Reference 17-

WVDP Terrestrial Background Study (S&EC, 2014)

WEST VALLEY DEMONSTRATION PROJECT TERRESTRIAL BACKGROUND STUDY

for

TASK ORDER 5
WEST VALLEY DEMONSTRATION PROJECT ENVIRONMENTAL CHARACTERIZATION SERVICES
WEST VALLEY, NEW YORK

SEC-TBS
Rev. 1

July 2014

Prepared for:
U.S. Department of Energy
West Valley Demonstration Project (WVDP)
Environmental Characterization Services (ECS)
West Valley, New York

Prepared by:
Safety and Ecology Corporation (SEC)
2800 Solway Road
Knoxville, TN 37931

UNCONTROLLED DOCUMENT

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West Valley Demonstration Project
Terrestrial Background Study
U.S. Department of Energy
West Valley Demonstration Project
West Valley, New York

Contract No.: DE-EM0001242

TBS APPROVALS

By their specific signature, the undersigned certify that they prepared, reviewed, or provided comments on this Terrestrial Background Study (TBS) for the DOE West Valley Demonstration Project, West Valley, New York.

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ABBREVIATIONS, ACRONYMS, AND SYMBOLS

ANL	Argonne National Laboratory
CLP	Contract Laboratory Procedure
cm	centimeter
cpm	counts per minute
CSAP	Characterization Sampling and Analysis Plan
CV	Coefficient of Variation
DER	Normalized Absolute Difference
DOE	U.S. Department of Energy
DP	Decommissioning Plan
dpm	disintegration per minute
ECS	Environmental Characterization Services
EDD	Electronic Data Deliverable
EPA	U.S. Environmental Protection Agency
FIDLER	Field Instrument for Detection of Low-Energy Radiation
FSP	Field Sampling Plan
FSSP	Final Status Survey Plan
ft	foot/feet
g	gram
GPS	Global Positioning System
GWS	Gamma Walkover Survey
HLW	High-Level Waste
km	kilometer
LAGGSS	Large Area GPS Gamma Survey System
Lc	Lower Critical Level
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
LLRW	Low-level Radioactive Waste
m	meter
m^2	square meter
m/s	meters per second
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDA	Minimum Detectable Activity
MDC	Minimum Detectable Concentration
NaI	Sodium Iodide
NYSERDA	New York State Energy Research and Development Authority
pCi	picocuries
PDOP	Position Dilution of Precision
PROI	Potential Radionuclide of Interest
QA	Quality Assurance
QC	Quality Control
RE	Relative Error
ROI	Radionuclide of Interest
RPD	Relative Percent Difference
SEC	Safety and Ecology Corporation
SOP	Standard Operating Procedure
TBS	Terrestrial Background Study

TRU	Transuranic
UTL	Upper Tolerance Limit
WNYNSC	Western New York Nuclear Service Center
WVDP	West Valley Demonstration Project

EXECUTIVE SUMMARY

Radiological characterization of background reference areas is the subject of this Terrestrial Background Study (TBS). Background reference areas were characterized to determine the background radionuclide concentrations allowing a comparison to results of samples collected at locations potentially impacted by past operations at the West Valley Demonstration Project (WVDP).

Two background reference areas were selected to represent sand and gravel near surface geology and an area of Lavery till near surface geology. These two different surface geologies are present at WVDP. The geology on the north plateau is typically sand and gravel. The geology on the South Plateau is typically Lavery till.

Characterization was performed in accordance with the *Field Sampling Plan (FSP) for Task Order 5, West Valley Demonstration Project Environmental Characterization Services* (SEC 2012). Each background reference area was characterized by performing gamma walkover surveys (GWSs), collecting soil samples with a hand auger and with a geoprobe, scanning collected soil cores for gamma radiation, performing down-hole gamma logging in some cases, and performing a civil survey to record the sampling locations. The results of this characterization are provided in this TBS.

1.0 INTRODUCTION

This introductory section contains a site description, project description, and objectives.

1.1 Site Description

The West Valley Demonstration Project (WVDP) (established to implement the WVDP Act) is located on approximately 152 acres within the 3,345-acre Western New York Nuclear Service Center (WNYNSC), owned by the New York State Energy Research and Development Authority (NYSERDA) in rural Cattaraugus County, about 35 miles south of Buffalo, New York. The WVDP site is complex, involving a large number of potential radionuclides of concern and a variety of historical processes and events that are known to have or may have released contaminants into the environment. Known affected environmental media include surface soils, subsurface soils, groundwater, surface water, and sediments. The decommissioning of the WVDP site will involve a sequential set of activities that will vary significantly depending on the exact location and activity purpose.

WVDP is a unique operation within the U.S. Department of Energy (DOE). The West Valley Demonstration Project Act of 1980 directed the Secretary of Energy to undertake five major activities, as follows:

- Solidify the liquid high-level waste (HLW) stored at WNYNSC into a form suitable for transportation and disposal (completed);
- Develop containers for the solidified HLW suitable for permanent disposal of the HLW (completed);
- Transport the waste to a federal repository for disposal (pending);
- Dispose of low-level radioactive waste (LLRW) and transuranic (TRU) waste produced by the Project (in progress); and
- Decontaminate and decommission the HLW storage tanks (PUREX and THOREX HLW tanks deactivated, July 2003), the HLW solidification facilities (in progress), and any material and hardware used in connection with the Project (in progress).

Decommissioning of the site will occur in two phases. Phase 1 of the decommissioning will entail removal of the Main Plant Process Building, the Low-Level Waste Treatment Facility, and certain other facilities within the WVDP area, which is known as the project premises. These activities will clean up much of the project premises to standards that will not prejudice decisions on the approach for Phase 2, which will complete the decommissioning. The Phase 2 decision shall be made within 10 years of the Record of Decision and Findings Statement documenting the Phase 1 decisions. Phase 2 actions will complete the decommissioning or long-term management of those facilities remaining at WVDP and WNYNSC following the completion of Phase 1 decommissioning.

Characterization of WVDP premises during and after Phase 1 decommissioning work is performed according to the Characterization Sampling and Analysis Plan (CSAP) (DOE 2011a). Characterization will be performed by Safety and Ecology Corporation (SEC) under a Task Order contract with DOE. As DOE identifies needed characterization work, Task Orders are issued to SEC with defined work scope.

1.2 Project Description

This Terrestrial Background Study (TBS) has been prepared for two background reference areas. Two background reference areas were used because of differences in near surface geology at WVDP. The two different geologies are sand and gravel and Lavery till.

The background reference areas will be used throughout the remedial efforts at WVDP. The overall plan for Phase 1 decommissioning is specified in the *Phase 1 Decommissioning Plan for the West Valley Demonstration Project* (Phase 1 DP) (DOE 2009). Refer to that document for a discussion of project history and contaminants. Characterization was performed according to specifications in the Field Sampling Plan (FSP) for Task Order 5 (SEC 2012).

SEC mobilized the appropriate equipment and qualified personnel to perform the required data collection activities associated with the task. The FSP discusses the gamma walkover survey (GWS) methods, civil surveying, field instrumentation, soil sampling methods, sample chain of custody documentation, quality assurance (QA)/quality control (QC) procedures, laboratory analytical methods, and statistical data evaluation methods. This TBS discusses the results of the characterization effort.

1.3 Objective

The objective of this effort was to characterize two background reference areas. The surveys required to meet the objective included GWSs and systematic surface and subsurface soil sampling. The soil samples were analyzed for the 18 radionuclides of interest (ROIs) and the 12 potential radionuclides of interest (PROIs) as described in the CSAP and listed in Table 1-1. Also included in the table are the minimum volume of soil collected for each analysis and the analytical method used.

The objective of the GWS was to determine the background gamma radiation signal for future comparisons. The objective of soil sampling was to assess the average concentration of ROIs and PROIs in the background.

Table 1-1. Primary and Secondary Radionuclides of Interest

Radionuclide	Minimum Volume	Analysis Method	Required Detection Limit (pCi/g)
Primary ROIs			
Am-241	5 g	EML HASL 300 A-01-R (alpha spectroscopy)	1
C-14	100 g	EERF C-01-1 (liquid scintillation)	2
Cm-243	5 g	EML HASL 300 A-01-R	1
Cm-244	5 g	EML HASL 300 A-01-R	1
Cs-137	500 g	EML HASL 300 Ga-01-R (gamma spectroscopy)	0.1
I-129	500 g	EML HASL 300 Ga-01-R	0.06
Np-237	5 g	EML HASL 300 A-01-R	0.01
Pu-238	5 g	EML HASL 300 A-01-R	1
Pu-239	5 g	EML HASL 300 A-01-R	1
Pu-240	5 g	EML HASL 300 A-01-R	1
Pu-241	5 g	EML HASL 300 A-01-R	15
Sr-90	5 g	EML HASL 300 Sr-03-RC (extraction, gross beta)	0.9
Tc-99	100 g	EML HASL 300 TC-02-RC (extraction, gross beta)	3
U-232	5 g	EML HASL 300 A-01-R	0.5
U-233	5 g	EML HASL 300 A-01-R	0.2
U-234	5 g	EML HASL 300 A-01-R	0.2
U-235	5 g	EML HASL 300 A-01-R	0.1
U-238	5 g	EML HASL 300 A-01-R	0.2
Secondary ROIs			
Ac-227	500 g	EML HASL 300 Ga-01-R	0.5
Co-60	500 g	EML HASL 300 Ga-01-R	0.5
Cd-113m	500 g	EML HASL 300 Ga-01-R	1
Eu-154	500 g	EML HASL 300 Ga-01-R	1
H-3	100 g	EML HASL 300 H3-04-RC (liquid scintillation)	50
Pa-231	500 g	EML HASL 300 Ga-01-R	0.3
Ra-226	500 g	EML HASL 300 Ga-01-R	0.5
Ra-228	500 g	EML HASL 300 Ga-01-R	1
Sb-125	500 g	EML HASL 300 Ga-01-R	1
Sn-126	500 g	EML HASL 300 Ga-01-R	1
Th-229	500 g	EML HASL 300 Ga-01-R	1
Th-232	500 g	EML HASL 300 Ga-01-R	0.5

2.0 CHARACTERIZATION ACTIVITIES AND RESULTS

Each background reference area was characterized by performing GWSs, collecting soil samples with a hand auger and with a geoprobe for samples deeper than 15 centimeters (cm), scanning collected soil cores for gamma radiation, performing down-hole gamma logging in some cases, and performing a civil survey to record the sampling locations.

Gamma radiation was measured at each sampling location with both the Field Instrument for Detection of Low-Energy Radiation (FIDLER) and Sodium Iodide (NaI) detector for 30 seconds each, 15 cm above the ground surface. The gross gamma measurements were made before soil samples were collected.

The soil cores were scanned for gross gamma radiation. Down-hole gamma logging was also performed.

The work performed was specified in the FSP for Task Order 5 (SEC 2012) and briefly summarized in the following section.

2.1 Gamma Walkover Survey

SEC performed a GWS of 100 percent of accessible surfaces of each background reference area with a FIDLER detector and a 2-inch diameter by 2-inch tall NaI detector.

The detectors were coupled to a Large Area GPS Gamma Survey System (LAGGSS) consisting of a Trimble Global Positioning System (GPS) unit coupled to the detector(s) and subsequently downloaded and plotted to provide a visual map and the relative gross gamma activity. The SEC LAGGSS system delivered multiple gross gamma results and coordinates per square meter of surface area. The raw data was processed into graphic depictions of gamma ray count contours. The data was also used to compare the relative sensitivity of the NaI and FIDLER detectors to the mix of radionuclides present.

The walkovers were performed using the cart shown in Photograph 1 in Appendix A in large open areas of the site. Detectors on the cart were positioned no farther apart than 85 cm to assure the minimum data density of one measurement per square meter is not exceeded. A technician walked with the detector in other areas of the site where cart access was difficult or impractical.

The GWS recorded a survey measurement and a paired position approximately every second. The GPS attains sub-meter accuracy (x, y data). Data were electronically logged and include coordinates in New York West State Plane feet (NAD83). The data contain counts per minute (cpm), northing and easting (x, y), position dilution of precision (PDOP), date, and time. The average walkover speed did not exceed 0.5 meters per second (m/s).

2.2 Soil Sampling

Soil horizons are defined as "shallow surface," 0 – 15 cm below ground surface; "deep surface," 15 – 100 cm below ground surface; "surface," 0 – 100 cm below ground surface; and "subsurface," 100 cm and deeper. Shallow surface soil samples to a depth of 15 cm below

ground surface were collected using a 10-cm diameter hand auger. Samples deeper than 15 cm below ground surface were collected using direct-push drilling methods.

A sufficient volume of soil was collected allowing all 18 ROIs and 12 PROIs to be analyzed. Sufficient volume was approximately 900 grams (g). By collecting surface soil samples from 10-cm diameter holes 15-cm deep and deeper soil samples from 5-cm diameter holes, a sufficient volume of media was collected.

Thirty-second static FIDLER counts and 30-second NaI detector counts were performed at a distance of 15 cm above the ground surface prior to acquiring samples. A physical description of the material sampled, date, and time was included. Additionally, the location (coordinates) of the sample was recorded in NY State Plane West NAD83 with a quality of ± a hundredth of a foot [± 0.01 foot (ft)] for each sample.

Hand-auger samples were placed in stainless steel mixing bowls and homogenized with a stainless steel trowel and packaged in plastic jars or glass vials (for tritium or carbon-14 analysis) as samples. The mixing bowls were placed on plastic sheeting to prevent sample cross-contamination.

Samples taken using direct push methods were collected in acetate liners. Once removed from the steel collection tube, the acetate liners were cut open and the sample was extracted and placed into a mixing bowl for homogenization and packaging. Sample collection was sometimes performed on a table covered with plastic sheeting. The typical sample collection approach was shown in Photograph 2 in Appendix A.

Sample tools and drilling equipment was wiped clean with masslin and 409 cleaning solution as necessary to remove visible dirt. Tools were scanned for alpha and beta-gamma radiation and a swipe for radioactive contamination was collected. The swipe was counted in a low background counter. The sampling equipment was considered free of radioactive contamination provided results were less than the instrument lower critical level (Lc) of approximately 1 cpm for alpha and 19 cpm for beta-gamma radiation. Surface and subsurface samples were scanned for gamma radiation before they were homogenized.

2.3 Radionuclide Concentrations in Background Soils Near the West Valley Demonstration Project

Background soil data is discussed in Section 2.3.1. Gamma walkover data is discussed in Section 2.3.2. Gamma radiation data taken 15 cm above each soil sampling location before sample collection scans of soil cores and down-hole data are discussed in Section 2.3.3.

Data used has been validated and more discussion of the validation results is presented in Section 3.3. All data was used in computations (e.g., means of data sets) unless it was rejected by the validator. This is discussed further in the *Radiological Interferences Technical Memorandum* (SEC 2013).

2.3.1 Background Soil Data from Background Reference Areas

There are three sources of background soil radionuclide concentrations discussed in this TBS. The first is historical data compiled from 1991 through 2007 at the Great Valley soil sampling location. This sampling station is located approximately 30 kilometers (km) directly south of WVDP. In 2007, soil sampling was reduced to once every 5 years; therefore, the sample collected in 2007 is the last available sample (DOE 2011b). This data, collected from 0 – 15 cm deep, is compiled and shown in Table 2-1. The original data set was provided in scientific notation and was not altered for presentation herein. The data shown is uncensored; values less than the detection level are reported and values less than the laboratory detector background are reported as are negative values.

