 to 80 ft.	5.58E-02	N/A	N/A	CHAR
CSM-RC-06	2015-1441	Soil at 0 to 80 ft.	2.54E-02	5.00E-02	1.47E-01	CHAR
CSM-RC-07	2015-1519	Soil at 0 to 80 ft.	-8.27E-03	3.00E-02	1.56E-01	CHAR
CSM-RC-08	2015-1763	Soil at 0 to 80 ft.	**1.58E+00**	1.00E-02	-1.24E-01	CHAR
CSM-RC-09	2015-1679	Soil at 0 to 80 ft.	3.00E-02	1.00E-02	8.60E-02	CHAR
Average			4.48E-01	1.00E-02	4.30E-02	
Standard Deviation			7.39E-01	2.83E-02	1.18E-01	

Note: Cs-137 activity values listed in **bold** were positively identified greater than *a-posteriori* minimum detectable concentration calculated for the analysis.
N/A-Not Analyzed
CHAR-Characterization

It should be noted that the above sample data for the CSM wall is considered an overestimate, since approximately half of the soil volume used to construct the CSM wall was displaced by the concrete and bentonite slurry used to homogenize the mixture. The soil that was displaced within the CSM Wall footprint was sent thru the GARDIAN for characterization as reuse material and transferred to the discharge canal for use as backfill. Additionally, since not all CSM boring composite samples were analyzed for HTDs, insignificant radionuclide dose from the CSM that was not fully addressed in the characterization plan was considered and addressed as discussed later in this report. There were no surrogate ratios calculated or applied in this characterization survey plan as none were warranted.

The statistical sample data for the North Yard FSS Survey area (NOL01-05) was used to support the survey design planning for FSS Survey Unit NOL01-09 as there was no specific characterization data available at the time of plan development. The first series of Characterization surveys on the Caisson excavation bottom were performed on 12/20/17, with three locations of samples taken at depths of 0”-6”, 6”-12”, and 12”-18.” All three locations where the samples were collected contained at least one sample which exceeded the Cobalt-60 (Co-60) DCGL, likely because the samples were collected at locations where there were concrete remnants of tremie.

Table 1.2 – Summary of Caisson Bottom Characterization Samples

Sample	1A	2A	3A	1B	2B	3B	1C	2C	3C
Depth	0"-6"	6"-12"	12"-18"	0"-6"	6"-12"	12"-18"	0"-6"	6"-12"	12"-18"
CO-60 pCi/g	8.0	4.2	1.3	2.5	1.5	1.5	4.5	4.3	3.1
Cs-137 pCi/g	2.24	1.1	3.7	0.73	0.36	0.42	0.13	0.13	0.85

On 1/4/18, two sediment characterization samples were collected inside the inoperable northeast (NE) dewatering well. Both sediment samples contained fission and activation radionuclides (Cs-137, Sr-90, Carbon-14 (C-14), Co-60, Europium-152 (Eu-152), and Europium-154 (Eu-154)), collectively exceeding the derived concentration guideline level elevated measurement comparison ($DCGL_{EMC}$) by a factor of up to 3 for a 1 m^2 area. Since both samples exceeded the $DCGL_{EMC}$, the NE Well, along with the three other operational dewatering wells were excluded from FSS unit NOL01-09 for HBPP Site Closure FSS Survey and concurrent verification survey by the ORAU Survey Team.

Further details regarding the corrective actions taken for the NE Well remediation are summarized later in this report. No other characterization samples were collected inside the three active dewatering wells as there was no residual material available for collection.

On 1/5/18 in order to characterize the soil and gravel pack surrounding the four dewatering wells, a total of forty-eight (48) samples were collected at depths 0"-6" and 18"-24". One of the samples, collected from the 0"-6" depth at the Southwest 1 (SW 1) Well Location, exceeded the Co-60 DCGL at 4.0 pCi/g.

1.3.4 REMEDIAL ACTION SURVEYS AND ACTIVITIES

As mentioned in the previous section, characterization samples were collected to determine the extent of contamination near each of the four dewatering wells. On 1/6/18, the entire excavation was scanned, and twenty-two (22) biased samples were collected. During the scan it was noted that the NE well had readings ~2 times above background. The reason the soils surrounding the NE well exhibited elevated scan readings was due to source term residing in the well (which was later remediated) and source term residing in the gravel pack surrounding the well as described later in this report.

On 1/8/18 an additional five biased samples were collected in the area near the SW Well. According to the remediation turnover survey conducted on 1/8/18, elevated areas on the southern portion of the Caisson near the SW Well were remediated using hand shovels. Approximately 60 large bags of soil were removed from the area and the area was re-scanned. Four additional samples were collected at a depth of 24" - 36" to characterize the potential source term at depth around the NE and SW dewatering wells. The following table shows the Remediation Turnover Survey results of the soil samples collected from this effort.

Table 1.3 - Remediation Turnover Survey Biased Sample Results

Sample Number	Date Collected	Depth	Eu-152 pCi/g	Co-60 pCi/g	Cs-137 pCi/g	Comments
2018-0103	1/6/2018	0"-6"	<1.34E-01	2.05E-01	<9.41E-02	Near NW Well
2018-0104	1/6/2018	0"-6"	<9.84E-02	5.35E-02	<6.01E-02	Near tremie area
2018-0105	1/6/2018	0"-6"	<9.06E-02	1.70E-01	<6.53E-02	Near tremie area
2018-0106	1/6/2018	0"-6"	<1.21E-01	1.34E-01	6.88E-02	Near tremie area
2018-0107	1/6/2018	0"-6"	<1.07E-01	<1.13E-01	<6.18E-02	North of SW Well
2018-0108	1/6/2018	0"-6"	<1.14E-01	7.74E-01	2.37E-01	North of SW Well
2018-0109	1/6/2018	0"-6"	<1.31E-01	4.58E-01	1.65E-01	North of SW Well
2018-0110	1/6/2018	0"-6"	<1.33E-01	8.37E-01	4.16E-01	North of SW Well
2018-0111	1/6/2018	0"-6"	<1.26E-01	1.11E+00	2.04E-01	North of SW Well
2018-0112	1/6/2018	0"-6"	<1.43E-01	2.64E-01	6.47E-01	Near SW-6 Well
2018-0113	1/6/2018	0"-6"	<1.11E-01	7.69E-01	1.80E-01	Near SW-1 Well
2018-0114	1/6/2018	0"-6"	<9.74E-02	<1.06E-01	<7.07E-02	Near SW-3/4 Well
2018-0115	1/6/2018	0"-6"	<1.33E-01	7.18E-01	2.65E-01	Near SW-3/4 Well
2018-0116	1/6/2018	0"-6"	<1.18E-01	4.35E-01	1.20E-01	Near SW-3/4 Well
2018-0117	1/6/2018	0"-6"	<9.50E-02	<5.39E-02	<5.76E-02	Near tremie area
2018-0118	1/6/2018	0"-6"	<1.13E-01	3.14E-01	1.18E-01	Between SE/SW Wells
2018-0119	1/6/2018	0"-6"	<8.89E-02	<7.92E-02	<5.17E-02	Between SE/SW Wells
2018-0120	1/6/2018	0"-6"	<9.82E-02	3.33E-01	<8.56E-02	Between SE/SW Wells
2018-0121	1/6/2018	0"-6"	<1.19E-01	1.48E-01	<9.11E-02	North of SE Well
2018-0122	1/6/2018	0"-6"	<9.85E-02	<5.90E-02	<5.85E-02	South of NE Well
2018-0123	1/6/2018	0"-6"	<1.03E-01	2.29E-01	<8.40E-02	Near tremie area
2018-0124	1/6/2018	0"-6"	<1.09E-01	3.82E-01	8.50E-02	Between NE/NW Wells
2018-0125	1/8/2018	0"-6"	<1.21E-01	7.71E-01	2.80E-01	Near SW-1 Well
2018-0126	1/8/2018	0"-6"	<1.06E-01	<9.10E-02	<6.64E-02	Near SW-2 Well
2018-0127	1/8/2018	0"-6"	<1.18E-01	4.86E-01	2.05E-01	Near SW-3/4 Well
2018-0128	1/8/2018	0"-6"	<1.35E-01	1.60E+00	5.78E-01	Near SW-3/4 Well
2018-0129	1/8/2018	0"-6"	<1.13E-01	2.80E-01	<8.71E-02	Between NE/NW Wells
2018-0133	1/9/2018	24"-36"	<1.35E-01	<6.71E-02	2.58E-01	NE-2
2018-0134	1/9/2018	24"-36"	1.32E+00	7.08E-02	1.66E+00	NE-4
2018-0135	1/9/2018	24"-36"	<9.34E-02	<7.90E-02	<5.61E-02	SW-4
2018-0136	1/9/2018	24"-36"	<1.02E-01	<5.13E-02	<6.48E-02	Near SW-3/4 Well

As mentioned previously in this report, there were various corrective actions warranted during or resulting from the decommissioning effort of the Caisson. The Systems Application and Products Notifications (SAPNs) are summarized below:

SAPN 1434048 Failure of GARDIAN System to Identify Discrete Commodities up to and exceeding the $DCGL_{EMC}$

On 8/30/17, a tracking SAPN was generated to document and evaluate the impact of repeated discoveries of failures of the GARDIAN system to detect discrete commodities in material intended for reuse, including a neutron-activated piece of concrete of approximately 3" in diameter from the core region of the Caisson.

The concrete commodity was evaluated by survey and laboratory analysis on-site and determined to exceed the $DCGL_{EMC}$ (based on 1 m^2 area factors) collectively by almost a factor of 3. While this event appeared to be an outlier compared to collection of commodities identified during a 9/15/17 case study survey campaign where thirty-five (35) ten (10) cubic yard (yd^3) truckloads of Class 1 spoils materials from the Caisson decommissioning were placed in six-inch lifts and gamma walkover scanned with no commodities collectively identified greater than $DCGL_{EMC}$. However, it was still possible that other outliers of this magnitude may have been deposited in completed FSS areas backfilled with spoils reuse material from the Caisson, which include Northeast Laydown Area and the Discharge Canal. Later FSR surveys where reuse soil was used did not indicate the presence of residual activated concrete.

It should be noted that the root cause of this SAPN was poor remediation and material segregation work practices. As part of the evaluation corrective actions taken, the work process for the Caisson excavation was modified so that there was better segregation between source term and reuse spoils materials. Additionally, a quality control monitoring campaign was instituted whereby trucks containing Caisson spoils soil that had cleared the GARDIAN were dumped at an area and spread out in six-inch lifts for NaI detector walkover scanning to identify commodities. While there were still instances where commodities were identified in truckloads of spoils material spread out in this fashion, it is evident that the new work controls instituted in the Caisson have been more effective in segregating source term material from reuse material. Once enhanced work and compensatory controls were instituted the number of commodities discovered in trucks that had cleared the GARDIAN averaged one in every thirty-nine (39) truckloads, compared with an average of one commodity in every other load before instituting control measures.

SAPN 1439210 Caisson NE Dewatering Well Remediation

During performance of the Caisson Remediation Turnover Survey two sediment samples collected inside the pump casing of the NE Dewatering Well on January 4, 2018 indicated elevated activity exceeding the Unity $DCGL_{EMC}$ fraction (based on 1 m^2 area factors) collectively by a factor of three for a 1 m^2 area. Discussion with personnel indicated that the well pump had become inoperable after water containing concrete fines/slurry had been pumped to the well on four separate occasions from February 2017 to May 2017 from the Suppression Chamber. The inoperable well contained an estimated fifteen foot column of sediment material above the pump which was later remediated on 2/1/18. Table 1.4 provides the summary of the two sediment samples collected. It should be noted that the Total EMC fractions calculated below does not adjust for the survey unit mean activity levels as applied when multiple radionuclides are present as described in Equation 5-7 of Section 5.3.6.3.1 of the LTP. The Total EMC Fraction listed in the table below conservatively estimated the entire source term to exist in a 1 m^2 contamination zone to a depth of 15 cm (from an original source term estimated mass of 5.15E+05 g), for an adjustment factor of 2.22. For reference, the Elevated Measurement Comparison (EMC) fractions for the samples in the following table was calculated using the following equation:

$$\left[\frac{[Co-60]}{[\,DCGL_{Co-60}*AF_{Co-60}]}+\frac{[Cs-137]}{[\,DCGL_{Cs-137}*AF_{Cs-137}]}+\frac{[Eu-152]}{[\,DCGL_{Eu-152}*AF_{Eu-152}]}+\frac{[Eu-154]}{[\,DCGL_{Eu-154}*AF_{Eu-154}]}\right]*2.22=\text{EMC Fraction}$$

Where AF=1 m^2 Area factor

Table 1.4 - NE Well Characterization Sample Results

Sample No.	Description	Co-60 pCi/g	Cs-137 pCi/g	Eu-152 pCi/g	Eu-154 pCi/g	Total EMC Fraction
2018-0044	NE Well Sediment Sample A	3.16E+00	1.12E+01	7.73E+01	2.28E+00	2.36
2018-0045	NE Well Sediment Sample B	5.00E+00	1.15E+01	1.36E+02	4.29E+00	3.95

Since the sample results presented above indicated that remediation was required, the three other active dewatering wells were also excluded from FSS unit NOL01-09.

SAPN 1439681 Caisson NE Dewatering Well Gravel Pack Assessment

Additional characterization samples were collected during the NE Well remediation effort to provide nuclide ratios for two response scenario MicroShield® runs used for the estimate of residual source term remaining in the gravel pack. The remediated sediment sample results are shown in Table 1.5.

Table 1.5 - NE Well Sediment Sample Results

Sample No.	Description	Co-60 pCi/g	Cs-137 pCi/g	Eu-152 pCi/g
2018-0369	NE Well-Sediment Sample from top of pump	ND	1.87E+00	ND
2018-0370	Sediment composited from dewatering box	1.53E+00	2.06E+01	3.47E+01
2018-0373	Sediment at +1' from well bottom	1.31E+00	9.34E+01	7.19E-01
2018-0375	Sediment from bottom of well	7.00E-02	4.33E+00	ND

ND-Nuclide not detected above method detection levels

For the two MicroShield® case runs, samples 2018-0370 and 2018-0373 were selected to best represent the residual activity assumed for the gravel pack from Europium and Cesium dominated source term respectively. To determine the extent of condition for the gravel pack surrounding the well casing after the source term had been removed from inside the well, a characterization survey was performed inside the well using a Ludlum Model 44-162 3" by 3" Sodium Iodide (NaI) gamma pipe detector coupled to a Ludlum Model 2350-1 Data logger. Down-hole gamma measurements were collected at 6" increments, each for one-minute duration to collect an activity profile of the residual source term residing in the gravel pack surrounding the well casing. A total of 46 measurements were collected, excluding the 4 recounts performed at locations 11, 13, 31, and 40, which corresponded to elevations of -17.5', -16.5', -7.5', and -2.5' respectively relative to the well bottom. Humboldt Bay Power Plant Engineering Calculation NX-503 "NE Caisson Dewatering Well Assessment," February 14, 2018 (Ref. 7) was generated to provide the results and conclusions of the data assessment for the gravel pack.

In summary the following conclusions were noted:

- Detector response from a Cesium dominated source term was similar to the Europium dominated source term for the comparison of the two cases modeled (80-81 micro- Roentgens per hour (µR/hr)).
- The detector response indicated that the source term was deposited in a 2' vertical column of gravel pack, with the bottom of the response corresponding to the top of the well pump housing where the material was deposited. Additionally, the data suggests that the deposited source term in the gravel pack did move vertically within the gravel pack.
- The MicroShield predicted dose rates (80 µR/hr) assumed the removed sediments sample represent the residual source term in the gravel pack but was nominally 5 times the actual measured residual activity (i.e., 15-18 µR/hr vs. 80 µR/hr).
- The overall conclusion is that residual contamination in the gravel pack around the well casing is less than 31% of the $DCGL_{EMC}$ and is acceptable to remain without further remediation effort.

1.3.5 AREA SURVEILLANCE SURVEY PLAN

As per HBPP Procedure RCP FSS-13 "Area Surveillance Following Final Status Survey," Rev 03, May 5th, 2017 (Ref. 8) there were two Area Surveillance Survey Plans (ASSPs) written to assure that the conditions verified by the FSS have not changed.

The primary functions of periodic surveillances are to determine the adequacy of isolation and control measures in areas where FSS activities are complete and to assure that the conditions verified by the FSS are unchanged and to detect the potential migration of contaminants from decommissioning activities taking place in adjacent areas. Due to decommissioning project work activities two ASSPs were written.

NOL01-09 is a Class 1 Area that is located inside the CSM Wall. There was a resurvey ASSP written for the area because of additional remediation and decommissioning activities occurring in the four dewatering wells. The second ASSP was an investigation survey warranted from the evaluation of the ASSP resurvey results.

1) ASSP-18-02-001 for NOL01-09

   An ASSP was warranted because Caisson Dewatering Well pumps were removed which could result in the survey area or unit being compromised from HBPP plant-related radioactive material that was introduced into well casings during decommissioning activities. The ASSP required biased samples around each well casing and walkover scans of the area in the immediate vicinity. The results indicated only one area exceeding the investigation level of no audible indications discernable above the background range of 4.5 kilo-counts per minute (kcpm) to 6.4 kcpm.

   It should be noted that the ASSP survey unit data evaluation required an ASSP Investigation survey because the Cs-137 results were greater than two standard deviations from the FSS Unit statistical sample mean requiring a survey per Section 2.5 of RCP FSS-13.

2) ASSP-18-02-004 for NOL01-09

An ASSP Investigation Survey was warranted because the mean of the Cs-137 results from ASSP Resurvey of NOL01-09 when compared to the original FSS resulted in >2 standard deviations. A total of six biased samples were collected within the two areas where Cs-137 results were identified from the resurvey and a walkover scan of the area. The two areas were selected based on the highest biased result and the investigation sample result.

The gamma walkover survey results indicated no audible indications of elevated readings discernable above the background range. However, both the survey means for both Co-60 and Cs-137 resulted in >2 standard deviations when compared to the original FSS requiring additional evaluation in accordance with Section 2.6 of RCP FSS-13 to determine if a full FSS re-survey was warranted. The evaluation is captured in SAPN 1439992, with the evaluation from review of the investigation survey results concluding that there was no evidence that suggests the remediation, characterization, and deactivation activities performed since the original FSS was completed had adversely impacted the area, challenging the original decision that the survey unit met the release criteria. Therefore, an FSS resurvey was not warranted. It should be noted that the original FSS statistical data set did not identify any plant-derived gamma-emitting radionuclides with the exception of a single sample that indicated Co-60, with a result of less than 8% of the scaled DCGL. While it is recognized that biased and investigation sample results are of limited value as data sets when evaluating against FSS statistical results from plant-derived radionuclides that are less than method detection levels as the ASSP data sets are not collected in a random start/systematic grid fashion, FSS-13 was enhanced to clarify requirements pertaining to the data evaluation method used to compare ASSP results to FSS results.

All biased and investigation samples collected during the performance of ASSP 18-02-001 and ASSP 18-02-004 were analyzed by gamma spectroscopy at the on-site laboratory. Samples obtained during the ASSPs were collected using Procedure FSS-8, "Collection of Site Characterization and Final Status Survey Samples" (Ref. 9).

No other periodic surveys were performed as both survey units were exempted from periodic surveillance surveys by the Site Closure Manager as both Survey Unit areas had an engineered surface or barrier in place.

1.3.6 FINAL SITE RESTORATION FSS

To determine the level of residual activity remaining after decommissioning activities were completed for the Caisson, a formal Final Site Restoration (FSR) survey was conducted on Survey Unit NOL01-09-FSR on 11/19/18, 11/20/18 and 12/8/18. As mentioned earlier in this report, the Caisson excavation was backfilled with concrete rubble originating from onsite demolition activities, and soil approved for reuse after GARDIAN analysis. Survey Unit NOL01-09 FSR, in addition to the backfilled Caisson excavation, also covered the area of the CSM wall that was covered by several feet of reuse material. Survey Unit NOL01-09-FSR met the clearance requirements as set forth for Class 1 open land areas.

2.0 SURVEY UNIT DESIGN INFORMATION

The survey units were classified in accordance with Procedure RCP FSS-1, "Survey Unit Classification" (Ref. 10). NOL01-09 and NOL01-09-FSR were classified as Class 1 survey units based on the potential to contain residual radioactive material exceeding the DCGLs.

Guidance for preparing FSS plans is provided in Procedure RCP FSS-2, "Preparation of Final Status Survey Plans" (Ref. 11). The FSS plans developed used an integrated sample design that combines scanning surveys with a random start systematic grid sampling. A map of each respective area Survey Area is provided in Figures 1.3-1.4 above.

2.1 DATA QUALITY OBJECTIVES (DQOS)

FSS design and planning used the Data Quality Objective (DQO) process as described by the LTP, Procedure RCP FSS-2 and the NUREG 1575, *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM) (Ref. 12).

The primary objective of the FSS plan was to demonstrate that the level of residual radioactivity in the Survey Units described in this report did not exceed the release criteria specified in the LTP and that the potential dose from residual radioactivity is ALARA.

A fundamental precursor to survey design is to establish a relationship between the release criteria and some measurable quantity. This is done through the development of DCGLs. The DCGLs represent average levels of radioactivity above background levels and are presented in terms of surface or mass activity concentrations. Chapter 6 of the LTP describes in detail the modeling used to develop the DCGLs for soil.

The regulatory limit specified in the LTP is 25 mrem/yr Total Effective Dose Equivalent (TEDE) from all of the potentially present plant derived nuclides.

2.2 DQOS REGARDING NUCLIDE SELECTION AND DCGLS

The DQO process is used for designing and conducting all final status surveys at HBPP. Each survey package contains the appropriate information, statistical parameters, and contingencies to support the DQO process. The appropriate design for a given survey area is developed using the DQO process as outlined in MARSSIM, Appendix D.

The FSS data used to support the survey design of NOL01-09 included a complete screening for all HTD radionuclides that were potentially present on the NOL01-05 North Yard FSS statistical sample data set. The FSS data indicated that Co-60 and Cs-137, both Easy to Detect (ETD) radionuclides are the most prevalently detected radionuclides inside the Radiologically Controlled Area (RCA).

Additionally, the CSM Wall Characterization core soil boring results were used for NOL01-09 FSS Plan design to scale the soil Table 5-1 DCGLs presented in the LTP. The only plant-derived radionuclide that was identified in the CSM soil samples was Cs-137.

Since there was insufficient characterization data to confirm the assumption that HTD nuclides were not present at significant (i.e. >10% of the release criteria) levels in survey unit NOL01-09, all statistical samples were selected to receive analyses for the full FSS HTD suite of nuclides at an off-site laboratory with the exception of Sr-90 and H-3, which were analyzed by the HBPP laboratory. To confirm the assumption that HTD nuclides are not present in survey unit NOL01-

09-FSR, two (2) split samples were randomly selected to receive analyses for the full FSS suite of nuclides with the exception of Sr-90 and H-3 analysis at an off-site laboratory.

Instrument DQOs included a verification of the ability of the survey instrument to detect the radiation(s) of interest relative to the DCGL. Survey instrument response checks were required prior to use and after the instrument had been used. Control and accountability of survey instruments was required to assure the quality and prevent the loss of data.

As part of the DQOs applied to laboratory processes, analysis results were reported as actual calculated results. Therefore, results reported as less than Minimum Detectable Concentration (MDC) were not used for FSS. Sample report summaries included unique sample identification, analytical method, radionuclide, result, uncertainty, laboratory data qualifiers, units, and the Lower Limits of Detection (LLD) and MDC. Also, two recount samples and two split samples were taken to verify data quality for each survey unit.

Another important facet of the DQO process is to identify the radionuclides of concern and determine the concentration and variability. The surveys performed in Survey Units: CHAR-CSM-RC, NOL01-09, NOL01-09-FSR, and CHAR-CAISSON-DW spanned the time period of 2015-2018. Table 2.1 presents the Soil DCGLs respectively per the HBPP LTP Table 5-1. For survey unit NOL01-09, Am-241, C-14, Co-60, Cs-137, Eu-152, Eu-154, and Sr-90 were the nuclides that could potentially be present based on characterization and remediation survey data.

Table 2.1 - Soil DCGLs and Analysis Lower Limits of Detection (LLDs)

Radionuclide [1]	Soil DCGL (pCi/g) [2]	LLD (pCi/g) [3] 10% to 50%	
H-3	6.8E+02	6.8E+01	3.4E+02
C-14	6.3E+00	6.3E-01	3.1E+00
Co-60	3.8E+00	3.8E-01	1.9E+00
Ni-59	1.9E+03	1.9E+02	9.8E+02
Ni-63	7.2E+02	7.2E+01	3.6E+02
Sr-90	1.5E+00	1.5E-01	7.5E-01
Nb-94	7.1E+00	7.1E-01	3.5E+00
Tc-99	1.2E+01	1.2E+00	6.2E+00
Cs-137	7.9E+00	7.9E-01	3.9E+00
Eu-152	1.0E+01	1.0E+00	5.0E+00
Eu-154	9.4E+00	9.4E-01	4.7E+00
Np-237	1.1E+00	1.1E-01	5.5E-01
Pu-238	2.9E+01	2.9E+00	1.4E+01
Pu-239/240 [5]	2.6E+01	2.6E+00	1.3E+01
Am-241 [4]	2.5E+01	2.8E+00	1.2E+01
Pu-241	8.6E+02	8.6E+01	4.3E+02
Cm-243/244[5]	2.9E+01	2.9E+00	1.4E+01
Cm-245/246[5]	1.7E+01	1.7E+00	8.9E+00

(1) Bold text indicates radionuclides that are considered Hard to Detect (HTD)

(2) The Soil DCGL(s) are specified by the LTP in Chapter 6 and are equivalent to twenty-five (25) mrem/yr TEDE.

(3) The required LLD is between 10% to 50% of the Soil DCGL.

(4) Americium-241 can be analyzed by gamma and alpha spectroscopy and is considered to be Easy to Detect (ETD). The preferred result is the alpha spectroscopy's when both analyses are performed.

(5) For radiochemical analyses whose results cannot discern between two isotopes, i.e. Pu-239/240, Cm-243/244 and Cm-245/246, the lower of the two DCGLs was selected from the LTP.

2.2.1 SURVEY APPROACH/METHODS

Prior to mobilizing the radiological survey team to the survey site, the survey team was briefed on the FSS package requirements associated with each individual survey unit which referenced the appropriate field sampling equipment and procedures to be used. A set of maps created using Visual Sample Plan of Survey Unit NOL01-09 and Survey Unit NOL01-09-FSR were created. These maps were then used in laying out the sampling and survey locations.

The prescribed survey approach for Class 1 land areas consisted of soil collection of statistically random start in a systematically gridded fashion and 100% walk-over scanning of all accessible areas with a 2" x 2" Thallium-activated Sodium Iodide (NaI (Tl)) scintillation detector.

Additionally, all direct non-parametric and biased soil sample locations were accessed. One CSM soil sample boring location was sent to an off-site laboratory for HTD analysis with the exception of H-3 and Sr-90.

2.2.2 NUMBER OF SAMPLES AND MEASUREMENTS

The DQO process determined that Co-60 and/or Cs-137 are the radionuclide of concern in the survey units. Other radionuclides (if present) that were positively identified during the performance of this FSS would be evaluated to ensure adequate survey designs. Except for small trace amounts of Co-60 and Cs-137 found in samples NOL01-09-003 and NOL01-09-009-FSR respectively analyzed onsite, and Cs-137 in split sample NOL01-09-013-FSR-S analyzed off-site, no other plant-derived radionuclides were identified in the survey units direct soil samples analyzed by the onsite and off-site laboratories, indicating that the survey design was adequate.

The Sign Test was selected as the non-parametric statistical test. The use of the Sign Test did not require the selection or use of a background reference area, which simplified survey design and implementation. This approach was conservative since it included background Cs-137 as part of the sample set.

The minimum number of soil samples for FSS was determined in accordance with Procedure RCP FSS-7, "Determination of the Number and Location of FSS Samples" (Ref. 13). The Lower Bound of the Gray Region (LBGR) was set in accordance with Procedure RCP FSS-7 to achieve a relative shift (Δ/σ) in the range of 1 and 3. The resulting relative shift for each survey unit is specified in their respective survey plans.

A Prospective Power Curve was generated with these settings using MARSSIM Power 2000 (Ref. 14) and is provided in the Data Quality Assessment (Attachment 1). MARSSIM Power 2000 is a software package developed under the sponsorship of the United States Department of Energy (DOE) Environmental Measurement Laboratory. The results of the A Posteriori (retrospective) computer run showed adequate power for the survey design. This indicates that the survey area had a high probability of rejecting the null hypothesis, assuming the characterization data are representative of the FSS results. The retrospective power curve is provided in Attachment 1.

The grid pattern and locations of the soil samples were determined using Visual Sample Plan (VSP) in accordance with Procedure RCP FSS-18, "Computer Determination of Number and Locations of FSS Samples" (Ref. 15) Visual Sample Plan was created by Pacific Northwest National Laboratory (PNNL) for the DOE (Ref. 16). A systematic triangular grid sampling pattern with a random starting point was selected for sample design for NOL01-09 and NOL01-09-FSR, which is appropriate for Class 1 survey areas.

Sample locations were identified using AutoCAD, a commercially available plotting software package with coordinates consistent with the California State Plane System. These coordinates were integrated with a GPS to locate sample locations in the field. Sample Measurement Locations for the design are listed with the GPS coordinates in Tables 2.2 thru 2.4 as displayed in the Survey Plans for survey units CSM-RC, NOL01-09, NOL01-09-FSR respectively.

Table 2.2 - CSM-RC Push-probe Soil Boring GPS Coordinates

Sample	Easting	Northing
CHAR-CSM-RC-01	5949384.51	2161179.68
CHAR-CSM-RC-01S	5949384.51	2161179.68
CHAR-CSM-RC-02	5949363.93	2161168.43
CHAR-CSM -RC-03R*	5949353.04	2161157.35
CHAR-CSM-RC-04	5949343.27	2161136.89
CHAR-CSM-RC-05	5949347.19	2161092.10
CHAR-CSM-RC-05S	5949347.19	2161092.10
CHAR-CSM-RC-06	5949386.74	2161058.92
CHAR-CSM-RC-07	5949440.97	2161068.48
CHAR-CSM-RC-08	5949465.20	2161104.22
CHAR-CSM-RC-09	5949434.90	2161174.68

*To facilitate sampling, the above sample was relocated 5.3’ north of original location due to drilling crew encountering rock at 63’ depth on original bore hole.

Table 2.3 - Sample Measurement Locations with GPS Coordinates NOL01-09

Sample	Easting	Northing
NOL01-09-001-F	5949397.72	2161066.45
NOL01-09-002-F	5949384.19	2161089.89
NOL01-09-003-F	5949411.26	2161089.89
NOL01-09-004-F	5949438.32	2161089.89
NOL01-09-005-F	5949370.66	2161113.33
NOL01-09-006-F	5949397.72	2161113.33
NOL01-09-007-F	5949424.79	2161113.33
NOL01-09-008-F	5949451.86	2161113.33
NOL01-09-009-F	5949357.12	2161136.77
NOL01-09-010-F	5949384.19	2161136.77
NOL01-09-011-F	5949411.26	2161136.77
NOL01-09-012-F	5949438.32	2161136.77
NOL01-09-013-F	5949370.66	2161160.21
NOL01-09-014-F	5949397.72	2161160.21
NOL01-09-015-F	5949424.79	2161160.21

Table 2.4 - Sample Measurement Locations with GPS Coordinates NOL01-09-FSR

Sample	Easting	Northing
NOL01-09-001-FSR	5949445.73	2161066.92
NOL01-09-002-FSR	5949413.41	2161075.58
NOL01-09-003-FSR	5949437.07	2161099.23
NOL01-09-004-FSR	5949460.72	2161122.89
NOL01-09-005-FSR	5949381.10	2161084.24
NOL01-09-006-FSR	5949404.76	2161107.89
NOL01-09-007-FSR	5949428.41	2161131.55
NOL01-09-008-FSR	5949452.07	2161155.20
NOL01-09-009-FSR	5949348.79	2161092.89
NOL01-09-010-FSR	5949372.44	2161116.55
NOL01-09-011-FSR	5949396.10	2161140.20
NOL01-09-012-FSR	5949419.75	2161163.86
NOL01-09-013-FSR	5949340.13	2161125.21
NOL01-09-014-FSR	5949363.78	2161148.86
NOL01-09-015-FSR	5949387.44	2161172.52

Procedure RCP FSS-2 specifies that 5% of the samples are required to be selected for HTD radionuclide analysis. The number and location of samples and measurements may be determined using RCP FSS-7 or RCP FSS-18. For Survey Unit NOL01-09 all fifteen (15) statistical or greater than 5% of the number of samples that would be used for non-parametric statistical testing were selected for HTD radionuclide analyses. For Survey Unit NOL01-09-FSR two (2) soil samples or greater than 5% of the number of samples that would be used for non-parametric statistical testing were randomly selected for HTD radionuclide analyses using the Microsoft Excel "RAND" function. For survey unit CSM-RC, one sample was selected which meets the 5% of the number of samples required for HTD radionuclide analyses. Each of the selected samples were sent off-site for a full suite analysis of the HTD radionuclides as specified.