The second and third sources are from data collected in July and August 2012 at two background reference areas within WNYNSC. The two background reference areas were chosen to represent differing surface geology found on the north versus the south plateaus of the WVDP site. Background Reference Area 1, shown on Figure 2-1, was in the sand and gravel unit. Background Reference Area 2, shown on Figure 2-2, was in a surface outcrop of Lavery till.

Both of these locations were evaluated using site historical soil sampling data collected at the WNYNSC air sampling station (FXVDR) at the intersection of Thornwood Drive (Highway 86) and Fox Valley Road. This intersection may be seen on Figure 2-2. Sample analytical data for strontium-90, cesium-137, americium-241, plutonium-238, and plutonium-239 were compared to the same radionuclide analytes at the Great Valley background station. A student t-test showed there was no reason to suspect that the means of the data sets for each radionuclide were different at the 95 percent confidence level (DOE 2012). These two background reference areas were selected on this basis and because both background reference areas are typically upwind of the WVDP site.

Each of the background reference areas was 2,000 m^2. Ten equally spaced locations representing 200 m^2 each were sampled. Two samples were collected at each location. One was a 0 – 15 cm near surface sample and the other was a 15 – 100 cm deep surface sample. The analytical data from each background reference area is shown in Appendix B and summarized in Tables 2-2 and 2-3.

Naturally occurring radionuclides and anthropogenic radionuclides reasonably detectable in background soils from nuclear fallout were compared to potential on-site radionuclide contaminants using the 95 percent upper tolerance level (UTL). Other radionuclides were compared to three times their uncertainty in accordance with the CSAP (DOE 2011). Tables 2-2 and 2-3 reflect these different methods for comparing data collected in areas potentially impacted by WVDP site operations to background soil data.

The Wilcoxon Rank Sum Test was used to compare the mean concentrations of strontium-90, cesium-137, americium-241, plutonium-238, plutonium-239, uranium-232, uranium-233/234, uranium-235, and uranium-238 found at the Great Valley sampling station to the Background Reference Area 1 and Background Reference Area 2 near surface sample concentrations at the 95 percent confidence level. This comparison was performed as a further check as to whether the Background Reference Areas 1 and 2 were potentially impacted by past WVDP operations.

Table 2-1. Background Soil Data Great Valley Location (pCi/g)

	Am-241	Co-60	Cs-137	Eu-154	Pu-238	Pu-239/ 240	Ra-226	Ra-228	Sr-90	U-232	U-233/ 234	U-235/ 236	U-238
	6.40e-3	3.60E-2	4.38e0	6.50e-2	6.35e-3	2.30e-2	1.49e0	8.18e-1	4.70e-1	1.10e-3	9.00e-2	7.603-3	1.10e-1
	1.80e-3	-1.00E-3	3.67e0	-2.30e-2	2.12e-2	1.80e-2	1.84e0		2.10e-1	2.10e-2	1.30e-1	7.40e-3	1.00e-1
	8.30e-4	-2.20E-3	6.10e-1	0.00e+0	0.00e+0	-5.10e-3	1.40e0		4.30e-1	2.20e-3	1.60e-1	1.36e-2	1.30e-1
	9.40e-3	2.10E-2	5.10e-1	2.20e-2	5.67e-3	8.70e-3	5.20e-1		1.70e-1	2.50e-3	1.60e-1	1.50e-3	1.50e-1
	4.98e-3	3.30E-3	5.40e-1	-7.10e-3	4.23e-4	1.00e-2	1.70e0		2.20e-1	2.70e-3	8.62e-1	1.36e-2	1.40e-1
	1.02e-2	-1.93E-3	3.86e-1	2.41e-2	2.94e-3	1.43e-2	7.63e-1		3.28e-1	0.00e+0	7.78e-1	2.82e-2	9.31e-1
	1.41e-2	-1.39E-2	9.85e-1	1.49e-3	0.00e+0	2.17e-2	8.83e-1		6.64e-1	1.89e-2	6.59e-1	6.91e-2	8.45e-1
	1.42e-3	2.12E-2	6.93e-1	3.58e-2	-3.96e-3	2.80e-2	5.69e-1		1.65e-1	4.71e-3	6.46e-1	2.29e-2	6.85e-1
	2.55e-2	-6.07E-3	7.70e-1	1.78e-2	2.82e-2	1.77e-2	9.98e-1		1.56e-1	1.10e-2	6.39e-1	5.70e-2	6.49e-1
	1.52e-2	2.50E-3	9.19e-1	5.07e-2	1.70e-2	2.74e-2			2.92e-1	-8.88e-3	7.79e-1	1.11e-1	6.31e-1
	1.48e-2	3.91E-3	5.20e-1	-3.70e-3	1.85e-3	1.06e-2			1.32e-1	4.90e-3	8.10e-1	6.87e-2	7.48e-1
	3.30e-2	2.23E-3	7.98e-1	-2.39e-3		1.91e-2			1.94e-1	-1.48e-2	8.48e-1	5.97e-2	8.43e-1
	1.75e-3	3.72E-3	7.81e-1	-8.62e-3		2.41e-2			1.95e-1	-4.76e-3	8.28e-1	4.28e-2	7.60e-1
	4.43e-2	-2.30E-3	6.47e-1	4.22e-2		1.38e-2			1.85e-1	2.31e-2	7.92e-1	2.18e-1	7.06e-1
	1.36e-2	-5.26E-3	6.21e-1	-1.59e-2		4.59e-2			1.03e-1	5.82e-3	5.52e-1	8.35e-2	7.21e-1
		1.66E-2	5.10e-1	-2.82e-2		3.39e-2			7.04e-2	2.67e-3	7.98e-1	5.45e-2	7.52e-1
			5.29e-1	-7.07-2		1.82e-2			4.70e-1	-6.37e-3	1.50e-1	4.11e-2	8.44e-1
Ave.	1.32e-2	5.19E-3	1.05e0	5.85e-3	7.24E-3	1.94e-2	1.13e0	8.18e-1	2.38e-1	3.87e-3	5.69e-1	5.30e-2	5.73e-1
St. dev.	1.02e-2	-3.93E-3	9.28e-1	3.30e-2	1.03e-2	1.13e-2	4.91e-1	N/A	1.57e-1	1.02e-2	2.99e-1	5.23e-2	3.07e-1

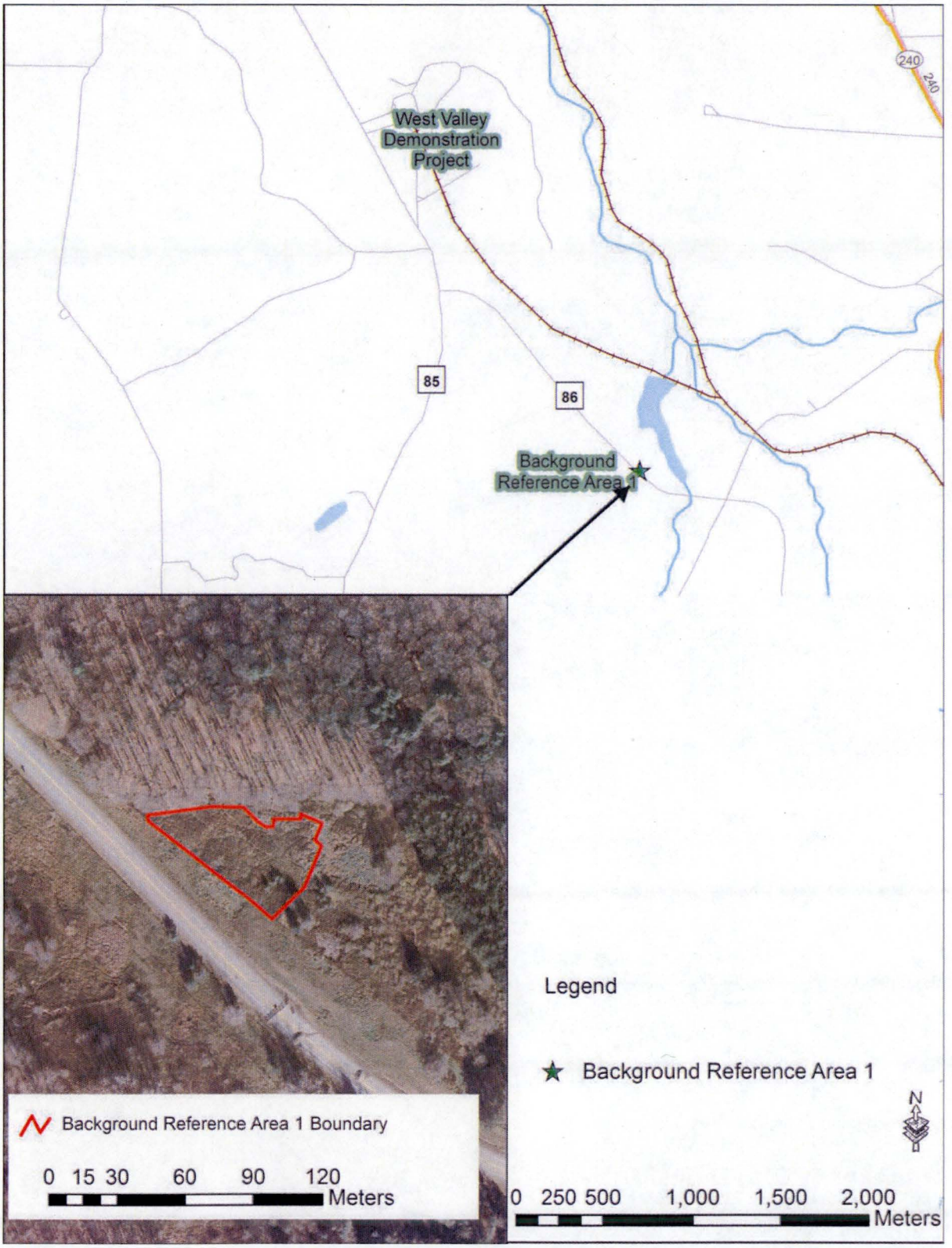

Figure 2-1. Background Reference Area 1

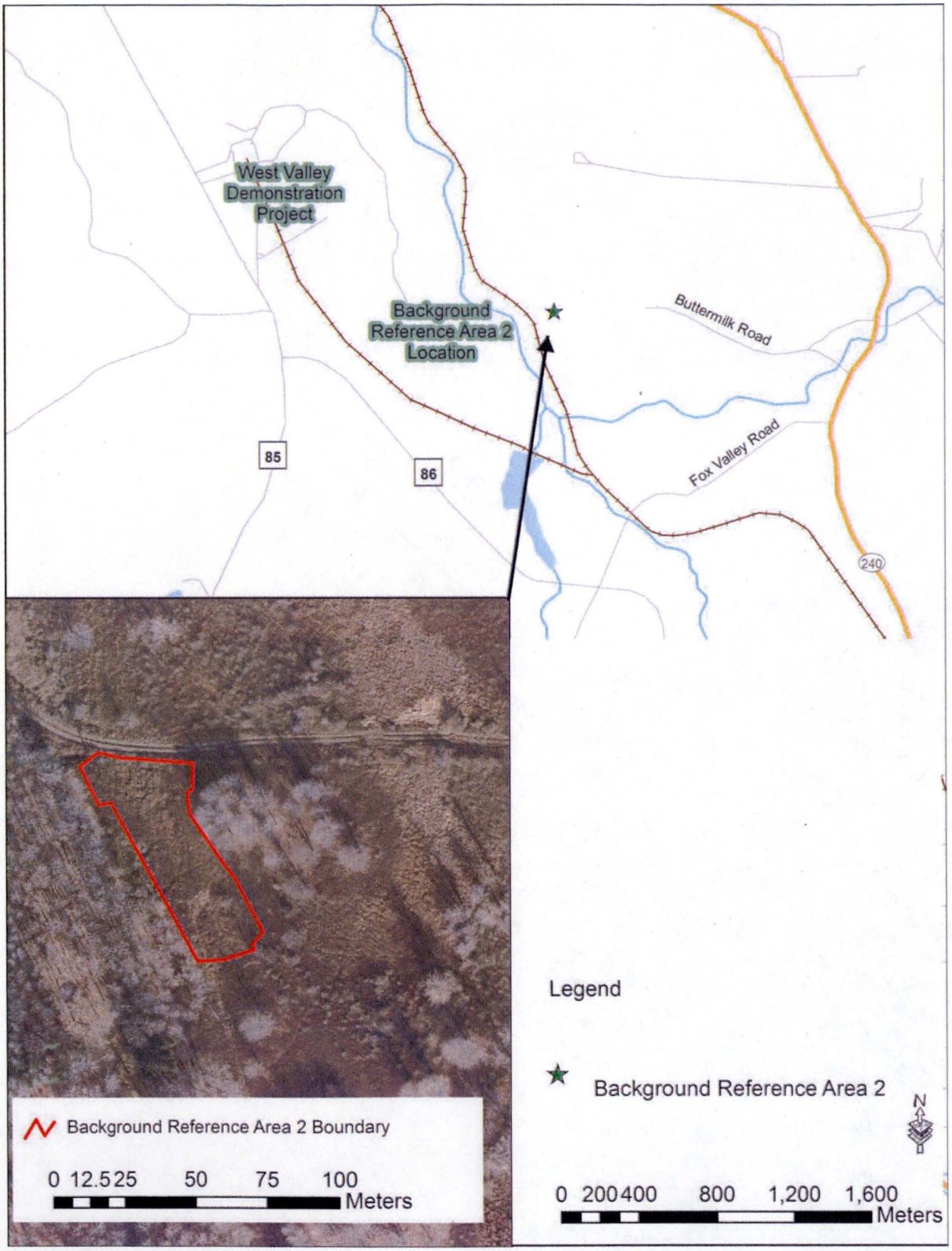

Figure 2-2. Background Reference Area 2

Table 2-2. Background Reference Area 1 Radionuclide Concentrations

Radionuclide	0 – 15 cm Average Result (pCi/g)	0 – 15 cm Standard Deviation (pCi/g)	0 – 15 cm UTL[1] (pCi/g)	15 – 100 cm Average Result (pCi/g)	15 – 100 cm Standard Deviation (pCi/g)	15-100 cm UTL[1] (pCi/g)
Am-241	0.052	0.069	N/A	0.007	0.033	N/A
C-14	1.23	0.470	2.33	0.185	0.233	0.733
Cm-243/244	0.042	0.083	N/A	0.042	0.061	N/A
Cs-137	0.187	0.134	0.503	0.067	0.072	N/A
I-129[2]						
Np-237	0.004	0.009	N/A	0.005	0.006	N/A
Pu-238	0.001	0.015	N/A	0.017	0.033	N/A
Pu-239/240	0.035	0.080	N/A	0.030	0.060	N/A
Pu-241	4.93	2.41	N/A	5.01	2.40	N/A
Sr-90	-0.039	0.101	N/A	0.088	0.068	N/A
Tc-99	-0.486	0.456	N/A	-0.588	0.651	N/A
U-232	0.005	0.007	N/A	0.008	0.010	N/A
U-233/234	0.554	0.265	1.18	0.561	0.201	1.03
U-235	0.017	0.015	0.052	0.019	0.016	0.056
U238	0.542	0.292	1.23	0.503	0.242	1.07
Ac-227	0.026	0.056	0.159	0.018	0.033	0.095
Co-60	0.000	0.002	N/A	0.001	0.002	N/A
Cd-113m[3]						
Eu-154	0.001	0.002	N/A	0.001	0.002	N/A
H-3	1.34	2.74	8.07	0.745	1.98	5.40
Pa-231[2]						
Ra-226	1.55	0.230	2.10	1.73	0.286	2.40
Ra-228	0.681	0.070	0.845	0.833	0.056	0.965
Sb-125	0.003	0.005	N/A	0.000	0.005	N/A
Sn-126	-0.000	0.001	N/A	0.001	0.002	N/A
Th-229	0.014	0.060	N/A	0.005	0.023	N/A
Th-232	0.681	0.070	0.845	0.833	0.056	0.965

[1] Values calculated using the computer program ProUCL.
[2] I-129 and Pa-231 data were rejected during data validation. See *Radiological Interferences Technical Memorandum* for further information (SEC 2013).
[3] Cd-113m is a pure beta-emitter and cannot be detected by the gamma spectroscopy method used.
N/A – radionuclide result compared to three times individual sample uncertainty.