The LTP requires a minimum of 5% of the samples taken for non-parametric statistical testing be selected for split sample analyses with the off-site laboratory. The implementation of quality control measures as referenced by Procedure RCP FSS-11, "Split Sample Assessment for Final Status Survey," (Ref. 17) included the collection of two (2) soil samples for "split sample" analysis by the off-site laboratory for survey units NOL01-09 and NOL01-09-FSR. These locations were selected randomly using the Microsoft Excel "RAND" function.

2.2.3 SYNOPSIS OF SURVEY UNIT DESIGN & DESELECTION

The design of each survey unit incorporates the MARSSIM approach to FSS. The DQO process as described in Procedure, *Final Status Survey Quality Assurance Project Plan (QAPP*) (Ref. 18) was used to develop each survey plan. It should also be noted that the area covered by scan measurement is based on the survey unit classification as described in MARSSIM. Table 5-4 of the LTP specifies scanning percentage of Class 1 survey units is 100%. There were no reported deviations from this requirement.

Table 2.5 - Synopsis of the Survey Design NOL01-09

Feature	Design Criteria	Basis
Survey Unit Land Area	884 m^2	Based on AutoCAD
Number of Measurements	15 required(1) (Random start, systematic triangular grid)	Type 1 and Type 2 errors were 0.05, sigma was 0.02 (of unity), the LBGR was set at 0.96 (of unity) to achieve a Relative Shift in the range of 1 and 3 (Δ/σ=2.0)
Grid Spacing	8.25 m	LTP Equation 5-5 for triangular grid pattern
Design $DCGL_{OP}$(2)	3.58 pCi/g Co-60 7.45 pCi/g Cs-137	Per Table 3 of the Scaled DCGLs from FSSP to achieve 23.58 mrem/yr TEDE
Soil Investigation Level	>$DCGL_{EMC}$ for Co-60 or Cs-137, Sum of $DCGL_{EMC}$ fractions >1.0, or >DCGL and a statistical parameter-based value (i.e., >3 standard deviations)	Table 5-5 of the LTP for a Class 1 survey unit.
Scan Survey Area Coverage	100%	Table 5-4 of the LTP requires 100% coverage of all accessible areas for Class 1 survey units
Scan Investigation Level	>$DCGL_{EMC}$	Table 5-5 of the LTP for Class 1 Survey Units

(1) The number of soil samples for FSS was determined in accordance with Procedure RCP FSS-7, *"Determination of Number and Location of FSS Samples"* (Ref. 13).

(2) $DCGL_{OP}$ Operational DCGL is the LTP Table 5-1 DCGL scaled to a dose of 23.58 mrem/yr based on a Cs-137 dose contribution from the CSM Wall of 1.42 mrem/yr.

Surrogate/Deselection Discussion for NOL01-09

It should be noted that for Survey Unit NOL01-09, surrogate ratios were not used and there were no deselected radionuclides which were determined to be insignificant. Since there were no deselected radionuclides that were deemed to be insignificant, all statistical samples collected from the survey unit were sent to an off-site laboratory for HTD analysis, with the exception of H-3 and Sr-90, which were analyzed by the HBPP on-site laboratory. The decision to not deselect any of the HBPP radionuclides potentially present is reasonable and appropriate given that there was no characterization information available at the time of FSS plan development.

However, the deselected dose for the CSM Wall was considered in the final estimate of Survey Unit NOL01-09 TEDE for comparison to the release criteria.

Table 2.6 - Synopsis of the Survey Design NOL01-09-FSR

Feature	Design Criteria	Basis
Survey Unit Land Area	1,351 m^2	Based on AutoCAD
Number of Measurements	15 required(1) (Random start, systematic triangular grid)	Type 1 and Type 2 errors were 0.05, sigma was 1.91 pCi/g, the LBGR was set at 3.82 pCi/g to achieve a Relative Shift in the range of 1 and 3 (Δ/σ=2.0)
Grid Spacing	10 m	LTP Equation 5-5 for triangular grid pattern
Design $DCGL_{OP}$(2)	7.65 pCi/g Cs-137	Per Table 3 of the Scaled DCGLs from FSSP based on deselected HTD nuclides to achieve 24.21 mrem/yr TEDE
Soil Investigation Level	>$DCGL_{EMC}$ for Cs-137, Sum of $DCGL_{EMC}$ fractions >1.0, or >DCGL and a statistical parameter-based value (i.e., >3 standard deviations)	Table 5-5 of the LTP for a Class 1 survey unit.
Scan Survey Area Coverage	100%	Table 5-4 of the LTP requires 100% coverage of all accessible areas for Class 1 survey units
Scan Investigation Level	>$DCGL_{EMC}$	Table 5-5 of the LTP for Class 1 Survey Units

(1) The number of soil samples for FSS was determined in accordance with Procedure RCP FSS-7, *"Determination of Number and Location of FSS Samples"* (Ref. 13).

(2) $DCGL_{OP}$ - Operational DCGL is the LTP Table 5-1 DCGL scaled to a dose of 24.21 mrem/yr based on deselected HTD nuclide dose from nuclides determined to have a minimal dose contribution (i.e., contribute less than 10% collectively to the dose).

Surrogate/Deselection Discussion for NOL01-09-FSR

It should be noted that for Survey Unit NOL01-09-FSR, surrogate ratios were not used. However, there were deselected HTD radionuclides which were determined to be insignificant (i.e., contribute less than 10% collectively to the dose). The deselected dose was considered in the final estimate of Survey Unit NOL01-09-FSR TEDE for comparison to the release criteria.

HBPP-FSSP-NOL01-09-FSR Applied DCGLs

Previous characterization has shown that not all the site-specific radionuclides would be present in this survey unit. The following nuclides were deselected from the analysis, with the exception of the QC off-site samples. Carbon-14 (C-14) was left off as there was no potential for it to be present in this area due to lack of production mechanism (neutron activated concrete).

- Cm-243/244
- Cm-245/246
- Cm-245
- H-3
- Ni-59
- Ni-63
- Pu-238
- Pu-239/240
- Pu-241
- Tc-99
- Sr-90

The dose contribution from the deselected HTD nuclides will be bounded by directly adding the dose contribution of a sample contaminated to approximately 3 times the DCGL (~22 pCi/g) for Cs-137. The resultant dose from HTD nuclides was 0.794 mrem/yr. Table 2.7 depicts the total dose calculated for deselected nuclides for Survey Unit NOL01-09-FSR.

Table 2.7 - Dose for Deselected Nuclides

Composite Soils - RDT Vault of the Liquid Radwaste Building				
Nuclide	**Building (dpm/100 cm^2)**	**Soil DCGL (pCi/g)**	**Results (pCi/g)**	**Results/DCGL Unity Fraction**
Am-241	3.00E+03	2.50E+01	0.00E+00	0.0E+00
C-14	7.00E+06	6.30E+00	0.00E+00	0.0E+00
Cm-243/244	4.30E+03	2.90E+01	-9.27E-03	-3.2E-04
Cm-245/246	2.20E+03	1.70E+01	8.05E-02	4.7E-03
Co-60	1.30E+04	3.80E+00		0.0E+00
Cs-137	4.60E+04	7.90E+00		0.0E+00
Eu-152	2.70E+04	1.00E+01		0.0E+00
Eu-154	2.50E+04	9.40E+00		0.0E+00
H-3	1.80E+08	6.80E+02	1.03E+00	1.5E-03
Nb-94	1.90E+04	7.10E+00		0.0E+00
Ni-59	6.30E+07	1.90E+03	-3.22E+00	-1.7E-03
Ni-63	2.40E+07	7.20E+02	-5.91E-02	-8.2E-05
Np-237	2.40E+03	1.10E+00		0.0E+00
Pu-238	3.40E+03	2.90E+01	2.16E-02	7.4E-04
Pu-239/240	3.10E+03	2.60E+01	1.40E-02	5.4E-04
Pu-241	1.40E+05	8.60E+02	-3.31E+00	-3.8E-03
Sr-90	9.70E+04	1.50E+00	4.46E-02	3.0E-02
Tc-99	9.60E+06	1.20E+01	5.15E-03	4.3E-04
			Total	**3.2E-02**
			Total (mrem/y)	**7.94E-01**

The table below depicts the DCGLs for analysis scaled to 24.21 mrem/yr that was used to apply the unity rule:

Table 2.8 - DCGLs Scaled to 24.21 mrem/y for NOL01-09-FSR

Nuclide	DCGL (pCi/g) 25 mrem	**DCGL (pCi/g)**	Nuclide	DCGL (pCi/g) 25 mrem	**DCGL (pCi/g)**
Co-60	3.8	**3.68E+00**	Eu-152	10	**9.68E+00**
Nb-94	7.1	**6.87E+00**	Eu-154	9.4	**9.10E+00**
Am-241	25	**2.42E+01**	Np-237	1.1	**1.07E+00**
Cs-137	7.9	**7.65E+00**			

The presence of all radionuclides listed in this plan (gamma emitters, HTD beta-emitters, and TRUs) in the soil was evaluated under the survey plan. The HBPP Site Closure Department analyzed each soil sample for all listed gamma-emitting nuclides. Additionally, two QC splits were also analyzed for gamma-emitting nuclides, Sr-90 and H-3 by an off-site laboratory. The QC splits analyzed by the independent laboratory were assessed to verify the absence of the HTD radionuclides deselected by the survey plan.

CSM-RC

The characterization survey was developed due to concerns with contamination at depth from previous spent fuel pool leakage. Although it was known that all underground commodities would need to be removed prior to CSM wall installation, no information existed on expected potential contamination below the commodities elevations. The sampling was developed to provide information if deeper excavation of the CSM wall path would be required since in situ soils would be incorporated into the CSM wall. The results of this characterization resulted in limiting the depth of excavation to commodities removal and the data supported incorporated soil in the CSM wall meeting the surface soil DCGL.

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Detailed discussion regarding the characterization survey plan is presented earlier in this report in SAPN 1439681 Caisson NE Dewatering Well Gravel Pack Assessment.

3.0 SURVEY RESULTS

Final Status Survey field activities were conducted under FSS Plans HBPP-FSSP-NOL01-09-01 and HBPP-FSSP-NOL01-09-FSR-00. The preparations for work included a detailed review of each FSS Plan, job safety analysis, job planning checklist, and related procedures for reference. Daily briefings were conducted to discuss the expectations for job performance and the safety aspects of the survey. The Daily Survey Journal was used to document field activities and other information pertaining to the FSS. All field survey activities were performed on various dates within the guidelines as set forth in the governing procedures. Sample measurement locations
using GPS coordinates were identified in the 1983 North American Datum (NAD) coordinate system.

3.1 SAMPLE MEASUREMENTS RESULTS

Each of the forty-one (41) statistical samples collected were analyzed by gamma spectroscopy at the HBPP laboratory. All samples obtained during the FSS of Survey Units: NOL01-09, and NOL01-09-FSR were collected using Procedure FSS-8, "Collection of Site Characterization and Final Status Survey Samples" (Ref. 9). In addition, four (4) of the samples were sent to an off-site laboratory and analyzed for each of the nuclides in the FSS nuclide suite, with the exception of H-3 and Sr-90, which were analyzed by the on-site laboratory. For survey unit NOL01-09, all statistical samples were sent to an off-site laboratory and analyzed for each of the nuclides in the FSS HTD nuclide suite, with the exception of H-3 and Sr-90, which were analyzed by the on-site laboratory. The off-site laboratory employed for the radiological analyses of samples was General Engineering Laboratories (GEL), located in Charleston, South Carolina. The corresponding split sample comparison results between the GEL and HBPP laboratories is located in Attachment 1 Data Assessment.

During the NOL01-09 survey, NRC Inspectors and ORISE personnel concurrently surveyed the Caisson excavation with PG&E FSS personnel. Three (3) samples from locations selected by ORISE within Survey Unit NOL01-09 were collected by PG&E as splits for comparison with the ORISE laboratory. The samples split with ORISE were NOL01-09-020-F-I (ORISE No. S0021), NOL01-09-022-F-I (ORISE No. S0023), and NOL01-09-023-F-B (ORISE No. S0022). The corresponding split sample comparison results between the ORISE and HBPP laboratories is located in Attachment 1 Data Assessment.

On-site gamma spectroscopy analysis was performed to the required MDC. Gamma spectroscopy results positively identified Co-60 and Cs-137 in two separate statistical samples collected for survey unit NOL01-09 and NOL01-09-FSR respectively. Similarly, Cs-137 was found to be present in three of eleven boring characterization samples collected for the CSM Wall. The two split samples from survey unit NOL01-09-FSR analyzed by GEL were >MDC but <LLD for Cs-137. Additionally, the three investigation samples collected as a result from the scan survey of survey unit NOL01-09 analyzed by GEL were >MDC but <LLD for Cs-137 and/or Co-60.

Statistical sample results did not exceed the Investigation Level for soil samples. Therefore, gamma spectroscopy sample results did not require further investigation.

A summary of the statistical soil sample results for each specific area is provided in Tables 3.1 and 3.3 for survey units NOL01-09 and NOL01-09-FSR respectively. CSM Wall characterization composite soil boring sample results were previously presented in Table 1.1. Additionally, while not considered in the non-parametric statistical evaluation of compliance with the release criteria, there were five (5) biased and three (3) investigation samples that were collected in Survey Unit NOL01-09 and analyzed using gamma spectroscopy at the on-site laboratory. A summary of these eight samples is provided in Table 3.2.

3.1.1 SURVEY UNIT NOL01-09 STATISTICAL SOIL SAMPLE ACTIVITY RESULTS

Each of the fifteen (15) random-start, systematically-placed soil samples obtained during FSS in Survey Unit NOL01-09 were analyzed by gamma spectroscopy, H-3 and Sr-90 on-site. Since there was no characterization information available at the time of FSS Plan design, the FSS data from an adjacent survey area, NOL01-05 (The North Yard) was used to support the planning of Survey Unit NOL01-09. The FSS Plan stated that the radionuclides of concern include all plant-related nuclides with emphasis on Cs-137 and Co-60. However, Americium-241 (Am-241), Eu-152, Eu-154, C-14, and Sr-90 were identified in a commodity removed from an FSS investigation sample or the characterization samples collected in the NE Dewatering Well. Therefore, all statistical samples were sent to the off-site laboratory for HTD analysis with the exception of H-3 and Sr-90. The analytical results show that the maximum fraction is less than 17% of Unity. Data quality assessments indicated that the results meet the data quality requirements and are acceptable for use. Table 3.1 presents the FSS results for the fifteen (15) nonparametric samples collected for Survey unit NOL01-09.

Table 3.1 - Summary of Nonparametric Soil Sample Data for NOL01-09

FSS Direct Soil Samples Radionuclides of Concern Results (pCi/g)								
Sample Number	**Am-241**	**Co-60**	**Cs-137**	**Eu-152**	**Eu-154**	**C-14**	**Sr-90**	**SOF[(1)]**
NOL01-09-001-F	4.74E-02	-3.51E-02	1.40E-02	-1.50E-02	4.43E-02	1.91E-01	1.78E-01	14.7%
NOL01-09-002-F	-1.49E-02	2.09E-02	3.13E-02	-1.77E-01	2.07E-02	1.51E-01	1.45E-01	11.4%
NOL01-09-003-F	8.32E-02	**2.76E-01**	2.85E-03	-1.55E-01	-5.12E-02	3.90E-02	1.52E-01	16.3%
NOL01-09-004-F	-2.25E-01	-9.92E-02	-3.89E-02	-8.76E-02	-6.34E-02	-4.15E-03	1.88E-01	6.9%
NOL01-09-005-F	-3.29E-02	-5.45E-02	3.36E-03	1.26E-01	-3.18E-02	-5.72E-02	1.26E-01	6.9%
NOL01-09-006-F	-1.41E-01	-1.31E-02	1.98E-02	-7.13E-02	1.59E-02	5.64E-02	1.48E-01	9.6%
NOL01-09-007-F	-7.71E-02	-1.16E-03	-1.02E-02	-5.33E-02	4.30E-02	-2.23E-03	6.50E-02	3.8%
NOL01-09-008-F	1.66E-02	4.85E-03	7.58E-03	-1.29E-02	-9.37E-02	-1.21E-02	1.37E-01	8.1%
NOL01-09-009-F	3.05E-02	1.55E-02	-2.17E-02	1.64E-02	1.90E-03	-1.12E-01	2.06E-01	12.4%
NOL01-09-010-F	-2.17E-02	3.87E-03	-1.36E-02	-2.18E-02	-3.49E-02	9.58E-02	1.75E-01	12.4%
NOL01-09-011-F	1.30E-02	-2.15E-02	6.35E-04	6.31E-02	5.15E-03	2.25E-02	1.75E-01	12.2%
NOL01-09-012-F	-7.39E-02	7.80E-03	-1.05E-03	-6.76E-02	-5.54E-02	1.40E-01	1.96E-01	13.9%
NOL01-09-013-F	-8.92E-02	1.16E-02	-4.93E-03	7.43E-03	-1.08E-02	8.02E-02	1.39E-01	10.4%
NOL01-09-014-F	-3.95E-02	-1.82E-02	2.54E-02	6.88E-03	-4.19E-02	-5.34E-03	1.95E-01	12.2%
NOL01-09-015-F	-6.77E-03	1.80E-02	4.32E-03	6.95E-03	-3.35E-02	5.05E-02	1.42E-01	10.5%

*Result in **bold** indicates a positive result for Co-60

Note [(1)] The SOF (sum of fractions) presented in the table is calculated relative to the DCGLs presented in LTP Table 5-1

3.1.2 Survey Unit NOL01-09 Biased and Investigation Soil Sample Activity Results

As mentioned earlier in this report, there were five (5) biased and three (3) investigation samples that were collected in Survey Unit NOL01-09 and analyzed using gamma spectroscopy at the on-site laboratory. Additionally, two investigation and one biased sample collected were requested to be split during the independent verification survey performed by the ORISE Team. The FSS Engineer selected four of five biased sample locations near each of the four dewatering wells. Three one-liter investigation soil samples were collected per the survey plan as walkover scans indicated elevated activity readings present in these locations. Gamma results from the on-site laboratory indicated plant-derived activity (Co-60 and/or Cs-137) in two of the three investigation samples collected. Since all investigation soil samples indicated less than the direct investigation levels specified for Class 1 areas as listed in Table 5-5 of the LTP, an investigation survey was not warranted. It should be noted that a discrete anomaly totaling approximately 0.03 µCi was removed from sample NOL01-09-020-F-I during preparation. Table 3.2 presents the gamma analysis results for the biased and investigative samples collected for Survey unit NOL01-09.

Table 3.2 - Summary of Biased and Investigative Soil Sample Results for NOL01-09

Biased/Investigative FSS Soil /Sediment Samples Analyzed using the On-Site Laboratory HPGe Gamma System				
Sample Number	**Co-60 pCi/g**	**Cs-137 pCi/g**	**ORISE Split Sample #**	**Location**
NOL01-09-016-F-B	-2.02E-02	2.61E-02		Near SE Dewatering Well
NOL01-09-017-F-B	-5.09E-02	-1.65E-02		Near NE Dewatering Well
NOL01-09-018-F-B	-7.16E-02	-1.23E-02		Near SW Dewatering Well
NOL01-09-019-F-B	3.40E-03	2.43E-02		Near NW Dewatering Well
NOL01-09-020-F-I	**1.10E-01**	2.48E-02	S0021	Near South Wall
NOL01-09-021-F-I	**3.58E-01**	**1.15E-01**		~29' W of the SE Dewatering Well
NOL01-09-022-F-I	-3.66E-03	5.32E-02	S0023	Near NE Dewatering Well
NOL01-09-023-F-B	**5.23E-01**	**2.88E-01**	S0022	23' NW of the SW Dewatering Well

*Results in **bold** indicates a positive result for the associated radionuclide

3.1.3 Survey Unit NOL01-09-FSR Statistical Soil Sample Activity Results

Each of the fifteen (15) random-start, systematically-placed soil samples obtained during FSS in Survey Unit NOL01-09-FSR were analyzed by gamma spectroscopy at the HBPP on-site laboratory. The FSS Plan stated that the radionuclide of concern was Cs-137 for Class 1 reuse materials cleared through the GARDIAN system. The analytical results show that the maximum fraction is less than 1% of Unity. Data quality assessments indicated that the results meet the data quality requirements and are acceptable for use. Table 3.3 presents the FSS results for the fifteen (15) nonparametric samples collected for Survey Unit NOL01-09-FSR.

Table 3.3 - Summary of Systematic Soil Sample Results for NOL01-09-FSR

Cs-137 Results for FSS Direct Soil /Sediment Samples Analyzed using the On-Site Laboratory HPGe Gamma System		
Sample Number	**Cs-137 (pCi/g)**	**Fraction of the DCGL(1)**
NOL01-09-001-FSR	2.05E-02	2.59E-03
NOL01-09-002-FSR	-1.34E-02	-1.70E-03
NOL01-09-003-FSR	3.33E-02	4.22E-03
NOL01-09-004-FSR	2.64E-02	3.34E-03
NOL01-09-005-FSR	-6.19E-03	-7.84E-04
NOL01-09-006-FSR	3.65E-02	4.62E-03
NOL01-09-007-FSR	-3.08E-03	-3.90E-04
NOL01-09-008-FSR	2.57E-02	3.25E-03
NOL01-09-009-FSR	4.81E-02	6.09E-03
NOL01-09-010-FSR	3.78E-02	4.78E-03
NOL01-09-011-FSR	3.87E-02	4.90E-03
NOL01-09-012-FSR	-6.05E-03	-7.66E-04
NOL01-09-013-FSR	6.97E-02	8.82E-03
NOL01-09-014-FSR	**4.88E-02**	6.18E-03
NOL01-09-015-FSR	3.58E-02	4.53E-03

*Result in **bold** indicates a positive result

Note (1) The calculated fractions presented above are the activity values relative to the Cs-137 DCGL from LTP Table 5-1 (7.9 pCi/g)

3.2 SCAN SUMMARY

Survey Unit NOL01-09

Approximately 100% of the accessible surface area (884 m^2) of Survey Unit NOL01-09 was surveyed on January 11, 2018 by walking transects across the area, moving the detector in a serpentine fashion. Instrument readings ranging from 4.8 kcpm to 6.3 kcpm were recorded during the walkover survey for the 2" by 2" NaI detector systems. As previously mentioned earlier in this report, FSS Technicians identified three areas exceeded the scan investigation criteria specified in Table 5-5 of the LTP of >$DCGL_{EMC}$. Since all investigation soil samples indicated less than the direct investigation levels specified for Class 1 areas as listed in Table 5-5 of the LTP, an investigation survey was not warranted. The 100% scanned area percentage meets the LTP requirements stipulated for Class 1 areas.

Survey Unit NOL01-09-FSR

Approximately 100% of the accessible surface area (1,351 m^2) of Survey Unit NOL01-09-FSR was walkover scan surveyed by FSS Technicians from a period of November 20th, 2018 to December 8th, 2018. Instrument readings ranging from 4.0 kcpm to 6.5 kcpm were recorded during

the gamma walkover survey for the 2" by 2" NaI detector systems. There were no areas which exceeded the scan investigation criteria. Therefore, an investigation survey was not warranted. The 100% scanned area percentage meets the LTP requirements stipulated for Class 1 areas.

4.0 SURVEY UNIT DATA ASSESSMENT

4.1 STATISTICAL EVALUATIONS

The DQO sample design and data were reviewed in accordance with Procedure RCP FSS-14, "Data Quality Assessment" (Ref. 19) for completeness and consistency. The sampling design had adequate power for the Survey Units NOL01-09 and NOL01-09-FSR as indicated by their Retrospective Power Curves. The Sign Test was performed on the data and compared to the original assumptions of the DQOs. The evaluation of the Sign Test results demonstrates that the survey unit passes the unrestricted release criteria, thus, the null hypothesis is rejected.

Survey documentation was complete and legible. Surveys and sample collection were consistent with the DQOs and were adequate enough to ensure that the survey units were properly designated as Class 1.

The final data review consisted of calculating basic statistical quantities (e.g., mean, median, standard deviation). The mean and median values are well below the beta gross activity DCGLs. Also, the retrospective power curves show that a sufficient number of samples were collected to achieve the desired power. Therefore, the survey unit meets the unrestricted release criteria with adequate power as required by the DQOs. The basic statistical quantities for the statistical sample population for Survey Units: NOL01-09 and NOL01-09-FSR are provided below respectively in Tables 4.1 and Table 4.2.

Table 4.1 - Statistical Soil Sample Results Summary for NOL01-09

Statistic	Sum of Fractions		
Minimum Value:	3.75E-02	18.7%	Difference between mean and median
Maximum Value:	1.63E-01	-0.48	Skew
Mean:	1.08E-01	3.79	Range of Data
Median:	1.14E-01	9.26	Max Dose contribution (mrem/yr)
Standard Deviation:	3.31E-02	7.88	Hypothetical dose contribution (mrem/yr)

The range of the data for survey unit NOL01-09 is approximately 4 standard deviations. The difference between the mean and median was about -19% of the standard deviation which indicates moderate skewness in the data. The data was represented graphically through posting plots, a frequency plot, and a quantile plot. The frequency plot indicates a negative skewness as confirmed by the calculated skew of -0.48, indicating a moderate skewness in the data. The data contained no abnormalities and supported all the key assumptions of the statistical test.

All statistical soil samples were below the Investigation Levels of greater than 100% of the $DCGL_{EMC}$ for Cs-137 or Co-60, greater than unity for the sum of $DCGL_{EMC}$ fractions, or greater than DCGL and greater than a statistical parameter-based value, as provided in the Final Status

Survey Plan (FSSP) for the associated area. Since the Sign Test is passed if none of the data values exceed the DCGL, performing the test is unnecessary as it is passed by inspection.

The maximum hypothetical dose of 7.88 mrem/yr (from all sources, including groundwater) to a future resident farmer is less than a third of the release criteria. It should be noted that the dose estimate is a large overestimate given that the source term is covered by over 80' of backfill reuse soil and concrete. Therefore, there was no effort to refine the estimated doses presented in this report by performing additional RESRAD modeling of the FSS and characterization results for NOL01-09, the CSM Wall, and the NE Dewatering Well using a more realistic but unlikely critical exposure group scenario (i.e., an Intruder drilling a well approximately 100' in depth). This dose is compiled from the statistical data evaluated from Survey Unit NOL01-09 (2.69 mrem/yr), the CSM Wall Characterization Survey Unit dose (2.21 mrem/yr), and the NE Well dose (2.97 mrem/yr). It should be noted that the NE Well dose estimate provides a revised estimate of the residual Gravel Pack dose evaluated using Engineering Calculation NX-503 (Ref. 7) of 2.96 mrem/yr and the Embedded Pipe casing dose of 0.01 mrem/yr evaluated per TBD-403 (Ref. 6).

The results included in this report conclude that Survey Unit NOL01-09 has met the FSS data quality objectives and the regulatory release criteria of less than 25 mrem/yr to the average member of the critical group plus ALARA.

Table 4.2 - Statistical Soil Sample Results Summary for NOL01-09-FSR

Statistic	pCi/g	Fraction of the DCGL		
Minimum Value:	-1.34E-02	-1.70E-03	29.7%	Difference between mean and median
Maximum Value:	6.97E-02	8.82E-03	-0.27	Skew
Mean:	2.62E-02	3.32E-03	3.48	Range of Data
Median:	3.33E-02	4.22E-03	1.02	Max Dose contribution (mrem/yr)
Standard Deviation:	2.39E-02	3.03E-03	0.88	Hypothetical dose contribution (mrem/yr)

The range of the data for survey unit NOL01-09-FSR is approximately 3 standard deviations. The difference between the mean and median was about 30% of the standard deviation which is indicative of background variability in the data, which is expected since there was no Cs-137 identified from review of the on-site laboratory gamma spectroscopy reports. The data was represented graphically through posting plots, a frequency plot, and a quantile plot. The frequency plot indicates a negative skewness as confirmed by the calculated skew of -0.27, indicating fair symmetry and a normal distribution with no multimodal distribution noted. The data contained no abnormalities and supported all the key assumptions of the statistical test.

All soil samples were below the Investigation Levels of greater than 100% of the scaled $DCGL_{EMC}$ (13 pCi/g Cs-137), greater than unity for the sum of $DCGL_{EMC}$ fractions, or greater than DCGL (7.65 pCi/g Cs-137) and greater than a statistical parameter-based value, as provided in the FSSP for the associated area. Since the Sign Test is passed if none of the data values exceed the DCGL, performing the test is unnecessary as it is passed by inspection.

The maximum hypothetical dose of 0.88 mrem/yr (from all sources, including groundwater) to a future resident farmer was determined to be a small fraction of the release criteria. This dose is compiled from the statistical data evaluated from Survey Unit NOL01-09-FSR (0.08 mrem/yr) and the deselected dose (0.794 mrem/yr).

The results included in this report conclude that Survey Unit NOL01-09-FSR has met the FSS data quality objectives and the regulatory release criteria of less than 25 mrem/yr to the average member of the critical group plus ALARA.

4.2 GRAPHICAL EVALUATIONS

The data assessments and graphical representations for all survey units are provided in Attachment 1, Data Quality Assessment (DQA).

4.3 SURVEY UNIT INVESTIGATIONS AND RESULTS

As discussed previously in Section 3.1.2 of this report, since all investigative soil samples indicated less than the direct investigation levels specified for Class 1 areas as listed in Table 5-5 of the LTP, an investigation survey was not warranted for Survey Unit NOL01-09. There were no investigations performed for Survey Units NOL01-09 and NOL01-09-FSR.

4.4 CHANGES IN INITIAL SURVEY UNIT ASSUMPTIONS

None of the initial assumptions were changed or challenged from information gained in the performance of the FSS survey or in reviewing its results.

5.0 DATA QUALITY ASSURANCE

An important aspect of any survey or sampling evolution is the effort made to assure the quality of data collected. It is critical to assure the quality of the data through quality checks and controls, calibrations, and training. The purpose of the DQA is to evaluate the data collected from the field considering its intended use in decision making. Decision makers should obtain an understanding of the verity of the data used in the FSS from reading this section.

Quality checks and controls were designed into the FSS to ensure adequate data quality. QC measurements were designed to provide a means of assessing the quality of the data set and demonstrate that measurement results had the required precision and were sufficiently free of errors to accurately represent the residual radiological conditions in the soils of the various survey units within the potentially impacted areas. The DQA uses guidance from MARSSIM and professional judgment.

Direct soil measurement results are subjected to a focused DQA prior to using the data in FSS activities. The results are evaluated for apparent precision, accuracy, representativeness, completeness, and comparability; and appropriate data qualifiers are applied to the data set.

Since several naturally occurring radioactive material (NORM) nuclides are routinely identified during analysis of the FSS volumetric soil samples, a good test of accuracy and precision for a particular analytical program is to compare the detected radionuclide results for the samples homogenized and split from a single sample location, laboratory recounts of the same sample, and third-party analysis of split samples. This comparison method provides a more realistic view of the detection capability of the analytical method. Since there is much less uncertainty with a detected result that may be more than several times its detection threshold than a result near or less

than its detection level, it is reasonable and appropriate to evaluate the accuracy and precision data quality indicators using quantifiable radionuclide concentrations.

5.1 LABORATORY INSTRUMENTS

The prescribed QC for laboratory instruments consists of instrument source response checks, energy calibration checks, efficiency calibration checks, background checks, and replicate volumetric measurements performed on a percentage of the samples collected using an off-site system.

The on-site HPGe system used in the analysis of volumetric soil media during FSS was controlled by Canberra's Genie System software. The software was used to perform the energy and efficiency calibration checks. A QA check of the on-site gamma spectroscopy systems for both energy and efficiency parameters was performed daily, prior to counting operations. This was achieved by using a National Institute of Standards and Technology (NIST) traceable multi-line standard calibration source in a comparable geometry (with a volumetric equivalent density) as the samples to be counted. The QA checks performed on the gamma spectroscopy system verify that the system parameters have not changed such that the energy and efficiency calibrations are still valid. This was accomplished by tracking peak location from a low-energy peak (59 kilo-electron volts [keV]) and a high-energy peak (1,332 keV) from a calibration source (to indicate a problem relative to the energy calibration), peak energy resolution (full width at half maximum [FWHM]) (indicate a problem relative to the energy shape calibration), and decay corrected activity (indicate a problem relative to the efficiency calibration).

Examination of data concludes that the gamma spectroscopy system was functioning correctly during FSS. A check of the gamma spectroscopy system QA Background measurements (in units of cps) covering the significant time periods when FSS sample analysis occurred showed no issues related to instrument background prior to FSS sample analysis. Coupled with the gamma spectroscopy system's source check QA measurements, the measured background data presents additional evidence of the gamma spectroscopy system's stability.

5.2 LAB INSTRUMENTS QUALITY CONTROL

The prescribed QC for laboratory instruments consists of instrument source response checks, energy calibration checks, efficiency calibration checks, background checks, and replicate volumetric measurements performed on a percentage of the samples collected using an off-site system.