Background Reference Area 1 and Background Reference Area 2 mean concentrations for all ROIs and all PROIs that would reasonably be expected in background soil were also compared at the 95 percent confidence level using the Wilcoxon Rank Sum Test. The comparisons were made separately for the near surface samples and then with the deep surface samples.

The hypothesis tested for the comparison to the Great Valley data set was:

Null Hypothesis H_0: The mean concentration in the background reference areas is equal to or less than the mean concentration at the Great Valley sampling station.

Table 2-3. Background Reference Area 2 Radionuclide Concentrations

Radionuclide	0 – 15 cm Average Result (pCi/g)	0 – 15 cm Standard Deviation (pCi/g)	0 – 15 cm UTL[1] (pCi/g)	15 – 100 cm Average Result (pCi/g)	15 – 100 cm Standard Deviation (pCi/g)	15-100 cm UTL[1] (pCi/g)
Am-241	0.012	0.022	N/A	0.022	0.039	N/A
C-14	1.56	0.590	2.95	0.779	0.324	1.54
Cm-243/244	0.038	0.059	N/A	0.016	0.071	N/A
Cs-137	0.262	0.109	0.520	0.032	0.112	N/A
I-129[2]						
Np-237	-0.000	0.005	N/A	0.001	0.005	N/A
Pu-238	0.005	0.013	N/A	-0.004	0.013	N/A
Pu-239/240	0.007	0.007	N/A	-0.002	0.011	N/A
Pu-241	0.596	2.81	N/A	1.88	4.37	N/A
Sr-90	0.114	0.135	N/A	0.011	0.059	N/A
Tc-99	-0.291	0.593	N/A	-0.174	0.528	N/A
U-232	-0.003	0.017	N/A	-0.004	0.007	N/A
U-233/234	0.777	0.184	1.21	0.851	0.194	1.31
U-235	0.038	0.022	0.092	0.047	0.067	0.203
U238	0.782	0.197	1.25	0.822	0.193	1.28
Ac-227	0.027	0.048	0.141	0.025	0.043	0.126
Co-60	-0.000	0.002	N/A	-0.001	0.002	N/A
Cd-113m[3]						
Eu-154	0.001	0.002	N/A	0.000	0.002	N/A
H-3	-2.96	1.31	0.265	-0.170	1.09	2.12
Pa-231[2]						
Ra-226	1.62	0.267	2.25	1.80	0.277	2.34
Ra-228	0.708	0.126	1.01	0.902	0.151	1.26
Sb-125	0.003	0.003	N/A	0.002	0.004	N/A
Sn-126	-0.000	0.002	N/A	0.004	0.002	N/A
Th-229	0.019	0.029	N/A	0.005	0.036	N/A
Th-232	0.708	0.126	1.01	0.902	0.151	1.26

[1] Values calculated using the computer program ProUCL.
[2] I-129 and Pa-231 data were rejected during data validation. See *Radiological Interferences Technical Memorandum* for further information (SEC 2013).
[3] Cd-113m is a pure beta-emitter and cannot be detected by the gamma spectroscopy method used.
N/A – radionuclide result compared to three times individual sample uncertainty.

Versus

Alternative Hypothesis H_a: The mean concentration in the background reference area is greater than the mean concentration at the Great Valley sampling station.

The hypotheses tested when Background Reference Area 1 was compared to Background Reference Area 2 were:

Null Hypotheses H_0: The mean concentration in Background Reference Area 1 (or 2) is equal to or less than the mean concentration in Background Reference Area 2 (or 1).

Versus

Alternative Hypothesis: H_a: The mean concentration in Reference Area 2 (or 1) is greater than the mean concentration in Background Reference 1 (or 2).

The results of these comparisons for the radionuclides are summarized in Table 2-4. If the entries indicate "yes," the null hypothesis was rejected or "no" if it was not. The entries in the table also indicate which background reference data set mean was greater than the other when the null hypothesis was rejected. "NA" in the table means that the radionuclide was not analyzed in both data sets that were compared.

Table 2-4. Summary of Statistical Comparisons

Radionuclide	Great Valley Vs. Ref. 1	Great Valley Vs. Ref. 2	Ref. 1. Vs. Ref. 2 (0 – 15 cm depth)	Ref. 1. Vs. Ref. 2 (15 – 100 cm depth)
Am-241	No	No	Yes (1>2)	No
C-14	NA	NA	Yes (2>1)	Yes (2>1)
Cm-243/244	NA	NA	No	No
Cs-137	No	No	No	Yes (1>2)
Np-237	NA	NA	No	No
Pu-238	No	No	No	Yes (1>2)
Pu-239/240	No	No	No	Yes (1>2)
Pu-241	NA	NA	Yes (1>2)	No
Sr-90	No	No	Yes (2>1)	Yes (1>2)
U-233/234	No	No	Yes (2>1)	Yes (2>1)
U-235	No	No	Yes (2>1)	No
U-238	No	Yes	No	Yes (2>1)
Ac-227	NA	NA	No	No
Ra-226	NA	NA	No	No
Ra-228	NA	NA	No	No
Th-232	NA	NA	No	No

NA means not applicable. This analyte was not analyzed in the Great Valley background location data set.

The mean concentration for U-238, 0.78 pCi/g, at Background Reference Area 2, was greater than the mean U-238 concentration, 0.57 pCi/g, at the Great Valley location. These results, while statistically significant, are well within typical concentrations of naturally occurring uranium throughout the United States. Otherwise there was no reason to suspect that the mean concentration of any other radionuclide was greater at a background reference area than at Great Valley. This conclusion is an indicator that the background reference areas selected have not been impacted by WVDP operations.

Table 2-4 above shows a statistical difference between the mean concentrations of several of the different radionuclides between the two background reference areas. However, many of the individual sample results used to compute the mean and standard deviation of the data sets were less than the analytical minimum detectable concentration (MDC).

2.3.2 Gamma Walkover Data for Background Reference Areas

The surface of each background reference area was surveyed 100% with both the FIDLER and the NaI detector types. The number of data points collected, minimum, maximum, average, and

standard deviation for each detector type at each background reference area is shown in Table 2-5.

Table 2-5. Summary Statistics for Each Detector Type

Statistics	FIDLER		NaI	
	Reference Area 1	Reference Area 2	Reference Area 1	Reference Area 2
Measurements	26,026	11,318	21,806	8,820
Minimum (cpm)	6,177	7,436	4,697	5,787
Maximum (cpm)	13,184	17,756	11,485	11,450
Average (cpm)	9,684	10,537	6,961	8,248
Std. Dev. (cpm)	926	979	698	794

Shown on Figures 2-3 and 2-4 are side-by-side comparisons of the two detector types at each background reference area. FIDLER detectors are larger and more sensitive than NaI detectors, thus the higher overall count rates for the FIDLER detectors are expected. Also shown on Figures 2-3 and 2-4 are the locations where soil samples were collected.

Figures 2-5 through 2-8 are plots of the count rates versus frequency of occurrence. The data are clearly normally distributed as would be expected for background data sets.

A t-test was performed comparing the means of each detector type at the two background reference areas at the 95 percent confidence level. The t-test was appropriate because the sample sizes were large and the data was normally distributed as seen in Figures 2-5 through 2-8. The mean count rate with both detectors is higher at Background Reference Area 2 compared to Background Reference Area 1 with 95 percent confidence.

2.3.3 Gamma Measurements at References Areas Sampling Locations

A 30-second gamma measurement was made with each detector type at each location before soil samples were collected. These results, along with location information, are shown in Table 2-6.

The gamma signal was logged in each hole formed when the soil cores were extracted at the 10 sampling locations at each reference location. The FSP required this to be done at 15 cm increments from four sample locations drilled 1 m deep in Lavery till. All locations in Background Reference Area 2 (Lavery till) were logged in 15-cm increments. All locations at Background Reference Area 1 (sand and gravel) were logged in 30-cm increments. This field practice exceeded the FSP specifications. The results of the gamma logs at each sample location are provided in Appendix C. Lithologic logs are also provided in Appendix C.

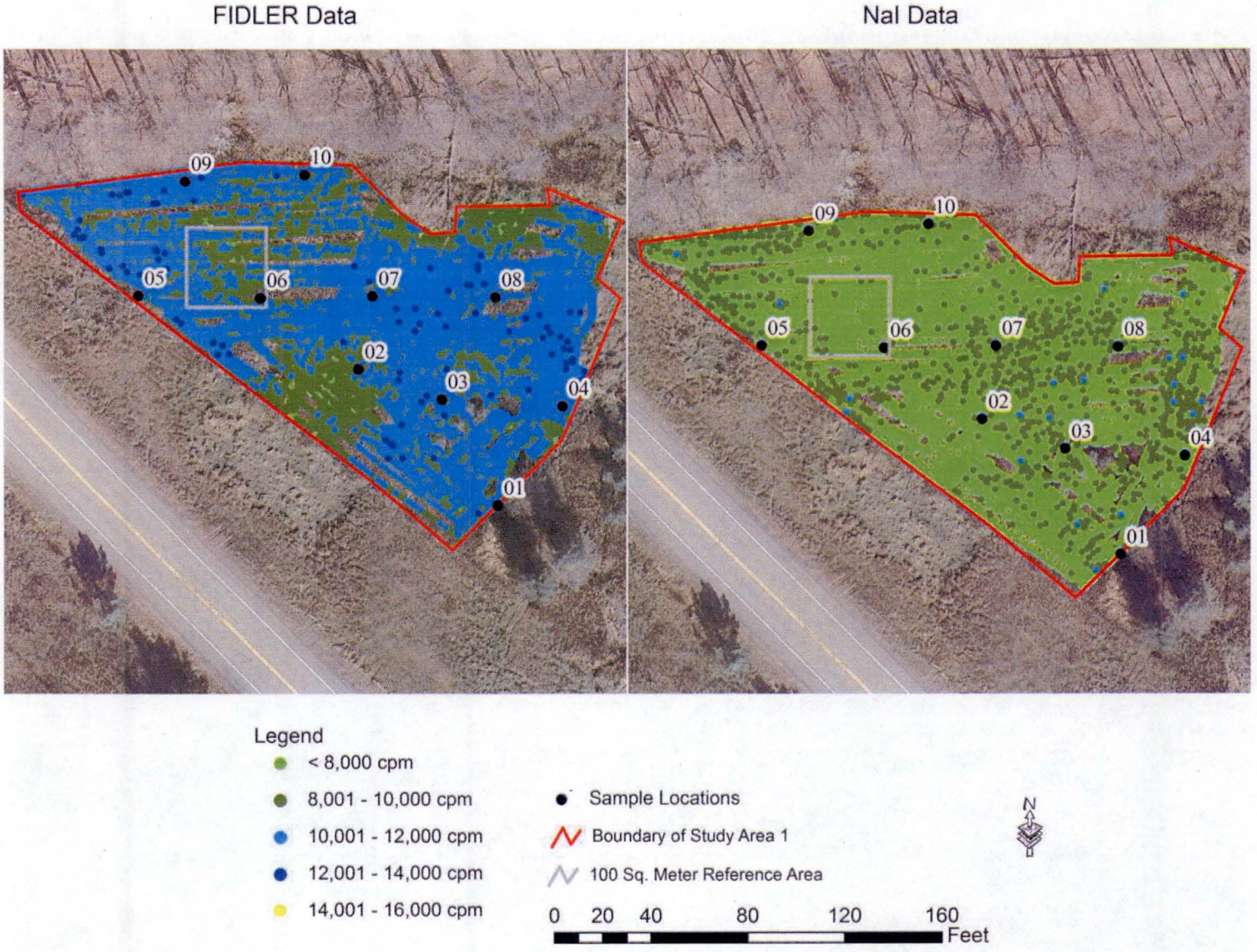

Figure 2-3. Side-by-Side Comparison of FIDLER and NaI Detector Results at Background Reference Area 1

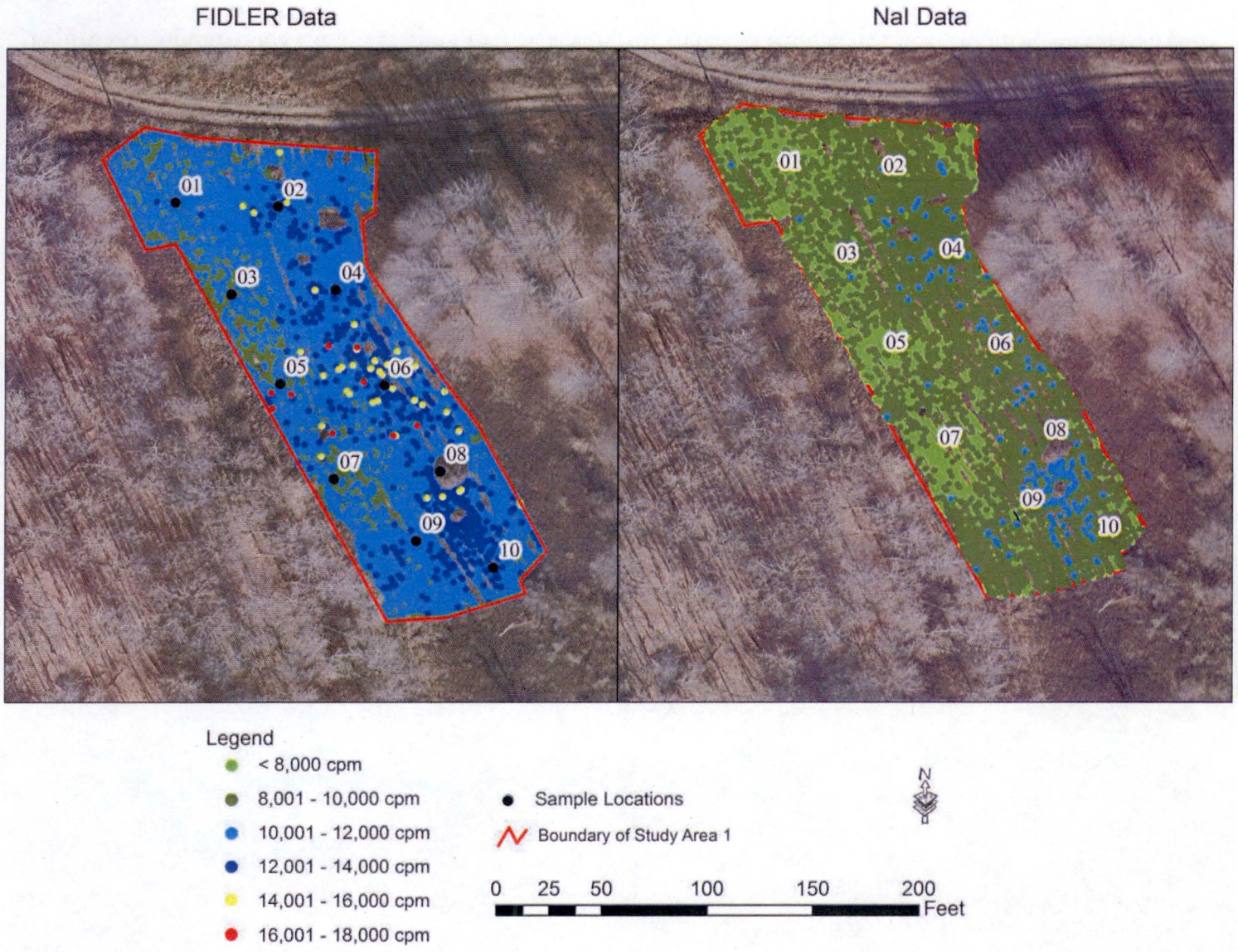

Figure 2-4. Side-by-Side Comparison of FIDLER and NaI Detector Results at Background Reference Area 2

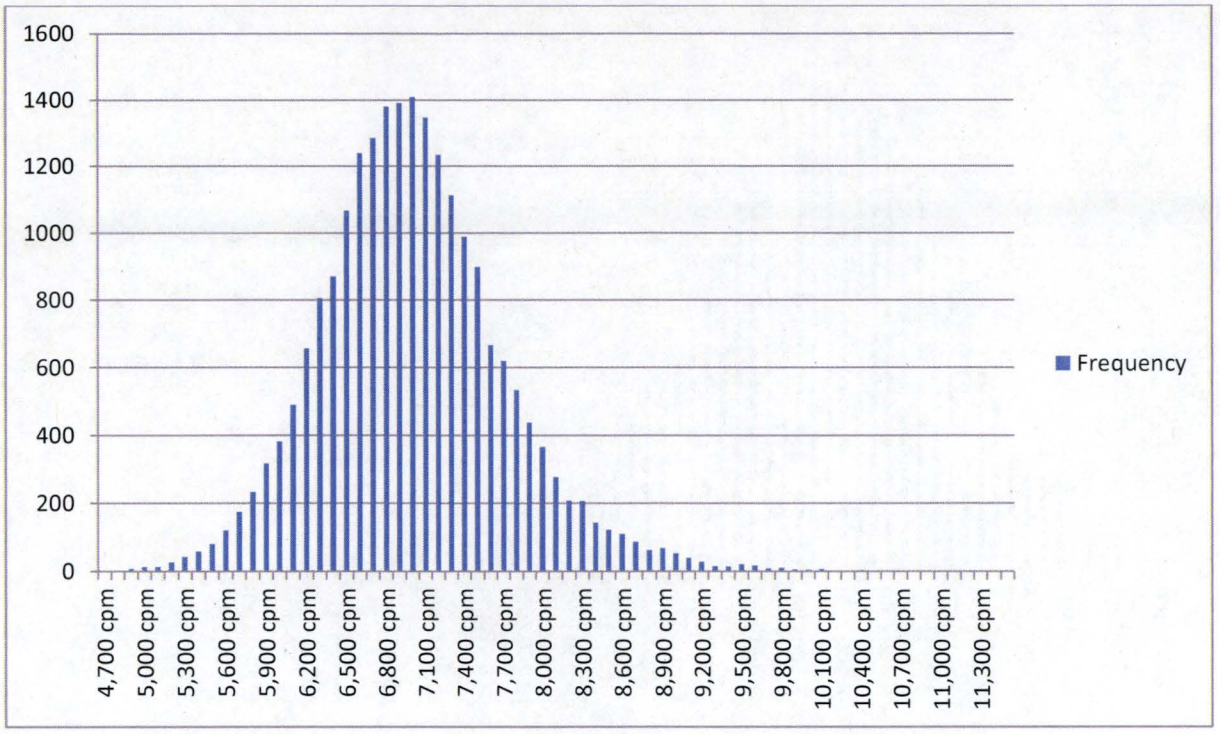

Figure 2-5. Background Reference Area 1 NaI Distibution

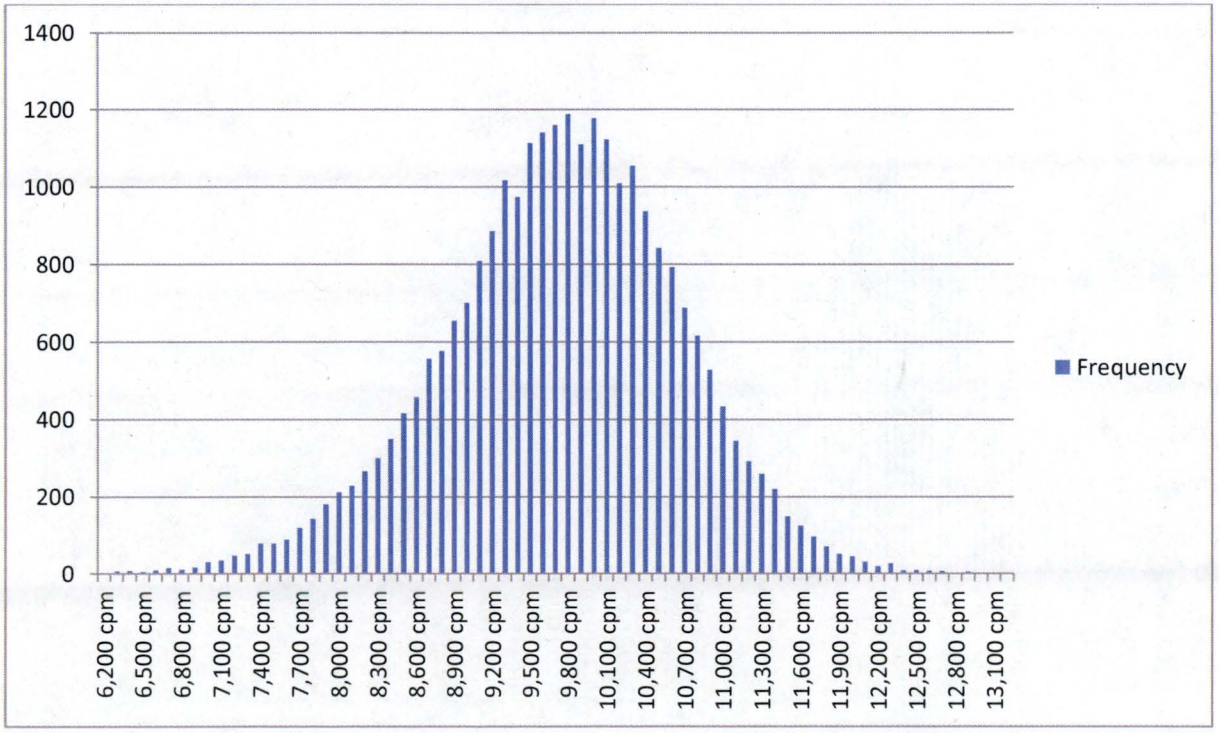

Figure 2-6. Background Reference Area 1 FIDLER Distibution

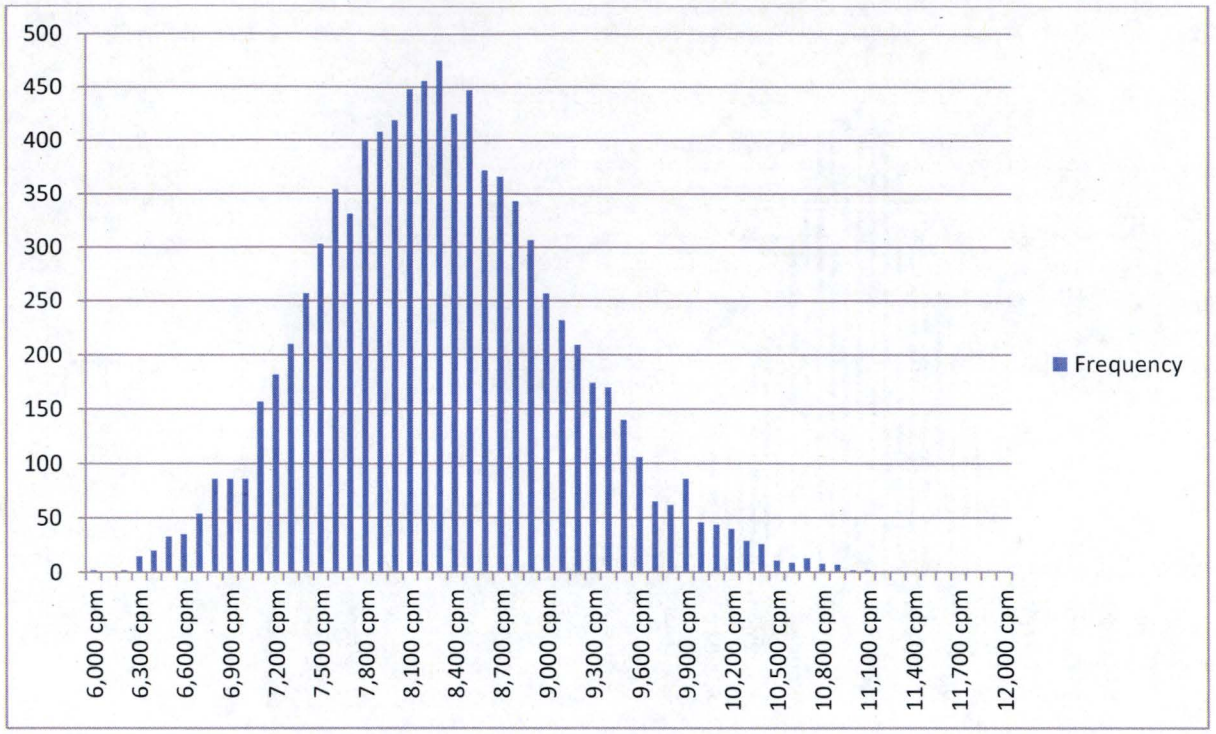

Figure 2-7. Background Reference Area 2 NaI Distribution

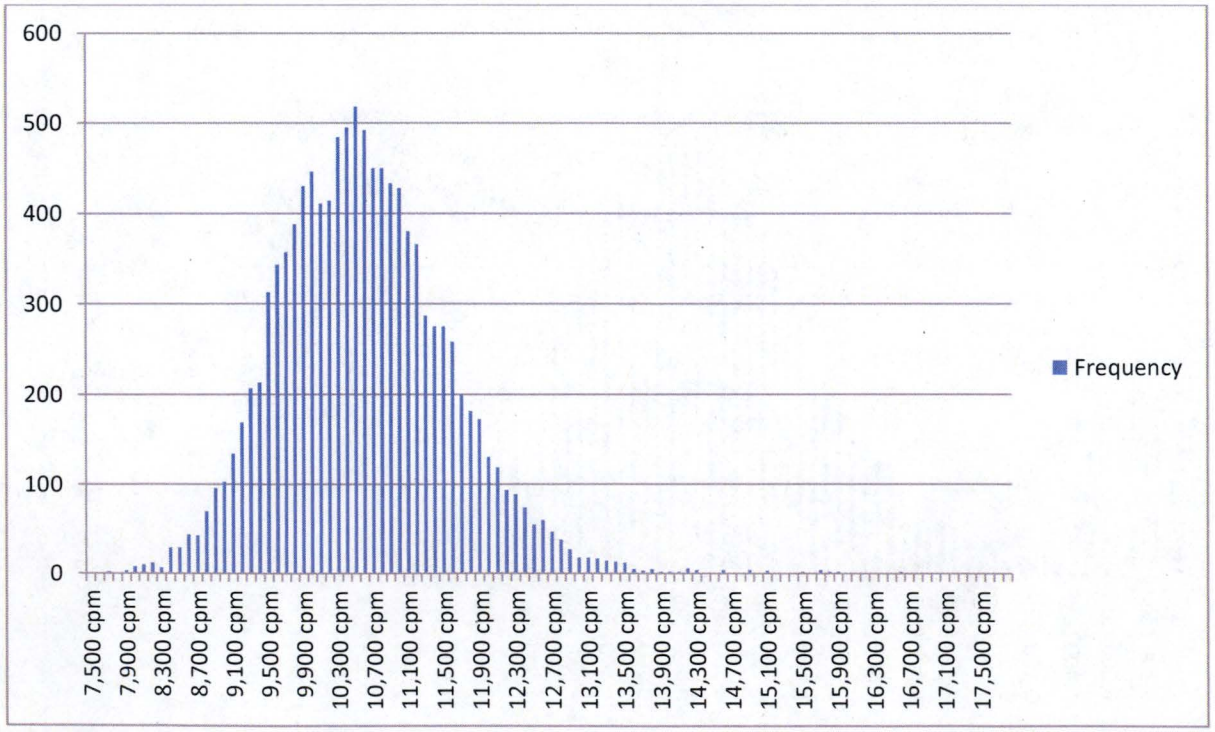

Figure 2-8. Background Reference Area 2 FIDLER Distribution

Table 2-6. Gamma Measurements at Each Sample Location

Location	FIDLER (cpm)	NaI (cpm)	Northing (ft)	Easting (ft)	Elevation (ft)
Background Reference Area 1					
1	10,190	7,278	885995.23	1133639.66	1440.243
2	8,002	6,266	886051.77	1133582.49	1440.075
3	9,962	7,664	886039.35	1133616.68	1440.304
4	9,930	7,202	886036.54	1133666.50	1438.849
5	9,564	7,028	886082.25	1133491.66	1440.165
6	9,232	6,932	886081.27	1133542.18	1440.282
7	9,866	7,406	886082.09	1133588.14	1439.567
8	10,368	7,698	886081.67	1133638.76	1439.738
9	9,904	7,624	886129.60	1133511.15	1438.671
10	9,658	7,244	886132.39	1133560.34	1439.345
Background Reference Area 2					
1	9,879	7,284	890110.917	1134457.852	1394.762
2	11,111	7,875	890108.926	1134506.751	1395.245
3	9,749	7,108	890066.994	1134484.737	1395.508
4	11,098	8,242	890069.027	1134534.07	1395.804
5	9,507	6,724	890024.338	1134507.902	1396.154
6	11,139	8,447	890023.73	1134557.031	1396.098
7	9,291	6,530	889979.098	1134533.251	1396.364
8	11,605	8,444	889982.845	1134583.566	1396.743
9	11,489	8,308	889949.628	1134572.237	1396.449
10	11,585	8,396	889936.75	1134608.726	1396.773

3.0 QUALITY ASSURANCE

QA information was collected for soil data and for the GWS data. Soil QA data is presented in Section 3.1 and GWS QA data is presented in Section 3.2. Data verification and validation information is presented in Section 3.3.

3.1 Soil Sample Quality Assurance

The characteristics of precision, accuracy, representativeness, completeness, and comparability are discussed in Sections 3.1.1 through 3.1.5, respectively.

3.1.1 Precision

Precision is a measure of the degree to which two or more measurements are in agreement. Precision in the laboratory results was assessed through the calculation of relative percent differences (RPDs) for the replicate laboratory control samples (LCSs) and laboratory control sample duplicates (LCSDs). Precision was also evaluated for field duplicate sample analyses.

According to the CSAP, precision reflects measurement variability as observed in repeated measurements of the same subsample; for radio-analytical methods, the required precision is reflected by required method detection limits (DOE 2011a). In other words, specifying the required detection limits is equivalent to specifying the required method precision; therefore, specific tolerance limits for precision were not set in the FSP. The results of precision evaluations are simply reported.

Field duplicates are the least precise because they introduce all sample uncertainty from field sample collection through laboratory analysis. Field duplicates are collected as sample splits from the same sample mass. Two samples were extracted after homogenization with hand tools. These two samples were sent separately for laboratory analysis and the results were compared to establish a measure of precision.