The on-site HPGe system used in the analysis of volumetric soil media during FSS was controlled by Canberra's Genie System software. The software was used to perform the energy and efficiency calibration checks. A QA check of the on-site gamma spectroscopy system for both energy and efficiency parameters was performed daily, prior to counting operations. This was achieved by using a National Institute of Standards and Technology (NIST) traceable multi-line standard calibration source in a comparable geometry (with a volumetric equivalent density) as the samples to be counted.

Examination of the data concluded that the gamma spectroscopy system was functioning correctly during FSS. A check of the gamma spectroscopy system QA Background measurements covering

the time periods when FSS sample analysis occurred showed no issues related to instrument background prior to FSS sample analysis.

5.3 LABORATORY INSTRUMENT DATA QUALITY INDICATORS

To provide an assessment of precision, a measurement of the repeatability of a measurement or measurement technique was performed by the on-site analytical laboratory by performing a recount gamma analysis on samples and performing a comparison to the original count using the split sample assessment method described in HBPP Procedure RCP FSS-11, "Split Sample Assessment for Final Status Survey" (Ref. 17). The Recount sample numbers for Survey Units NOL01-09 and NOL01-09-FSR are listed in Table 6.1 below.

Table 5.1 - List of Recount Samples

Survey Unit	Sample Number
NOL01-09	NOL01-09-003-F-RC
NOL01-09	NOL01-09-006-F-RC
NOL01-09-FSR	NOL01-09-010-FSR-RC
NOL01-09-FSR	NOL01-09-014-FSR-RC

No DQA issues were noted during the comparison evaluation. The recount sample results were within the expected tolerance for the analysis, providing additional evidence that the sample preparation and measurement processes were precise (Attachment 1).

To provide an assessment of accuracy, the degree to which a measurement technique or method can reflect a known value or be compared to a known value or standard, a QC metric for split samples collected by the FSS Field Team were generated for Survey Units NOL01-09 and NOL01-09-FSR as shown in Table 6.2 below. The samples were analyzed by the on-site gamma laboratory and the corresponding split samples were analyzed by the off-site analytical laboratory. As mentioned earlier in this report, the ORISE requested that PG&E provide three split samples from the FSS of Survey Unit NOL01-09. Therefore, those sample results were also evaluated via inter-laboratory comparison. The inter-laboratory comparison was evaluated using the split sample assessment method previously described. No DQA issues were noted during the split sample comparison evaluation. The split sample results were within the expected tolerance for the analysis, providing additional evidence that the sample preparation and measurement processes were accurate (Attachment 1).

Table 5.2 - List of Split Samples

Survey Unit	Survey Plan Sample Number	Off-Site Split Sample Number
NOL01-09	NOL01-09-007-F	NOL01-09-007-F-S
	NOL01-09-014-F	NOL01-09-014-F-S
	NOL01-09-020-F-I	5272S0021*
	NOL01-09-022-F-I	5272S0023*
	NOL01-09-023-F-B	5272S0022*
NOL01-09-FSR	NOL01-09-005-FSR	NOL01-09-005-FSR-S
	NOL01-09-013-FSR	NOL01-09-013-FSR-S

* These samples analyzed by the Oak Ridge Associated Universities (ORAU) Laboratory under the ORISE contract.

To provide an assessment of representativeness, the degree to which a data set is actually a sample of a population (e.g., information presented by the data set can be extrapolated to describe the overall site or system), the survey was designed to produce a random start systematic triangular grid sample allocation distribution that ensured DQOs were met. The sample locations identified using VSP meet the survey design DQOs and are considered representative of the conditions for Site soils in the survey area. No DQA issues regarding analytical or measurement effects (e.g., holding times or compositing effects) were noted during the data evaluation process that suggest that representativeness was affected.

To provide an assessment of completeness, the ability of the data set to encompass the entirety of the target system, a minimum of fifteen (15) volumetric soil samples from each survey unit were calculated, as classified according to area contamination potential.

To provide an assessment of comparability, the degree to which a data set, or single datum, can be compared to another measurement for purposes of assessing change over time, or other dynamic conditions, sampling procedures and protocols were used throughout the FSS process for the impacted Site area described in this report. There were no DQA issues regarding comparability as no critical deviation from procedures and protocols was encountered.

5.4 CORRECTIVE ACTIONS

As mentioned earlier in this report, an ASSP Investigation survey was warranted because the resurvey results evaluated from NOL01-09 indicated Cs-137 results greater than two standard deviations from the original FSS mean. The resurvey was required because the three active Caisson Dewatering Pumps were deactivated and removed, and remediation had been performed within the NE Dewatering Well casing to remove source term sediment >$DCGL_{EMC}$. The evaluation of the ASSP Investigation Survey as captured in SAPN 1439992 concluded that there was no evidence that activities performed since the original FSS was completed had adversely impacted the area. No other corrective actions were warranted during the performance and subsequent evaluation of FSS Survey Units NOL01-09 and NOL01-09-FSR.

5.5 QUALITY VERIFICATION

There were no quality verification assessments that were performed on Survey Units FSS Survey Units NOL01-09 and NOL01-09-FSR.

6.0 ALARA STATEMENT

The cost benefit analysis indicates that residual radioactivity in soils at the Site has been reduced to concentrations that are ALARA. A Generic ALARA Statement has been prepared to demonstrate that it is not ALARA to further remediate soil at levels below the DCGL. The analysis shows that shipping affected soil to a low-level waste disposal facility is not cost effective for unrestricted release.

Therefore, by demonstrating that the rest of the decision criteria have been met, also demonstrates that the level of residual radioactivity is ALARA without taking additional remedial action. The decision rules, having been derived from the dose-based radiological criteria for unrestricted release, ensure that residual radioactivity in soils on the site will not pose an unacceptable radiological risk to humans under any reasonable and foreseeable future use or occupancy (Ref. 17). The Generic ALARA Review for Final Status Survey of Soil at HBPP, along with each Survey Unit ALARA Evaluation Comparison is provided in Attachment 2.

7.0 SUMMARY AND CONCLUSIONS

This report demonstrates that FSS Survey Units NOL01-09 and NOL01-09-FSR have met the release requirements associated with the DCGLs listed in the HBPP LTP.

All identified radionuclides of concern were used for statistical testing to determine the adequacy of the survey unit for FSS. Although it is not required to demonstrate compliance with the release criteria, the sample data passed the Sign Test and the null hypothesis was rejected. All survey units were properly designated as Class 1.

Additionally, the data shows that the ALARA criteria for soils as specified in Chapter 4 of the HBPP LTP were achieved. This value is the TEDE based on the average concentration of the samples used for non-parametric statistical sampling. To uphold the commitments in License Amendment No. 40 to DPR-7, periodic surveillance surveys are performed for survey units that have undergone FSS to ensure adequate isolation controls are being maintained to preclude recontamination from Unit 3 decommissioning activities in accordance with HBPP Procedure RCP C-220, “Cross Contamination Prevention Plan” (Ref.20). As discussed in Section 1.3.5 of this report, Survey Units NOL01-09 and NOL01-09-FSR were exempted from the periodic surveillance surveys by the Site Closure Manager as these areas had an engineered surface or barrier in place.

Based on the analysis presented in this report, FSS data demonstrates that the subject area associated with potentially impacted areas has met the decision criteria, specifically:

- No unexpected results or trends are evident in the data.
- The sampling and survey results demonstrate that soil residual radioactivity in the potentially impacted areas is very minimal, and essentially indistinguishable from background.

- The data quality is judged to be adequate for its intended purpose.
- The amount of data collected from each survey unit is adequate to provide the required statistical confidence needed to decide that the DCGLs were met.
- The retrospective power of the Sign Test, used to judge compliance, was almost 100%.

Survey Units: Survey Units NOL01-09 and NOL01-09-FSR have met the final DQOs of the FSS process based on the following criteria:

- The ALARA criteria for soils as specified in Chapter 4 of the LTP were achieved.
- The sample data passed the Sign Test.
- The null hypothesis was rejected.
- Graphical representation of data indicates some limited skewness.
- The Retrospective Power Curves generated show adequate power was achieved.
- The survey units were properly designated as Class 1.

The maximum hypothetical dose (from all sources, including groundwater) to a future resident farmer was determined to be a fraction of the DCGL. The maximum hypothetical dose for each Survey Unit is provided in Table 7.1 below.

Table 7.1 - Maximum Hypothetical Dose Per Area

Survey Unit	Max Hypothetical Dose (mrem/yr)
NOL01-09	7.88
NOL01-09-FSR	0.88

Thus, the null hypothesis, that residual radioactivity in the survey units exists in concentrations above the applicable DCGLs, should be rejected for each of the survey units in the potentially impacted area. The area surveyed and sampled during FSS (the survey unit identified in this report) should be released from further radiological controls. Therefore, this FSS Report submittal supports the regulatory decision to terminate the license following completion of all FSS report submittals for the site.

8.0 REFERENCES

1 Humboldt Bay Power Plant License Termination Plan, Rev. 02, January, 2018.

2 Humboldt Bay Power Plant Historical Site Assessment 2011 Update, July, 2011.

3 Humboldt Bay Power Plant CSM Wall Characterization Plan, December 17, 2014

4 NRC Docket No. 50-133, Humboldt Bay Power Plant, Unit No. 3 Facility License DPR-7, As Amended.

5 Humboldt Bay Power Plant Radiological Characterization Report, HBPP-RPT-001, Rev. 01, ENERCON Services, Inc., November 21, 2008

6 Humboldt Bay Power Plant Technical Basis Document-403 "DCGLs for Embedded and Buried Piping in Support of Final Status Survey at HBPP", Rev. 01, September 8, 2017

7 Humboldt Bay Power Plant Calculation NX-503 "NE Caisson Dewatering Well Assessment", February 14, 2018

8 HBPP Procedure RCP FSS-13 "Area Surveillance Following Final Status Survey," Rev 03, May 5th, 2017

9 HBPP Procedure FSS-8, "Collection of Site Characterization and Final Status Survey Samples" Rev 2, June 30, 2016.

10 HBPP Procedure RCP FSS-1, "Survey Unit Classification", Rev 0C, September 11, 2013.

11 HBPP Procedure RCP FSS-2, "Preparation of FSS Plans", Rev. 2B, August 15, 2016.

12 NUREG 1575 *Multi Agency Radiation Site Survey and Investigation Manual*, (MARSSIM), USNRC Rev. 1 August 2000.

13 HBPP Procedure RCP FSS-7, "Determination of the Number and Location of FSS Samples" Rev. 1, June 30, 2016.

14 MARSSIM Power 2000 Software Program, Environmental Measurements Laboratory, US Department of Energy, Version 1.0.0, December 2000

15 HBPP Procedure RCP FSS-18, "Computer Determination of Number and Locations of FSS Samples", Rev. 1, June 30, 2016.

16 VSP Development Team (2014). *Visual Sample Plan: A Tool for Design and Analysis of Environmental Sampling*, Version 6.2d, Pacific Northwest National Laboratory. Richland, WA. http://vsp.pnnl.gov.

17 HBPP Procedure RCP FSS-11, "Split Sample Assessment for Final Status Survey" Rev. 1, June 30, 2016.

18 HBPP Procedure C-202, "Final Status Survey Quality Assurance Project Plan" Rev 4A, July 28, 2017.

19 HBPP Procedure RCP FSS-14, "Data Quality Assessment" Rev. 1, June 30, 2016.

20 HBPP Procedure C-220, "Cross Contamination Prevention and Monitoring Plan" Rev 1B, February 11, 2016.

21 USNRC, Inspection Report 050-00133/16-001, March 3, 2016

LIST OF ACRONYMS AND ABBREVIATIONS

ALARA	As Low As Reasonably Achievable
Am-241	Americium-241
ASSP	Area Surveillance Survey Plan
C-14	Carbon-14
CHAR	Characterization
Cs-137	Cesium-137
Co-60	Cobalt-60
CPS	Counts per second
CSM	Cutter Soil Mix
DCGL	Derived concentration guideline level, the radionuclide specific activity concentration that corresponds to the release criterion (25 mrem/y) within a survey unit
$DCGL_{EMC}$	Derived Concentration Guideline Level Elevated Measurement Comparison
$DCGL_{op}$	Operational DCGL
DOE	United States Department of Energy
DPM	Disintegrations per minute
DQA	Data Quality Assurance
DQO	Data Quality Objectives
EMC	elevated measurement comparison
ETD	easy to detect
Eu-152	Europium-152
Eu-154	Europium-154
FSS	Final Status Survey
FSSP	Final Status Survey Plan
FSR	Final Site Restoration
FWHM	Full Width at Half Maximum
GARDIAN	Gamma Radiation Detection and In-Container Analysis
GEL	General Engineering Laboratories, LLC
GPS	global positioning system
H-3	Tritium
HBPP	Humboldt Bay Power Plant

HBAP	Humboldt Bay Administrative Procedure
HSA	Historical Site Assessment
HTD	hard to detect (for this purpose, nuclides that are not detectable by gamma analysis)
kcpm	kilo-counts per minute
keV	kilo-electron volts
LBGR	lower bound of the gray region
LLD	lower limit of detection
LTP	License Termination Plan
m^2	meter(s) squared
MARSAME	Multi-Agency Radiation Survey and Assessment of Materials and Equipment
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	minimum detectable concentration
MicroShield®	Comprehensive photon/gamma ray shielding and dose assessment Radiation Software, Version 9.05, Grove Engineering
mrem/yr	Millirem per year
NAD	North American Datum
NaI	Sodium-Iodide Detector
NaI (Tl)	Thallium-activated sodium iodide gamma scintillation detector
NE	Northeast
NW	Northwest
NIST	National Institute of Standards and Technology
NORM	naturally occurring radioactive material
NRC	Nuclear Regulatory Commission
NW	Northwest
ORAU	Oak Ridge Associated Universities
ORISE	Oak Ridge Institute for Science and Education
pCi/g	picocuries per gram
PG&E	Pacific Gas and Electric Company
PNNL	Pacific Northwest National Laboratory
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RCA	Radiologically Controlled Area
RCP	Radiation Control Procedure

RESRAD	Residual Radioactivity (model)
RP	Radiation Protection
SAPN	Systems Application and Products Notification
SE	Southeast
SFP	Spent Fuel Pool
SOF	Sum of Fractions
Sr-90	Strontium-90
SW	Southwest
TBD	Technical Basis Document
TEDE	total effective dose equivalent
TPS	Total Position Station
TRU	transuranic
µR/hr	micro-Roentgens per hour
VSP	Visual Sample Plan computer program
yd^3	cubic yard

Attachment 1

Data Assessment

Data Quality Assessment of NOL01-09;

1. *The HBPP LTP and Historical Site Assessment were reviewed and compared to the DQOs of HBPP-FSSP-NOL01-09. The classification history satisfies the DQOs in the survey plan.*
2. *The survey unit description as well as the design, measurement locations, analytical methods and detection limits, variability (a-priori σ), QC requirements and survey and sampling accuracy were adequately discussed in the FSSP.*
3. *All field documents, instrument issue, measurement results and maps were complete and legible.*
4. *A preliminary data review was performed of the 15 statistical samples gathered. The survey had more than sufficient power.*

Statistical quantities (Reported in Fraction of Unity):

Number of statistical samples	15
Minimum value	3.75E-02
Maximum Value	1.63E-01
Mean	1.08E-01
Median	1.14E-01
a-posteriori σ	3.31E-02

5. *The mean is approximately equal to the median indicating a common central tendency.*
6. *The range of the data varies within ~3.8 standard deviations about the arithmetic mean.*
7. *The Scatter Plot exhibits that there were no outlier sample results.*
8. *The Quantile Plot exhibits relatively normal symmetry.*
9. *The Frequency Plot demonstrates a normal distribution with no multimodal distribution.*
10. *The data posting plot does not clearly reveal any systematic spatial trends.*
11. *No sample data exceeded the DCGL, therefore a statistical test was not required.*
12. *The data was of sufficient quantity and quality to be used as FSS data.*
13. *The data verified all the key assumptions of the statistical test.*
14. *The survey possessed sufficient power to pass the survey unit.*

Summary:

The survey was performed as stated in the survey package, the data contained no abnormalities and supported all the key assumptions of the statistical test, and no sample exceeded the DCGL.

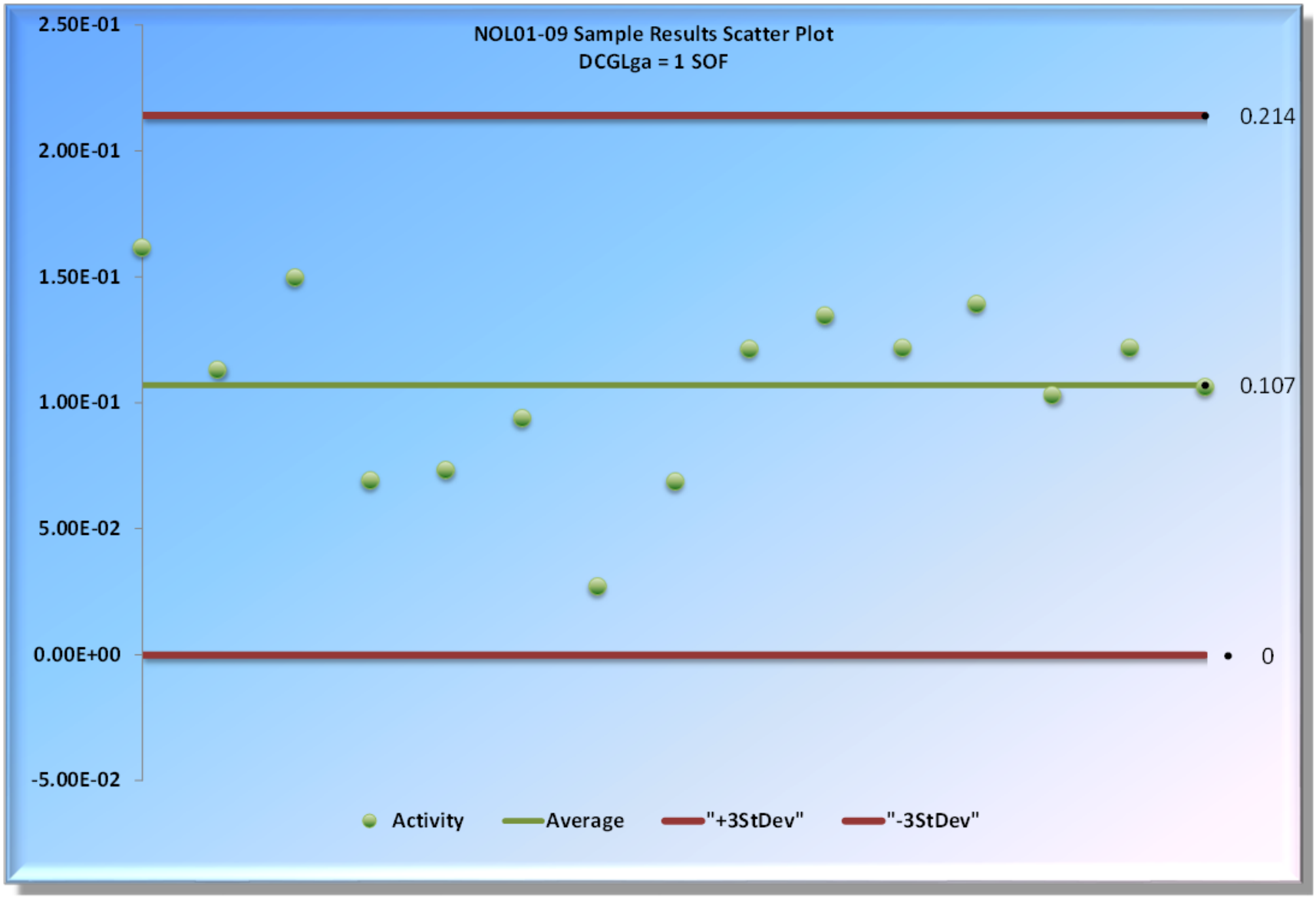
Survey Unit NOL01-09 meets the HBPP release criteria thus the null hypothesis is rejected for NOL01-09.

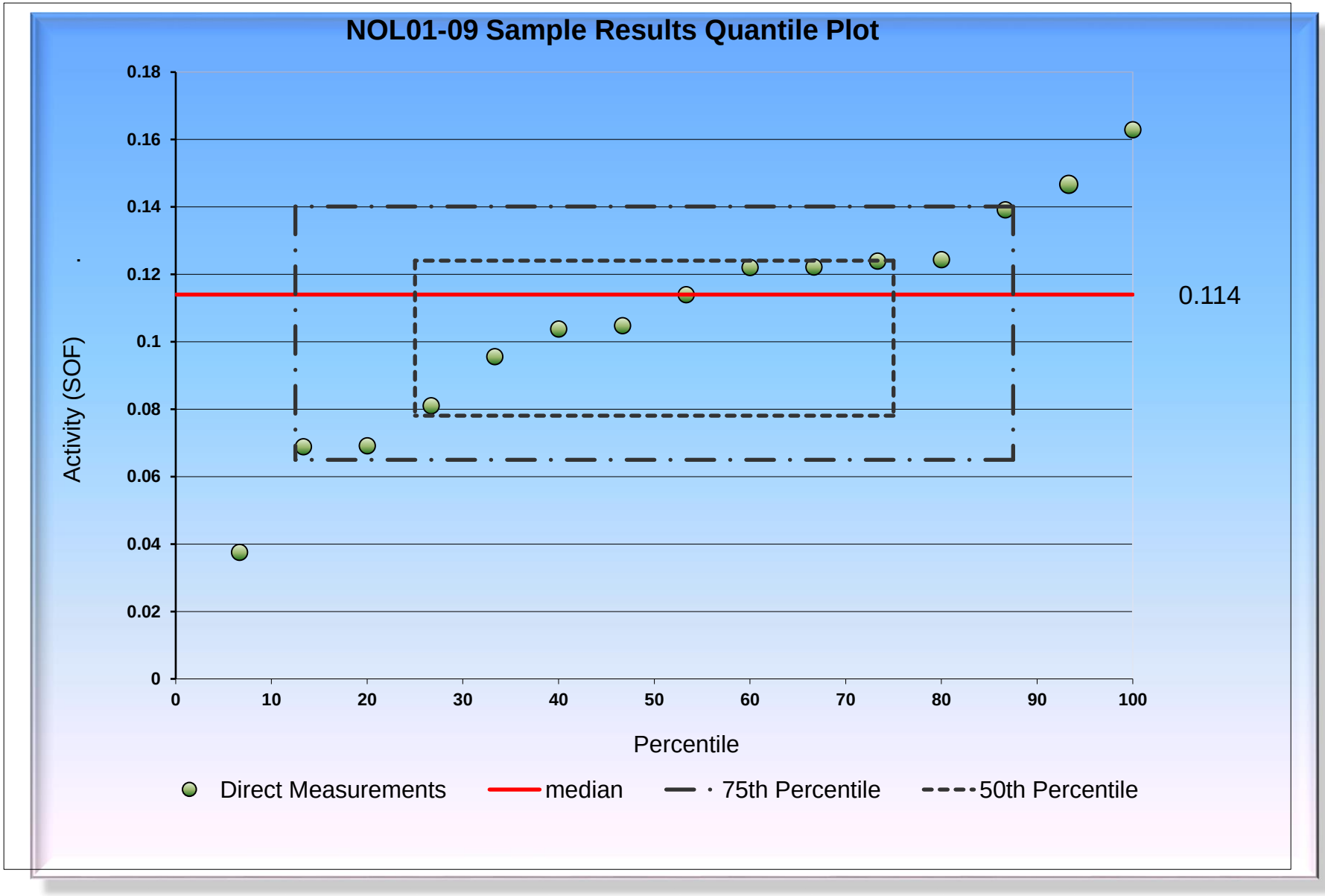
Radionuclides of Concern Results[2] for FSS Direct Soil /Sediment Samples pCi/g								
Sample Number	**Am-241**	**Co-60**	**Cs-137**	**Eu-152**	**Eu-154**	**C-14**	**Sr-90**	**SOF[1]**
NOL01-09-001-F	4.74E-02	-3.51E-02	1.40E-02	-1.50E-02	4.43E-02	1.91E-01	1.78E-01	14.7%
NOL01-09-002-F	-1.49E-02	2.09E-02	3.13E-02	-1.77E-01	2.07E-02	1.51E-01	1.45E-01	11.4%
NOL01-09-003-F	8.32E-02	**2.76E-01**	2.85E-03	-1.55E-01	-5.12E-02	3.90E-02	1.52E-01	16.3%
NOL01-09-004-F	-2.25E-01	-9.92E-02	-3.89E-02	-8.76E-02	-6.34E-02	-4.15E-03	1.88E-01	6.9%
NOL01-09-005-F	-3.29E-02	-5.45E-02	3.36E-03	1.26E-01	-3.18E-02	-5.72E-02	1.26E-01	6.9%
NOL01-09-006-F	-1.41E-01	-1.31E-02	1.98E-02	-7.13E-02	1.59E-02	5.64E-02	1.48E-01	9.6%
NOL01-09-007-F	-7.71E-02	-1.16E-03	-1.02E-02	-5.33E-02	4.30E-02	-2.23E-03	6.50E-02	3.8%
NOL01-09-008-F	1.66E-02	4.85E-03	7.58E-03	-1.29E-02	-9.37E-02	-1.21E-02	1.37E-01	8.1%
NOL01-09-009-F	3.05E-02	1.55E-02	-2.17E-02	1.64E-02	1.90E-03	-1.12E-01	2.06E-01	12.4%
NOL01-09-010-F	-2.17E-02	3.87E-03	-1.36E-02	-2.18E-02	-3.49E-02	9.58E-02	1.75E-01	12.4%
NOL01-09-011-F	1.30E-02	-2.15E-02	6.35E-04	6.31E-02	5.15E-03	2.25E-02	1.75E-01	12.2%
NOL01-09-012-F	-7.39E-02	7.80E-03	-1.05E-03	-6.76E-02	-5.54E-02	1.40E-01	1.96E-01	13.9%
NOL01-09-013-F	-8.92E-02	1.16E-02	-4.93E-03	7.43E-03	-1.08E-02	8.02E-02	1.39E-01	10.4%
NOL01-09-014-F	-3.95E-02	-1.82E-02	2.54E-02	6.88E-03	-4.19E-02	-5.34E-03	1.95E-01	12.2%
NOL01-09-015-F	-6.77E-03	1.80E-02	4.32E-03	6.95E-03	-3.35E-02	5.05E-02	1.42E-01	10.5%

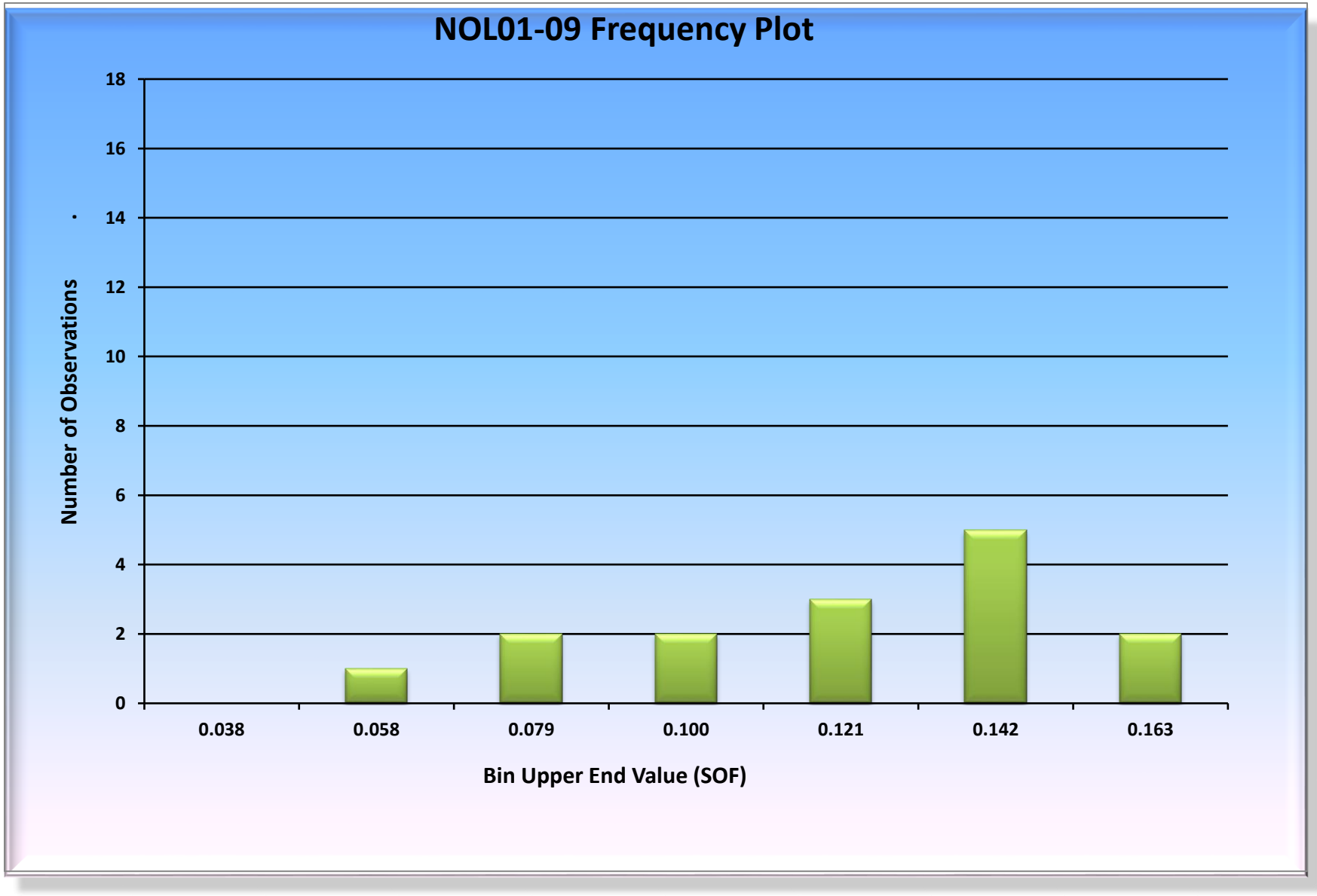
*Result in **bold** indicates a positive result for Co-60

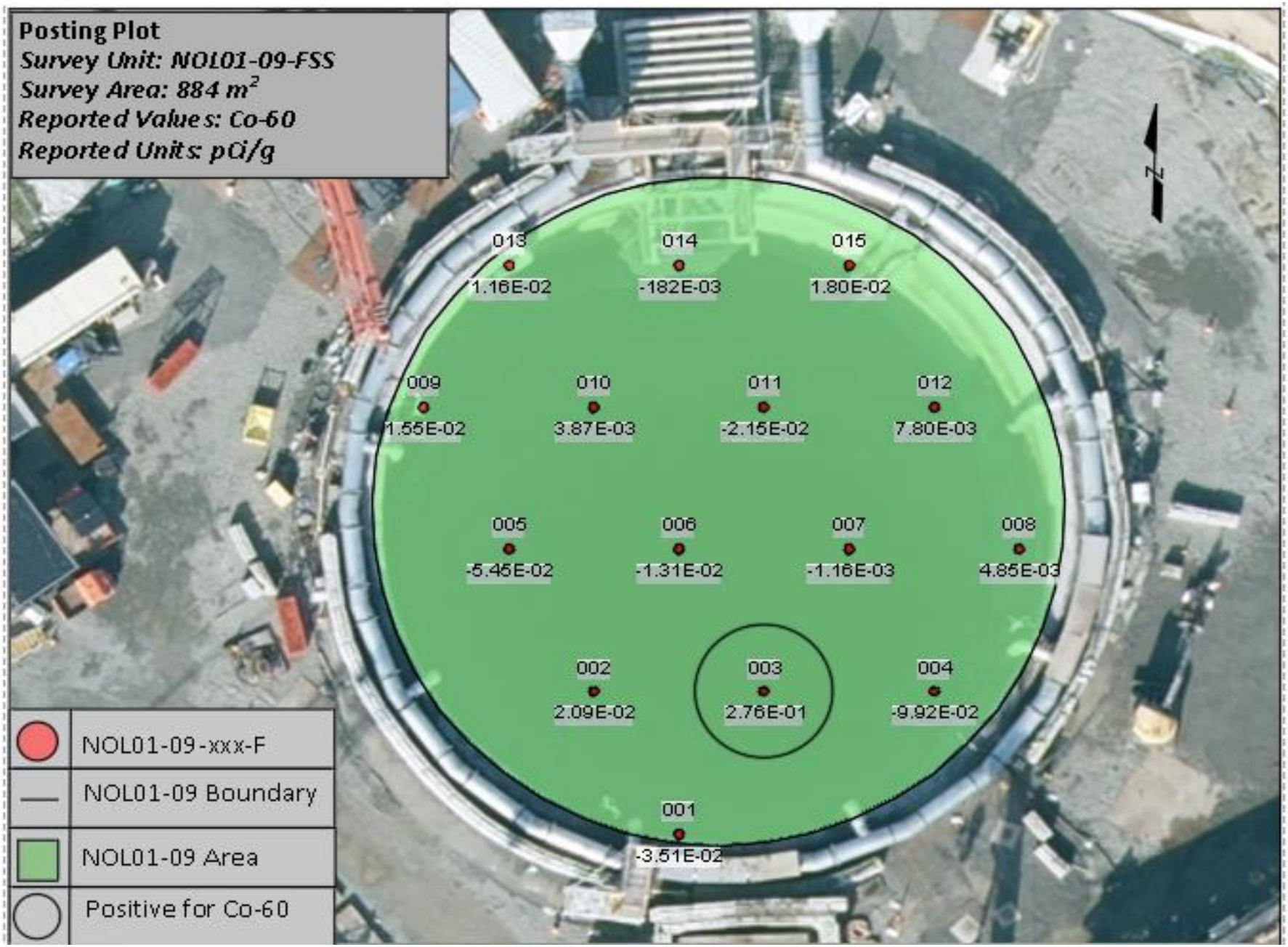
Note [1] The SOF (sum of fractions) presented in the table is calculated relative to the DCGLs presented in LTP Table 5-1