The RPD calculation allows for the comparison of two analysis values in terms of precision with no estimate of accuracy. RPD is calculated as:

$$RPD = \left(\frac{m - M}{\overline{M}} \right) \times 100$$

Where:
m = First measurement value,
M = Second measurement value, and
$\overline{M}$ = Mean value of M and m.

LCS and LCSD samples were analyzed for the following:

- Americium-241 by alpha spectroscopy and gamma spectroscopy,
- Carbon-14 by liquid scintillation,
- Cobalt-60 by gamma spectroscopy,

- Cesium-137 by gamma spectroscopy,
- Tritium by liquid scintillation,
- Neptunium-237 by alpha spectroscopy,
- Plutonium-239/240 by alpha spectroscopy,
- Strontium-90 by chemical extraction and gross beta analysis,
- Technetium-99 by chemical extraction and liquid scintillation,
- Uranium-232 by alpha spectroscopy, and
- Uranium-238 by alpha spectroscopy.

The LCS and LCSD RPD for gamma spectroscopy were all performed using a calibration check source with 40,000 to 70,000 disintegrations per minute (dpm) in the radionuclide-specific energy channel for the spectrometer. While this is a measure of precision, this amount of radioactivity (dpm) is significantly higher than the amounts measured in the actual samples. The LCS and LCSD RPD for liquid scintillation, alpha spectroscopy, and gross beta analysis were calculated at concentrations that were representative of the soil clean-up goals.

There were 23 LCS and LCSD data pairs that were evaluated. In 74 percent of the data pairs, the RPD was 10 percent or less. Analyses for tritium, carbon-14, technetium-99, americium-241, and plutonium 239/240 each had at least one RPD result greater than 10 percent.

The Normalized Absolute Difference (DER) between the LCS and LCSD is used to determine that the results do not differ significantly (at the 99 percent confidence interval) when compared to their respective combined standard uncertainty. A DER of less than or equal to three is considered acceptable.

$$DER = \frac{|S - D|}{\sqrt{(CSU_S)^2 + (CSU_D)^2}}$$

Where:

S	=	LCS result
D	=	Duplicate result
CSU_S	=	Combined Standard Uncertainty of the LCS
CSU_D	=	Combined Standard Uncertainty of the duplicate

Ninety-three percent of the DER calculations for the LCS and LCSD were three or less.

Precision for the field duplicates was calculated for cases when both samples analyzed for the same analyte had results greater than the minimum detectable activity (MDA) for each background reference area. This evaluation was performed for cesium-137, uranium-233/234, uranium-238, radium-226, radium-228, and thorium-232 (which is the same as for radium-228). The results are shown in Table 3-1.

The RPD and coefficient of variation (CV) for uranium-233/234 and uranium-238 exceeded 10 percent; otherwise, the results are acceptable. These differences sometimes occur in field duplicates when the analytical results are small.

Table 3-1. Precision Using Field Duplicates

Sample ID	ROI			PROIs		
	Cs-137 Result	U-233/ 234 Result	U-238 Result	Ra-226 Result	Ra-228 Result	Th-232 Result
WVDP-SS-SY-05-03-02-0-15-073112	0.289	0.390	0.360	2.030	0.743	0.743
WVDP-SS-SY-05-11-02-0-15-073112	0.274	0.730	0.793	1.866	0.796	0.796
RPD	**5.07**	**60.72**	**75.09**	**8.44**	**6.95**	**6.95**
CV	**3.59**	**42.93**	**53.10**	**5.96**	**4.91**	**4.91**

Sample ID	ROI			PROIs			
	C-14 Result	Cs-137 Result	U-233/ 234 Result	U-238 Result	Ra-226 Result	Ra-228 Result	Th-232 Result
WVDP-SS-SY-05-10-03-0-15-080712	1.968	0.341	0.923	0.918	1.910	0.827	0.827
WVDP-SS-SY-05-11-03-0-15-080712	1.809	0.338	0.976	0.987	2.192	0.917	0.917
RPD	**8.42**	**0.71**	**5.58**	**7.24**	**13.74**	**10.37**	**10.37**
CV	**5.95**	**0.50**	**3.95**	**5.12**	**9.72**	**7.33**	**7.33**

3.1.2 Accuracy

Accuracy addresses the potential for bias and lack of precision in laboratory analytical results and is typically monitored through the use of standards, spikes, blanks, and control charts, as appropriate, depending on the method. The accuracy requirement for off-site laboratory analyses set in the CSAP is a relative standard error of 10 percent, as measured at the cleanup goal value, after correcting for precision.

Analytical accuracy is expressed as the percent recovery of an analyte that has been added to the control samples at a known concentration prior to analysis or duplicate analysis of a gamma spectroscopy standard with a known amount of radioactivity.

The accuracy of data was summarized in terms of relative error (RE). This calculation reflects the degree to which the measured value agrees with the actual value, in terms of percent of the actual value. RE is calculated as:

$$\% \, RE = \frac{Measured\ Value - Actual\ Value}{Actual\ Value} \times 100$$

Table 3-2 shows the results of accuracy determinations for LCS and LCSD samples.

3.1.3 Representativeness

Representativeness is guaranteed by appropriate sampling and analytical protocols and by collecting sufficient samples or obtaining sufficient measurements such that uncertainties

Table 3-2. Accuracy Data

Method	Nuclide	Minimum Accuracy	Maximum Accuracy	Average Accuracy	Standard Deviation	Number of Measurements
Alpha Spectroscopy	Am-241	93.80	94.86	94.33	0.75	2
Gamma Spectroscopy	Am-241	88.37	94.29	91.33	4.18	2
Liquid Scintillation	C-14	77.30	98.16	87.73	14.75	2
Gamma Spectroscopy	Co-60	99.83	99.83	99.83	N/A	1
Gamma Spectroscopy	Cs-137	97.31	99.65	98.48	1.66	2
Liquid Scintillation	H-3	88.02	89.95	88.99	1.36	2
Alpha Spectroscopy	Np-237	96.96	97.69	97.33	0.52	2
Alpha Spectroscopy	Pu-239/240	29.12	98.31	63.71	48.93	2
Gross Beta	Sr-90	94.90	98.98	96.94	2.89	2
Liquid Scintillation	Tc-99	73.64	93.78	83.71	14.24	2
Alpha Spectroscopy	U-232	96.65	97.20	96.93	0.39	2
Alpha Spectroscopy	U-234/233	94.78	94.78	94.78	N/A	1
Alpha Spectroscopy	U-238	94.69	94.69	94.69	N/A	1

introduced by the heterogeneity of contaminated media are sufficiently controlled for decision making purposes. There is no formal quantitative requirement for representativeness; representativeness is monitored by ensuring that sampling and analytical protocols are, in fact, carried out during field and laboratory work and that the quantity of data collected is sufficient to allow decision-making with the necessary level of confidence.

The data were collected in accordance with the FSP and the standard operating procedures (SOPs) contained in the FSP and the supporting plans and procedures. The data are considered representative of the field conditions and locations where they were collected.

3.1.4 Completeness

Completeness is a measure of the degree to which the amount of sample data collected meets the scope and a measure of the relative number of analytical data points that meet the acceptance criteria, including accuracy, precision, and any other criteria required by the specific analytical method used. Completeness is defined as a comparison of the actual numbers of valid data points and expected numbers of points expressed as a percentage. The data completeness goal for the CSAP is 80 percent, consistent with the Phase 1 Final Status Survey Plan (FSSP).

Completeness is calculated after the QC data have been evaluated, and the results applied to the measurement data. In addition to results identified as being outside of the QC limits established for the method, broken or spilled samples, or samples that could not be analyzed for any other reason, are included in the assessment of completeness. The percent of valid results is reported as completeness. The completeness will be calculated as follows:

$$Completeness\ (\%) = \frac{T - (I + NC)}{T} \times 100$$

Where:

T = Total number of expected measurements for a method and matrix,

I = Number of invalidated results for a method and matrix, and

NC = Number of results not collected (e.g., bottles broken, etc.) for a method and a matrix.

Table 3-3 shows that the 80 percent completeness goal was met except for iodine-129 and protactinium-231. These were the data sets where all the data were rejected. Reasons for this are discussed in the *Radiological Interferences Technical Memorandum* (SEC 2013).

Table 3-3. Completeness Data

TO 05 ROI	
Nuclide	**Percent Valid**
Am-241	97.5
C-14	100
Cm-243/244	97.5
Cs-137	100
I-129	0.00
Np-237	100
Pu-238	97.5
Pu-239/240	97.5
Pu-241	100
Sr-90	100
Tc-99	100
U-232	100
U-233/234	100
U-235	97.5
U-238	100

TO 05 PROI	
Nuclide	**Percent Valid**
Ac-227	100
Co-60	100
Cd-113m	100
Eu-154	100
H-3	95
Pa-231	0.00
Ra-226	100
Ra-228	100
Sb-125	100
Sn-126	100
Th-229	75
Th-232	100

3.1.5 Comparability

Comparability refers to how well data sets generated by CSAP work pertaining to the decisions that need to be made. Comparability is a qualitative parameter expressing the confidence with which one data set can be compared with another. The comparability of the data, a relative measure, is influenced by sampling and analytical procedures. The data was collected with the specific protocols in the FSP. The collection methods were in accordance with the CSAP; therefore, this data set and future data sets should be comparable regardless of who obtains the sample or performs the analysis.

3.2 Gamma Walkover Quality Assurance

GWS QA includes the following:

- Each detector was calibrated according to procedure SEC-RP-08, *Workplace Monitoring*.
- Instruments were set-up and checked according to procedure SEC-RP-52, *Set-up and Operability Tests for Portable Field Instruments*. This establishes reference readings and a ±20 percent acceptance range.

- Instruments were checked with a source of known radioactivity and for background according to procedure SEC-RP-53, *Operability Tests – Field Instruments*. Instruments all passed the specification that source and background checks fall within ±20 percent of their original set-up readings.
- A 30-second measurement was made each day before use and at the end of the day at a reference location as specified in the FSP. Control charts were generated and an example is provided in Appendix D.

In addition to the measures listed above, each different detector was to be used to survey a 100-m^2 area established in Background Reference Area 1. The purpose was to allow measurements made by different detectors of the same type (FIDLER or NaI) to be normalized, if needed. A tarp was then placed over the area to attain, over time, and maintain stable soil moisture content. Soil moisture may have an impact on the detector response. It is expected that the moisture content will equilibrate over the course of several weather seasons.

When the survey of the 100-m^2 area was performed, two FIDLER and two NaI detectors were used. The number of measurements, minimum, maximum, average, and standard deviation for each detector at the 100-m^2 test plot are shown in Table 3-4. Now that the 100-m^2 plot on Background Reference Area 1 has been established, future site survey work can begin with the survey of this plot.

Table 3-4. Detector Statistics (Readings in cpm)

Ratemeter / Detector SN	Calibration Due Date	Date of Survey	Number of Measurements	Minimum	Maximum	Average	Std. Dev.
FIDLER							
119204 / 071211A	6/13/13	08/02/12	576	7,098	12,547	9,629	876
183995 / 091806A1	7/24/13	08/02/12	389	7,119	13,148	10,181	858
NaI							
216510 / PR242829	08/02/12	08/02/12	383	5,594	8,423	6,966	500
262318 / PR240330	06/21/13	08/02/12	233	5,850	10,302	7,676	797

A t-test showed that the mean count rate of the FIDLER and the NAI detectors were different with 99 percent confidence. The two FIDLER detectors exhibited a 552 cpm difference in the mean response. The NaI detectors exhibited a 709 cpm difference in the mean response. A way to normalize the detector response would have been to add 276 cpm to the response of one FIDLER and subtract 276 cpm from the response of the other FIDLER. Similarly, 355 cpm could be added to the response of one NaI detector and 354 cpm could be subtracted from the response of the other NaI detector.

Such normalization would affect the response of the detectors by less than 5 percent. This would have virtually no impact in the GWS data interpretation. The gamma radiation contours shown in Figures 2-1 and 2-2 are ±2,000 cpm. Because the results of the two detector pairs shown in Table 3-3 is considered typical, normalization of detector response would not have added value to the way the data was interpreted. The differences in the detector response are considered

typical because detector crystals of the same media, size, and shape that are operated at their similar plateau voltages with photomultiplier tubes of a similar age will behave as the detectors shown in Table 3-4.

3.3 Data Verification and Validation

Data verification was performed on 100% of the laboratory analytical data. Verification was performed to assure that samples sent for analysis were analyzed with results returned in hard copy and as an Electronic Data Deliverable (EDD). Verification of completeness of chain of custody records was performed. Verification that hard copy records from the laboratory matched the EDD was also completed. Errors found during verification were corrected.

Data deliverables meet U.S. Environmental Protection Agency (EPA) Level IV quality. Contract Laboratory Procedure (CLP)-like data packages were provided by the analytical laboratory to support independent third party validation. Ten percent of analyses were validated by an independent third party. The independent third party performed validation according to the *U.S. Department of Energy NNSA Service Center Model Data Validation Procedure* (AQA 2010) and the applicable methods.

All data were used in computations (e.g., means of data sets) unless it was rejected by the validator. The data that was rejected is shown in Appendix B. Further discussion of data validation is provided in the *Radiological Interferences Technical Memorandum* (SEC 2013). Reasons for rejected data were:

- Samples with a negative result with an absolute value greater than the MDC,
- Iodine-129 results where there was significant interference from a gamma photo-peak from naturally occurring bismuth-212, and
- Samples where the chemical yield was less than 10 percent and with results less than the MDC.

4.0 REFERENCES

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APPENDIX A

Photographs

Photograph 1. Detector Cart

Photograph 2. Typical Sampling Arrangement

APPENDIX B

Sample Analytical Results for Background Reference Areas

Table B-1. Reference Area 1 Sample ROIs

Location	Am241 Result	Am241 Error	Am241 MDA	C14 Result	C14 Error	C14 MDA	Cm243 244 Result	Cm243 244 Error	Cm243/244 MDA
01 (0-15cm)	0.099	0.065	0.083	0.918	1.43	1.012	-0.020	0.049	0.109
02 (0-15cm)	0.075	0.055	0.067	1.11	1.20	0.980	0.043	0.043	0.060
03 (0-15cm)	0.212	0.095	0.099	0.617	1.15	0.775	0.086	0.070	0.102
04 (0-15cm)	0.004	0.041	0.087	1.21	1.21	1.02	-0.050	0.038	0.112
05 (0-15cm)	0.014	0.047	0.095	1.920	1.16	1.34	-0.005	0.045	0.104
06 (0-15cm)	0.013	0.041	0.079	1.25	1.04	0.973	0.010	0.044	0.087
07 (0-15cm)	0.034	0.051	0.087	2.12	1.29	1.49	0.193	0.117	0.169
08 (0-15cm)	0.017	0.038	0.071	1.28	1.16	1.03	0.145	0.100	0.147
09 (0-15cm)	0.078	0.147	0.271	0.794	1.22	0.867	-0.095	0.229	0.510
10 (0-15cm)	0.000	0.031	0.072	1.04	1.09	0.901	-0.027	0.027	0.086
01 (15-100cm)	0.000	0.027	0.068	-0.113	1.03	0.602	-0.012	0.036	0.090
02 (15-100cm)	0.006	0.038	0.080	0.019	1.28	0.745	0.015	0.042	0.082
03 (15-100cm)	-0.026	0.059	0.136	0.192	0.838	0.506	0.037	0.062	0.109
04 (15-100cm)	-0.005	0.055	0.118	-0.025	1.25	0.728	-0.004	0.047	0.105
05 (15-100cm)	-0.004	0.030	0.072	0.218	0.972	0.586	0.049	0.041	0.047
06 (15-100cm)	0.093	0.062	0.076	0.256	0.970	0.591	0.085	0.057	0.069
07 (15-100cm)	0.000	0.051	0.108	0.680	1.12	0.781	0.101	0.110	0.180
08 (15-100cm)	-0.006	0.037	0.083	0.131	0.941	0.557	0.170	0.099	0.136
09 (15-100cm)	-0.011	0.039	0.092	0.427	1.06	0.676	-0.027	0.045	0.110
10 (15-100cm)	0.021	0.036	0.064	0.061	1.03	0.601	0.007	0.039	0.081

[1] Units are pCi/g.
[2] Error is total propagated uncertainty at two standard deviations.
[3] Shaded results were rejected during data validation.

Table B-1. Reference Area 1 Sample ROIs

Location	Cs137 Result	Cs137 Error	Cs137 MDA	I129 Result	I129 Error	I129 MDA	Np237 Result	Np237 Error	Np237 MDA
01 (0-15cm)	0.447	0.030	0.007	-0.009	0.589	0.104	0.002	0.352	0.018
02 (0-15cm)	0.090	0.009	0.006	0.099	0.049	0.059	0.000	0.416	0.028
03 (0-15cm)	0.289	0.021	0.007	0.154	0.051	0.067	0.001	0.333	0.027
04 (0-15cm)	0.139	0.011	0.007	0.110	0.059	0.073	0.008	0.397	0.029
05 (0-15cm)	0.105	0.011	0.007	0.129	0.056	0.085	0.010	0.376	0.022
06 (0-15cm)	0.118	0.010	0.005	0.080	0.048	0.062	-0.011	0.375	0.027
07 (0-15cm)	0.345	0.029	0.006	0.210	0.042	0.056	-0.008	0.351	0.024
08 (0-15cm)	0.227	0.020	0.006	0.099	0.060	0.072	0.018	0.415	0.016
09 (0-15cm)	0.065	0.007	0.006	0.110	0.060	0.094	0.016	0.445	0.031
10 (0-15cm)	0.047	0.006	0.004	0.093	0.029	0.045	0.009	0.378	0.034
01 (15-100cm)	0.002	0.004	0.006	0.110	0.052	0.066	0.008	0.356	0.017
02 (15-100cm)	0.198	0.019	0.008	0.106	0.055	0.086	0.004	0.331	0.022
03 (15-100cm)	0.013	0.005	0.006	0.128	0.057	0.086	0.003	0.246	0.010
04 (15-100cm)	0.061	0.007	0.005	0.129	0.035	0.052	0.018	0.324	0.022
05 (15-100cm)	0.002	0.003	0.005	0.213	0.054	0.057	0.004	0.234	0.015
06 (15-100cm)	0.176	0.013	0.006	0.142	0.061	0.073	-0.005	0.270	0.018
07 (15-100cm)	0.095	0.009	0.006	0.113	0.053	0.079	0.005	0.355	0.023
08 (15-100cm)	-0.001	0.017	0.006	0.194	0.051	0.057	0.003	0.302	0.015
09 (15-100cm)	0.079	0.008	0.006	0.137	0.048	0.062	0.002	0.247	0.013
10 (15-100cm)	0.047	0.006	0.005	0.142	0.048	0.056	0.002	0.211	0.011

[1] Units are pCi/g.
[2] Error is total propagated uncertainty at two standard deviations.
[3] Shaded results were rejected during data validation.

Table B-1. Reference Area 1 Sample ROIs

Location	Pu238 Result	Pu238 Error	Pu238 MDA	Pu239/240 Result	Pu239/240 Error	Pu239/240 MDA	Pu241 Result	Pu241 Error	Pu241 MDA
01 (0-15cm)	-0.011	0.022	0.052	0.019	0.019	0.025	4.26	4.71	7.57
02 (0-15cm)	0.000	0.025	0.055	0.000	0.015	0.036	6.75	5.70	8.79
03 (0-15cm)	-0.008	0.023	0.054	0.006	0.012	0.022	3.86	4.97	8.11
04 (0-15cm)	-0.007	0.021	0.052	0.012	0.016	0.026	9.25	6.47	9.50
05 (0-15cm)	0.000	0.029	0.062	0.018	0.018	0.018	3.86	5.80	9.59
06 (0-15cm)	0.010	0.038	0.074	0.012	0.027	0.051	5.03	6.86	11.3
07 (0-15cm)	0.018	0.040	0.075	-0.005	0.026	0.064	6.95	7.96	12.8
08 (0-15cm)	-0.012	0.101	0.243	0.024	0.073	0.160	6.23	12.3	20.4
09 (0-15cm)	-0.021	0.014	0.055	0.249	0.078	0.045	1.01	6.18	10.6
10 (0-15cm)	0.028	0.041	0.070	0.002	0.024	0.054	3.39	6.90	11.6
01 (15-100cm)	0.003	0.019	0.041	-0.004	0.011	0.034	3.86	4.96	8.11
02 (15-100cm)	0.012	0.022	0.040	0.012	0.020	0.035	2.63	4.89	8.19
03 (15-100cm)	0.108	0.047	0.046	0.194	0.059	0.029	7.17	5.05	7.43
04 (15-100cm)	0.011	0.024	0.043	0.005	0.015	0.030	5.04	4.43	6.88
05 (15-100cm)	0.007	0.041	0.084	0.003	0.027	0.061	9.98	8.87	13.8
06 (15-100cm)	-0.001	0.029	0.065	-0.002	0.014	0.041	7.20	7.22	11.45
07 (15-100cm)	0.015	0.029	0.054	0.008	0.023	0.046	4.36	5.95	9.77
08 (15-100cm)	0.018	0.022	0.036	0.008	0.015	0.027	3.20	4.90	8.12
09 (15-100cm)	-0.015	0.043	0.100	0.056	0.041	0.020	4.21	9.21	15.5
10 (15-100cm)	0.010	0.024	0.046	0.017	0.025	0.043	2.45	6.01	10.2

[1] Units are pCi/g.
[2] Error is total propagated uncertainty at two standard deviations.
[3] Shaded results were rejected during data validation.

Table B-1. Reference Area 1 Sample ROIs

Location	Sr90 Result	Sr90 Error	Sr90 MDA	Tc99 Result	Tc99 Error	Tc99 MDA	U232 Result	U232 Error	U232 MDA
01 (0-15cm)	0.058	0.210	0.363	-0.230	0.820	1.40	0.000	0.015	0.020
02 (0-15cm)	-0.075	0.160	0.296	-0.420	0.820	1.40	0.010	0.020	0.038
03 (0-15cm)	-0.137	0.174	0.325	0.070	0.830	1.40	0.014	0.025	0.046
04 (0-15cm)	0.091	0.187	0.316	-0.090	0.770	1.30	0.004	0.016	0.040
05 (0-15cm)	-0.253	0.142	0.272	-1.06	0.840	1.40	-0.005	0.015	0.042
06 (0-15cm)	-0.060	0.166	0.302	-0.650	0.800	1.40	-0.001	0.015	0.035
07 (0-15cm)	-0.018	0.148	0.266	-1.30	1.10	2.00	0.003	0.015	0.038
08 (0-15cm)	0.022	0.200	0.351	0.040	0.790	1.30	0.018	0.020	0.016
09 (0-15cm)	-0.043	0.136	0.248	-0.550	0.880	1.50	0.008	0.013	0.024
10 (0-15cm)	0.029	0.276	0.159	-0.670	0.890	1.50	0.004	0.018	0.038
01 (15-100cm)	0.014	0.147	0.259	-0.090	0.730	1.20	0.000	0.013	0.018
02 (15-100cm)	0.183	0.292	0.484	-0.230	0.740	1.30	-0.003	0.006	0.035
03 (15-100cm)	-0.009	0.208	0.370	0.170	0.800	1.40	0.006	0.011	0.016
04 (15-100cm)	0.083	0.175	0.296	-0.530	0.830	1.40	0.000	0.012	0.016
05 (15-100cm)	0.054	0.147	0.250	-0.700	0.980	1.70	0.030	0.035	0.056
06 (15-100cm)	0.127	0.164	0.268	-0.960	0.840	1.40	0.006	0.018	0.038
07 (15-100cm)	0.037	0.126	0.216	-1.180	0.900	1.50	0.014	0.026	0.048
08 (15-100cm)	0.191	0.199	0.318	-0.050	0.810	1.40	0.014	0.027	0.051
09 (15-100cm)	0.075	0.253	0.429	-0.310	0.830	1.40	0.003	0.021	0.043
10 (15-100cm)	0.127	0.164	0.268	-2.00	1.30	2.10	0.008	0.028	0.057

[1] Units are pCi/g.
[2] Error is total propagated uncertainty at two standard deviations.

Table B-1. Reference Area 1 Sample ROIs

Location	U233/234 Result	U233/234 Error	U233/234 MDA	U235 Result	U235 Error	U235 MDA	U238 Result	U238 Error	U238 MDA
01 (0-15cm)	0.375	0.084	0.023	0.007	0.013	0.024	0.349	0.080	0.023
02 (0-15cm)	0.448	0.097	0.039	0.008	0.014	0.023	0.367	0.087	0.044
03 (0-15cm)	0.390	0.093	0.041	0.003	0.010	0.025	0.360	0.089	0.042
04 (0-15cm)	0.250	0.066	0.024	0.001	0.003	0.011	0.255	0.067	0.024
05 (0-15cm)	0.769	0.136	0.040	0.027	0.024	0.031	0.828	0.142	0.031
06 (0-15cm)	0.503	0.099	0.039	0.023	0.020	0.023	0.467	0.096	0.052
07 (0-15cm)	0.651	0.125	0.047	0.015	0.017	0.023	0.679	0.129	0.047
08 (0-15cm)	0.283	0.071	0.029	0.009	0.014	0.022	0.212	0.060	0.031
09 (0-15cm)	1.08	0.179	0.047	0.038	0.028	0.031	1.09	0.179	0.029
10 (0-15cm)	0.792	0.145	0.043	0.043	0.028	0.012	0.812	0.148	0.040
01 (15-100cm)	0.302	0.071	0.026	0.007	0.010	0.014	0.214	0.061	0.046
02 (15-100cm)	0.669	0.124	0.048	0.024	0.020	0.021	0.511	0.103	0.045
03 (15-100cm)	0.478	0.183	0.147	0.000	0.032	0.045	0.206	0.146	0.201
04 (15-100cm)	0.291	0.092	0.066	-0.007	0.016	0.052	0.260	0.088	0.073
05 (15-100cm)	0.648	0.125	0.036	0.017	0.017	0.012	0.611	0.121	0.042
06 (15-100cm)	0.602	0.122	0.049	0.020	0.020	0.025	0.719	0.137	0.047
07 (15-100cm)	0.709	0.135	0.046	0.038	0.027	0.025	0.698	0.135	0.059
08 (15-100cm)	0.313	0.071	0.008	0.017	0.015	0.009	0.270	0.065	0.008
09 (15-100cm)	0.804	0.144	0.039	0.047	0.029	0.023	0.744	0.136	0.040
10 (15-100cm)	0.792	0.142	0.030	0.020	0.020	0.025	0.800	0.143	0.020

[1] Units are pCi/g.
[2] Error is total propagated uncertainty at two standard deviations.

Table B-2. Reference Area 1 Sample PROIs

Location	Ac227 Result	Ac227 Error	Ac227 MDA	Co60 Result	Co60 Error	Co60 MDA	Cd113m Result	Cd113m Error	Cd113m MDA
01 (0-15cm)	0.124	0.049	0.078	-0.002	0.009	0.009	-0.001	0.010	0.009
02 (0-15cm)	0.025	0.065	0.057	0.002	0.005	0.008	-0.003	0.004	0.007
03 (0-15cm)	0.022	0.062	0.074	0.001	0.005	0.009	-0.002	0.005	0.008
04 (0-15cm)	0.036	0.043	0.062	-0.004	0.011	0.009	-0.003	0.005	0.008
05 (0-15cm)	-0.009	0.040	0.063	0.000	0.005	0.009	-0.001	0.005	0.008
06 (0-15cm)	0.110	0.040	0.062	0.001	0.004	0.007	0.000	0.175	0.007
07 (0-15cm)	0.031	0.086	0.062	0.001	0.005	0.009	-0.004	0.006	0.006
08 (0-15cm)	-0.040	0.037	0.055	0.002	0.005	0.008	-0.002	0.005	0.008
09 (0-15cm)	-0.050	0.040	0.065	-0.001	0.020	0.009	-0.003	0.005	0.007
10 (0-15cm)	0.017	0.045	0.049	0.000	0.004	0.007	-0.004	0.004	0.005
01 (15-100cm)	0.013	0.042	0.064	-0.001	1.655	0.009	0.000	0.004	0.006
02 (15-100cm)	0.019	0.051	0.067	-0.002	0.006	0.010	-0.004	0.005	0.008
03 (15-100cm)	-0.051	0.039	0.064	0.001	0.005	0.008	-0.003	0.005	0.007
04 (15-100cm)	0.046	0.023	0.045	0.001	0.005	0.008	-0.002	0.008	0.006
05 (15-100cm)	0.069	0.022	0.056	-0.002	0.011	0.008	-0.003	0.005	0.008
06 (15-100cm)	0.045	0.040	0.066	0.000	0.010	0.009	-0.002	0.005	0.008
07 (15-100cm)	0.028	0.080	0.064	0.002	0.005	0.009	-0.002	0.005	0.008
08 (15-100cm)	-0.002	0.084	0.071	-0.002	0.012	0.008	-0.001	0.005	0.008
09 (15-100cm)	0.004	0.039	0.058	-0.004	0.013	0.010	-0.001	0.004	0.007
10 (15-100cm)	0.005	0.109	0.062	0.000	0.004	0.007	-0.002	0.004	0.007

[1] Units are pCi/g.
[2] Error is total propagated uncertainty at two standard deviations.

Table B-2. Reference Area 1 Sample PROIs

Location	Eu154 Result	Eu154 Error	Eu154 MDA	H3 Result	H3 Error	H3 MDA	Pa231 Result	Pa231 Error	Pa231 MDA
01 (0-15cm)	0.002	0.007	0.011	2.28	2.87	4.80	-0.333	0.166	0.261
02 (0-15cm)	-0.002	0.006	0.009	-1.47	2.43	4.38	-0.254	0.125	0.201
03 (0-15cm)	0.002	0.010	0.010	1.39	3.61	6.19	-0.358	0.159	0.256
04 (0-15cm)	-0.002	0.013	0.009	6.94	2.64	3.88	-0.332	0.136	0.217
05 (0-15cm)	-0.004	0.004	0.011	-1.27	3.53	6.29	-0.388	0.174	0.245
06 (0-15cm)	-0.003	0.006	0.009	3.61	3.23	5.31	-0.252	0.126	0.198
07 (0-15cm)	-0.003	0.006	0.009	-1.11	3.78	6.72	-0.242	0.118	0.186
08 (0-15cm)	-0.002	0.007	0.009	-0.069	2.87	5.04	-0.394	0.158	0.228
09 (0-15cm)	0.002	0.009	0.009	0.090	2.81	4.92	-0.278	0.142	0.223
10 (0-15cm)	0.000	0.008	0.006	1.74	2.70	4.56	-0.159	0.092	0.146
01 (15-100cm)	-0.001	0.301	0.009	-0.08	1.92	3.37	-0.491	0.147	0.230
02 (15-100cm)	-0.003	0.007	0.011	-2.47	3.58	6.48	-0.510	0.179	0.257
03 (15-100cm)	0.003	0.009	0.010	4.634	2.05	3.10	-0.401	0.139	0.218
04 (15-100cm)	-0.002	0.005	0.009	-0.890	2.72	4.84	-0.212	0.107	0.168
05 (15-100cm)	0.002	0.009	0.010	1.58	2.01	3.36	-0.431	0.145	0.230
06 (15-100cm)	-0.002	0.013	0.010	2.31	2.74	4.57	-0.458	0.153	0.241
07 (15-100cm)	0.000	0.022	0.008	0.092	2.87	5.02	-0.430	0.149	0.236
08 (15-100cm)	0.000	0.008	0.010	2.09	1.59	2.58	-0.396	0.147	0.235
09 (15-100cm)	0.003	0.006	0.009	-0.035	2.18	3.82	-0.527	0.150	0.230
10 (15-100cm)	-0.004	0.006	0.010	0.124	1.72	2.99	-0.313	0.134	0.216

[1] Units are pCi/g.
[2] Error is total propagated uncertainty at two standard deviations.
[3] Shaded results were rejected during data validation.