Note [2] The table results shown for all radionuclides except C-14 were analyzed at the on-site laboratory. Carbon-14 analysis was performed at the off-site laboratory

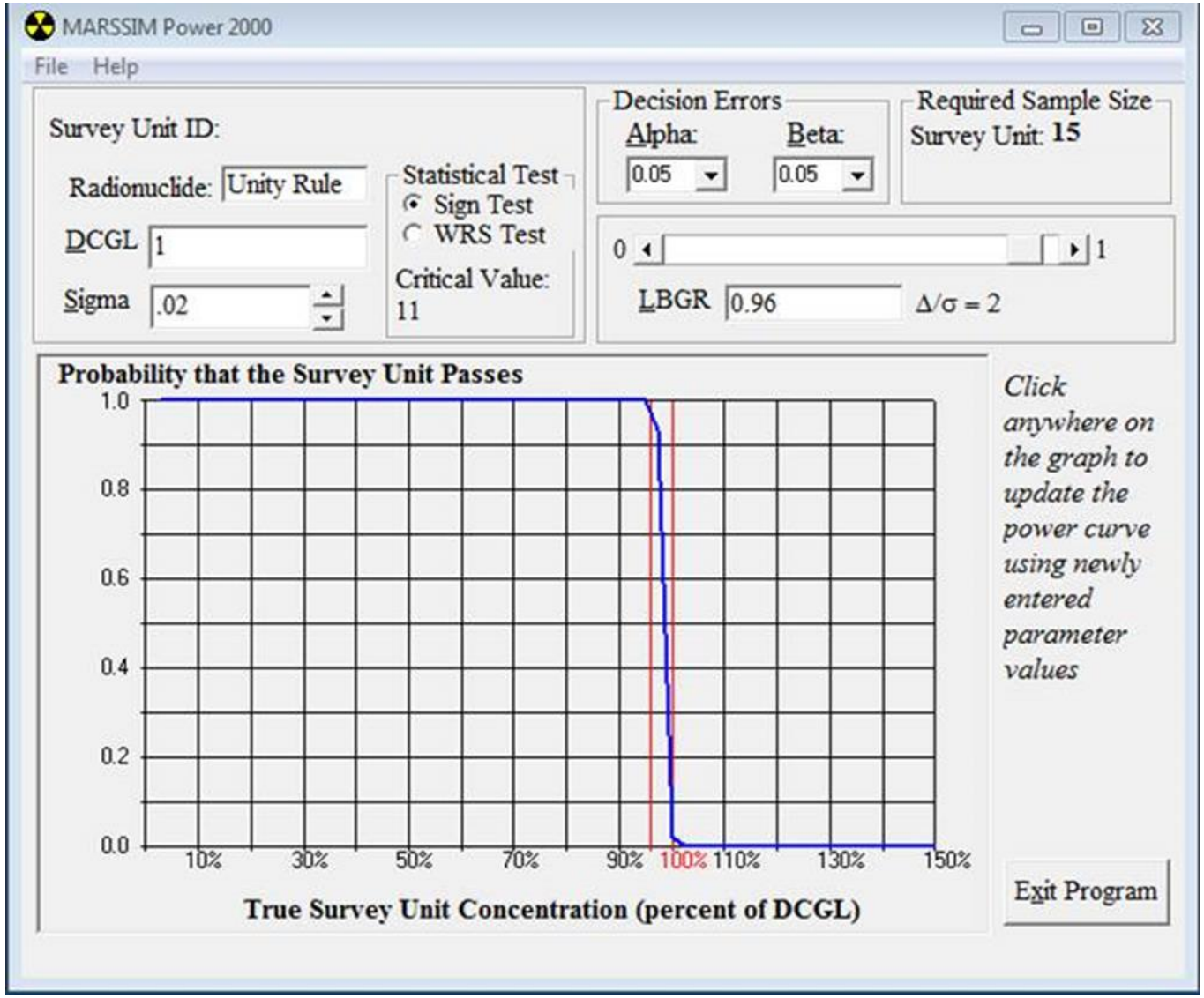

NOL01-09 Sample Results Scatter Plot
DCGLga = 1 SOF
2.50E-01
2.00E-01
1.50E-01
1.00E-01
5.00E-02
0.00E+00
-5.00E-02
0.214
0.107
0
Activity
Average
"+3StDev"
"-3StDev"


NOL01-09 Sample Results Quantile Plot
Activity (SOF)
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0
10
20
30
40
50
60
70
80
90
100
Percentile
0.114
Direct Measurements
median
75th Percentile
50th Percentile

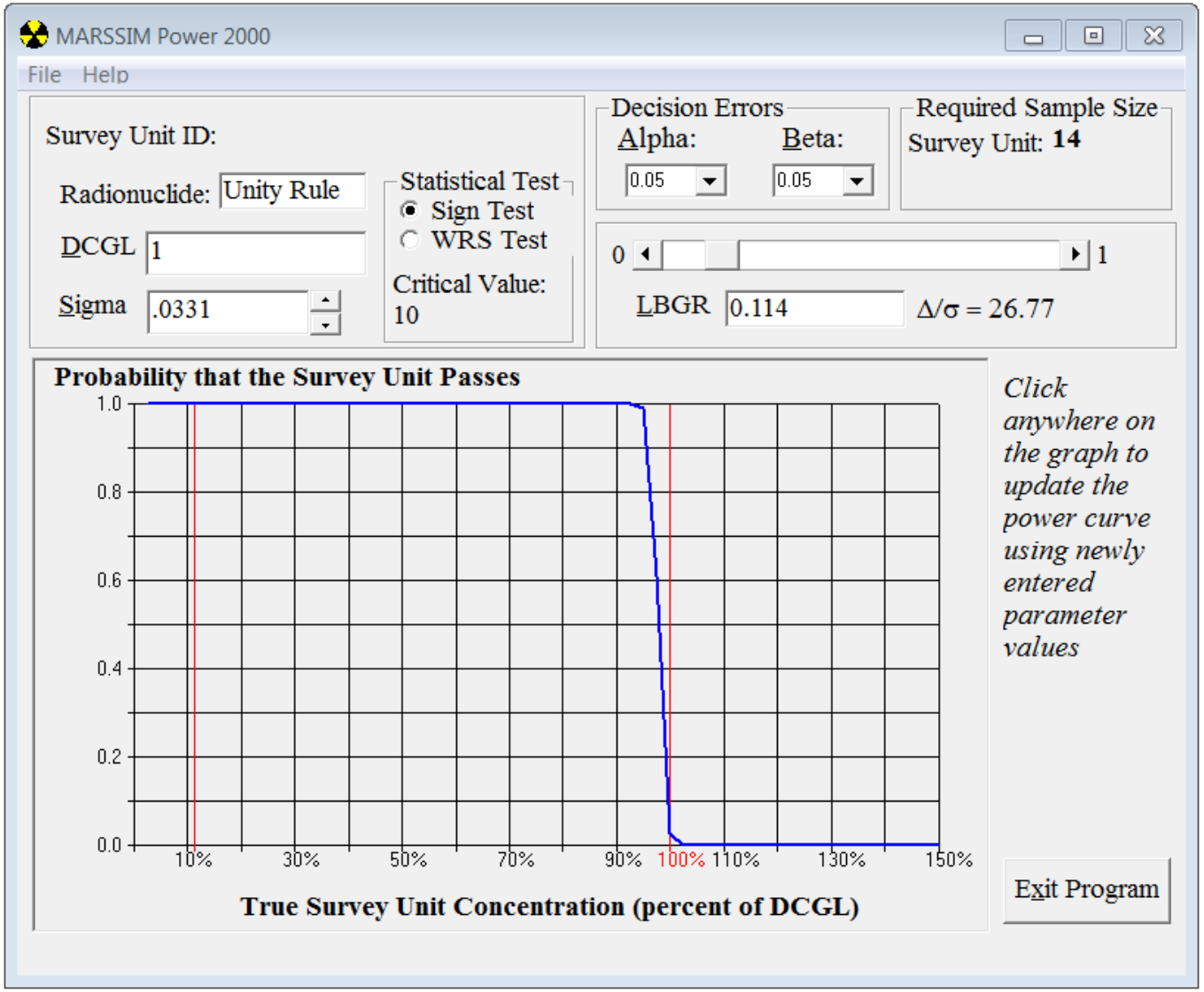

NOL01-09 Frequency Plot
Number of Observations
18
16
14
12
10
8
6
4
2
0
0.038
0.058
0.079
0.100
0.121
0.142
0.163
Bin Upper End Value (SOF)


Posting Plot
Survey Unit: NOL01-09-FSS
Survey Area: 884 m²
Reported Values: Co-60
Reported Units: pCi/g
N
013
1.16E-02
014
-182E-03
015
1.80E-02
009
1.55E-02
010
3.87E-03
011
-2.15E-02
012
7.80E-03
005
-5.45E-02
006
-1.31E-02
007
-1.16E-03
008
4.85E-03
002
2.09E-02
003
2.76E-01
004
-9.92E-02
001
-3.51E-02
NOL01-09-xxx-F
NOL01-09 Boundary
NOL01-09 Area
Positive for Co-60

Prospective Power Curve



Retrospective Power Curve



Split Sample #007

Split Sample Assessment Form

Survey Area No.:	NOL01	Survey Unit No.:	9	Survey Unit Name:	NOL Open Land Area inside the RA (Caisson)
Sample Plan No.:	HBPP-FSSP-NOL01-09-01			Sample Measurement Location:	#007

Sample Description:

Comparison of split samples collected from sample measurement location #007 and analyzed using gamma spectroscopy by an off-site vendor laboratory. The on-site result is the standard count and the off-site is the comparison.

STANDARD						COMPARISON			
Radionuclide chosen (a)	Standard Activity (b)	1σ *Uncertainty* (c)	Resolution (d)=(b)/(c)	Agreement Range (e)		Comparison Activity (f)	Comparison Error (g)	Comparison Ratio (h)=(f)/(b)	Acceptable (Y/N)
K-40	4.58	0.48	10	0.6	1.66	4.17	0.18	0.91	Y
Pb-212	0.21	0.03	7	0.5	2	0.24	0.01	1.13	Y

Comments/Corrective Actions:

N/A

Table 1 is provided to show acceptance criteria to assess split samples.

Resolution (d)		Agreement Range (e)	
Min	Max	Min	Max
<4		No Comaprison	No Comaprison
4	7	0.5	2
8	15	0.6	1.66
16	50	0.75	1.33
51	200	0.8	1.25
>200		0.85	1.18

Performed By:	Gordon Madison	Date:	11/25/2019	Concurrence by:	Marshall Blake		11/25/2019
Signature:				Signature:			

Split Sample #014

Split Sample Assessment Form

Survey Area No.:	NOL01	Survey Unit No.:	9	Survey Unit Name:	NOL Open Land Area inside the RA (Caisson)		
Sample Plan No.:	HBPP-FSSP-NOL01-09-01					Sample Measurement Location:	#014

Sample Description:

Comparison of split samples collected from sample measurement location #014 and analyzed using gamma spectroscopy by an off-site vendor laboratory. The on-site result is the standard count and the off-site is the comparison.

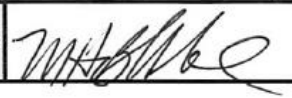
STANDARD						COMPARISON			
Radionuclide chosen (a)	Standard Activity (b)	1σ *Uncertainty* (c)	Resolution (d)=(b)/(c)	Agreement Range (e)		Comparison Activity (f)	Comparison Error (g)	Comparison Ratio (h)=(f)/(b)	Acceptable (Y/N)
K-40	4.11	0.39	11	0.6	1.66	4.86	0.19	1.18	Y
Pb-212	0.22	0.02	10	0.6	1.66	0.27	0.01	1.21	Y

Comments/Corrective Actions:

N/A

Table 1 is provided to show acceptance criteria to assess split samples.

Resolution (d)		Agreement Range (e)	
Min	Max	Min	Max
<4		No Comaprison	No Comaprison
4	7	0.5	2
8	15	0.6	1.66
16	50	0.75	1.33
51	200	0.8	1.25
>200		0.85	1.18

Performed By:	Gordon Madison	Date:	11/25/2019	Concurrence by:	Marshall Blake	Date:	11/25/2019
Signature:				Signature:			

Recount Sample #003

Recount Sample Assessment Form

Survey Area No.:	NOL01	Survey Unit No.:	9	Survey Unit Name:	NOL Open Land Area inside the RA (Caisson)
Sample Plan No.:	HBPP-FSSP-NOL01-09-01			Sample Measurement Location:	#003

Sample Description:

Duplicate count comparison from sample measurement location #003 and analyzed using gamma spectroscopy by the on-site laboratory. The original count result is the standard count and the recount is the comparison.

STANDARD						COMPARISON			
Radionuclide chosen (a)	Standard Activity (b)	1σ *Uncertainty* (c)	Resolution (d)=(b)/(c)	Agreement Range (e)		Comparison Activity (f)	Comparison Error (g)	Comparison Ratio (h)=(f)/(b)	Acceptable (Y/N)
K-40	4.12	0.98	4	0.5	2	3.72	0.43	0.90	Y
Co-60	0.28	0.03	11	0.6	1.66	0.28	0.03	1.00	Y

Comments/Corrective Actions:

N/A

Table 1 is provided to show acceptance criteria for sample recounts.

Resolution (d)		Agreement Range (e)	
Min	Max	Min	Max
<4		No Comaprison	No Comaprison
4	7	0.5	2
8	15	0.6	1.66
16	50	0.75	1.33
51	200	0.8	1.25
>200		0.85	1.18

Performed By:	Gordon Madison	Date:	11/25/2019	Concurrence by:	Marshall Blake	Date:	11/25/2019
Signature:				Signature:			

Recount Sample #006

Recount Sample Assessment Form

Survey Area No.:	NOL01	Survey Unit No.:	9	Survey Unit Name:	NOL Open Land Area inside the RA (Caisson)
Sample Plan No.:	HBPP-FSSP-NOL01-09-01			Sample Measurement Location:	#006

Sample Description:

Recount comparison of sample collected from measurement location #006 analyzed using gamma spectroscopy by the on-site laboratory. The on-site result is the standard count and the recount is the comparison.

STANDARD						COMPARISON			
Radionuclide chosen (a)	Standard Activity (b)	1σ *Uncertainty* (c)	Resolution (d)=(b)/(c)	Agreement Range (e)		Comparison Activity (f)	Comparison Error (g)	Comparison Ratio (h)=(f)/(b)	Acceptable (Y/N)
K-40	4.65	0.51	9	0.6	1.66	5.05	0.53	1.09	Y
Pb-212	0.26	0.03	8	0.6	1.66	0.22	0.03	0.84	Y

Comments/Corrective Actions:

N/A

Table 1 is provided to show acceptance criteria to assess sample recounts.

Resolution (d)		Agreement Range (e)	
Min	Max	Min	Max
<4		No Comaprison	No Comaprison
4	7	0.5	2
8	15	0.6	1.66
16	50	0.75	1.33
51	200	0.8	1.25
>200		0.85	1.18

Performed By:	Gordon Madison	Date:	11/25/2019	Concurrence by:	Marshall Blake	Date:	11/25/2019
Signature:				Signature:			

ORISE

Split Sample #020I

Split Sample Assessment Form

Survey Area No.:	NOL01	Survey Unit No.:	9	Survey Unit Name:	NOL Open Land Area inside the RA (Caisson)
Sample Plan No.:	HBPP-FSSP-NOL01-09-01			Sample Measurement Location:	#020I

Sample Description:

Comparison of split samples collected from investigation sample measurement location #20I and analyzed using liquid scintillation spectroscopy by an off-site vendor laboratory. The on-site result is the standard count and the ORISE result from Split S0021 is the comparison. No other plant-derived radionuclides were identified in the on-site gamma analysis results for comparison. ORISE result provided from Appendix B: Data Tables of DCN 5272-SR-03-0 Humboldt Bay Confirmatory Survey Report April 2018

STANDARD						COMPARISON			
Radionuclide chosen (a)	Standard Activity (b)	1σ *Uncertainty* (c)	Resolution (d)=(b)/(c)	Agreement Range (e)		Comparison Activity (f)	Comparison Error (g)	Comparison Ratio (h)=(f)/(b)	Acceptable (Y/N)
Co-60	0.11	0.02	6	0.5	2	0.13	0.01	1.18	Y

Comments/Corrective Actions:

N/A

Table 1 is provided to show acceptance criteria to assess split samples.

Resolution (d)		Agreement Range (e)	
Min	Max	Min	Max
<4		No Comaprison	No Comaprison
4	7	0.5	2
8	15	0.6	1.66
16	50	0.75	1.33
51	200	0.8	1.25
>200		0.85	1.18

Performed By:	Gordon Madison	Date:	11/25/2019	Concurrence by:	Marshall Blake	Date:	11/25/2019
Signature:				Signature:			

ORISE

Split Sample #022I

Split Sample Assessment Form

Survey Area No.:	NOL01	Survey Unit No.:	9	Survey Unit Name:	NOL Open Land Area inside the RA (Caisson)		
Sample Plan No.:	HBPP-FSSP-NOL01-09-01					Sample Measurement Location:	#022I

Sample Description:

Comparison of split samples collected from investigation sample measurement location #22I and analyzed using gamma spectroscopy by an off-site vendor laboratory. The on-site result is the standard count and the ORISE result from Split S0023 is the comparison. ORISE results provided from Appendix B: Data Tables of DCN 5272-SR-03-0 Humboldt Bay Confirmatory Survey Report April 2018. No plant-derived radionuclides were identified in the on-site gamma analysis results for comparison.

STANDARD						COMPARISON			
Radionuclide chosen (a)	Standard Activity (b)	1σ *Uncertainty* (c)	Resolution (d)=(b)/(c)	Agreement Range (e)		Comparison Activity (f)	Comparison Error (g)	Comparison Ratio (h)=(f)/(b)	Acceptable (Y/N)
H-3	11.24	0.06	200	0.8	1.25	10.30	0.77	0.92	Y

Comments/Corrective Actions:

N/A

Table 1 is provided to show acceptance criteria to assess split samples.

Resolution (d)		Agreement Range (e)	
Min	Max	Min	Max
<4		No Comaprison	No Comaprison
4	7	0.5	2
8	15	0.6	1.66
16	50	0.75	1.33
51	200	0.8	1.25
>200		0.85	1.18

Performed By:	Gordon Madison	Date:	11/25/2019	Concurrence by:	Marshall Blake	Date:	11/25/2019
Signature:				Signature:			

ORISE

Split Sample #023B

Split Sample Assessment Form

Survey Area No.:	NOL01	Survey Unit No.:	9	Survey Unit Name:	NOL Open Land Area inside the RA (Caisson)		
Sample Plan No.:	HBPP-FSSP-NOL01-09-01					Sample Measurement Location:	#023B

Sample Description:

Comparison of split samples collected from biased sample measurement location #23B and analyzed using liquid scintillation spectroscopy by an off-site vendor laboratory. The on-site result is the standard count and the ORISE result from Split S0022 is the comparison. No other plant-derived radionuclides were identified in the on-site gamma analysis results for comparison. ORISE result provided from Appendix B: Data Tables of DCN 5272-SR-03-0 Humboldt Bay Confirmatory Survey Report April 2018

STANDARD						COMPARISON			
Radionuclide chosen (a)	Standard Activity (b)	1σ *Uncertainty* (c)	Resolution (d)=(b)/(c)	Agreement Range (e)		Comparison Activity (f)	Comparison Error (g)	Comparison Ratio (h)=(f)/(b)	Acceptable (Y/N)
Co-60	0.52	0.04	15	0.6	1.66	0.56	0.02	1.07	Y
Cs-137	0.29	0.03	9	0.6	1.66	0.19	0.01	0.66	Y

Comments/Corrective Actions:

N/A

Table 1 is provided to show acceptance criteria to assess split samples.

Resolution (d)		Agreement Range (e)	
Min	Max	Min	Max
<4		No Comaprison	No Comaprison
4	7	0.5	2
8	15	0.6	1.66
16	50	0.75	1.33
51	200	0.8	1.25
>200		0.85	1.18

Performed By:	Gordon Madison	Date:	11/25/2019	Concurrence by:	Marshall Blake	Date:	11/25/2019
Signature:				Signature:			

OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION

April 4, 2018

Mr. John Hickman
U.S. Nuclear Regulatory Commission
Office of Nuclear Material Safety and Safeguards
Division of Decommissioning, Uranium Recovery, and Waste Programs
Reactor Decommissioning Branch
Mail Stop: T8F5
11545 Rockville Pike
Rockville, MD 20852

SUBJECT: INDEPENDENT CONFIRMATORY SURVEY SUMMARY AND RESULTS FOR SURVEY UNITS OOL10-14 AND NOL01-09 AT THE HUMBOLDT BAY POWER PLANT, EUREKA, CALIFORNIA (RFTA NO. 18-005); DCN 5272-SR-03-0

Dear Mr. Hickman:

The Oak Ridge Institute for Science and Education (ORISE) is pleased to provide the enclosed final report detailing the independent confirmatory survey activities of survey units OOL10-14, remainder of land area (parking lot A), and NOL01-09, open land area inside the restricted area (caisson), at the Humboldt Bay Power Plant in Eureka, California. This report provides the summary and results of activities performed by ORISE during the period of January 9–11, 2018.

You may contact me at 865.576.6659 if you have any questions.

Sincerely,

Erika N. Bailey

Erika N. Bailey
Survey and Technical Projects Group Manager
ORAU

ASO:KME: lw

electronic distribution: L. Gersey, NRC; T. Carter, NRC; File/5272; S. Roberts, ORAU; D. Hagemeyer, ORAU

Table B.1. ORISE Soil Sample Results (pCi/g)									
ROC	5272S0021			5272S0022			5272S0023		
	Concentration		MDC	Concentration		MDC	Concentration		MDC
Am-241	0.0081 ± 0.0080		0.0060	0.016 ± 0.011		0.006	0.0019 ± 0.0037		0.0057
C-14	0.35 ± 0.83		1.41	0.76 ± 0.85		1.42	-0.53 ± 0.86		1.51
Cm-243/244	0.0020 ± 0.0040		0.0060	-0.0019 ± 0.0038		0.0186	-0.0019 ± 0.0037		0.0182
Cm-245	0.023 ± 0.068		0.164	0.001 ± 0.044		0.138	0.027 ± 0.079		0.188
Co-60	0.130 ± 0.028		0.039	0.562 ± 0.047		0.024	0.010 ± 0.011		0.028
Cs-137	0.048 ± 0.016		0.029	0.190 ± 0.024		0.029	0.051 ± 0.013		0.022
Eu-152	0.000 ± 0.035		0.076	0.008 ± 0.027		0.064	-0.009 ± 0.029		0.067
Eu-154	-0.091 ± 0.077		0.144	0.013 ± 0.045		0.129	-0.007 ± 0.033		0.103
H-3	0.88 ± 0.98		1.64	0.31 ± 0.96		1.65	10.3 ± 1.5		1.8
Nb-94	-0.007 ± 0.015		0.031	0.003 ± 0.014		0.029	-0.002 ± 0.010		0.022
Ni-59	-9.93 ± 7.21		11.1	1.51 ± 6.31		12.7	0.00 ± 4.12		3.28
Ni-63	0.37 ± 0.42		0.71	0.89 ± 0.42		0.68	0.58 ± 0.43		0.71
Np-237	0.0078 ± 0.0076		0.0058	0.000 ± 0.0040		0.0061	0.0041 ± 0.0080		0.0196
Pu-238	0.017 ± 0.011		0.006	0.027 ± 0.015		0.006	0.016 ± 0.011		0.006
Pu-239/240	0.0058 ± 0.0066		0.0058	0.014 ± 0.011		0.006	0.0061 ± 0.0090		0.0196
Pu-241	0.8 ± 1.9		3.2	-0.6 ± 1.9		3.4	1.7 ± 2.1		3.5
Sr-90	-0.06 ± 0.16		0.31	0.07 ± 0.17		0.30	-0.06 ± 0.17		0.32
Tc-99	0.05 ± 0.47		0.83	-0.07 ± 0.48		0.85	-0.09 ± 0.47		0.83
SOF[a]	0.12			0.36			0.03		

[a]The SOFs were calculated using the most conservative DCGL for Cm-243/244 and Pu-239/240.

GEL LABORATORIES LLC

2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

GEL Sample ID: 441900003
Client Sample ID: FSS-1322: NOL01-09-001-F
Client Matrix: Soil
Amount of Sample Received:
Sample Description: HTDs

Client: Pacific Gas and Electric Company
Collect Date: January 11, 2018
Receive Date: January 18, 2018
Report Date: January 24, 2018

Isotope	Run Date	Qualifier	Activity	2 Sigma Uncertainty	MDC	LLD	2 Sigma TPU	Units
C-14	01/22/18	U	1.91E-01	2.30E-01	3.79E-01	6.07E-01	2.31E-01	pCi/g
Ni-63	01/23/18	U	1.16E+01	1.45E+01	2.35E+01	6.94E+01	1.46E+01	pCi/g
Tc-99	01/23/18	U	-1.09E-01	4.32E-01	7.27E-01	1.16E+00	4.31E-01	pCi/g
Pu-241	01/23/18	U	-1.13E+01	2.62E+01	4.49E+01	8.29E+01	2.62E+01	pCi/g
Alpha Spec								
Pu-238	01/22/18	U	2.09E-02	1.04E-01	1.95E-01	2.80E+00	1.04E-01	pCi/g
Pu-239/240	01/22/18	U	2.09E-02	1.04E-01	1.95E-01	2.51E+00	1.04E-01	pCi/g
Am-241	01/20/18	U	1.13E-01	1.33E-01	1.44E-01	2.41E+00	1.34E-01	pCi/g
Cm-243/244	01/20/18	U	-7.09E-03	6.11E-02	1.42E-01	2.80E+00	6.12E-02	pCi/g
Cm-245/246	01/20/18	U	1.63E-01	1.66E-01	1.64E-01	1.64E+00	1.67E-01	pCi/g
Gamma Spec								
Ni-59	01/22/18	U	5.11E+00	6.81E+00	1.45E+01	1.83E+02	7.21E+00	pCi/g

Notes:
1. LLDs are a-priori values.
2. MDCs are calculated a-posteriori values.
3. Gamma spectroscopy analysis results are calculated from a measurement using only one gamma energy line.
4. Air sample volumes are received in units of ft3. GEL converts the units and reports them as m3.

Qualifiers:
U Target isotope was analyzed for but not detected above the MDC and LLD.
UI Uncertain identification for gamma spectroscopy.
X Lab-specific qualifier-please see case narrative, data summary package or contact your project manager for details.
M Reported result is less than the LLD and greater than the MDC.

GEL LABORATORIES LLC

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Certificate of Analysis

GEL Sample ID: 441900004
Client Sample ID: FSS-1323: NOL01-09-002-F
Client Matrix: Soil
Amount of Sample Received:
Sample Description: HTDs

Client: Pacific Gas and Electric Company
Collect Date: January 11, 2018
Receive Date: January 18, 2018
Report Date: January 24, 2018

Isotope	Run Date	Qualifier	Activity	2 Sigma Uncertainty	MDC	LLD	2 Sigma TPU	Units
C-14	01/22/18	U	1.51E-01	2.29E-01	3.78E-01	6.07E-01	2.29E-01	pCi/g
Ni-63	01/23/18	U	1.75E+00	7.32E+00	1.22E+01	6.94E+01	7.32E+00	pCi/g
Tc-99	01/23/18	U	-6.64E-01	4.16E-01	7.18E-01	1.16E+00	4.16E-01	pCi/g
Pu-241	01/23/18	U	-1.58E+01	3.04E+01	5.23E+01	8.29E+01	3.04E+01	pCi/g
Alpha Spec								
Pu-238	01/20/18	U	1.12E-02	1.17E-01	2.44E-01	2.80E+00	1.17E-01	pCi/g
Pu-239/240	01/20/18	U	-7.68E-02	9.66E-02	3.23E-01	2.51E+00	9.67E-02	pCi/g
Am-241	01/20/18	U	2.82E-02	1.57E-01	3.00E-01	2.41E+00	1.57E-01	pCi/g
Cm-243/244	01/20/18	U	6.84E-02	1.88E-01	3.26E-01	2.80E+00	1.89E-01	pCi/g
Cm-245/246	01/20/18	U	6.20E-02	1.74E-01	1.86E-01	1.64E+00	1.75E-01	pCi/g
Gamma Spec								
Ni-59	01/22/18	UI	2.57E+01	2.51E+01	2.57E+01	1.83E+02	2.52E+01	pCi/g

Notes:
1. LLDs are a-priori values.
2. MDCs are calculated a-posteriori values.
3. Gamma spectroscopy analysis results are calculated from a measurement using only one gamma energy line.
4. Air sample volumes are received in units of ft3. GEL converts the units and reports them as m3.

Qualifiers:
U Target isotope was analyzed for but not detected above the MDC and LLD.
UI Uncertain identification for gamma spectroscopy.
X Lab-specific qualifier-please see case narrative, data summary package or contact your project manager for details.
M Reported result is less than the LLD and greater than the MDC.

GEL LABORATORIES LLC

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Certificate of Analysis

GEL Sample ID: 441900005
Client Sample ID: FSS-1324: NOL01-09-003-F
Client Matrix: Soil
Amount of Sample Received:
Sample Description: HTDs

Client: Pacific Gas and Electric Company
Collect Date: January 11, 2018
Receive Date: January 18, 2018
Report Date: January 24, 2018

Isotope	Run Date	Qualifier	Activity	2 Sigma Uncertainty	MDC	LLD	2 Sigma TPU	Units
C-14	01/22/18	U	3.90E-02	2.72E-01	4.56E-01	6.07E-01	2.72E-01	pCi/g
Ni-63	01/23/18	U	-3.51E-01	1.13E+01	1.90E+01	6.94E+01	1.13E+01	pCi/g
Tc-99	01/23/18	U	5.12E-01	3.98E-01	6.52E-01	1.16E+00	4.03E-01	pCi/g
Pu-241	01/23/18	U	1.26E+01	2.97E+01	4.87E+01	8.29E+01	2.98E+01	pCi/g
Alpha Spec								
Pu-238	01/22/18	U	2.70E-02	1.01E-01	1.70E-01	2.80E+00	1.01E-01	pCi/g
Pu-239/240	01/22/18	U	-8.51E-03	7.34E-02	1.70E-01	2.51E+00	7.35E-02	pCi/g
Am-241	01/22/18	U	6.89E-02	1.10E-01	1.52E-01	2.41E+00	1.10E-01	pCi/g
Cm-243/244	01/22/18	U	7.56E-03	7.90E-02	1.65E-01	2.80E+00	7.91E-02	pCi/g
Cm-245/246	01/22/18	U	5.51E-02	1.08E-01	1.50E-01	1.64E+00	1.09E-01	pCi/g
Gamma Spec								
Ni-59	01/22/18	UI	3.63E+01	6.59E+01	3.63E+01	1.83E+02	6.60E+01	pCi/g

Notes:
1. LLDs are a-priori values.
2. MDCs are calculated a-posteriori values.
3. Gamma spectroscopy analysis results are calculated from a measurement using only one gamma energy line.
4. Air sample volumes are received in units of ft3. GEL converts the units and reports them as m3.

Qualifiers:
U Target isotope was analyzed for but not detected above the MDC and LLD.
UI Uncertain identification for gamma spectroscopy.
X Lab-specific qualifier-please see case narrative, data summary package or contact your project manager for details.
M Reported result is less than the LLD and greater than the MDC.

GEL LABORATORIES LLC

2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

GEL Sample ID: 441900006
Client Sample ID: FSS-1325: NOL01-09-004-F
Client Matrix: Soil
Amount of Sample Received:
Sample Description: HTDs

Client: Pacific Gas and Electric Company
Collect Date: January 11, 2018
Receive Date: January 18, 2018
Report Date: January 24, 2018

Isotope	Run Date	Qualifier	Activity	2 Sigma Uncertainty	MDC	LLD	2 Sigma TPU	Units
C-14	01/22/18	U	-4.15E-03	2.26E-01	3.79E-01	6.07E-01	2.26E-01	pCi/g
Ni-63	01/23/18	U	-2.17E+00	6.72E+00	1.14E+01	6.94E+01	6.72E+00	pCi/g
Tc-99	01/23/18	U	-3.89E-01	4.19E-01	7.14E-01	1.16E+00	4.19E-01	pCi/g
Pu-241	01/23/18	U	-7.26E+00	3.64E+01	6.17E+01	8.29E+01	3.64E+01	pCi/g
Alpha Spec								
Pu-238	01/20/18	U	3.68E-03	1.69E-01	3.72E-01	2.80E+00	1.69E-01	pCi/g
Pu-239/240	01/20/18	U	1.47E-02	1.68E-01	3.57E-01	2.51E+00	1.68E-01	pCi/g
Am-241	01/20/18	U	-4.10E-02	9.49E-02	2.81E-01	2.41E+00	9.51E-02	pCi/g
Cm-243/244	01/20/18	U	8.58E-02	1.71E-01	2.77E-01	2.80E+00	1.71E-01	pCi/g
Cm-245/246	01/20/18	U	7.42E-02	1.71E-01	2.70E-01	1.64E+00	1.71E-01	pCi/g
Gamma Spec								
Ni-59	01/22/18	U	-6.00E+00	1.19E+01	1.85E+01	1.83E+02	1.23E+01	pCi/g

Notes:
1. LLDs are a-priori values.
2. MDCs are calculated a-posteriori values.
3. Gamma spectroscopy analysis results are calculated from a measurement using only one gamma energy line.
4. Air sample volumes are received in units of ft3. GEL converts the units and reports them as m3.

Qualifiers:
U Target isotope was analyzed for but not detected above the MDC and LLD.
UI Uncertain identification for gamma spectroscopy.
X Lab-specific qualifier-please see case narrative, data summary package or contact your project manager for details.
M Reported result is less than the LLD and greater than the MDC.

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Certificate of Analysis

GEL Sample ID: 441900007
Client Sample ID: FSS-1326: NOL01-09-005-F
Client Matrix: Soil
Amount of Sample Received:
Sample Description: HTDs

Client: Pacific Gas and Electric Company
Collect Date: January 11, 2018
Receive Date: January 18, 2018
Report Date: January 24, 2018

Isotope	Run Date	Qualifier	Activity	2 Sigma Uncertainty	MDC	LLD	2 Sigma TPU	Units
C-14	01/22/18	U	-5.72E-02	2.23E-01	3.76E-01	6.07E-01	2.23E-01	pCi/g
Ni-63	01/23/18	U	2.60E-02	7.72E+00	1.30E+01	6.94E+01	7.72E+00	pCi/g
Tc-99	01/23/18	U	-1.52E-01	4.39E-01	7.42E-01	1.16E+00	4.39E-01	pCi/g
Pu-241	01/23/18	U	7.51E+00	2.76E+01	4.57E+01	8.29E+01	2.76E+01	pCi/g
Alpha Spec								
Pu-238	01/20/18	U	5.75E-02	1.30E-01	2.24E-01	2.80E+00	1.31E-01	pCi/g
Pu-239/240	01/20/18	U	-6.00E-02	1.04E-01	2.94E-01	2.51E+00	1.04E-01	pCi/g
Am-241	01/20/18	U	4.28E-02	9.84E-02	1.56E-01	2.41E+00	9.85E-02	pCi/g
Cm-243/244	01/20/18	U	-2.00E-02	6.04E-02	1.70E-01	2.80E+00	6.05E-02	pCi/g
Cm-245/246	01/20/18	U	8.90E-02	1.28E-01	1.55E-01	1.64E+00	1.29E-01	pCi/g
Gamma Spec								
Ni-59	01/22/18	U	9.46E+00	1.64E+01	3.05E+01	1.83E+02	1.70E+01	pCi/g

Notes:
1. LLDs are a-priori values.
2. MDCs are calculated a-posteriori values.
3. Gamma spectroscopy analysis results are calculated from a measurement using only one gamma energy line.
4. Air sample volumes are received in units of ft3. GEL converts the units and reports them as m3.

Qualifiers:
U Target isotope was analyzed for but not detected above the MDC and LLD.
UI Uncertain identification for gamma spectroscopy.
X Lab-specific qualifier-please see case narrative, data summary package or contact your project manager for details.
M Reported result is less than the LLD and greater than the MDC.

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Certificate of Analysis

GEL Sample ID: 441900008
Client Sample ID: FSS-1327: NOL01-09-006-F
Client Matrix: Soil
Amount of Sample Received:
Sample Description: HTDs

Client: Pacific Gas and Electric Company
Collect Date: January 11, 2018
Receive Date: January 18, 2018
Report Date: January 24, 2018

Isotope	Run Date	Qualifier	Activity	2 Sigma Uncertainty	MDC	LLD	2 Sigma TPU	Units
C-14	01/22/18	U	5.64E-02	2.26E-01	3.78E-01	6.07E-01	2.26E-01	pCi/g
Ni-63	01/23/18	U	2.11E+00	1.10E+01	1.83E+01	6.94E+01	1.10E+01	pCi/g
Tc-99	01/23/18	U	-3.39E-01	4.14E-01	7.05E-01	1.16E+00	4.14E-01	pCi/g
Pu-241	01/23/18	U	3.67E+00	2.67E+01	4.46E+01	8.29E+01	2.67E+01	pCi/g
Alpha Spec								
Pu-238	01/20/18	U	3.63E-02	1.24E-01	2.30E-01	2.80E+00	1.24E-01	pCi/g
Pu-239/240	01/20/18	U	2.79E-03	1.28E-01	2.82E-01	2.51E+00	1.28E-01	pCi/g
Am-241	01/22/18	U	-8.68E-02	1.09E-01	3.65E-01	2.41E+00	1.09E-01	pCi/g
Cm-243/244	01/22/18	U	1.32E-01	2.80E-01	5.01E-01	2.80E+00	2.81E-01	pCi/g
Cm-245/246	01/22/18	U	1.43E-01	2.06E-01	2.48E-01	1.64E+00	2.07E-01	pCi/g
Gamma Spec								
Ni-59	01/22/18	U	-6.41E+00	1.22E+01	1.51E+01	1.83E+02	1.25E+01	pCi/g

Notes:
1. LLDs are a-priori values.
2. MDCs are calculated a-posteriori values.
3. Gamma spectroscopy analysis results are calculated from a measurement using only one gamma energy line.
4. Air sample volumes are received in units of ft3. GEL converts the units and reports them as m3.

Qualifiers:
U Target isotope was analyzed for but not detected above the MDC and LLD.
UI Uncertain identification for gamma spectroscopy.
X Lab-specific qualifier-please see case narrative, data summary package or contact your project manager for details.
M Reported result is less than the LLD and greater than the MDC.

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Certificate of Analysis

GEL Sample ID: 441900001
Client Sample ID: FSS-1328: NOL01-09-007-F-S
Client Matrix: Soil
Amount of Sample Received:
Sample Description: gamma

Client: Pacific Gas and Electric Company
Collect Date: January 11, 2018
Receive Date: January 18, 2018
Report Date: January 24, 2018

Isotope	Run Date	Qualifier	Activity	2 Sigma Uncertainty	MDC	LLD	2 Sigma TPU	Units
Gamma Spec								
Be-7	01/19/18	U	1.14E-03	5.14E-02	8.69E-02		5.14E-02	pCi/g
Na-22	01/19/18	UI	1.20E-02	1.95E-02	1.20E-02		1.95E-02	pCi/g
K-40	01/19/18		4.17E+00	3.53E-01	6.83E-02		5.13E-01	pCi/g
Cr-51	01/19/18	U	-7.43E-02	6.27E-02	9.67E-02		7.13E-02	pCi/g
Mn-54	01/19/18	U	2.32E-03	7.29E-03	1.25E-02		7.37E-03	pCi/g
Fe-59	01/19/18	U	8.20E-04	1.38E-02	2.26E-02		1.38E-02	pCi/g
Co-56	01/19/18	U	5.25E-03	6.48E-03	1.20E-02		6.91E-03	pCi/g
Co-57	01/19/18	U	-1.45E-03	6.72E-03	1.16E-02		6.76E-03	pCi/g
Co-58	01/19/18	U	2.63E-03	6.47E-03	1.13E-02		6.58E-03	pCi/g
Co-60	01/19/18	U	7.78E-03	6.93E-03	1.41E-02	3.48E-01	7.79E-03	pCi/g
Zn-65	01/19/18	U	1.42E-03	1.52E-02	2.50E-02		1.52E-02	pCi/g
Y-88	01/19/18	U	8.43E-04	5.88E-03	1.04E-02		5.89E-03	pCi/g
Zr-95	01/19/18	U	-3.20E-03	1.21E-02	1.92E-02		1.22E-02	pCi/g
Nb-94	01/19/18	U	3.18E-03	6.07E-03	1.08E-02	6.51E-01	6.24E-03	pCi/g
Nb-95	01/19/18	U	-5.92E-04	8.60E-03	1.41E-02		8.60E-03	pCi/g
Ru-106	01/19/18	U	4.75E-02	5.67E-02	1.05E-01		6.09E-02	pCi/g
Ag-110m	01/19/18	U	-2.82E-03	9.06E-03	1.41E-02		9.15E-03	pCi/g
Sn-113	01/19/18	U	4.17E-03	7.43E-03	1.34E-02		7.68E-03	pCi/g
Sb-124	01/19/18	U	6.98E-03	7.10E-03	1.69E-02		7.79E-03	pCi/g
Sb-125	01/19/18	U	8.91E-04	1.69E-02	2.88E-02		1.69E-02	pCi/g
Cs-134	01/19/18	U	7.92E-03	1.31E-02	1.57E-02		1.36E-02	pCi/g
Cs-136	01/19/18	U	-6.13E-03	1.18E-02	1.70E-02		1.21E-02	pCi/g
Cs-137	01/19/18	U	5.51E-03	6.87E-03	1.26E-02	7.24E-01	7.33E-03	pCi/g
Ba-133	01/19/18	U	-1.31E-03	9.05E-03	1.36E-02		9.07E-03	pCi/g
Ba-140	01/19/18	U	3.70E-03	3.43E-02	5.24E-02		3.43E-02	pCi/g
Ce-139	01/19/18	U	-1.76E-03	6.54E-03	1.12E-02		6.59E-03	pCi/g
Ce-141	01/19/18	U	-1.47E-04	1.33E-02	2.32E-02		1.33E-02	pCi/g
Ce-144	01/19/18	U	-1.01E-02	5.86E-02	9.16E-02		5.88E-02	pCi/g
Nd-147	01/19/18	U	3.42E-02	6.50E-02	1.07E-01		6.69E-02	pCi/g
Pm-144	01/19/18	U	-1.91E-03	6.07E-03	9.59E-03		6.13E-03	pCi/g
Pm-146	01/19/18	U	5.77E-03	8.09E-03	1.47E-02		8.52E-03	pCi/g
Eu-152	01/19/18	U	-1.69E-02	1.89E-02	2.97E-02	9.17E-01	2.04E-02	pCi/g
Eu-154	01/19/18	UI	3.73E-02	5.53E-02	3.73E-02	8.62E-01	6.17E-02	pCi/g
Eu-155	01/19/18	U	3.49E-03	3.37E-02	5.40E-02		3.38E-02	pCi/g
Ir-192	01/19/18	U	6.57E-03	6.01E-03	1.12E-02		6.72E-03	pCi/g

Notes:
1. LLDs are a-priori values.
2. MDCs are calculated a-posteriori values.
3. Gamma spectroscopy analysis results are calculated from a measurement using only one gamma energy line.
4. Air sample volumes are received in units of ft3. GEL converts the units and reports them as m3.

Qualifiers:
U Target isotope was analyzed for but not detected above the MDC and LLD.
UI Uncertain identification for gamma spectroscopy.
X Lab-specific qualifier-please see case narrative, data summary package or contact your project manager for details.
M Reported result is less than the LLD and greater than the MDC.

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Certificate of Analysis

GEL Sample ID: 441900001
Client Sample ID: FSS-1328: NOL01-09-007-F-S
Client Matrix: Soil
Amount of Sample Received:
Sample Description: gamma

Client: Pacific Gas and Electric Company
Collect Date: January 11, 2018
Receive Date: January 18, 2018
Report Date: January 24, 2018

Isotope	Run Date	Qualifier	Activity	2 Sigma Uncertainty	MDC	LLD	2 Sigma TPU	Units
Hg-203	01/19/18	U	3.39E-03	7.01E-03	1.24E-02		7.18E-03	pCi/g
Tl-208	01/19/18		7.17E-02	1.81E-02	1.20E-02		1.96E-02	pCi/g
Pb-210	01/19/18	UI	2.07E+00	1.10E+00	2.07E+00		1.61E+00	pCi/g
Pb-212	01/19/18		2.39E-01	2.59E-02	2.15E-02		3.18E-02	pCi/g
Pb-214	01/19/18		2.27E-01	3.40E-02	2.30E-02		3.83E-02	pCi/g
Bi-212	01/19/18	UI	2.60E-01	1.79E-01	2.60E-01		2.38E-01	pCi/g
Bi-214	01/19/18		1.71E-01	3.90E-02	2.58E-02		4.32E-02	pCi/g
Ra-228	01/19/18		3.30E-01	6.35E-02	3.93E-02		6.87E-02	pCi/g
Ac-228	01/19/18		3.30E-01	6.35E-02	3.93E-02		6.87E-02	pCi/g
Th-234	01/19/18	U	3.13E-01	8.82E-01	7.60E-01		8.86E-01	pCi/g
U-235	01/19/18	U	-3.24E-02	4.95E-02	8.39E-02		5.17E-02	pCi/g
U-238	01/19/18	U	3.13E-01	8.82E-01	7.60E-01		8.86E-01	pCi/g
Np-237	01/19/18	U	2.61E-03	1.18E-02	2.05E-02	1.01E-01	1.18E-02	pCi/g
Np-239	01/19/18	U	2.15E-02	7.69E-02	1.24E-01		7.76E-02	pCi/g
Am-241	01/19/18	U	-4.07E-02	6.47E-02	9.12E-02	2.40E+00	6.76E-02	pCi/g

Notes:
1. LLDs are a-priori values.
2. MDCs are calculated a-posteriori values.
3. Gamma spectroscopy analysis results are calculated from a measurement using only one gamma energy line.
4. Air sample volumes are received in units of ft3. GEL converts the units and reports them as m3.

Qualifiers:
U Target isotope was analyzed for but not detected above the MDC and LLD.
UI Uncertain identification for gamma spectroscopy.
X Lab-specific qualifier-please see case narrative, data summary package or contact your project manager for details.
M Reported result is less than the LLD and greater than the MDC.

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Certificate of Analysis

GEL Sample ID: 441900009
Client Sample ID: FSS-1328: NOL01-09-007-F
Client Matrix: Soil
Amount of Sample Received:
Sample Description: HTDs

Client: Pacific Gas and Electric Company
Collect Date: January 11, 2018
Receive Date: January 18, 2018
Report Date: January 24, 2018

Isotope	Run Date	Qualifier	Activity	2 Sigma Uncertainty	MDC	LLD	2 Sigma TPU	Units
C-14	01/22/18	U	-2.23E-03	2.24E-01	3.76E-01	6.07E-01	2.24E-01	pCi/g
Ni-63	01/23/18	U	1.54E-01	8.79E+00	1.47E+01	6.94E+01	8.79E+00	pCi/g
Tc-99	01/23/18	U	-3.76E-01	4.44E-01	7.57E-01	1.16E+00	4.44E-01	pCi/g
Pu-241	01/23/18	U	-1.54E+01	2.51E+01	4.34E+01	8.29E+01	2.51E+01	pCi/g
Alpha Spec								
Pu-238	01/20/18	U	3.08E-02	1.05E-01	1.95E-01	2.80E+00	1.05E-01	pCi/g
Pu-239/240	01/20/18	U	-3.43E-02	9.30E-02	2.48E-01	2.51E+00	9.31E-02	pCi/g
Am-241	01/20/18	U	5.59E-02	1.28E-01	2.03E-01	2.41E+00	1.29E-01	pCi/g
Cm-243/244	01/20/18	U	0.00E+00	7.30E-02	1.09E-01	2.80E+00	7.32E-02	pCi/g
Cm-245/246	01/20/18	U	8.41E-02	1.44E-01	1.26E-01	1.64E+00	1.45E-01	pCi/g
Gamma Spec								
Ni-59	01/22/18	U	-1.49E+01	4.60E+01	7.26E+01	1.83E+02	4.65E+01	pCi/g

Notes:
1. LLDs are a-priori values.
2. MDCs are calculated a-posteriori values.
3. Gamma spectroscopy analysis results are calculated from a measurement using only one gamma energy line.
4. Air sample volumes are received in units of ft3. GEL converts the units and reports them as m3.

Qualifiers:
U Target isotope was analyzed for but not detected above the MDC and LLD.
UI Uncertain identification for gamma spectroscopy.
X Lab-specific qualifier-please see case narrative, data summary package or contact your project manager for details.
M Reported result is less than the LLD and greater than the MDC.

GEL LABORATORIES LLC

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Certificate of Analysis

GEL Sample ID: 441900010
Client Sample ID: FSS-1329: NOL01-09-008-F
Client Matrix: Soil
Amount of Sample Received:
Sample Description: HTDs

Client: Pacific Gas and Electric Company
Collect Date: January 11, 2018
Receive Date: January 18, 2018
Report Date: January 24, 2018

Isotope	Run Date	Qualifier	Activity	2 Sigma Uncertainty	MDC	LLD	2 Sigma TPU	Units
C-14	01/22/18	U	-1.21E-02	2.23E-01	3.75E-01	6.07E-01	2.23E-01	pCi/g
Ni-63	01/23/18	U	6.97E+00	8.14E+00	1.31E+01	6.94E+01	8.24E+00	pCi/g
Tc-99	01/23/18	U	-4.97E-01	4.57E-01	7.81E-01	1.16E+00	4.57E-01	pCi/g
Pu-241	01/23/18	U	-8.38E+00	2.72E+01	4.64E+01	8.29E+01	2.72E+01	pCi/g
Alpha Spec								
Pu-238	01/20/18	U	1.60E-02	1.91E-01	3.99E-01	2.80E+00	1.91E-01	pCi/g
Pu-239/240	01/20/18	U	-8.34E-02	1.58E-01	4.17E-01	2.51E+00	1.58E-01	pCi/g
Am-241	01/20/18	U	-2.11E-02	6.36E-02	1.79E-01	2.41E+00	6.37E-02	pCi/g
Cm-243/244	01/20/18	U	0.00E+00	5.82E-02	8.66E-02	2.80E+00	5.83E-02	pCi/g
Cm-245/246	01/20/18	U	5.90E-02	1.16E-01	1.61E-01	1.64E+00	1.16E-01	pCi/g
Gamma Spec								
Ni-59	01/22/18	U	-9.20E+00	1.38E+01	1.91E+01	1.83E+02	1.44E+01	pCi/g

Notes:
1. LLDs are a-priori values.
2. MDCs are calculated a-posteriori values.
3. Gamma spectroscopy analysis results are calculated from a measurement using only one gamma energy line.
4. Air sample volumes are received in units of ft3. GEL converts the units and reports them as m3.

Qualifiers:
U Target isotope was analyzed for but not detected above the MDC and LLD.
UI Uncertain identification for gamma spectroscopy.
X Lab-specific qualifier-please see case narrative, data summary package or contact your project manager for details.
M Reported result is less than the LLD and greater than the MDC.

GEL LABORATORIES LLC

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Certificate of Analysis

GEL Sample ID: 441900011
Client Sample ID: FSS-1330: NOL01-09-009-F
Client Matrix: Soil
Amount of Sample Received:
Sample Description: HTDs

Client: Pacific Gas and Electric Company
Collect Date: January 11, 2018
Receive Date: January 18, 2018
Report Date: January 24, 2018

Isotope	Run Date	Qualifier	Activity	2 Sigma Uncertainty	MDC	LLD	2 Sigma TPU	Units
C-14	01/22/18	U	-1.12E-01	2.22E-01	3.78E-01	6.07E-01	2.22E-01	pCi/g
Ni-63	01/23/18	U	9.17E+00	7.89E+00	1.26E+01	6.94E+01	8.07E+00	pCi/g
Tc-99	01/23/18	U	-4.77E-01	4.30E-01	7.36E-01	1.16E+00	4.30E-01	pCi/g
Pu-241	01/23/18	U	1.12E+01	3.38E+01	5.59E+01	8.29E+01	3.39E+01	pCi/g
Alpha Spec								
Pu-238	01/20/18	U	-2.01E-02	8.90E-02	2.32E-01	2.80E+00	8.92E-02	pCi/g
Pu-239/240	01/20/18	U	2.18E-02	1.21E-01	2.32E-01	2.51E+00	1.21E-01	pCi/g
Am-241	01/20/18	U	5.73E-02	1.27E-01	2.23E-01	2.41E+00	1.27E-01	pCi/g
Cm-243/244	01/20/18	U	-6.52E-03	5.63E-02	1.30E-01	2.80E+00	5.63E-02	pCi/g
Cm-245/246	01/20/18	U	1.19E-01	1.40E-01	1.51E-01	1.64E+00	1.41E-01	pCi/g
Gamma Spec								
Ni-59	01/22/18	U	1.84E+00	1.76E+01	3.18E+01	1.83E+02	1.77E+01	pCi/g

Notes:
1. LLDs are a-priori values.
2. MDCs are calculated a-posteriori values.
3. Gamma spectroscopy analysis results are calculated from a measurement using only one gamma energy line.
4. Air sample volumes are received in units of ft3. GEL converts the units and reports them as m3.

Qualifiers:
U Target isotope was analyzed for but not detected above the MDC and LLD.
UI Uncertain identification for gamma spectroscopy.
X Lab-specific qualifier-please see case narrative, data summary package or contact your project manager for details.
M Reported result is less than the LLD and greater than the MDC.

GEL LABORATORIES LLC

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Certificate of Analysis

GEL Sample ID: 441900012
Client Sample ID: FSS-1331: NOL01-09-010-F
Client Matrix: Soil
Amount of Sample Received:
Sample Description: HTDs

Client: Pacific Gas and Electric Company
Collect Date: January 11, 2018
Receive Date: January 18, 2018
Report Date: January 24, 2018

Isotope	Run Date	Qualifier	Activity	2 Sigma Uncertainty	MDC	LLD	2 Sigma TPU	Units
C-14	01/23/18	U	9.58E-02	2.25E-01	3.74E-01	6.07E-01	2.25E-01	pCi/g
Ni-63	01/23/18	U	-2.99E+00	1.04E+01	1.77E+01	6.94E+01	1.04E+01	pCi/g
Tc-99	01/23/18	U	-4.20E-01	4.32E-01	7.38E-01	1.16E+00	4.32E-01	pCi/g
Pu-241	01/23/18	U	-1.19E+01	3.05E+01	5.22E+01	8.29E+01	3.05E+01	pCi/g
Alpha Spec								
Pu-238	01/22/18	U	-2.56E-02	1.74E-01	4.12E-01	2.80E+00	1.74E-01	pCi/g
Pu-239/240	01/22/18	U	1.01E-01	1.89E-01	2.97E-01	2.51E+00	1.90E-01	pCi/g
Am-241	01/22/18	U	-6.25E-03	9.38E-02	2.19E-01	2.41E+00	9.39E-02	pCi/g
Cm-243/244	01/22/18	U	-6.16E-03	9.25E-02	2.16E-01	2.80E+00	9.26E-02	pCi/g
Cm-245/246	01/22/18	U	9.01E-02	1.43E-01	1.98E-01	1.64E+00	1.44E-01	pCi/g
Gamma Spec								
Ni-59	01/22/18	U	4.60E+00	5.30E+00	1.26E+01	1.83E+02	5.71E+00	pCi/g

Notes:
1. LLDs are a-priori values.
2. MDCs are calculated a-posteriori values.
3. Gamma spectroscopy analysis results are calculated from a measurement using only one gamma energy line.
4. Air sample volumes are received in units of ft3. GEL converts the units and reports them as m3.

Qualifiers:
U Target isotope was analyzed for but not detected above the MDC and LLD.
UI Uncertain identification for gamma spectroscopy.
X Lab-specific qualifier-please see case narrative, data summary package or contact your project manager for details.
M Reported result is less than the LLD and greater than the MDC.

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Certificate of Analysis

GEL Sample ID: 441900013
Client Sample ID: FSS-1332: NOL01-09-011-F
Client Matrix: Soil
Amount of Sample Received:
Sample Description: HTDs

Client: Pacific Gas and Electric Company
Collect Date: January 11, 2018
Receive Date: January 18, 2018
Report Date: January 24, 2018

Isotope	Run Date	Qualifier	Activity	2 Sigma Uncertainty	MDC	LLD	2 Sigma TPU	Units
C-14	01/23/18	U	2.25E-02	2.23E-01	3.73E-01	6.07E-01	2.23E-01	pCi/g
Ni-63	01/23/18	U	6.02E+00	9.34E+00	1.52E+01	6.94E+01	9.41E+00	pCi/g
Tc-99	01/23/18	U	-2.74E-01	4.49E-01	7.62E-01	1.16E+00	4.49E-01	pCi/g
Pu-241	01/23/18	U	7.88E+00	3.10E+01	5.15E+01	8.29E+01	3.11E+01	pCi/g
Alpha Spec								
Pu-238	01/20/18	U	7.79E-02	1.55E-01	2.52E-01	2.80E+00	1.55E-01	pCi/g
Pu-239/240	01/20/18	U	-5.35E-02	1.21E-01	3.31E-01	2.51E+00	1.22E-01	pCi/g
Am-241	01/22/18	U	7.43E-02	1.07E-01	1.29E-01	2.41E+00	1.07E-01	pCi/g
Cm-243/244	01/22/18	U	2.02E-02	7.57E-02	1.27E-01	2.80E+00	7.58E-02	pCi/g
Cm-245/246	01/22/18	U	1.09E-01	1.37E-01	1.71E-01	1.64E+00	1.38E-01	pCi/g
Gamma Spec								
Ni-59	01/23/18	U	-1.92E+01	2.53E+01	3.77E+01	1.83E+02	2.68E+01	pCi/g

Notes:
1. LLDs are a-priori values.
2. MDCs are calculated a-posteriori values.
3. Gamma spectroscopy analysis results are calculated from a measurement using only one gamma energy line.
4. Air sample volumes are received in units of ft3. GEL converts the units and reports them as m3.

Qualifiers:
U Target isotope was analyzed for but not detected above the MDC and LLD.
UI Uncertain identification for gamma spectroscopy.
X Lab-specific qualifier-please see case narrative, data summary package or contact your project manager for details.
M Reported result is less than the LLD and greater than the MDC.

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Certificate of Analysis

GEL Sample ID: 441900014
Client Sample ID: FSS-1333: NOL01-09-012-F
Client Matrix: Soil
Amount of Sample Received:
Sample Description: HTDs

Client: Pacific Gas and Electric Company
Collect Date: January 11, 2018
Receive Date: January 18, 2018
Report Date: January 24, 2018

Isotope	Run Date	Qualifier	Activity	2 Sigma Uncertainty	MDC	LLD	2 Sigma TPU	Units
C-14	01/23/18	U	1.40E-01	2.23E-01	3.69E-01	6.07E-01	2.24E-01	pCi/g
Ni-63	01/23/18	U	6.85E+00	8.89E+00	1.44E+01	6.94E+01	8.98E+00	pCi/g
Tc-99	01/23/18	U	-2.44E-01	4.14E-01	7.01E-01	1.16E+00	4.14E-01	pCi/g
Pu-241	01/23/18	U	-9.87E+00	2.29E+01	3.93E+01	8.29E+01	2.29E+01	pCi/g
Alpha Spec								
Pu-238	01/22/18	U	6.03E-02	1.33E-01	2.05E-01	2.80E+00	1.33E-01	pCi/g
Pu-239/240	01/22/18	U	6.84E-02	1.32E-01	1.79E-01	2.51E+00	1.32E-01	pCi/g
Am-241	01/20/18	U	-5.20E-02	9.84E-02	2.60E-01	2.41E+00	9.84E-02	pCi/g
Cm-243/244	01/20/18	U	1.28E-02	7.12E-02	1.36E-01	2.80E+00	7.13E-02	pCi/g
Cm-245/246	01/20/18	U	8.01E-03	8.37E-02	1.75E-01	1.64E+00	8.38E-02	pCi/g
Gamma Spec								
Ni-59	01/23/18	U	6.24E+00	1.65E+01	2.96E+01	1.83E+02	1.68E+01	pCi/g

Notes:
1. LLDs are a-priori values.
2. MDCs are calculated a-posteriori values.
3. Gamma spectroscopy analysis results are calculated from a measurement using only one gamma energy line.
4. Air sample volumes are received in units of ft3. GEL converts the units and reports them as m3.

Qualifiers:
U Target isotope was analyzed for but not detected above the MDC and LLD.
UI Uncertain identification for gamma spectroscopy.
X Lab-specific qualifier-please see case narrative, data summary package or contact your project manager for details.
M Reported result is less than the LLD and greater than the MDC.

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Certificate of Analysis

GEL Sample ID: 441900015
Client Sample ID: FSS-1334: NOL01-09-013-F
Client Matrix: Soil
Amount of Sample Received:
Sample Description: HTDs

Client: Pacific Gas and Electric Company
Collect Date: January 11, 2018
Receive Date: January 18, 2018
Report Date: January 24, 2018

Isotope	Run Date	Qualifier	Activity	2 Sigma Uncertainty	MDC	LLD	2 Sigma TPU	Units
C-14	01/23/18	U	8.02E-02	2.26E-01	3.76E-01	6.07E-01	2.26E-01	pCi/g
Ni-63	01/23/18	U	6.49E+00	8.33E+00	1.35E+01	6.94E+01	8.42E+00	pCi/g
Tc-99	01/23/18	U	-3.51E-01	4.55E-01	7.73E-01	1.16E+00	4.55E-01	pCi/g
Pu-241	01/23/18	U	-3.47E+01	2.59E+01	4.63E+01	8.29E+01	2.59E+01	pCi/g
Alpha Spec								
Pu-238	01/20/18	U	-5.83E-02	8.22E-02	2.69E-01	2.80E+00	8.23E-02	pCi/g
Pu-239/240	01/20/18	U	-1.94E-02	1.69E-01	3.75E-01	2.51E+00	1.69E-01	pCi/g
Am-241	01/20/18	U	9.23E-02	1.63E-01	2.72E-01	2.41E+00	1.64E-01	pCi/g
Cm-243/244	01/20/18	U	-4.62E-02	7.44E-02	2.37E-01	2.80E+00	7.45E-02	pCi/g
Cm-245/246	01/20/18	U	6.55E-02	1.29E-01	1.78E-01	1.64E+00	1.29E-01	pCi/g
Gamma Spec								
Ni-59	01/23/18	U	-3.70E-01	6.57E+00	1.06E+01	1.83E+02	6.57E+00	pCi/g

Notes:
1. LLDs are a-priori values.
2. MDCs are calculated a-posteriori values.
3. Gamma spectroscopy analysis results are calculated from a measurement using only one gamma energy line.
4. Air sample volumes are received in units of ft3. GEL converts the units and reports them as m3.

Qualifiers:
U Target isotope was analyzed for but not detected above the MDC and LLD.
UI Uncertain identification for gamma spectroscopy.
X Lab-specific qualifier-please see case narrative, data summary package or contact your project manager for details.
M Reported result is less than the LLD and greater than the MDC.