Table B-2. Reference Area 1 Sample PROIs

Location	Ra226 Result	Ra226 Error	Ra226 MDA	Ra228 Result	Ra228 Error	Ra228 MDA	Sb125 Result	Sb125 Error	Sb125 MDA
01 (0-15cm)	1.62	0.179	0.148	0.649	0.048	0.023	0.007	0.012	0.018
02 (0-15cm)	1.57	0.149	0.121	0.638	0.044	0.020	0.003	0.009	0.015
03 (0-15cm)	2.03	0.230	0.156	0.743	0.053	0.025	0.004	0.013	0.020
04 (0-15cm)	1.40	0.161	0.139	0.668	0.049	0.023	-0.001	0.010	0.014
05 (0-15cm)	1.64	0.232	0.168	0.648	0.049	0.026	0.000	0.012	0.017
06 (0-15cm)	1.39	0.147	0.117	0.563	0.040	0.017	0.004	0.009	0.014
07 (0-15cm)	1.37	0.144	0.119	0.786	0.104	0.021	-0.003	0.041	0.015
08 (0-15cm)	1.71	0.178	0.132	0.769	0.057	0.018	0.000	0.012	0.017
09 (0-15cm)	1.61	0.175	0.138	0.708	0.048	0.020	0.014	0.010	0.012
10 (0-15cm)	1.20	0.116	0.092	0.634	0.084	0.018	0.002	0.032	0.011
01 (15-100cm)	1.64	0.170	0.135	0.846	0.058	0.020	0.003	0.011	0.017
02 (15-100cm)	2.29	0.248	0.166	0.930	0.070	0.022	-0.003	0.013	0.020
03 (15-100cm)	1.62	0.164	0.124	0.841	0.056	0.020	-0.001	0.009	0.016
04 (15-100cm)	1.18	0.160	0.119	0.730	0.098	0.021	0.000	0.036	0.013
05 (15-100cm)	1.68	0.164	0.138	0.826	0.056	0.022	-0.001	0.010	0.017
06 (15-100cm)	1.67	0.188	0.153	0.778	0.051	0.022	-0.001	0.011	0.018
07 (15-100cm)	1.98	0.185	0.135	0.838	0.058	0.020	0.000	0.010	0.016
08 (15-100cm)	1.62	0.159	0.136	0.900	0.058	0.022	-0.001	0.010	0.017
09 (15-100cm)	1.83	0.191	0.150	0.808	0.060	0.022	0.007	0.012	0.016
10 (15-100cm)	1.78	0.168	0.126	0.832	0.056	0.024	0.002	0.010	0.016

[1] Units are pCi/g.
[2] Error is total propagated uncertainty at two standard deviations.

Table B-2. Reference Area 1 Sample PROIs

Location	Sn126 Result	Sn126 Error	Sn126 MDA	Th229 Result	Th229 Error	Th229 MDA	Th232 Result	Th232 Error	Th232 MDA
01 (0-15cm)	0.000	0.005	0.007	-0.016	0.012	0.020	0.649	0.048	0.023
02 (0-15cm)	0.000	0.003	0.005	-0.012	0.009	0.015	0.638	0.044	0.020
03 (0-15cm)	-0.001	0.942	0.007	-0.029	0.012	0.020	0.743	0.053	0.025
04 (0-15cm)	-0.001	0.011	0.006	0.042	0.012	0.018	0.668	0.049	0.023
05 (0-15cm)	0.000	0.004	0.007	-0.042	0.013	0.021	0.648	0.049	0.026
06 (0-15cm)	0.000	0.003	0.005	0.136	0.015	0.017	0.563	0.040	0.017
07 (0-15cm)	-0.001	0.021	0.006	-0.043	0.012	0.019	0.786	0.104	0.021
08 (0-15cm)	0.001	0.004	0.006	0.000	0.009	0.018	0.769	0.057	0.018
09 (0-15cm)	0.003	0.002	0.006	-0.014	0.011	0.019	0.708	0.048	0.020
10 (0-15cm)	-0.001	0.015	0.005	-0.030	0.010	0.015	0.634	0.084	0.018
01 (15-100cm)	0.003	0.001	0.007	-0.047	0.012	0.019	0.846	0.058	0.020
02 (15-100cm)	-0.001	0.004	0.007	-0.051	0.014	0.022	0.930	0.070	0.022
03 (15-100cm)	0.000	0.007	0.006	-0.018	0.011	0.018	0.841	0.056	0.020
04 (15-100cm)	-0.001	0.034	0.006	0.040	0.013	0.081	0.730	0.098	0.021
05 (15-100cm)	0.005	0.002	0.006	0.024	0.007	0.017	0.826	0.056	0.022
06 (15-100cm)	-0.001	0.014	0.005	0.021	0.007	0.019	0.778	0.051	0.022
07 (15-100cm)	-0.001	0.004	0.006	-0.005	0.006	0.017	0.838	0.058	0.020
08 (15-100cm)	0.004	0.002	0.006	-0.013	0.011	0.018	0.900	0.058	0.022
09 (15-100cm)	0.002	0.002	0.007	-0.095	0.017	0.025	0.808	0.060	0.022
10 (15-100cm)	0.000	0.004	0.006	-0.013	0.010	0.016	0.832	0.056	0.024

[1] Units are pCi/g.
[2] Error is total propagated uncertainty at two standard deviations.
[3] Shaded results were rejected during data validation.

Table B-3. Reference Area 2 Sample ROIs

Location	Am241 Result	Am241 Error	Am241 MDA	C14 Result	C14 Error	C14 MDA	Cm243 244 Result	Cm243 244 Error	Cm243/244 MDA
01 (0-15cm)	0.013	0.038	0.074	1.55	1.27	1.45	0.093	0.057	0.063
02 (0-15cm)	-0.007	0.045	0.099	1.67	1.30	1.36	0.055	0.094	0.163
03 (0-15cm)	-0.001	0.042	0.090	0.025	0.762	1.31	0.135	0.100	0.149
04 (0-15cm)	-0.005	0.046	0.098	1.35	1.17	1.41	0.098	0.062	0.076
05 (0-15cm)	0.017	0.037	0.070	1.91	1.40	1.34	0.053	0.048	0.063
06 (0-15cm)	0.044	0.046	0.070	1.42	1.09	1.14	-0.035	0.046	0.112
07 (0-15cm)	-0.013	0.034	0.082	1.76	1.34	1.37	-0.010	0.025	0.067
08 (0-15cm)	-0.004	0.040	0.088	2.04	1.43	1.24	-0.040	0.039	0.105
09 (0-15cm)	0.048	0.045	0.064	1.93	1.34	1.13	0.014	0.042	0.082
10 (0-15cm)	0.029	0.049	0.087	1.97	1.40	1.26	0.020	0.037	0.068
01 (15-100cm)	0.021	0.046	0.085	1.01	0.881	1.07	0.080	0.100	0.166
02 (15-100cm)	0.046	0.045	0.066	0.759	0.717	0.928	0.196	0.102	0.138
03 (15-100cm)	0.004	0.049	0.101	0.054	0.664	1.14	0.023	0.057	0.106
04 (15-100cm)	0.000	0.039	0.109	0.979	0.886	1.11	-0.024	0.027	0.123
05 (15-100cm)	0.119	0.062	0.065	1.11	0.918	1.06	0.000	0.030	0.067
06 (15-100cm)	-0.011	0.032	0.096	0.430	0.627	0.965	-0.017	0.051	0.128
07 (15-100cm)	0.036	0.040	0.060	0.748	0.846	1.21	-0.029	0.050	0.115
08 (15-100cm)	0.014	0.035	0.067	0.763	0.720	0.93	-0.025	0.025	0.080
09 (15-100cm)	0.011	0.042	0.083	0.879	0.836	1.09	-0.018	0.039	0.096
10 (15-100cm)	-0.014	0.032	0.080	1.06	0.890	1.04	-0.024	0.034	0.089

[1] Units are pCi/g.
[2] Error is total propagated uncertainty at two standard deviations.

Table B-3. Reference Area 2 Sample ROIs

Location	Cs137 Result	Cs137 Error	Cs137 MDA	I129 Result	I129 Error	I129 MDA	Np237 Result	Np237 Error	Np237 MDA
01 (0-15cm)	0.398	0.028	0.009	0.150	0.057	0.081	0.000	0.234	0.013
02 (0-15cm)	0.236	0.018	0.008	0.221	0.095	0.102	-0.004	0.338	0.026
03 (0-15cm)	0.243	0.017	0.006	0.094	0.047	0.061	0.002	0.260	0.014
04 (0-15cm)	-0.001	0.004	0.007	0.079	0.057	0.091	0.001	0.308	0.021
05 (0-15cm)	0.298	0.021	0.007	0.157	0.049	0.063	0.001	0.353	0.023
06 (0-15cm)	0.210	0.015	0.007	0.136	0.074	0.091	-0.010	0.385	0.029
07 (0-15cm)	0.293	0.026	0.006	0.065	0.035	0.056	-0.006	0.310	0.019
08 (0-15cm)	0.251	0.022	0.006	0.090	0.053	0.084	0.001	0.219	0.013
09 (0-15cm)	0.351	0.030	0.006	0.104	0.056	0.087	0.003	0.242	0.013
10 (0-15cm)	0.341	0.023	0.008	0.145	0.071	0.107	0.007	0.186	0.013
01 (15-100cm)	0.003	0.005	0.008	0.111	0.059	0.077	0.006	0.183	0.008
02 (15-100cm)	-0.007	0.005	0.008	0.188	0.044	0.063	0.002	0.266	0.016
03 (15-100cm)	0.350	0.030	0.008	0.114	0.061	0.096	-0.006	0.271	0.020
04 (15-100cm)	-0.007	0.006	0.010	0.155	0.071	0.107	0.006	0.270	0.017
05 (15-100cm)	-0.005	0.005	0.008	0.110	0.066	0.079	0.007	0.330	0.026
06 (15-100cm)	-0.006	0.006	0.008	0.253	0.061	0.060	-0.002	0.277	0.015
07 (15-100cm)	0.000	0.004	0.006	0.093	0.044	0.067	0.002	0.315	0.016
08 (15-100cm)	0.001	0.004	0.006	0.090	0.035	0.054	0.002	0.095	0.003
09 (15-100cm)	-0.005	0.005	0.008	-0.001	0.056	0.092	-0.005	0.208	0.015
10 (15-100cm)	-0.002	0.004	0.007	0.074	0.058	0.074	-0.006	0.469	0.060

[1] Units are pCi/g.
[2] Error is total propagated uncertainty at two standard deviations.
[3] Shaded results were rejected during data validation.

Table B-3. Reference Area 2 Sample ROIs

Location	Pu238 Result	Pu238 Error	Pu238 MDA	Pu239/240 Result	Pu239/240 Error	Pu239/240 MDA	Pu241 Result	Pu241 Error	Pu241 MDA
01 (0-15cm)	0.000	0.009	0.012	-0.002	0.004	0.025	1.69	5.35	9.11
02 (0-15cm)	0.000	0.011	0.015	-0.003	0.005	0.030	0.719	6.34	10.9
03 (0-15cm)	0.006	0.011	0.015	0.008	0.016	0.031	-0.082	6.47	11.2
04 (0-15cm)	-0.007	0.013	0.041	0.000	0.029	0.060	0.934	4.58	7.85
05 (0-15cm)	0.004	0.033	0.066	0.010	0.014	0.013	-4.65	8.73	15.0
06 (0-15cm)	-0.005	0.028	0.070	0.018	0.036	0.066	-1.04	13.3	22.9
07 (0-15cm)	-0.010	0.027	0.066	0.017	0.027	0.048	-1.98	9.16	15.8
08 (0-15cm)	0.010	0.030	0.058	0.004	0.017	0.037	5.74	9.04	15.0
09 (0-15cm)	0.013	0.025	0.045	0.012	0.021	0.038	2.62	7.09	12.0
10 (0-15cm)	0.035	0.040	0.061	0.007	0.021	0.045	2.00	11.8	20.1
01 (15-100cm)	0.000	0.010	0.013	-0.002	0.005	0.027	5.27	6.13	9.91
02 (15-100cm)	-0.003	0.005	0.029	0.000	0.010	0.014	4.20	6.56	10.9
03 (15-100cm)	0.000	0.009	0.013	-0.012	0.010	0.043	-2.93	4.94	8.60
04 (15-100cm)	-0.016	0.030	0.083	-0.011	0.022	0.069	-5.44	13.7	23.7
05 (15-100cm)	0.008	0.030	0.059	0.002	0.020	0.045	7.64	8.78	14.2
06 (15-100cm)	-0.014	0.039	0.092	0.020	0.024	0.027	5.07	12.33	20.8
07 (15-100cm)	0.016	0.059	0.115	-0.021	0.019	0.080	6.01	15.2	25.7
08 (15-100cm)	0.000	0.030	0.065	0.008	0.021	0.042	0.804	9.49	16.3
09 (15-100cm)	-0.012	0.031	0.084	0.000	0.020	0.055	-0.133	14.7	25.3
10 (15-100cm)	-0.015	0.036	0.085	0.000	0.021	0.051	-1.72	10.5	18.1

[1] Units are pCi/g.
[2] Error is total propagated uncertainty at two standard deviations.