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Certificate of Analysis

GEL Sample ID: 441900002
Client Sample ID: FSS-1335: NOL01-09-014-F-S
Client Matrix: Soil
Amount of Sample Received:
Sample Description: gamma

Client: Pacific Gas and Electric Company
Collect Date: January 11, 2018
Receive Date: January 18, 2018
Report Date: January 24, 2018

Isotope	Run Date	Qualifier	Activity	2 Sigma Uncertainty	MDC	LLD	2 Sigma TPU	Units
Gamma Spec								
Be-7	01/19/18	U	-3.06E-02	5.30E-02	8.42E-02		5.48E-02	pCi/g
Na-22	01/19/18	U	-5.08E-03	7.62E-03	1.13E-02		7.97E-03	pCi/g
K-40	01/19/18		4.86E+00	3.75E-01	7.35E-02		6.16E-01	pCi/g
Cr-51	01/19/18	U	-5.78E-02	5.50E-02	8.74E-02		6.10E-02	pCi/g
Mn-54	01/19/18	U	2.90E-03	7.97E-03	1.23E-02		8.08E-03	pCi/g
Fe-59	01/19/18	U	-1.00E-02	1.46E-02	2.23E-02		1.53E-02	pCi/g
Co-56	01/19/18	U	-2.88E-03	6.45E-03	9.62E-03		6.58E-03	pCi/g
Co-57	01/19/18	U	-2.93E-03	5.72E-03	9.31E-03		5.87E-03	pCi/g
Co-58	01/19/18	U	2.17E-03	6.24E-03	1.07E-02		6.32E-03	pCi/g
Co-60	01/19/18	U	-7.88E-05	7.68E-03	1.28E-02	3.48E-01	7.68E-03	pCi/g
Zn-65	01/19/18	U	2.03E-02	1.80E-02	3.23E-02		2.03E-02	pCi/g
Y-88	01/19/18	U	5.48E-03	5.41E-03	1.17E-02		5.96E-03	pCi/g
Zr-95	01/19/18	U	-4.56E-03	1.35E-02	2.11E-02		1.37E-02	pCi/g
Nb-94	01/19/18	U	-1.10E-03	5.69E-03	9.11E-03	6.51E-01	5.71E-03	pCi/g
Nb-95	01/19/18	U	-1.14E-02	8.53E-03	1.16E-02		1.00E-02	pCi/g
Ru-106	01/19/18	U	-4.40E-03	5.59E-02	9.21E-02		5.60E-02	pCi/g
Ag-110m	01/19/18	U	9.86E-03	1.30E-02	1.66E-02		1.38E-02	pCi/g
Sn-113	01/19/18	U	4.66E-03	8.01E-03	1.45E-02		8.29E-03	pCi/g
Sb-124	01/19/18	U	-2.65E-03	1.02E-02	1.50E-02		1.03E-02	pCi/g
Sb-125	01/19/18	U	-1.17E-02	1.51E-02	2.35E-02		1.60E-02	pCi/g
Cs-134	01/19/18	UI	1.62E-02	1.58E-02	1.62E-02		1.87E-02	pCi/g
Cs-136	01/19/18	U	-6.57E-03	1.34E-02	2.13E-02		1.38E-02	pCi/g
Cs-137	01/19/18	U	-1.67E-03	6.34E-03	1.01E-02	7.24E-01	6.38E-03	pCi/g
Ba-133	01/19/18	U	-2.03E-03	1.09E-02	1.32E-02		1.10E-02	pCi/g
Ba-140	01/19/18	U	9.63E-03	3.07E-02	5.37E-02		3.10E-02	pCi/g
Ce-139	01/19/18	U	-7.48E-03	6.51E-03	9.92E-03		7.49E-03	pCi/g
Ce-141	01/19/18	U	-6.84E-03	1.23E-02	1.98E-02		1.27E-02	pCi/g
Ce-144	01/19/18	U	-2.42E-03	4.87E-02	7.51E-02		4.87E-02	pCi/g
Nd-147	01/19/18	U	-1.97E-02	5.86E-02	9.43E-02		5.92E-02	pCi/g
Pm-144	01/19/18	U	4.10E-03	5.84E-03	1.05E-02		6.13E-03	pCi/g
Pm-146	01/19/18	U	1.86E-03	7.02E-03	1.23E-02		7.07E-03	pCi/g
Eu-152	01/19/18	U	3.87E-04	1.80E-02	3.14E-02	9.17E-01	1.80E-02	pCi/g
Eu-154	01/19/18	U	-1.33E-02	2.19E-02	3.28E-02	8.62E-01	2.27E-02	pCi/g
Eu-155	01/19/18	U	8.88E-03	2.66E-02	4.59E-02		2.69E-02	pCi/g
Ir-192	01/19/18	U	2.48E-03	6.14E-03	1.11E-02		6.25E-03	pCi/g

Notes:
1. LLDs are a-priori values.
2. MDCs are calculated a-posteriori values.
3. Gamma spectroscopy analysis results are calculated from a measurement using only one gamma energy line.
4. Air sample volumes are received in units of ft3. GEL converts the units and reports them as m3.

Qualifiers:
U Target isotope was analyzed for but not detected above the MDC and LLD.
UI Uncertain identification for gamma spectroscopy.
X Lab-specific qualifier-please see case narrative, data summary package or contact your project manager for details.
M Reported result is less than the LLD and greater than the MDC.

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Certificate of Analysis

GEL Sample ID: 441900002
Client Sample ID: FSS-1335: NOL01-09-014-F-S
Client Matrix: Soil
Amount of Sample Received:
Sample Description: gamma

Client: Pacific Gas and Electric Company
Collect Date: January 11, 2018
Receive Date: January 18, 2018
Report Date: January 24, 2018

Isotope	Run Date	Qualifier	Activity	2 Sigma Uncertainty	MDC	LLD	2 Sigma TPU	Units
Hg-203	01/19/18	U	2.86E-03	7.77E-03	1.18E-02		7.88E-03	pCi/g
Tl-208	01/19/18		7.59E-02	1.78E-02	1.10E-02		1.89E-02	pCi/g
Pb-210	01/19/18	U	-6.42E-01	1.82E+00	2.91E+00		1.85E+00	pCi/g
Pb-212	01/19/18		2.69E-01	2.65E-02	1.98E-02		3.54E-02	pCi/g
Pb-214	01/19/18		2.50E-01	3.73E-02	2.29E-02		4.27E-02	pCi/g
Bi-212	01/19/18		3.72E-01	1.55E-01	1.33E-01		1.59E-01	pCi/g
Bi-214	01/19/18		2.15E-01	3.63E-02	1.91E-02		4.05E-02	pCi/g
Ra-228	01/19/18		3.19E-01	6.30E-02	4.36E-02		6.96E-02	pCi/g
Ac-228	01/19/18		3.19E-01	6.30E-02	4.36E-02		6.96E-02	pCi/g
Th-234	01/19/18	U	4.59E-01	6.45E-01	6.80E-01		6.54E-01	pCi/g
U-235	01/19/18	U	-9.19E-03	4.85E-02	7.99E-02		4.85E-02	pCi/g
U-238	01/19/18	U	4.59E-01	6.45E-01	6.80E-01		6.54E-01	pCi/g
Np-237	01/19/18	U	1.85E-03	1.19E-02	2.11E-02	1.01E-01	1.19E-02	pCi/g
Np-239	01/19/18	U	-2.98E-02	6.24E-02	1.02E-01		6.39E-02	pCi/g
Am-241	01/19/18	U	-1.25E-02	4.87E-02	8.35E-02	2.40E+00	4.90E-02	pCi/g

Notes:
1. LLDs are a-priori values.
2. MDCs are calculated a-posteriori values.
3. Gamma spectroscopy analysis results are calculated from a measurement using only one gamma energy line.
4. Air sample volumes are received in units of ft3. GEL converts the units and reports them as m3.

Qualifiers:
U Target isotope was analyzed for but not detected above the MDC and LLD.
UI Uncertain identification for gamma spectroscopy.
X Lab-specific qualifier-please see case narrative, data summary package or contact your project manager for details.
M Reported result is less than the LLD and greater than the MDC.

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Certificate of Analysis

GEL Sample ID: 441900016
Client Sample ID: FSS-1335: NOL01-09-014-F
Client Matrix: Soil
Amount of Sample Received:
Sample Description: HTDs

Client: Pacific Gas and Electric Company
Collect Date: January 11, 2018
Receive Date: January 18, 2018
Report Date: January 24, 2018

Isotope	Run Date	Qualifier	Activity	2 Sigma Uncertainty	MDC	LLD	2 Sigma TPU	Units
C-14	01/23/18	U	-5.34E-03	2.19E-01	3.68E-01	6.07E-01	2.19E-01	pCi/g
Ni-63	01/23/18	U	6.23E+00	9.06E+00	1.48E+01	6.94E+01	9.13E+00	pCi/g
Tc-99	01/24/18	U	-4.16E-01	4.10E-01	7.00E-01	1.16E+00	4.10E-01	pCi/g
Pu-241	01/23/18	U	-1.11E+01	2.31E+01	3.97E+01	8.29E+01	2.31E+01	pCi/g
Alpha Spec								
Pu-238	01/20/18	U	7.90E-02	1.26E-01	1.74E-01	2.80E+00	1.26E-01	pCi/g
Pu-239/240	01/20/18	U	-6.27E-03	9.41E-02	2.20E-01	2.51E+00	9.42E-02	pCi/g
Am-241	01/20/18	U	8.20E-03	8.57E-02	1.79E-01	2.41E+00	8.58E-02	pCi/g
Cm-243/244	01/20/18	U	-2.08E-02	6.28E-02	1.76E-01	2.80E+00	6.29E-02	pCi/g
Cm-245/246	01/20/18	U	1.26E-01	1.49E-01	1.61E-01	1.64E+00	1.49E-01	pCi/g
Gamma Spec								
Ni-59	01/23/18	U	1.20E+01	2.45E+01	4.49E+01	1.83E+02	2.51E+01	pCi/g

Notes:
1. LLDs are a-priori values.
2. MDCs are calculated a-posteriori values.
3. Gamma spectroscopy analysis results are calculated from a measurement using only one gamma energy line.
4. Air sample volumes are received in units of ft3. GEL converts the units and reports them as m3.

Qualifiers:
U Target isotope was analyzed for but not detected above the MDC and LLD.
UI Uncertain identification for gamma spectroscopy.
X Lab-specific qualifier-please see case narrative, data summary package or contact your project manager for details.
M Reported result is less than the LLD and greater than the MDC.

GEL LABORATORIES LLC

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Certificate of Analysis

GEL Sample ID: 441900017
Client Sample ID: FSS-1336: NOL01-09-015-F
Client Matrix: Soil
Amount of Sample Received:
Sample Description: HTDs

Client: Pacific Gas and Electric Company
Collect Date: January 11, 2018
Receive Date: January 18, 2018
Report Date: January 24, 2018

Isotope	Run Date	Qualifier	Activity	2 Sigma Uncertainty	MDC	LLD	2 Sigma TPU	Units
C-14	01/23/18	U	5.05E-02	2.26E-01	3.77E-01	6.07E-01	2.26E-01	pCi/g
Ni-63	01/23/18	U	1.22E+00	1.02E+01	1.70E+01	6.94E+01	1.02E+01	pCi/g
Tc-99	01/24/18	U	-3.29E-01	4.41E-01	7.50E-01	1.16E+00	4.41E-01	pCi/g
Pu-241	01/23/18	U	-4.84E+00	3.11E+01	5.26E+01	8.29E+01	3.11E+01	pCi/g
Alpha Spec								
Pu-238	01/20/18	U	-2.62E-02	7.91E-02	2.22E-01	2.80E+00	7.93E-02	pCi/g
Pu-239/240	01/20/18	U	-6.11E-02	8.62E-02	2.82E-01	2.51E+00	8.63E-02	pCi/g
Am-241	01/22/18	U	-4.85E-02	6.83E-02	2.23E-01	2.41E+00	6.84E-02	pCi/g
Cm-243/244	01/22/18	U	7.97E-03	8.33E-02	1.74E-01	2.80E+00	8.33E-02	pCi/g
Cm-245/246	01/22/18	U	2.51E-02	9.41E-02	1.58E-01	1.64E+00	9.42E-02	pCi/g
Gamma Spec								
Ni-59	01/23/18	U	-7.99E+00	2.94E+01	4.95E+01	1.83E+02	2.96E+01	pCi/g

Notes:
1. LLDs are a-priori values.
2. MDCs are calculated a-posteriori values.
3. Gamma spectroscopy analysis results are calculated from a measurement using only one gamma energy line.
4. Air sample volumes are received in units of ft3. GEL converts the units and reports them as m3.

Qualifiers:
U Target isotope was analyzed for but not detected above the MDC and LLD.
UI Uncertain identification for gamma spectroscopy.
X Lab-specific qualifier-please see case narrative, data summary package or contact your project manager for details.
M Reported result is less than the LLD and greater than the MDC.

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Certificate of Analysis

GEL Sample ID: 441900021
Client Sample ID: FSS-1341: NOL01-09-020-F-I
Client Matrix: Soil
Amount of Sample Received:
Sample Description: gamma

Client: Pacific Gas and Electric Company
Collect Date: January 11, 2018
Receive Date: January 18, 2018
Report Date: January 24, 2018

Isotope	Run Date	Qualifier	Activity	2 Sigma Uncertainty	MDC	LLD	2 Sigma TPU	Units
Gamma Spec								
Be-7	01/19/18	U	-4.76E-02	6.57E-02	1.00E-01		6.92E-02	pCi/g
Na-22	01/19/18	U	-6.05E-03	9.28E-03	1.37E-02		9.69E-03	pCi/g
K-40	01/19/18		5.32E+00	3.97E-01	9.13E-02		6.67E-01	pCi/g
Cr-51	01/19/18	U	-4.34E-03	6.60E-02	1.12E-01		6.61E-02	pCi/g
Mn-54	01/19/18	U	1.17E-02	8.15E-03	1.59E-02		9.76E-03	pCi/g
Fe-59	01/19/18	U	-3.31E-03	1.85E-02	3.02E-02		1.86E-02	pCi/g
Co-56	01/19/18	U	-7.03E-03	8.21E-03	1.26E-02		8.82E-03	pCi/g
Co-57	01/19/18	U	5.01E-03	7.40E-03	1.24E-02		7.75E-03	pCi/g
Co-58	01/19/18	U	2.21E-03	6.99E-03	1.24E-02		7.06E-03	pCi/g
Co-60	01/19/18	M	1.23E-01	2.44E-02	1.55E-02	3.48E-01	2.72E-02	pCi/g
Zn-65	01/19/18	U	1.44E-02	1.87E-02	3.13E-02		1.98E-02	pCi/g
Y-88	01/19/18	U	7.50E-04	4.60E-03	8.23E-03		4.61E-03	pCi/g
Zr-95	01/19/18	U	1.05E-02	1.45E-02	2.45E-02		1.53E-02	pCi/g
Nb-94	01/19/18	U	3.40E-04	6.36E-03	1.11E-02	6.51E-01	6.37E-03	pCi/g
Nb-95	01/19/18	U	3.27E-03	1.05E-02	1.27E-02		1.06E-02	pCi/g
Ru-106	01/19/18	U	-2.02E-02	7.53E-02	1.18E-01		7.59E-02	pCi/g
Ag-110m	01/19/18	U	7.83E-03	1.04E-02	1.92E-02		1.10E-02	pCi/g
Sn-113	01/19/18	U	1.76E-03	9.16E-03	1.56E-02		9.20E-03	pCi/g
Sb-124	01/19/18	U	-1.56E-03	9.64E-03	1.54E-02		9.67E-03	pCi/g
Sb-125	01/19/18	U	-1.30E-02	1.91E-02	2.95E-02		2.00E-02	pCi/g
Cs-134	01/19/18	U	1.46E-02	9.28E-03	1.83E-02		1.14E-02	pCi/g
Cs-136	01/19/18	U	-4.26E-03	1.64E-02	2.65E-02		1.65E-02	pCi/g
Cs-137	01/19/18	M	4.52E-02	1.68E-02	1.34E-02	7.24E-01	1.72E-02	pCi/g
Ba-133	01/19/18	U	2.20E-04	1.03E-02	1.56E-02		1.03E-02	pCi/g
Ba-140	01/19/18	U	5.79E-03	3.68E-02	6.14E-02		3.69E-02	pCi/g
Ce-139	01/19/18	U	-2.69E-03	8.14E-03	1.27E-02		8.25E-03	pCi/g
Ce-141	01/19/18	U	1.23E-02	1.62E-02	2.72E-02		1.71E-02	pCi/g
Ce-144	01/19/18	U	-6.74E-03	5.69E-02	9.10E-02		5.70E-02	pCi/g
Nd-147	01/19/18	U	2.20E-02	6.39E-02	1.10E-01		6.47E-02	pCi/g
Pm-144	01/19/18	U	3.44E-03	6.46E-03	1.18E-02		6.65E-03	pCi/g
Pm-146	01/19/18	U	1.07E-02	9.47E-03	1.74E-02		1.07E-02	pCi/g
Eu-152	01/19/18	U	9.24E-03	2.12E-02	3.71E-02	9.17E-01	2.16E-02	pCi/g
Eu-154	01/19/18	U	-1.80E-02	2.63E-02	3.84E-02	8.62E-01	2.76E-02	pCi/g
Eu-155	01/19/18	U	1.00E-02	3.18E-02	5.28E-02		3.22E-02	pCi/g
Ir-192	01/19/18	U	-1.38E-03	7.52E-03	1.26E-02		7.55E-03	pCi/g

Notes:
1. LLDs are a-priori values.
2. MDCs are calculated a-posteriori values.
3. Gamma spectroscopy analysis results are calculated from a measurement using only one gamma energy line.
4. Air sample volumes are received in units of ft3. GEL converts the units and reports them as m3.

Qualifiers:
U Target isotope was analyzed for but not detected above the MDC and LLD.
UI Uncertain identification for gamma spectroscopy.
X Lab-specific qualifier-please see case narrative, data summary package or contact your project manager for details.
M Reported result is less than the LLD and greater than the MDC.

GEL LABORATORIES LLC

2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

GEL Sample ID: 441900021
Client Sample ID: FSS-1341: NOL01-09-020-F-I
Client Matrix: Soil
Amount of Sample Received:
Sample Description: gamma

Client: Pacific Gas and Electric Company
Collect Date: January 11, 2018
Receive Date: January 18, 2018
Report Date: January 24, 2018

Isotope	Run Date	Qualifier	Activity	2 Sigma Uncertainty	MDC	LLD	2 Sigma TPU	Units
Hg-203	01/19/18	U	-3.59E-03	8.06E-03	1.34E-02		8.23E-03	pCi/g
Tl-208	01/19/18		8.23E-02	1.83E-02	1.31E-02		1.96E-02	pCi/g
Pb-210	01/19/18	U	1.18E+00	2.42E+00	4.18E+00		2.49E+00	pCi/g
Pb-212	01/19/18		2.74E-01	3.07E-02	2.49E-02		3.94E-02	pCi/g
Pb-214	01/19/18		2.50E-01	3.78E-02	2.79E-02		4.30E-02	pCi/g
Bi-212	01/19/18	UI	2.60E-01	1.26E-01	2.60E-01		1.92E-01	pCi/g
Bi-214	01/19/18		2.27E-01	3.56E-02	2.11E-02		4.03E-02	pCi/g
Ra-228	01/19/18		3.04E-01	7.83E-02	5.33E-02		8.34E-02	pCi/g
Ac-228	01/19/18		3.04E-01	7.83E-02	5.33E-02		8.34E-02	pCi/g
Th-234	01/19/18	U	5.96E-01	8.60E-01	8.80E-01		8.72E-01	pCi/g
U-235	01/19/18	U	5.72E-02	6.22E-02	1.05E-01		6.24E-02	pCi/g
U-238	01/19/18	U	5.96E-01	8.60E-01	8.80E-01		8.72E-01	pCi/g
Np-237	01/19/18	U	2.66E-03	1.45E-02	2.50E-02	1.01E-01	1.45E-02	pCi/g
Np-239	01/19/18	U	1.49E-02	7.98E-02	1.21E-01		8.01E-02	pCi/g
Am-241	01/19/18	U	-2.32E-02	7.00E-02	1.15E-01	2.40E+00	7.08E-02	pCi/g

Notes:
1. LLDs are a-priori values.
2. MDCs are calculated a-posteriori values.
3. Gamma spectroscopy analysis results are calculated from a measurement using only one gamma energy line.
4. Air sample volumes are received in units of ft3. GEL converts the units and reports them as m3.

Qualifiers:
U Target isotope was analyzed for but not detected above the MDC and LLD.
UI Uncertain identification for gamma spectroscopy.
X Lab-specific qualifier-please see case narrative, data summary package or contact your project manager for details.
M Reported result is less than the LLD and greater than the MDC.

GEL LABORATORIES LLC

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Certificate of Analysis

GEL Sample ID: 441900018
Client Sample ID: FSS-1341: NOL01-09-020-F-I
Client Matrix: Soil
Amount of Sample Received:
Sample Description: HTDs

Client: Pacific Gas and Electric Company
Collect Date: January 11, 2018
Receive Date: January 18, 2018
Report Date: January 24, 2018

Isotope	Run Date	Qualifier	Activity	2 Sigma Uncertainty	MDC	LLD	2 Sigma TPU	Units
C-14	01/22/18	U	-1.60E-02	2.66E-01	4.47E-01	6.07E-01	2.66E-01	pCi/g
Ni-63	01/23/18	U	-1.36E+00	1.13E+01	1.91E+01	6.94E+01	1.13E+01	pCi/g
Tc-99	01/23/18	U	-6.46E-02	3.57E-01	6.02E-01	1.16E+00	3.57E-01	pCi/g
Pu-241	01/23/18	U	-1.22E+01	2.41E+01	4.16E+01	8.29E+01	2.41E+01	pCi/g
Alpha Spec								
Pu-238	01/22/18	U	-5.92E-02	8.34E-02	2.73E-01	2.80E+00	8.35E-02	pCi/g
Pu-239/240	01/22/18	U	-2.39E-02	1.08E-01	2.73E-01	2.51E+00	1.08E-01	pCi/g
Am-241	01/22/18	U	2.38E-03	1.09E-01	2.40E-01	2.41E+00	1.09E-01	pCi/g
Cm-243/244	01/22/18	U	-7.03E-03	6.06E-02	1.40E-01	2.80E+00	6.07E-02	pCi/g
Cm-245/246	01/22/18	U	2.58E-02	9.69E-02	1.63E-01	1.64E+00	9.70E-02	pCi/g
Gamma Spec								
Ni-59	01/22/18	U	-1.24E+01	3.04E+01	4.58E+01	1.83E+02	3.09E+01	pCi/g

Notes:
1. LLDs are a-priori values.
2. MDCs are calculated a-posteriori values.
3. Gamma spectroscopy analysis results are calculated from a measurement using only one gamma energy line.
4. Air sample volumes are received in units of ft3. GEL converts the units and reports them as m3.

Qualifiers:
U Target isotope was analyzed for but not detected above the MDC and LLD.
UI Uncertain identification for gamma spectroscopy.
X Lab-specific qualifier-please see case narrative, data summary package or contact your project manager for details.
M Reported result is less than the LLD and greater than the MDC.

GEL LABORATORIES LLC

2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

GEL Sample ID: 441900022
Client Sample ID: FSS-1342: NOL01-09-021-F-I
Client Matrix: Soil
Amount of Sample Received:
Sample Description: gamma

Client: Pacific Gas and Electric Company
Collect Date: January 11, 2018
Receive Date: January 18, 2018
Report Date: January 24, 2018

Isotope	Run Date	Qualifier	Activity	2 Sigma Uncertainty	MDC	LLD	2 Sigma TPU	Units
Gamma Spec								
Be-7	01/19/18	U	3.96E-02	6.19E-02	1.08E-01		6.45E-02	pCi/g
Na-22	01/19/18	U	1.97E-03	8.06E-03	1.23E-02		8.11E-03	pCi/g
K-40	01/19/18		4.42E+00	3.27E-01	7.22E-02		5.49E-01	pCi/g
Cr-51	01/19/18	U	3.38E-02	6.72E-02	1.17E-01		6.90E-02	pCi/g
Mn-54	01/19/18	U	-1.63E-03	8.25E-03	1.37E-02		8.28E-03	pCi/g
Fe-59	01/19/18	U	1.96E-03	1.96E-02	3.33E-02		1.97E-02	pCi/g
Co-56	01/19/18	U	-7.92E-03	7.85E-03	1.21E-02		8.66E-03	pCi/g
Co-57	01/19/18	U	-1.57E-03	6.73E-03	1.17E-02		6.77E-03	pCi/g
Co-58	01/19/18	U	-4.10E-03	7.80E-03	1.27E-02		8.02E-03	pCi/g
Co-60	01/19/18		3.89E-01	3.13E-02	1.29E-02	3.48E-01	4.89E-02	pCi/g
Zn-65	01/19/18	U	2.41E-02	2.25E-02	3.75E-02		2.50E-02	pCi/g
Y-88	01/19/18	U	1.99E-03	4.45E-03	8.53E-03		4.55E-03	pCi/g
Zr-95	01/19/18	U	-3.33E-03	1.38E-02	2.32E-02		1.39E-02	pCi/g
Nb-94	01/19/18	U	8.68E-03	6.69E-03	1.27E-02	6.51E-01	7.78E-03	pCi/g
Nb-95	01/19/18	U	-6.44E-03	8.15E-03	1.31E-02		8.67E-03	pCi/g
Ru-106	01/19/18	U	2.81E-02	5.75E-02	9.83E-02		5.90E-02	pCi/g
Ag-110m	01/19/18	U	-8.00E-03	1.15E-02	1.84E-02		1.21E-02	pCi/g
Sn-113	01/19/18	U	1.22E-02	9.58E-03	1.74E-02		1.11E-02	pCi/g
Sb-124	01/19/18	U	4.04E-03	1.20E-02	2.22E-02		1.22E-02	pCi/g
Sb-125	01/19/18	U	1.67E-02	2.05E-02	3.60E-02		2.19E-02	pCi/g
Cs-134	01/19/18	U	1.49E-02	1.40E-02	1.76E-02		1.56E-02	pCi/g
Cs-136	01/19/18	U	-4.20E-03	1.79E-02	2.95E-02		1.80E-02	pCi/g
Cs-137	01/19/18	M	1.47E-01	2.06E-02	1.40E-02	7.24E-01	2.38E-02	pCi/g
Ba-133	01/19/18	U	9.33E-03	9.67E-03	1.58E-02		1.06E-02	pCi/g
Ba-140	01/19/18	U	2.97E-02	3.70E-02	6.50E-02		3.94E-02	pCi/g
Ce-139	01/19/18	U	-3.84E-04	7.28E-03	1.26E-02		7.28E-03	pCi/g
Ce-141	01/19/18	U	-9.66E-03	1.29E-02	2.17E-02		1.36E-02	pCi/g
Ce-144	01/19/18	U	-3.03E-02	4.94E-02	8.41E-02		5.13E-02	pCi/g
Nd-147	01/19/18	U	2.50E-02	7.62E-02	1.28E-01		7.71E-02	pCi/g
Pm-144	01/19/18	U	3.38E-03	6.69E-03	1.09E-02		6.87E-03	pCi/g
Pm-146	01/19/18	U	8.55E-03	9.50E-03	1.54E-02		1.03E-02	pCi/g
Eu-152	01/19/18	U	-3.65E-03	2.19E-02	3.45E-02	9.17E-01	2.19E-02	pCi/g
Eu-154	01/19/18	U	5.60E-03	2.29E-02	3.50E-02	8.62E-01	2.31E-02	pCi/g
Eu-155	01/19/18	U	3.33E-02	3.68E-02	4.43E-02		3.70E-02	pCi/g
Ir-192	01/19/18	U	-3.28E-03	7.32E-03	1.20E-02		7.47E-03	pCi/g

Notes:
1. LLDs are a-priori values.
2. MDCs are calculated a-posteriori values.
3. Gamma spectroscopy analysis results are calculated from a measurement using only one gamma energy line.
4. Air sample volumes are received in units of ft3. GEL converts the units and reports them as m3.

Qualifiers:
U Target isotope was analyzed for but not detected above the MDC and LLD.
UI Uncertain identification for gamma spectroscopy.
X Lab-specific qualifier-please see case narrative, data summary package or contact your project manager for details.
M Reported result is less than the LLD and greater than the MDC.

GEL LABORATORIES LLC

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Certificate of Analysis

GEL Sample ID: 441900022
Client Sample ID: FSS-1342: NOL01-09-021-F-I
Client Matrix: Soil
Amount of Sample Received:
Sample Description: gamma

Client: Pacific Gas and Electric Company
Collect Date: January 11, 2018
Receive Date: January 18, 2018
Report Date: January 24, 2018

Isotope	Run Date	Qualifier	Activity	2 Sigma Uncertainty	MDC	LLD	2 Sigma TPU	Units
Hg-203	01/19/18	U	-4.25E-03	8.11E-03	1.33E-02		8.34E-03	pCi/g
Tl-208	01/19/18		6.75E-02	1.67E-02	1.21E-02		1.76E-02	pCi/g
Pb-210	01/19/18	U	7.46E-01	1.30E+00	2.19E+00		1.34E+00	pCi/g
Pb-212	01/19/18		2.39E-01	2.52E-02	2.21E-02		3.20E-02	pCi/g
Pb-214	01/19/18		2.57E-01	3.36E-02	6.08E-02		3.92E-02	pCi/g
Bi-212	01/19/18	UI	2.44E-01	2.14E-01	2.44E-01		2.75E-01	pCi/g
Bi-214	01/19/18		2.05E-01	3.33E-02	2.35E-02		3.73E-02	pCi/g
Ra-228	01/19/18		2.78E-01	7.26E-02	4.99E-02		7.74E-02	pCi/g
Ac-228	01/19/18		2.78E-01	7.26E-02	4.99E-02		7.74E-02	pCi/g
Th-234	01/19/18	U	2.33E-01	4.95E-01	6.16E-01		4.98E-01	pCi/g
U-235	01/19/18	U	3.50E-03	4.92E-02	8.54E-02		4.92E-02	pCi/g
U-238	01/19/18	U	2.33E-01	4.95E-01	6.16E-01		4.98E-01	pCi/g
Np-237	01/19/18	U	-3.33E-03	1.46E-02	2.42E-02	1.01E-01	1.47E-02	pCi/g
Np-239	01/19/18	U	-2.85E-02	6.54E-02	1.13E-01		6.67E-02	pCi/g
Am-241	01/19/18	U	1.11E-02	5.14E-02	7.78E-02	2.40E+00	5.16E-02	pCi/g

Notes:
1. LLDs are a-priori values.
2. MDCs are calculated a-posteriori values.
3. Gamma spectroscopy analysis results are calculated from a measurement using only one gamma energy line.
4. Air sample volumes are received in units of ft3. GEL converts the units and reports them as m3.

Qualifiers:
U Target isotope was analyzed for but not detected above the MDC and LLD.
UI Uncertain identification for gamma spectroscopy.
X Lab-specific qualifier-please see case narrative, data summary package or contact your project manager for details.
M Reported result is less than the LLD and greater than the MDC.

GEL LABORATORIES LLC

2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

GEL Sample ID: 441900019
Client Sample ID: FSS-1342: NOL01-09-021-F-I
Client Matrix: Soil
Amount of Sample Received:
Sample Description: HTDs

Client: Pacific Gas and Electric Company
Collect Date: January 11, 2018
Receive Date: January 18, 2018
Report Date: January 24, 2018

Isotope	Run Date	Qualifier	Activity	2 Sigma Uncertainty	MDC	LLD	2 Sigma TPU	Units
C-14	01/22/18	U	-9.30E-02	2.65E-01	4.48E-01	6.07E-01	2.65E-01	pCi/g
Ni-63	01/23/18	U	-5.32E+00	9.93E+00	1.71E+01	6.94E+01	9.93E+00	pCi/g
Tc-99	01/23/18	U	8.50E-02	4.05E-01	6.77E-01	1.16E+00	4.05E-01	pCi/g
Pu-241	01/23/18	U	1.95E+01	2.74E+01	4.43E+01	8.29E+01	2.77E+01	pCi/g
Alpha Spec								
Pu-238	01/22/18	U	-8.10E-03	6.99E-02	1.62E-01	2.80E+00	7.00E-02	pCi/g
Pu-239/240	01/22/18	U	-5.67E-02	7.99E-02	2.61E-01	2.51E+00	8.01E-02	pCi/g
Am-241	01/22/18	U	9.61E-02	1.94E-01	3.42E-01	2.41E+00	1.94E-01	pCi/g
Cm-243/244	01/22/18	U	-1.56E-02	6.89E-02	1.80E-01	2.80E+00	6.91E-02	pCi/g
Cm-245/246	01/22/18	U	1.06E-02	1.10E-01	2.30E-01	1.64E+00	1.10E-01	pCi/g
Gamma Spec								
Ni-59	01/22/18	U	9.20E+00	3.77E+01	6.94E+01	1.83E+02	3.79E+01	pCi/g

Notes:
1. LLDs are a-priori values.
2. MDCs are calculated a-posteriori values.
3. Gamma spectroscopy analysis results are calculated from a measurement using only one gamma energy line.
4. Air sample volumes are received in units of ft3. GEL converts the units and reports them as m3.

Qualifiers:
U Target isotope was analyzed for but not detected above the MDC and LLD.
UI Uncertain identification for gamma spectroscopy.
X Lab-specific qualifier-please see case narrative, data summary package or contact your project manager for details.
M Reported result is less than the LLD and greater than the MDC.

GEL LABORATORIES LLC

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Certificate of Analysis

GEL Sample ID: 441900023
Client Sample ID: FSS-1343: NOL01-09-022-F-I
Client Matrix: Soil
Amount of Sample Received:
Sample Description: gamma

Client: Pacific Gas and Electric Company
Collect Date: January 11, 2018
Receive Date: January 18, 2018
Report Date: January 24, 2018

Isotope	Run Date	Qualifier	Activity	2 Sigma Uncertainty	MDC	LLD	2 Sigma TPU	Units
Gamma Spec								
Be-7	01/19/18	U	3.14E-02	7.52E-02	1.36E-01		7.66E-02	pCi/g
Na-22	01/19/18	U	4.48E-03	1.03E-02	1.90E-02		1.05E-02	pCi/g
K-40	01/19/18		4.81E+00	4.64E-01	9.60E-02		6.32E-01	pCi/g
Cr-51	01/19/18	U	-6.74E-03	8.76E-02	1.39E-01		8.76E-02	pCi/g
Mn-54	01/19/18	U	7.35E-03	9.55E-03	1.77E-02		1.01E-02	pCi/g
Fe-59	01/19/18	U	-5.01E-03	1.98E-02	3.27E-02		2.00E-02	pCi/g
Co-56	01/19/18	U	-2.15E-03	7.63E-03	1.17E-02		7.70E-03	pCi/g
Co-57	01/19/18	U	2.78E-03	1.00E-02	1.20E-02		1.00E-02	pCi/g
Co-58	01/19/18	U	-8.46E-03	9.97E-03	1.09E-02		1.07E-02	pCi/g
Co-60	01/19/18	U	4.50E-03	8.78E-03	1.66E-02	3.48E-01	9.02E-03	pCi/g
Zn-65	01/19/18	U	1.04E-02	2.28E-02	3.83E-02		2.33E-02	pCi/g
Y-88	01/19/18	U	1.34E-03	5.50E-03	1.03E-02		5.53E-03	pCi/g
Zr-95	01/19/18	U	-8.25E-03	1.61E-02	2.39E-02		1.65E-02	pCi/g
Nb-94	01/19/18	U	6.66E-03	8.66E-03	1.61E-02	6.51E-01	9.19E-03	pCi/g
Nb-95	01/19/18	U	-3.99E-04	1.06E-02	1.75E-02		1.06E-02	pCi/g
Ru-106	01/19/18	U	-7.69E-02	8.15E-02	1.17E-01		8.89E-02	pCi/g
Ag-110m	01/19/18	U	1.29E-03	1.47E-02	2.43E-02		1.47E-02	pCi/g
Sn-113	01/19/18	U	2.65E-03	1.03E-02	1.85E-02		1.04E-02	pCi/g
Sb-124	01/19/18	U	3.02E-03	1.11E-02	2.11E-02		1.11E-02	pCi/g
Sb-125	01/19/18	U	2.23E-02	2.13E-02	3.57E-02		2.14E-02	pCi/g
Cs-134	01/19/18	U	3.10E-03	1.06E-02	1.76E-02		1.07E-02	pCi/g
Cs-136	01/19/18	U	-4.03E-04	1.68E-02	2.90E-02		1.68E-02	pCi/g
Cs-137	01/19/18	M	3.02E-02	1.94E-02	1.53E-02	7.24E-01	1.97E-02	pCi/g
Ba-133	01/19/18	U	-1.09E-02	1.09E-02	1.48E-02		1.20E-02	pCi/g
Ba-140	01/19/18	U	-1.57E-03	4.06E-02	6.91E-02		4.06E-02	pCi/g
Ce-139	01/19/18	U	-2.40E-03	7.21E-03	1.17E-02		7.31E-03	pCi/g
Ce-141	01/19/18	U	-9.09E-03	1.56E-02	2.52E-02		1.61E-02	pCi/g
Ce-144	01/19/18	U	-5.51E-04	5.29E-02	8.95E-02		5.29E-02	pCi/g
Nd-147	01/19/18	U	2.66E-02	8.75E-02	1.55E-01		8.83E-02	pCi/g
Pm-144	01/19/18	U	4.42E-03	8.37E-03	1.51E-02		8.62E-03	pCi/g
Pm-146	01/19/18	U	-4.05E-03	9.85E-03	1.61E-02		1.00E-02	pCi/g
Eu-152	01/19/18	U	1.72E-02	2.72E-02	4.63E-02	9.17E-01	2.83E-02	pCi/g
Eu-154	01/19/18	U	1.21E-02	2.92E-02	5.37E-02	8.62E-01	2.98E-02	pCi/g
Eu-155	01/19/18	U	7.48E-03	3.15E-02	5.48E-02		3.17E-02	pCi/g
Ir-192	01/19/18	U	-1.34E-04	8.58E-03	1.37E-02		8.58E-03	pCi/g

Notes:
1. LLDs are a-priori values.
2. MDCs are calculated a-posteriori values.
3. Gamma spectroscopy analysis results are calculated from a measurement using only one gamma energy line.
4. Air sample volumes are received in units of ft3. GEL converts the units and reports them as m3.

Qualifiers:
U Target isotope was analyzed for but not detected above the MDC and LLD.
UI Uncertain identification for gamma spectroscopy.
X Lab-specific qualifier-please see case narrative, data summary package or contact your project manager for details.
M Reported result is less than the LLD and greater than the MDC.

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Certificate of Analysis

GEL Sample ID: 441900023
Client Sample ID: FSS-1343: NOL01-09-022-F-I
Client Matrix: Soil
Amount of Sample Received:
Sample Description: gamma

Client: Pacific Gas and Electric Company
Collect Date: January 11, 2018
Receive Date: January 18, 2018
Report Date: January 24, 2018

Isotope	Run Date	Qualifier	Activity	2 Sigma Uncertainty	MDC	LLD	2 Sigma TPU	Units
Hg-203	01/19/18	U	-6.27E-03	8.53E-03	1.26E-02		9.01E-03	pCi/g
Tl-208	01/19/18		7.70E-02	2.24E-02	1.18E-02		2.36E-02	pCi/g
Pb-210	01/19/18	U	9.16E-01	1.67E+00	1.61E+00		1.67E+00	pCi/g
Pb-212	01/19/18		2.50E-01	3.12E-02	2.52E-02		3.76E-02	pCi/g
Pb-214	01/19/18		2.44E-01	5.14E-02	7.91E-02		5.53E-02	pCi/g
Bi-212	01/19/18	U	2.85E-01	1.44E-01	3.02E-01		1.95E-01	pCi/g
Bi-214	01/19/18		2.47E-01	4.77E-02	2.70E-02		5.35E-02	pCi/g
Ra-228	01/19/18		1.96E-01	8.82E-02	5.87E-02		8.97E-02	pCi/g
Ac-228	01/19/18		1.96E-01	8.82E-02	5.87E-02		8.97E-02	pCi/g
Th-234	01/19/18	U	3.61E-01	4.64E-01	8.55E-01		5.00E-01	pCi/g
U-235	01/19/18	U	6.32E-03	5.84E-02	9.93E-02		5.85E-02	pCi/g
U-238	01/19/18	U	3.61E-01	4.64E-01	8.55E-01		5.00E-01	pCi/g
Np-237	01/19/18	U	1.12E-02	1.64E-02	2.83E-02	1.01E-01	1.72E-02	pCi/g
Np-239	01/19/18	U	-6.17E-02	7.59E-02	1.22E-01		8.11E-02	pCi/g
Am-241	01/19/18	U	-2.01E-02	5.11E-02	8.79E-02	2.40E+00	5.20E-02	pCi/g

Notes:
1. LLDs are a-priori values.
2. MDCs are calculated a-posteriori values.
3. Gamma spectroscopy analysis results are calculated from a measurement using only one gamma energy line.
4. Air sample volumes are received in units of ft3. GEL converts the units and reports them as m3.

Qualifiers:
U Target isotope was analyzed for but not detected above the MDC and LLD.
UI Uncertain identification for gamma spectroscopy.
X Lab-specific qualifier-please see case narrative, data summary package or contact your project manager for details.
M Reported result is less than the LLD and greater than the MDC.

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Certificate of Analysis

GEL Sample ID: 441900020
Client Sample ID: FSS-1343: NOL01-09-022-F-I
Client Matrix: Soil
Amount of Sample Received:
Sample Description: HTDs

Client: Pacific Gas and Electric Company
Collect Date: January 11, 2018
Receive Date: January 18, 2018
Report Date: January 24, 2018

Isotope	Run Date	Qualifier	Activity	2 Sigma Uncertainty	MDC	LLD	2 Sigma TPU	Units
C-14	01/22/18	U	3.76E-02	2.72E-01	4.56E-01	6.07E-01	2.72E-01	pCi/g
Ni-63	01/23/18	U	-2.58E-01	1.05E+01	1.76E+01	6.94E+01	1.05E+01	pCi/g
Tc-99	01/23/18	U	2.27E-01	4.84E-01	8.06E-01	1.16E+00	4.85E-01	pCi/g
Pu-241	01/23/18	U	9.30E-01	2.55E+01	4.26E+01	8.29E+01	2.55E+01	pCi/g
Alpha Spec								
Pu-238	01/22/18	U	-8.60E-03	7.42E-02	1.72E-01	2.80E+00	7.43E-02	pCi/g
Pu-239/240	01/22/18	U	-1.72E-02	7.61E-02	1.98E-01	2.51E+00	7.62E-02	pCi/g
Am-241	01/22/18	U	-5.29E-03	1.22E-01	2.77E-01	2.41E+00	1.22E-01	pCi/g
Cm-243/244	01/22/18	U	-1.43E-02	9.90E-02	2.41E-01	2.80E+00	9.91E-02	pCi/g
Cm-245/246	01/22/18	U	6.65E-02	1.31E-01	1.81E-01	1.64E+00	1.31E-01	pCi/g
Gamma Spec								
Ni-59	01/22/18	U	-1.10E+01	1.55E+01	1.26E+01	1.83E+02	1.63E+01	pCi/g

Notes:
1. LLDs are a-priori values.
2. MDCs are calculated a-posteriori values.
3. Gamma spectroscopy analysis results are calculated from a measurement using only one gamma energy line.
4. Air sample volumes are received in units of ft3. GEL converts the units and reports them as m3.

Qualifiers:
U Target isotope was analyzed for but not detected above the MDC and LLD.
UI Uncertain identification for gamma spectroscopy.
X Lab-specific qualifier-please see case narrative, data summary package or contact your project manager for details.
M Reported result is less than the LLD and greater than the MDC.

Data Quality Assessment of NOL01-09-FSR;

1. *The HBPP LTP and Historical Site Assessment were reviewed and compared to the DQOs of HBPP-FSSP-NOL01-09-FSR. The classification history satisfies the DQOs in the survey plan.*
2. *The survey unit description as well as the design, measurement locations, analytical methods and detection limits, variability (a-priori σ), QC requirements and survey and sampling accuracy were adequately discussed in the FSSP.*
3. *All field documents, instrument issue, measurement results and maps were complete and legible.*
4. *A preliminary data review was performed of the 15 statistical samples gathered. The survey had more than sufficient power.*

Statistical quantities (Cs-137 reported in pCi/g):

Number of statistical samples	15
Minimum value	-1.34E-02
Maximum Value	6.97E-02
Mean	2.62E-02
Median	3.33E-02
a-posteriori σ	2.39E-02

5. *The mean is approximately equal to the median indicating a common central tendency.*
6. *The range of the data varies within ~3.5 standard deviations about the arithmetic mean.*
7. *The Quantile Plot exhibits relatively normal symmetry.*
8. *The Frequency Plot demonstrates a normal distribution with a positive skewness distribution.*
9. *The data posting plot does not clearly reveal any systematic spatial trends.*
10. *No sample data exceeded the DCGL, therefore a statistical test was not required.*
11. *The data verified all the key assumptions of the statistical test.*
12. *The survey possessed sufficient power to pass the survey unit.*

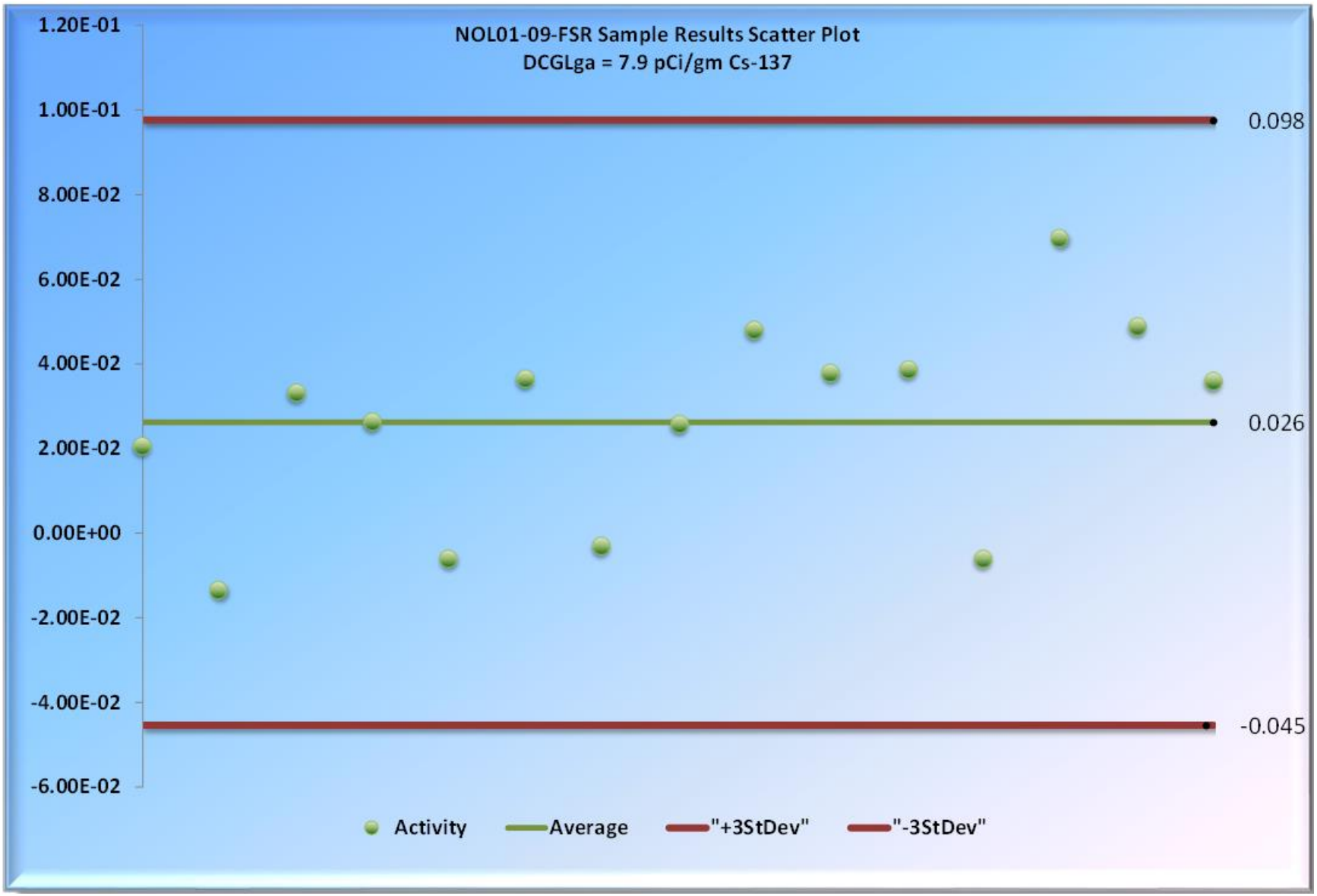
Summary:

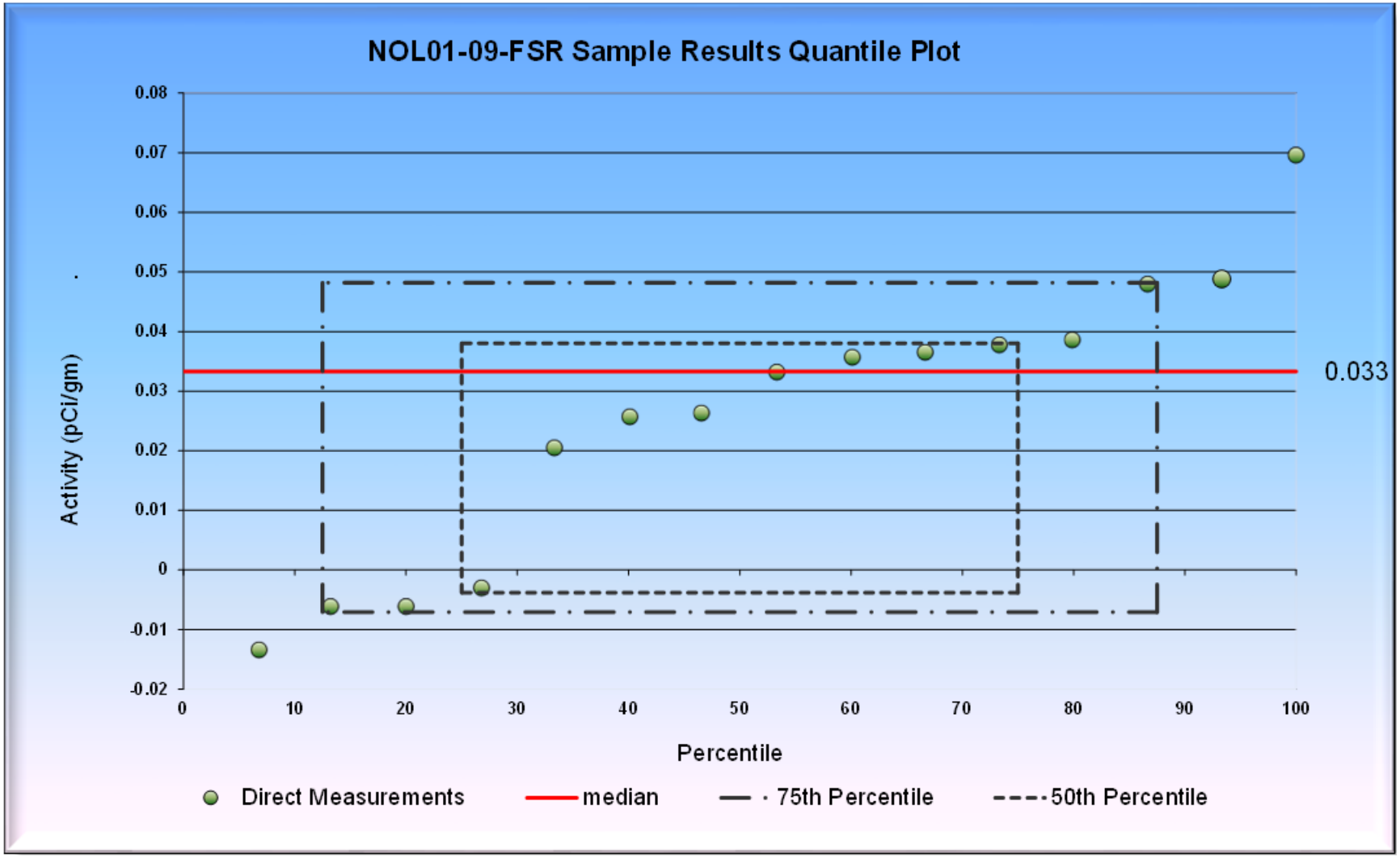
The survey was performed as stated in the survey package, the data contained no abnormalities and supported all the key assumptions of the statistical test, and no sample exceeded the DCGL.

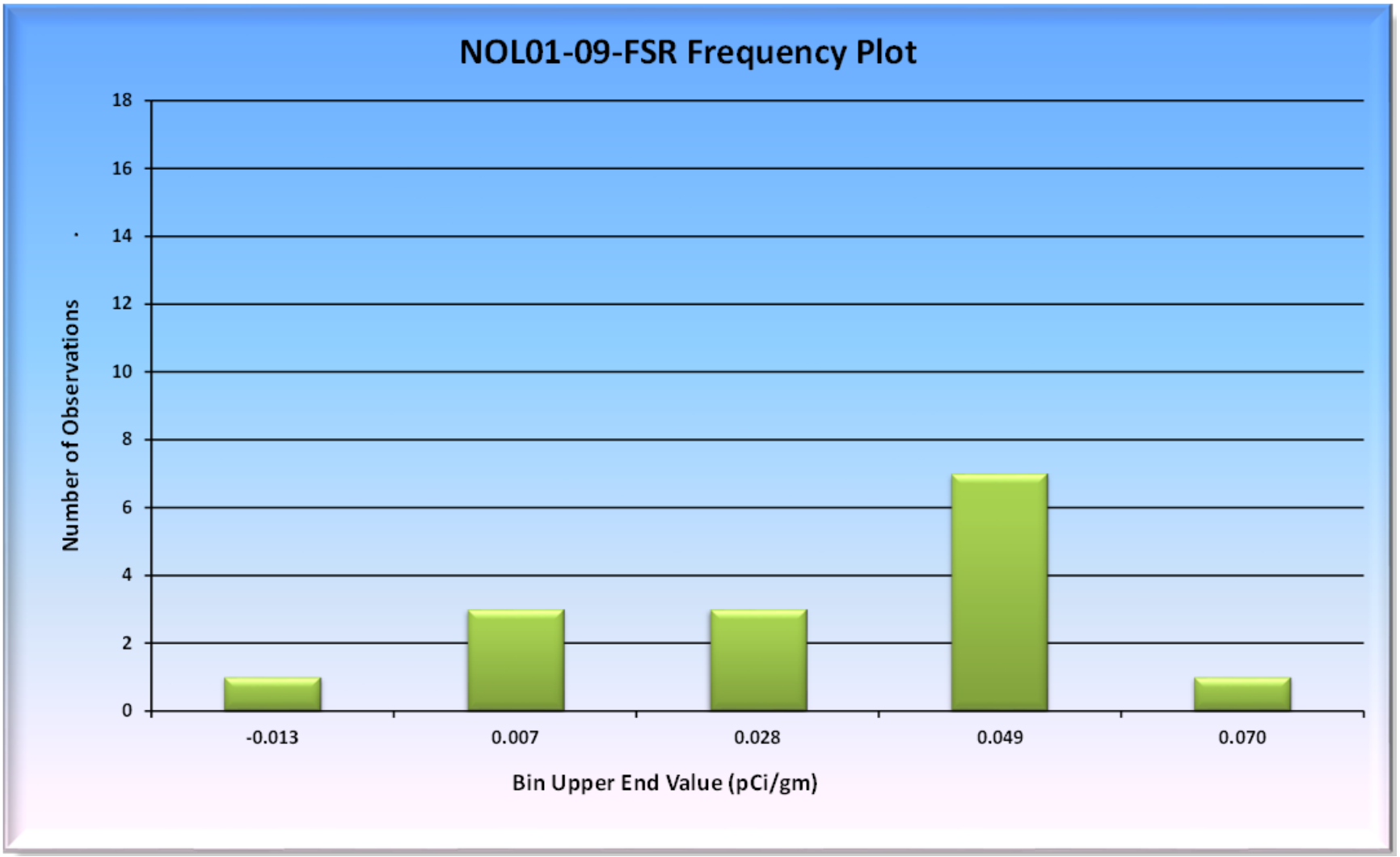
Survey Unit NOL01-09-FSR meets the HBPP release criteria thus the null hypothesis is rejected for NOL01-09-FSR.

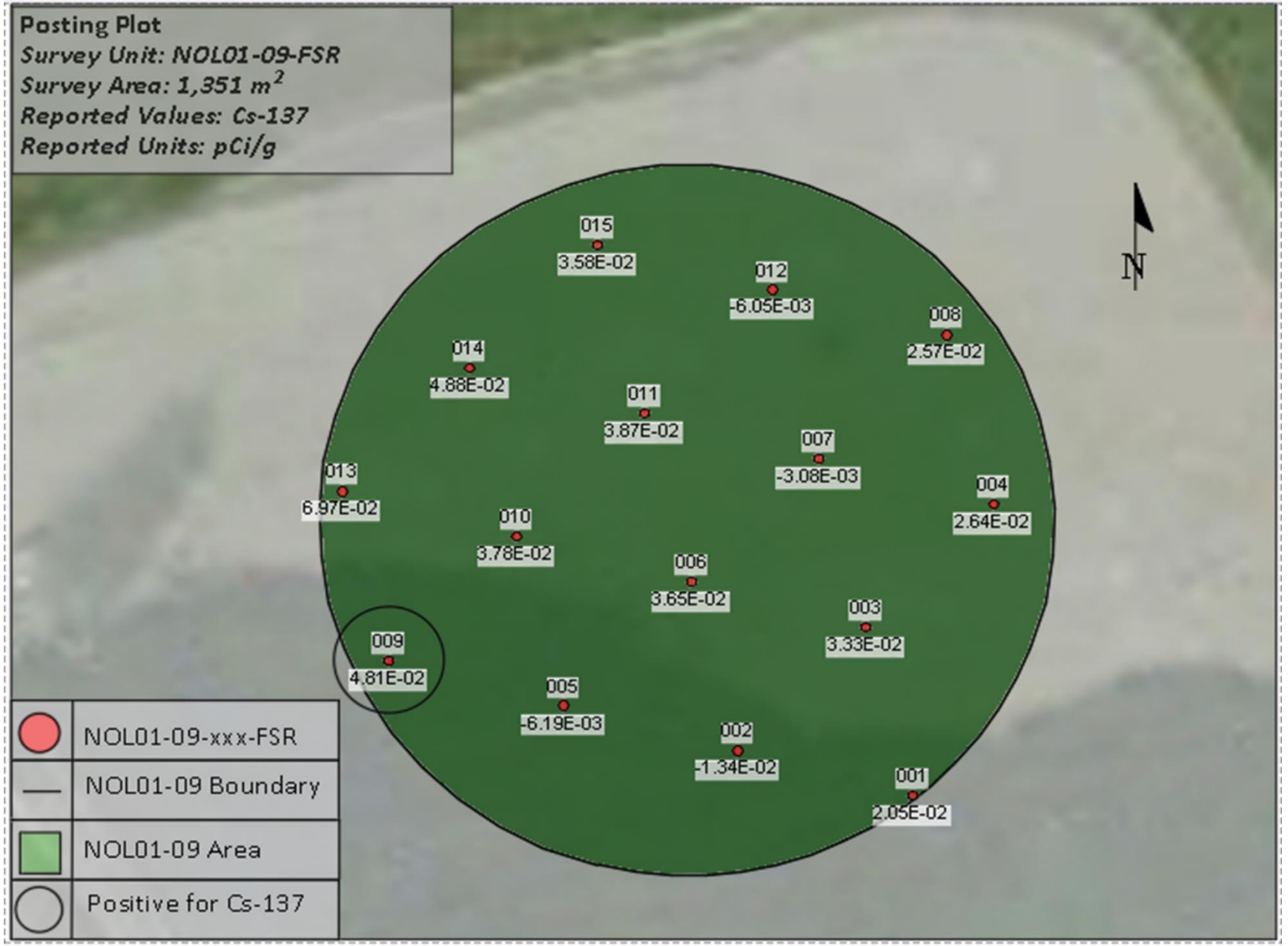
Cs-137 Results for FSS Direct Soil Samples Analyzed using the On-Site Laboratory HPGe Gamma System		
Sample Number	**Cs-137 (pCi/g)**	**Fraction of the DCGL**
NOL01-09-001-FSR	2.05E-02	2.59E-03
NOL01-09-002-FSR	-1.34E-02	-1.70E-03
NOL01-09-003-FSR	3.33E-02	4.22E-03
NOL01-09-004-FSR	2.64E-02	3.34E-03
NOL01-09-005-FSR	-6.19E-03	-7.84E-04
NOL01-09-006-FSR	3.65E-02	4.62E-03
NOL01-09-007-FSR	-3.08E-03	-3.90E-04
NOL01-09-008-FSR	2.57E-02	3.25E-03
NOL01-09-009-FSR	**4.81E-02**	6.09E-03
NOL01-09-010-FSR	3.78E-02	4.78E-03
NOL01-09-011-FSR	3.87E-02	4.90E-03
NOL01-09-012-FSR	-6.05E-03	-7.66E-04
NOL01-09-013-FSR	6.97E-02	8.82E-03
NOL01-09-014-FSR	4.88E-02	6.18E-03
NOL01-09-015-FSR	3.58E-02	4.53E-03

*Result in **bold** indicates a positive result for Cs-137

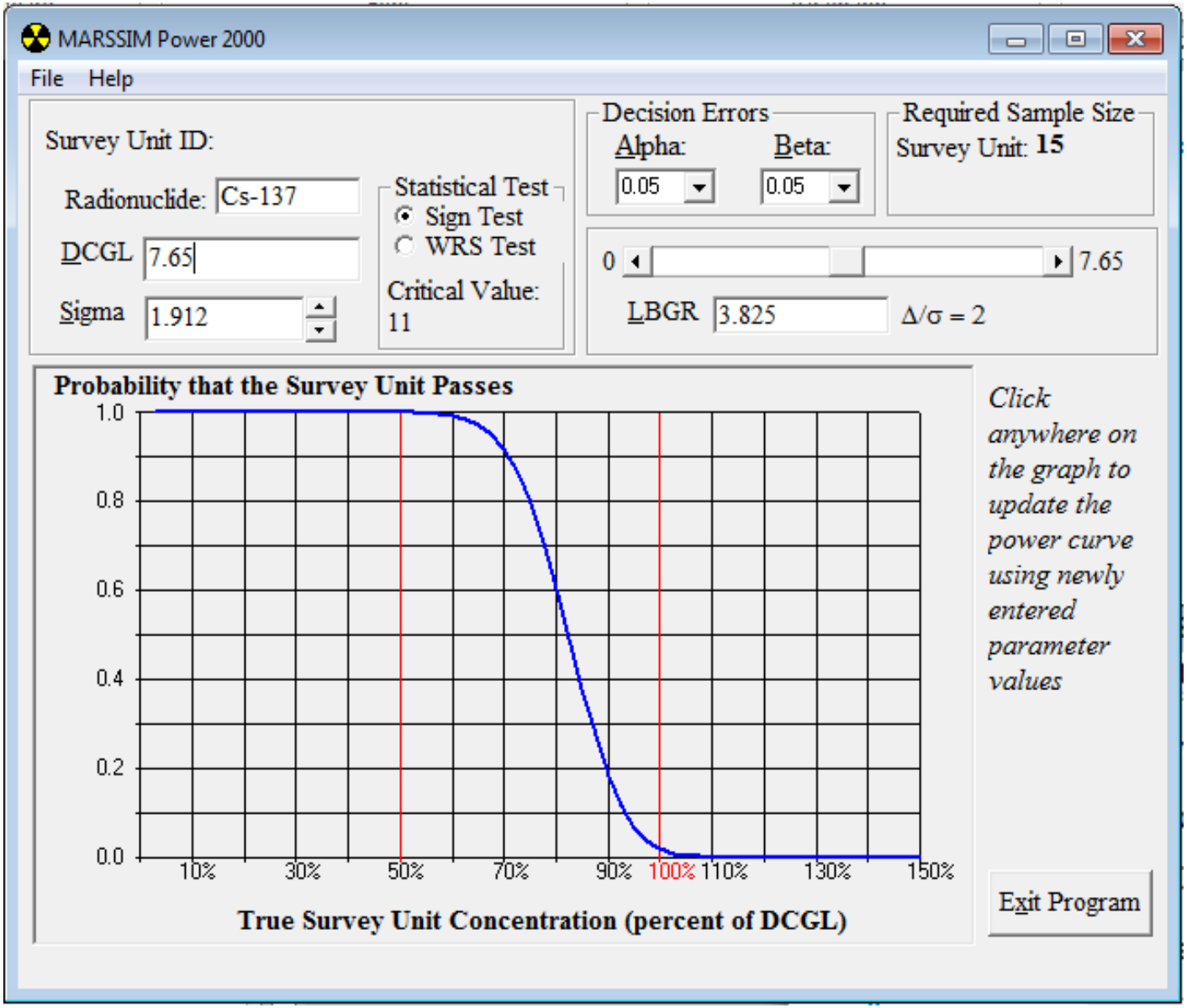

NOL01-09-FSR Sample Results Scatter Plot
DCGLga = 7.9 pCi/gm Cs-137
1.20E-01
1.00E-01
8.00E-02
6.00E-02
4.00E-02
2.00E-02
0.00E+00
-2.00E-02
-4.00E-02
-6.00E-02
0.098
0.026
-0.045
Activity
Average
"+3StDev"
"-3StDev"


NOL01-09-FSR Sample Results Quantile Plot
Activity (pCi/gm)
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
-0.01
-0.02
0.033
0
10
20
30
40
50
60
70
80
90
100
Percentile
Direct Measurements
median
75th Percentile
50th Percentile

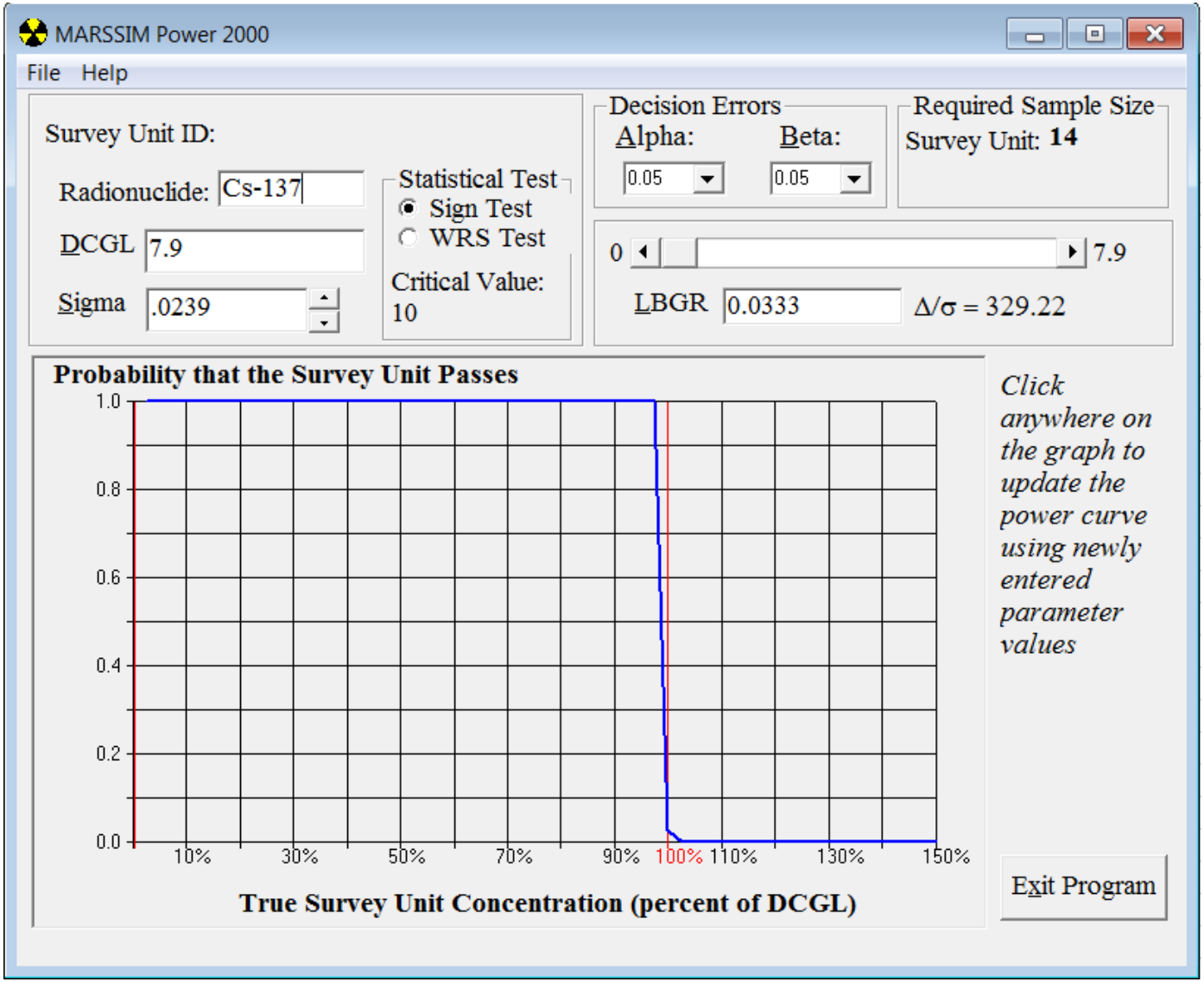

NOL01-09-FSR Frequency Plot
Number of Observations
18
16
14
12
10
8
6
4
2
0
-0.013
0.007
0.028
0.049
0.070
Bin Upper End Value (pCi/gm)


Posting Plot
Survey Unit: NOL01-09-FSR
Survey Area: 1,351 m2
Reported Values: Cs-137
Reported Units: pCi/g
015
3.58E-02
012
-6.05E-03
008
2.57E-02
014
4.88E-02
011
3.87E-02
007
-3.08E-03
013
6.97E-02
004
2.64E-02
010
3.78E-02
006
3.65E-02
003
3.33E-02
009
4.81E-02
005
-6.19E-03
002
-1.34E-02
001
2.05E-02
N
NOL01-09-xxx-FSR
NOL01-09 Boundary
NOL01-09 Area
Positive for Cs-137

Prospective Power Curve



Retrospective Power Curve



Split Sample #005

Split Sample Assessment Form

Survey Area No.:	NOL01	Survey Unit No.:	09	Survey Unit Name:	Caisson
Sample Plan No.:	HBPP-FSSP-NOL01-09-FSR-00			Sample Measurement Location:	005

Sample Description:

Comparison of split samples collected from sample measurement location #005 and analyzed using gamma spectroscopy by an off-site vendor laboratory. The on-site result is the standard count and the off-site is the comparison.

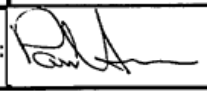
STANDARD						COMPARISON			
Radionuclide chosen	Standard Activity	1σ *Uncertainty*	Resolution	Agreement Range		Comparison Activity	Comparison Error	Comparison Ratio	Acceptable
(a)	(b)	(c)	(d)=(b)/(c)	(e)		(f)	(g)	(h)=(f)/(b)	(Y/N)
K-40	8.28	0.74	11	0.6	1.66	7.66	0.22	0.93	Y
Pb-212	0.39	0.04	9	0.6	1.66	0.45	0.02	1.14	Y
		0.00					0.00		
		0.00					0.00		

Comments/Corrective Actions:

N/A

Table 1 is provided to show acceptance criteria for sample recounts.

Resolution (d)		Agreement Range (e)	
Min	Max	Min	Max
<4		No Comaprison	No Comaprison
4	7	0.5	2
8	15	0.6	1.66
16	50	0.75	1.33
51	200	0.8	1.25
>200		0.85	1.18

Performed By:	Paul Sirois	Date:	2/25/2019	Concurrence by:	Gordon Madison	Date:	12/2/2019
Signature:				Signature:			

Split Sample #013

Split Sample Assessment Form

Survey Area No.:	NOL01	Survey Unit No.:	09	Survey Unit Name:	Caisson
Sample Plan No.:	HBPP-FSSP-NOL01-09-FSR-00			Sample Measurement Location:	013

Sample Description:

Comparison of split samples collected from sample measurement location #013 and analyzed using gamma spectroscopy by an off-site vendor laboratory. The on-site result is the standard count and the off-site is the comparison.

STANDARD						COMPARISON			
Radionuclide chosen	Standard Activity	1σ *Uncertainty*	Resolution	Agreement Range		Comparison Activity	Comparison Error	Comparison Ratio	Acceptable
(a)	(b)	(c)	(d)=(b)/(c)	(e)		(f)	(g)	(h)=(f)/(b)	(Y/N)
K-40	6.94	0.55	13	0.6	1.66	7.62	0.22	1.10	Y
Pb-212	0.45	0.03	14	0.6	1.66	0.41	0.02	0.90	Y
Cs-137	0.07	Note 1				0.05	0.01	0.69	N
		0.00					0.00		

Comments/Corrective Actions:

Note 1: The Cs-137 reported result for the on-site analysis was less than the method minimum detectable activity of 9.92E-02 pCi/g. It should be noted that no resolution could be calculated against the off-site lab result as the reported value listed above was not identified by the software, and there was no uncertianty calculated for the analysis. No further corrective actions are warranted.SCM notified.

Table 1 is provided to show acceptance criteria for sample recounts.

Resolution (d)		Agreement Range (e)	
Min	Max	Min	Max
<4		No Comaprison	No Comaprison
4	7	0.5	2
8	15	0.6	1.66
16	50	0.75	1.33
51	200	0.8	1.25
>200		0.85	1.18

Performed By:	Paul Sirois	Date:	2/25/2019	Concurrence by:	Gordon Madison	Date:	1/16/2020
Signature:				Signature:			

Recount Sample #010

Recount Sample Assessment Form

Survey Area No.:	NOL01	Survey Unit No.:	09	Survey Unit Name:	Caisson
Sample Plan No.:	HBPP-FSSP-NOL01-09-FSR-00			Sample Measurement Location:	010

Sample Description:

Duplicate count comparison from sample measurement location #010 and analyzed using gamma spectroscopy by the on-site laboratory. The original count result is the standard count and the recount is the comparison.

STANDARD						COMPARISON			
Radionuclide chosen	Standard Activity	1σ *Uncertainty*	Resolution	Agreement Range		Comparison Activity	Comparison Error	Comparison Ratio	Acceptable
(a)	(b)	(c)	(d)=(b)/(c)	(e)		(f)	(g)	(h)=(f)/(b)	(Y/N)
K-40	8.10	0.51	16	0.6	1.66	7.72	0.50	0.95	Y
Pb-212	0.37	0.04	9	0.6	1.66	0.42	0.04	1.15	Y
		0.00					0.00		
		0.00					0.00		

Comments/Corrective Actions:

Table 1 is provided to show acceptance criteria for sample recounts.

Resolution (d)		Agreement Range (e)	
Min	Max	Min	Max
<4		No Comaprison	No Comaprison
4	7	0.5	2
8	15	0.6	1.66
16	50	0.75	1.33
51	200	0.8	1.25
>200		0.85	1.18

Performed By:	Paul Sirois	Date:	2/25/2019	Concurrence by:	Gordon Madison	Date:	12/2/2019
Signature:				Signature:			

Recount Sample #014

Recount Sample Assessment Form

Survey Area No.:	NOL01	Survey Unit No.:	09	Survey Unit Name:	Caisson
Sample Plan No.:	HBPP-FSSP-NOL01-09-FSR-00			Sample Measurement Location:	014

Sample Description:

Duplicate count comparison from sample measurement location #014 and analyzed using gamma spectroscopy by the on-site laboratory. The original count result is the standard count and the recount is the comparison.

STANDARD						COMPARISON			
Radionuclide chosen	Standard Activity	1σ *Uncertainty*	Resolution	Agreement Range		Comparison Activity	Comparison Error	Comparison Ratio	Acceptable
(a)	(b)	(c)	(d)=(b)/(c)	(e)		(f)	(g)	(h)=(f)/(b)	(Y/N)
K-40	6.43	0.44	15	0.6	1.66	7.04	0.47	1.09	Y
Pb-212	0.32	0.04	8	0.6	1.66	0.36	0.04	1.13	Y
		0.00					0.00		
		0.00					0.00		

Comments/Corrective Actions:

Table 1 is provided to show acceptance criteria for sample recounts.

Resolution (d)		Agreement Range (e)	
Min	Max	Min	Max
<4		No Comaprison	No Comaprison
4	7	0.5	2
8	15	0.6	1.66
16	50	0.75	1.33
51	200	0.8	1.25
>200		0.85	1.18

Performed By:	Paul Sirois	Date:	2/25/2019	Concurrence by:	Gordon Madison	Date:	12/2/2019
Signature:				Signature:			

GEL LABORATORIES LLC

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Certificate of Analysis

GEL Sample ID: 467216011
Client Sample ID: FSS-2118: NOL01-09-005-FSR-S
Client Matrix: Soil
Amount of Sample Received:

Client: Pacific Gas and Electric Company
Collect Date: December 08, 2018
Receive Date: December 19, 2018
Report Date: January 07, 2019

Isotope	Run Date	Qualifier	Activity	2 Sigma Uncertainty	MDC	LLD	2 Sigma TPU	Units
Gamma Spec								
Be-7	12/22/18	UI	1.14E-01	1.46E-01	1.14E-01		1.47E-01	pCi/g
Na-22	12/22/18	U	8.96E-03	1.05E-02	1.75E-02		1.13E-02	pCi/g
K-40	12/22/18		7.66E+00	4.35E-01	9.77E-02		8.60E-01	pCi/g
Cr-51	12/22/18	U	3.84E-02	8.36E-02	1.48E-01		8.54E-02	pCi/g
Mn-54	12/22/18	U	9.00E-03	7.50E-03	1.43E-02		8.56E-03	pCi/g
Fe-59	12/22/18	U	-1.21E-02	1.95E-02	3.06E-02		2.02E-02	pCi/g
Co-56	12/22/18	U	3.02E-03	7.96E-03	1.42E-02		8.08E-03	pCi/g
Co-57	12/22/18	U	2.63E-03	7.98E-03	1.33E-02		8.07E-03	pCi/g
Co-58	12/22/18	U	2.57E-03	8.17E-03	1.45E-02		8.25E-03	pCi/g
Co-60	12/22/18	U	1.25E-03	7.48E-03	1.27E-02	3.42E-01	7.51E-03	pCi/g
Zn-65	12/22/18	U	7.37E-03	2.14E-02	3.35E-02		2.17E-02	pCi/g
Y-88	12/22/18	U	-3.92E-03	5.61E-03	7.70E-03		5.89E-03	pCi/g
Zr-95	12/22/18	U	9.97E-03	1.53E-02	2.81E-02		1.60E-02	pCi/g
Nb-94	12/22/18	U	-1.01E-04	7.33E-03	1.19E-02	6.39E-01	7.33E-03	pCi/g
Nb-95	12/22/18	U	-4.56E-03	1.07E-02	1.55E-02		1.09E-02	pCi/g
Ru-106	12/22/18	U	-3.79E-02	7.03E-02	1.09E-01		7.25E-02	pCi/g
Ag-110m	12/22/18	U	-7.60E-03	1.03E-02	1.62E-02		1.08E-02	pCi/g
Sn-113	12/22/18	U	-6.91E-03	1.09E-02	1.56E-02		1.14E-02	pCi/g
Sb-124	12/22/18	U	1.12E-02	1.37E-02	2.74E-02		1.46E-02	pCi/g
Sb-125	12/22/18	U	1.50E-03	1.98E-02	3.36E-02		1.98E-02	pCi/g
Cs-134	12/22/18	UI	2.00E-02	1.70E-02	2.00E-02		2.07E-02	pCi/g
Cs-136	12/22/18	U	1.38E-02	2.13E-02	3.86E-02		2.23E-02	pCi/g
Cs-137	12/22/18	U	9.95E-03	7.03E-03	1.29E-02	7.11E-01	7.08E-03	pCi/g
Ba-133	12/22/18	U	4.36E-03	9.76E-03	1.56E-02		9.96E-03	pCi/g
Ba-140	12/22/18	U	1.78E-02	5.96E-02	1.01E-01		6.01E-02	pCi/g
Ce-139	12/22/18	U	1.82E-04	8.68E-03	1.40E-02		8.69E-03	pCi/g
Ce-141	12/22/18	U	-5.80E-03	1.91E-02	3.06E-02		1.93E-02	pCi/g
Ce-144	12/22/18	U	-4.30E-02	5.99E-02	9.45E-02		6.31E-02	pCi/g
Nd-147	12/22/18	U	1.59E-02	1.08E-01	1.82E-01		1.08E-01	pCi/g
Pm-144	12/22/18	U	3.11E-04	7.13E-03	1.17E-02		7.14E-03	pCi/g
Pm-146	12/22/18	U	2.26E-03	9.71E-03	1.66E-02		9.77E-03	pCi/g
Eu-152	12/22/18	U	-3.23E-03	2.30E-02	3.72E-02	9.00E-01	2.31E-02	pCi/g
Eu-154	12/22/18	U	1.75E-02	3.05E-02	4.85E-02	8.46E-01	3.15E-02	pCi/g
Eu-155	12/22/18	U	5.25E-03	3.22E-02	5.36E-02		3.23E-02	pCi/g
Ir-192	12/22/18	U	-1.88E-03	8.06E-03	1.37E-02		8.11E-03	pCi/g

Notes:
1. LLDs are a-priori values.
2. MDCs are calculated a-posteriori values.
3. Gamma spectroscopy analysis results are calculated from a measurement using only one gamma energy line.
4. Air sample volumes are received in units of ft3. GEL converts the units and reports them as m3.

Qualifiers:
U Target isotope was analyzed for but not detected above the MDC and LLD.
UI Uncertain identification for gamma spectroscopy.
X Lab-specific qualifier-please see case narrative, data summary package or contact your project manager for details.
M Reported result is less than the LLD and greater than the MDC.

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Certificate of Analysis

GEL Sample ID: 467216011
Client Sample ID: FSS-2118: NOL01-09-005-FSR-S
Client Matrix: Soil
Amount of Sample Received:

Client: Pacific Gas and Electric Company
Collect Date: December 08, 2018
Receive Date: December 19, 2018
Report Date: January 07, 2019

Isotope	Run Date	Qualifier	Activity	2 Sigma Uncertainty	MDC	LLD	2 Sigma TPU	Units
Hg-203	12/22/18	U	1.10E-03	9.33E-03	1.63E-02		9.35E-03	pCi/g
Tl-208	12/22/18		1.39E-01	1.88E-02	1.36E-02		2.21E-02	pCi/g
Pb-210	12/22/18	U	2.03E+00	2.68E+00	2.86E+00		2.69E+00	pCi/g
Pb-212	12/22/18		4.48E-01	3.22E-02	2.46E-02		4.75E-02	pCi/g
Pb-214	12/22/18		5.86E-01	5.50E-02	8.84E-02		7.08E-02	pCi/g
Bi-212	12/22/18		5.62E-01	2.83E-01	1.58E-01		2.88E-01	pCi/g
Bi-214	12/22/18		5.03E-01	4.35E-02	2.58E-02		6.06E-02	pCi/g
Ra-228	12/22/18		3.98E-01	7.21E-02	5.40E-02		8.15E-02	pCi/g
Ac-228	12/22/18		3.98E-01	7.21E-02	5.40E-02		8.15E-02	pCi/g
Th-234	12/22/18	U	6.58E-01	8.99E-01	8.51E-01		9.12E-01	pCi/g
U-235	12/22/18	U	3.22E-03	6.28E-02	1.02E-01		6.28E-02	pCi/g
U-238	12/22/18	U	6.58E-01	8.99E-01	8.51E-01		9.12E-01	pCi/g
Np-237	12/22/18	U	1.68E-02	1.40E-02	2.59E-02	9.90E-01	1.60E-02	pCi/g
Np-239	12/22/18	U	2.37E-02	8.20E-02	1.37E-01		8.27E-02	pCi/g
Am-241	12/22/18	U	-9.31E-03	6.45E-02	1.01E-01	2.27E+00	6.46E-02	pCi/g

Notes:
1. LLDs are a-priori values.
2. MDCs are calculated a-posteriori values.
3. Gamma spectroscopy analysis results are calculated from a measurement using only one gamma energy line.
4. Air sample volumes are received in units of ft3. GEL converts the units and reports them as m3.

Qualifiers:
U Target isotope was analyzed for but not detected above the MDC and LLD.
UI Uncertain identification for gamma spectroscopy.
X Lab-specific qualifier-please see case narrative, data summary package or contact your project manager for details.
M Reported result is less than the LLD and greater than the MDC.

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Certificate of Analysis

GEL Sample ID: 467216012
Client Sample ID: FSS-2118: NOL01-09-005-FSR
Client Matrix: Soil
Amount of Sample Received:

Client: Pacific Gas and Electric Company
Collect Date: December 08, 2018
Receive Date: December 19, 2018
Report Date: January 07, 2019

Isotope	Run Date	Qualifier	Activity	2 Sigma Uncertainty	MDC	LLD	2 Sigma TPU	Units
H-3	12/21/18	U	-1.09E+01	8.93E+00	1.65E+01	6.16E+01	8.93E+00	pCi/g
C-14	01/02/19	U	-5.40E-02	2.29E-01	3.86E-01	5.00E-01	2.29E-01	pCi/g
Ni-63	01/03/19	U	-2.58E+00	1.28E+01	2.16E+01	6.94E+01	1.28E+01	pCi/g
Sr-90	12/31/18	U	7.45E-02	8.10E-02	1.13E-01	1.36E-01	8.21E-02	pCi/g
Tc-99	01/02/19	U	-6.49E-02	3.18E-01	5.41E-01	1.16E+00	3.18E-01	pCi/g
Pu-241	12/27/18	U	-1.17E+00	2.74E+01	4.60E+01	8.29E+01	2.74E+01	pCi/g
Alpha Spec								
Pu-238	12/26/18	U	3.75E-02	1.45E-01	2.80E-01	2.80E+00	1.45E-01	pCi/g
Pu-239/240	12/26/18	U	-7.49E-02	8.53E-02	2.91E-01	2.51E+00	8.55E-02	pCi/g
Am-241	12/27/18	U	-2.33E-02	1.30E-01	3.29E-01	2.28E+00	1.31E-01	pCi/g
Cm-243/244	12/27/18	U	-7.66E-03	1.27E-01	2.68E-01	2.80E+00	1.27E-01	pCi/g
Cm-245/246	12/27/18	U	1.48E-01	2.52E-01	2.22E-01	1.64E+00	2.53E-01	pCi/g
Gamma Spec								
Ni-59	01/03/19	U	9.45E-01	9.67E+00	1.81E+01	1.83E+02	9.68E+00	pCi/g

Notes:
1. LLDs are a-priori values.
2. MDCs are calculated a-posteriori values.
3. Gamma spectroscopy analysis results are calculated from a measurement using only one gamma energy line.
4. Air sample volumes are received in units of ft3. GEL converts the units and reports them as m3.

Qualifiers:
U Target isotope was analyzed for but not detected above the MDC and LLD.
UI Uncertain identification for gamma spectroscopy.
X Lab-specific qualifier-please see case narrative, data summary package or contact your project manager for details.
M Reported result is less than the LLD and greater than the MDC.

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Certificate of Analysis

GEL Sample ID: 465691003
Client Sample ID: FSS-2037: NOL01-09-013-FSR-S
Client Matrix: Soil
Amount of Sample Received:
Sample Description: gamma

Client: Pacific Gas and Electric Company
Collect Date: November 19, 2018
Receive Date: November 29, 2018
Report Date: December 14, 2018

Isotope	Run Date	Qualifier	Activity	2 Sigma Uncertainty	MDC	LLD	2 Sigma TPU	Units
Gamma Spec								
Be-7	12/11/18	U	-4.87E-02	7.89E-02	1.27E-01		8.20E-02	pCi/g
Na-22	12/11/18	U	-5.28E-03	8.39E-03	1.31E-02		8.73E-03	pCi/g
K-40	12/11/18		7.62E+00	4.33E-01	1.16E-01		8.42E-01	pCi/g
Cr-51	12/11/18	U	4.53E-03	9.98E-02	1.74E-01		9.98E-02	pCi/g
Mn-54	12/11/18	U	6.10E-03	8.05E-03	1.43E-02		8.53E-03	pCi/g
Fe-59	12/11/18	U	-1.74E-02	2.16E-02	3.40E-02		2.31E-02	pCi/g
Co-56	12/11/18	U	-6.81E-03	9.12E-03	1.35E-02		9.64E-03	pCi/g
Co-57	12/11/18	U	-2.15E-03	8.45E-03	1.38E-02		8.51E-03	pCi/g
Co-58	12/11/18	U	-4.12E-03	7.46E-03	1.12E-02		7.70E-03	pCi/g
Co-60	12/11/18	U	-3.19E-03	8.07E-03	1.29E-02	3.42E-01	8.20E-03	pCi/g
Zn-65	12/11/18	U	8.38E-03	1.68E-02	2.78E-02		1.73E-02	pCi/g
Y-88	12/11/18	U	4.75E-03	6.78E-03	1.31E-02		7.12E-03	pCi/g
Zr-95	12/11/18	U	8.19E-03	1.57E-02	2.75E-02		1.61E-02	pCi/g
Nb-94	12/11/18	U	-1.20E-03	6.73E-03	1.09E-02	6.39E-01	6.75E-03	pCi/g
Nb-95	12/11/18	U	7.37E-03	1.18E-02	1.87E-02		1.23E-02	pCi/g
Ru-106	12/11/18	U	-1.42E-02	6.59E-02	1.08E-01		6.62E-02	pCi/g
Ag-110m	12/11/18	U	-5.11E-03	1.09E-02	1.67E-02		1.11E-02	pCi/g
Sn-113	12/11/18	U	-4.87E-04	1.02E-02	1.75E-02		1.02E-02	pCi/g
Sb-124	12/11/18	U	-5.77E-03	1.77E-02	2.73E-02		1.79E-02	pCi/g
Sb-125	12/11/18	U	-1.32E-03	1.99E-02	3.39E-02		1.99E-02	pCi/g
Cs-134	12/11/18	UI	1.78E-02	1.50E-02	1.78E-02		1.86E-02	pCi/g
Cs-136	12/11/18	U	-8.82E-03	2.89E-02	4.82E-02		2.92E-02	pCi/g
Cs-137	12/11/18	M	4.78E-02	2.26E-02	1.36E-02	7.11E-01	2.30E-02	pCi/g
Ba-133	12/11/18	U	-1.11E-03	9.66E-03	1.48E-02		9.67E-03	pCi/g
Ba-140	12/11/18	U	-9.02E-03	7.69E-02	1.28E-01		7.70E-02	pCi/g
Ce-139	12/11/18	U	4.40E-03	9.01E-03	1.50E-02		9.27E-03	pCi/g
Ce-141	12/11/18	U	-2.05E-02	2.33E-02	3.66E-02		2.51E-02	pCi/g
Ce-144	12/11/18	U	-8.16E-03	6.18E-02	1.01E-01		6.19E-02	pCi/g
Nd-147	12/11/18	U	4.63E-02	1.91E-01	3.30E-01		1.93E-01	pCi/g
Pm-144	12/11/18	U	-1.43E-04	6.67E-03	1.10E-02		6.67E-03	pCi/g
Pm-146	12/11/18	U	2.49E-03	8.78E-03	1.47E-02		8.85E-03	pCi/g
Eu-152	12/11/18	U	-2.69E-03	2.31E-02	3.96E-02	9.00E-01	2.31E-02	pCi/g
Eu-154	12/11/18	U	-1.46E-02	2.37E-02	3.71E-02	8.46E-01	2.47E-02	pCi/g
Eu-155	12/11/18	U	2.06E-02	3.51E-02	5.97E-02		3.63E-02	pCi/g
Ir-192	12/11/18	U	1.34E-03	7.97E-03	1.40E-02		8.00E-03	pCi/g

Notes:
1. LLDs are a-priori values.
2. MDCs are calculated a-posteriori values.
3. Gamma spectroscopy analysis results are calculated from a measurement using only one gamma energy line.
4. Air sample volumes are received in units of ft3. GEL converts the units and reports them as m3.

Qualifiers:
U Target isotope was analyzed for but not detected above the MDC and LLD.
UI Uncertain identification for gamma spectroscopy.
X Lab-specific qualifier-please see case narrative, data summary package or contact your project manager for details.
M Reported result is less than the LLD and greater than the MDC.

GEL LABORATORIES LLC

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Certificate of Analysis

GEL Sample ID: 465691003
Client Sample ID: FSS-2037: NOL01-09-013-FSR-S
Client Matrix: Soil
Amount of Sample Received:
Sample Description: gamma

Client: Pacific Gas and Electric Company
Collect Date: November 19, 2018
Receive Date: November 29, 2018
Report Date: December 14, 2018

Isotope	Run Date	Qualifier	Activity	2 Sigma Uncertainty	MDC	LLD	2 Sigma TPU	Units
Hg-203	12/11/18	U	6.97E-03	1.59E-02	1.75E-02		1.61E-02	pCi/g
Tl-208	12/11/18		1.34E-01	2.03E-02	1.34E-02		2.31E-02	pCi/g
Pb-210	12/11/18	U	1.57E+00	2.88E+00	5.04E+00		2.97E+00	pCi/g
Pb-212	12/11/18		4.06E-01	3.77E-02	3.12E-02		5.07E-02	pCi/g
Pb-214	12/11/18		5.37E-01	4.94E-02	2.66E-02		6.52E-02	pCi/g
Bi-212	12/11/18		6.18E-01	2.45E-01	1.69E-01		2.51E-01	pCi/g
Bi-214	12/11/18		5.43E-01	4.79E-02	2.45E-02		6.57E-02	pCi/g
Ra-228	12/11/18		3.89E-01	7.75E-02	4.80E-02		8.53E-02	pCi/g
Ac-228	12/11/18		3.89E-01	7.75E-02	4.80E-02		8.53E-02	pCi/g
Th-234	12/11/18	U	2.87E-01	9.28E-01	9.99E-01		9.30E-01	pCi/g
U-235	12/11/18	U	1.09E-02	6.31E-02	1.05E-01		6.31E-02	pCi/g
U-238	12/11/18	U	2.87E-01	9.28E-01	9.99E-01		9.30E-01	pCi/g
Np-237	12/11/18	U	6.59E-03	1.49E-02	2.66E-02	9.90E-01	1.52E-02	pCi/g
Np-239	12/11/18	U	-1.12E-02	8.60E-02	1.41E-01		8.61E-02	pCi/g
Am-241	12/11/18	U	2.67E-02	7.77E-02	1.34E-01	2.27E+00	7.86E-02	pCi/g

Notes:
1. LLDs are a-priori values.
2. MDCs are calculated a-posteriori values.
3. Gamma spectroscopy analysis results are calculated from a measurement using only one gamma energy line.
4. Air sample volumes are received in units of ft3. GEL converts the units and reports them as m3.

Qualifiers:
U Target isotope was analyzed for but not detected above the MDC and LLD.
UI Uncertain identification for gamma spectroscopy.
X Lab-specific qualifier-please see case narrative, data summary package or contact your project manager for details.
M Reported result is less than the LLD and greater than the MDC.

GEL LABORATORIES LLC

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Certificate of Analysis

GEL Sample ID: 465691004
Client Sample ID: FSS-2037: NOL01-09-013-FSR
Client Matrix: Soil
Amount of Sample Received:
Sample Description: HTDs

Client: Pacific Gas and Electric Company
Collect Date: November 19, 2018
Receive Date: November 29, 2018
Report Date: December 14, 2018

Isotope	Run Date	Qualifier	Activity	2 Sigma Uncertainty	MDC	LLD	2 Sigma TPU	Units
C-14	12/10/18	U	4.01E-02	2.39E-01	4.00E-01	5.00E-01	2.39E-01	pCi/g
Ni-63	12/13/18	U	3.13E+01	2.52E+01	4.01E+01	6.88E+01	2.59E+01	pCi/g
Tc-99	12/11/18	U	-2.00E-03	3.88E-01	6.51E-01	1.15E+00	3.88E-01	pCi/g
Pu-241	12/07/18	U	-1.88E+01	2.87E+01	4.98E+01	7.94E+01	2.87E+01	pCi/g
Alpha Spec								
Pu-238	12/04/18	U	1.31E-01	2.64E-01	4.66E-01	2.80E+00	2.65E-01	pCi/g
Pu-239/240	12/04/18	U	4.30E-02	2.52E-01	5.03E-01	2.51E+00	2.53E-01	pCi/g
Am-241	12/04/18	U	0.00E+00	2.86E-01	6.30E-01	2.28E+00	2.86E-01	pCi/g
Cm-243/244	12/04/18	U	6.89E-02	1.92E-01	2.07E-01	2.80E+00	1.92E-01	pCi/g
Cm-245/246	12/04/18	U	1.31E-01	2.74E-01	4.07E-01	1.64E+00	2.75E-01	pCi/g
Gamma Spec								
Ni-59	12/13/18	U	8.29E-01	1.07E+01	1.99E+01	1.83E+02	1.07E+01	pCi/g

Notes:
1. LLDs are a-priori values.
2. MDCs are calculated a-posteriori values.
3. Gamma spectroscopy analysis results are calculated from a measurement using only one gamma energy line.
4. Air sample volumes are received in units of ft3. GEL converts the units and reports them as m3.

Qualifiers:
U Target isotope was analyzed for but not detected above the MDC and LLD.
UI Uncertain identification for gamma spectroscopy.
X Lab-specific qualifier-please see case narrative, data summary package or contact your project manager for details.
M Reported result is less than the LLD and greater than the MDC.

Attachment 2

ALARA Statement

Generic ALARA Evaluation Comparison Worksheet

Survey Area: NOL01 **Survey Unit:** 09

Reference Generic ALARA Evaluation No.: 13

Applicable Generic ALARA AL: 144

	Radionuclide	Average Concentration (%)	DCGL (%)	Fraction DCGL
1.	Unity	3.16E+01	100	3.16E-01
2.	N/A	N/A	N/A	N/A
3.	N/A	N/A	N/A	N/A
4.	N/A	N/A	N/A	N/A

If the ∑(fraction DCGL) <the generic ALARA AL, then the generic ALARA evaluation is applicable to the survey unit.

Check one:

X Generic ALARA AL IS satisfied

_____ Generic ALARA AL IS NOT satisfied

Prepared by: G. Madison Date: 1-31-20
FSS Engineer (Print/Sign)

Reviewed by: MH BLAKE Date: 1-31-20
FSS Engineer (Print/Sign)

Approved by: WH BARLEY Date: 2-4-2020
Site Closure Manager or Designee (Print/Sign)

Generic ALARA Evaluation Comparison Worksheet

Survey Area: NOL01 **Survey Unit:** 09-FSR

Reference Generic ALARA Evaluation No.: 14

Applicable Generic ALARA AL: 144

	Radionuclide	Average Concentration (pCi/g)	DCGL (pCi/g)	Fraction DCGL
1.	Cs-137	2.62E-02	7.90	3.32E-03
2.	N/A	N/A	N/A	N/A
3.	N/A	N/A	N/A	N/A
4.	N/A	N/A	N/A	N/A

If the ∑(fraction DCGL) <the generic ALARA AL, then the generic ALARA evaluation is applicable to the survey unit.

Check one:

X Generic ALARA AL IS satisfied

_____ Generic ALARA AL IS NOT satisfied

Prepared by: G. Madison Date: 1-31-20
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Reviewed by: MH BLAKE Date: 1-31-20
FSS Engineer (Print/Sign)

Approved by: WH BARLEY / WH Barley Date: 2-4-2020
Site Closure Manager or Designee (Print/Sign)