Table B-3. Reference Area 2 Sample ROIs

Location	Sr90 Result	Sr90 Error	Sr90 MDA	Tc99 Result	Tc99 Error	Tc99 MDA	U232 Result	U232 Error	U232 MDA
01 (0-15cm)	0.016	0.192	0.110	0.560	0.820	1.40	0.000	0.009	0.013
02 (0-15cm)	0.069	0.165	0.100	0.060	0.900	1.50	0.005	0.009	0.012
03 (0-15cm)	0.281	0.267	0.176	0.210	0.880	1.50	-0.005	0.008	0.037
04 (0-15cm)	-0.008	0.157	0.087	-0.020	0.860	1.50	0.004	0.009	0.012
05 (0-15cm)	0.114	0.216	0.133	0.200	0.780	1.30	0.001	0.028	0.059
06 (0-15cm)	-0.053	0.246	0.135	-0.700	0.820	1.40	-0.042	0.031	0.120
07 (0-15cm)	0.049	0.235	0.137	-0.420	0.790	1.30	0.008	0.032	0.066
08 (0-15cm)	0.392	0.345	0.230	-0.500	0.790	1.40	-0.006	0.044	0.098
09 (0-15cm)	0.138	0.199	0.127	-1.000	0.840	1.40	-0.015	0.040	0.089
10 (0-15cm)	0.137	0.274	0.168	-1.300	1.000	1.70	0.022	0.035	0.062
01 (15-100cm)	-0.049	0.192	0.104	-0.170	0.870	1.50	0.007	0.013	0.025
02 (15-100cm)	-0.060	0.183	0.099	0.850	0.900	1.50	0.000	0.010	0.014
03 (15-100cm)	0.017	0.181	0.104	0.330	0.730	1.20	-0.003	0.005	0.029
04 (15-100cm)	0.006	0.248	0.141	0.330	0.820	1.40	-0.015	0.028	0.073
05 (15-100cm)	-0.031	0.254	0.142	-0.350	0.760	1.30	-0.008	0.020	0.052
06 (15-100cm)	0.092	0.229	0.139	-0.560	0.810	1.40	-0.003	0.022	0.057
07 (15-100cm)	0.056	0.229	0.135	-0.520	0.760	1.30	-0.003	0.031	0.068
08 (15-100cm)	0.087	0.236	0.142	-0.890	0.850	1.50	-0.011	0.026	0.064
09 (15-100cm)	0.051	0.246	0.143	-0.210	0.830	1.40	0.003	0.016	0.034
10 (15-100cm)	-0.060	0.245	0.135	-0.550	0.930	1.60	-0.005	0.021	0.053

[1] Units are pCi/g.
[2] Error is total propagated uncertainty at two standard deviations.

Table B-3. Reference Area 2 Sample ROIs

Location	U233/234 Result	U233/234 Error	U233/234 MDA	U235 Result	U235 Error	U235 MDA	U238 Result	U238 Error	U238 MDA
01 (0-15cm)	0.799	0.164	0.056	0.031	0.028	0.017	0.800	0.166	0.077
02 (0-15cm)	0.783	0.167	0.069	0.000	0.022	0.055	0.922	0.186	0.077
03 (0-15cm)	0.725	0.154	0.077	0.055	0.038	0.034	0.741	0.155	0.072
04 (0-15cm)	0.728	0.134	0.030	0.012	0.014	0.016	0.798	0.145	0.053
05 (0-15cm)	0.634	0.185	0.094	0.064	0.057	0.035	0.677	0.194	0.108
06 (0-15cm)	1.096	0.222	0.057	0.043	0.038	0.023	1.039	0.214	0.062
07 (0-15cm)	0.405	0.269	0.337	0.052	0.102	0.193	0.314	0.236	0.307
08 (0-15cm)	0.769	0.185	0.075	0.058	0.047	0.026	0.734	0.177	0.046
09 (0-15cm)	0.909	0.243	0.089	0.031	0.056	0.103	0.881	0.245	0.142
10 (0-15cm)	0.923	0.207	0.163	0.053	0.057	0.089	0.918	0.209	0.171
01 (15-100cm)	0.727	0.141	0.029	0.014	0.016	0.014	0.818	0.153	0.029
02 (15-100cm)	1.07	0.176	0.037	0.028	0.022	0.022	0.990	0.166	0.041
03 (15-100cm)	0.955	0.186	0.039	-0.002	0.012	0.042	1.016	0.195	0.039
04 (15-100cm)	1.06	0.196	0.030	0.063	0.040	0.017	1.138	0.207	0.036
05 (15-100cm)	0.95	0.233	0.092	0.229	0.114	0.086	0.592	0.177	0.092
06 (15-100cm)	0.701	0.166	0.050	0.039	0.039	0.048	0.633	0.158	0.072
07 (15-100cm)	0.509	0.118	0.028	0.006	0.012	0.016	0.643	0.137	0.034
08 (15-100cm)	0.796	0.153	0.052	0.031	0.028	0.035	0.870	0.163	0.048
09 (15-100cm)	1.07	0.201	0.068	0.029	0.040	0.066	0.899	0.189	0.131
10 (15-100cm)	0.688	0.142	0.033	0.029	0.025	0.016	0.622	0.132	0.013

[1] Units are pCi/g.
[2] Error is total propagated uncertainty at two standard deviations.
[3] Shaded results were rejected during data validation.

Table B-4. Reference Area 2 Sample PROIs

Location	Ac227 Result	Ac227 Error	Ac227 MDA	Co60 Result	Co60 Error	Co60 MDA	Cd113m Result	Cd113m Error	Cd113m MDA
01 (0-15cm)	0.081	0.034	0.067	-0.002	0.092	0.012	0.000	0.005	0.008
02 (0-15cm)	-0.015	0.118	0.073	-0.002	0.011	0.009	-0.003	0.006	0.008
03 (0-15cm)	0.030	0.092	0.061	-0.001	0.005	0.009	0.002	0.004	0.006
04 (0-15cm)	0.068	0.028	0.059	-0.002	0.009	0.009	-0.003	0.005	0.008
05 (0-15cm)	0.035	0.069	0.069	-0.001	0.079	0.010	-0.002	0.005	0.008
06 (0-15cm)	0.047	0.056	0.077	0.000	0.009	0.012	0.000	0.006	0.010
07 (0-15cm)	-0.004	0.069	0.049	0.000	0.005	0.009	-0.003	0.007	0.006
08 (0-15cm)	0.069	0.030	0.053	0.003	0.006	0.010	-0.004	0.005	0.008
09 (0-15cm)	-0.078	0.044	0.058	0.002	0.006	0.010	-0.004	0.005	0.008
10 (0-15cm)	0.043	0.057	0.080	-0.002	0.062	0.011	-0.001	0.006	0.010
01 (15-100cm)	0.035	0.053	0.072	-0.001	1.91	0.011	0.004	0.004	0.007
02 (15-100cm)	0.043	0.072	0.068	0.001	0.007	0.012	-0.001	0.169	0.006
03 (15-100cm)	0.033	0.052	0.073	-0.001	0.007	0.011	-0.004	0.006	0.010
04 (15-100cm)	0.081	0.048	0.065	-0.002	0.064	0.013	-0.001	0.006	0.010
05 (15-100cm)	-0.011	0.066	0.070	-0.001	0.041	0.009	-0.002	0.006	0.008
06 (15-100cm)	0.002	0.038	0.069	-0.004	0.009	0.010	-0.002	0.005	0.008
07 (15-100cm)	0.048	0.021	0.042	0.000	0.005	0.008	-0.001	0.004	0.006
08 (15-100cm)	0.052	0.024	0.046	-0.002	0.006	0.009	-0.002	0.007	0.006
09 (15-100cm)	0.039	0.096	0.074	0.001	0.006	0.011	0.001	0.005	0.008
10 (15-100cm)	-0.074	0.047	0.076	-0.003	0.008	0.010	-0.004	0.005	0.008

[1] Units are pCi/g.
[2] Error is total propagated uncertainty at two standard deviations.

Table B-4. Reference Area 2 Sample PROIs

Location	Eu154 Result	Eu154 Error	Eu154 MDA	H3 Result	H3 Error	H3 MDA	Pa231 Result	Pa231 Error	Pa231 MDA
01 (0-15cm)	-0.002	0.005	0.012	-3.42	3.16	5.56	-0.426	0.185	0.297
02 (0-15cm)	0.000	0.006	0.010	-5.60	2.76	4.92	-0.344	0.164	0.257
03 (0-15cm)	0.000	0.008	0.007	-2.66	2.90	5.08	-0.333	0.137	0.219
04 (0-15cm)	0.001	0.008	0.011	-5.05	3.59	6.35	-0.442	0.145	0.227
05 (0-15cm)	-0.001	0.006	0.010	-4.75	2.94	5.37	-0.360	0.150	0.239
06 (0-15cm)	0.003	0.007	0.011	-2.41	2.52	4.52	-0.451	0.177	0.282
07 (0-15cm)	-0.001	0.005	0.008	-1.22	2.65	4.67	-0.178	0.110	0.174
08 (0-15cm)	0.003	0.010	0.009	-3.18	2.74	4.95	-0.431	0.170	0.242
09 (0-15cm)	0.001	0.006	0.010	-2.53	2.54	4.56	-0.349	0.174	0.244
10 (0-15cm)	0.003	0.006	0.010	-1.42	2.70	4.76	-0.562	0.188	0.296
01 (15-100cm)	0.001	0.006	0.010	1.21	1.66	2.79	-0.471	0.162	0.257
02 (15-100cm)	-0.002	0.014	0.010	0.064	1.86	3.19	-0.333	0.129	0.203
03 (15-100cm)	0.002	0.006	0.010	-0.812	1.63	2.83	-0.481	0.195	0.277
04 (15-100cm)	-0.001	0.162	0.012	0.717	2.81	4.83	-0.523	0.181	0.288
05 (15-100cm)	0.003	0.017	0.010	-0.446	2.00	3.51	-0.373	0.149	0.235
06 (15-100cm)	0.000	0.006	0.010	0.445	2.03	3.50	-0.322	0.149	0.239
07 (15-100cm)	-0.003	0.008	0.008	0.506	2.64	4.62	-0.396	0.123	0.194
08 (15-100cm)	0.000	0.006	0.008	0.432	2.22	3.82	-0.262	0.109	0.172
09 (15-100cm)	-0.001	0.017	0.009	-1.563	2.09	3.71	-0.593	0.170	0.268
10 (15-100cm)	0.002	0.007	0.011	-2.25	2.54	4.55	-0.440	0.148	0.232

[1] Units are pCi/g.
[2] Error is total propagated uncertainty at two standard deviations.
[3] Shaded results were rejected during data validation.

Table B-4. Reference Area 2 Sample PROIs

Location	Ra226 Result	Ra226 Error	Ra226 MDA	Ra228 Result	Ra228 Error	Ra228 MDA	Sb125 Result	Sb125 Error	Sb125 MDA
01 (0-15cm)	1.88	0.199	0.180	0.737	0.053	0.028	0.005	0.013	0.020
02 (0-15cm)	1.69	0.175	0.151	0.747	0.053	0.024	0.001	0.011	0.019
03 (0-15cm)	1.41	0.145	0.127	0.553	0.038	0.023	0.003	0.010	0.017
04 (0-15cm)	1.66	0.175	0.136	0.835	0.056	0.021	0.000	0.010	0.015
05 (0-15cm)	1.40	0.149	0.139	0.547	0.041	0.020	0.004	0.010	0.018
06 (0-15cm)	1.84	0.215	0.181	0.893	0.066	0.029	0.004	0.017	0.022
07 (0-15cm)	1.05	0.131	0.106	0.551	0.074	0.019	0.005	0.031	0.014
08 (0-15cm)	1.74	0.197	0.149	0.724	0.059	0.027	0.003	0.017	0.019
09 (0-15cm)	1.66	0.180	0.150	0.664	0.052	0.021	0.000	0.012	0.019
10 (0-15cm)	1.91	0.200	0.163	0.827	0.056	0.028	0.009	0.014	0.021
01 (15-100cm)	1.99	0.207	0.160	0.918	0.066	0.027	0.007	0.012	0.019
02 (15-100cm)	1.75	0.192	0.128	1.08	0.143	0.027	0.001	0.052	0.016
03 (15-100cm)	2.00	0.210	0.159	0.799	0.063	0.025	0.005	0.014	0.021
04 (15-100cm)	2.14	0.214	0.166	1.13	0.080	0.031	0.002	0.014	0.021
05 (15-100cm)	1.64	0.177	0.148	0.779	0.052	0.022	0.005	0.010	0.016
06 (15-100cm)	1.76	0.173	0.148	0.828	0.056	0.023	0.004	0.011	0.018
07 (15-100cm)	1.42	0.152	0.118	0.682	0.046	0.019	0.002	0.009	0.013
08 (15-100cm)	1.46	0.150	0.110	0.864	0.114	0.022	0.001	0.043	0.014
09 (15-100cm)	2.23	0.215	0.162	1.10	0.073	0.025	0.005	0.012	0.019
10 (15-100cm)	1.64	0.178	0.142	0.850	0.057	0.021	-0.007	0.012	0.017

[1] Units are pCi/g.
[2] Error is total propagated uncertainty at two standard deviations.

Table B-4. Reference Area 2 Sample PROIs

Location	Sn126 Result	Sn126 Error	Sn126 MDA	Th229 Result	Th229 Error	Th229 MDA	Th232 Result	Th232 Error	Th232 MDA
01 (0-15cm)	-0.003	0.012	0.008	0.006	0.017	0.022	0.737	0.053	0.028
02 (0-15cm)	-0.002	0.017	0.007	0.000	0.020	0.021	0.747	0.053	0.024
03 (0-15cm)	0.001	0.004	0.006	0.002	0.009	0.016	0.553	0.038	0.023
04 (0-15cm)	0.005	0.002	0.006	0.070	0.022	0.092	0.835	0.056	0.021
05 (0-15cm)	0.000	0.004	0.007	-0.019	0.011	0.018	0.547	0.041	0.020
06 (0-15cm)	0.000	0.007	0.008	0.000	0.008	0.023	0.893	0.066	0.029
07 (0-15cm)	-0.001	0.060	0.006	-0.019	0.011	0.017	0.551	0.074	0.019
08 (0-15cm)	0.000	0.004	0.007	0.051	0.019	0.030	0.724	0.059	0.027
09 (0-15cm)	0.000	0.004	0.007	0.000	0.010	0.020	0.664	0.052	0.021
10 (0-15cm)	0.000	0.007	0.008	-0.046	0.015	0.024	0.827	0.056	0.028
01 (15-100cm)	0.004	0.002	0.008	0.003	0.008	0.020	0.918	0.066	0.027
02 (15-100cm)	0.007	0.002	0.007	-0.052	0.013	0.021	1.079	0.143	0.027
03 (15-100cm)	-0.002	0.005	0.008	0.002	0.012	0.015	0.799	0.063	0.025
04 (15-100cm)	0.007	0.003	0.008	0.092	0.029	0.037	1.128	0.080	0.031
05 (15-100cm)	0.005	0.002	0.006	-0.041	0.013	0.021	0.779	0.052	0.022
06 (15-100cm)	0.005	0.002	0.007	0.010	0.010	0.018	0.828	0.056	0.023
07 (15-100cm)	0.003	0.002	0.005	-0.009	0.007	0.011	0.682	0.046	0.019
08 (15-100cm)	0.004	0.001	0.006	-0.006	0.010	0.016	0.864	0.114	0.022
09 (15-100cm)	0.005	0.002	0.007	0.007	0.020	0.019	1.097	0.073	0.025
10 (15-100cm)	0.005	0.002	0.005	-0.015	0.012	0.019	0.850	0.057	0.021

[1] Units are pCi/g.
[2] Error is total propagated uncertainty at two standard deviations.
[3] Shaded results were rejected during data validation.

APPENDIX C

Borehole Gamma Logs and Lithologic Logs

APPENDIX C

Borehole Gamma Logs and Lithologic Logs

The borehole gamma logs were performed using a ½-inch by 1-inch NaI detector. The smaller detector was used so that it could fit into the borehole. Note that the smaller volume detector has a lower efficiency and a lower count rate response than the bigger NaI detectors used for the GWSs. Note also that the background count rate taken outside the borehole is less than that taken inside the borehole because inside the borehole the detector is surrounded by the source of gamma radiation signal.

The borehole gamma logs were handwritten while work was performed. The borehole gamma logs shown in this appendix were typed for this TBS. The signed original forms are on file.

RADIOLOGICAL SURVEY FORM

Survey Type: ☐ Job Coverage ☐ Characterization ☐ Equipment ☐ Routine ☐ Uppost/Downpost ☑ Miscellaneous Page 1 of 1

Survey Number: WVDP-MIS-017-8212 Date: 8/2/2012 Time: 1000 RWP No: N/A

Survey Location (Site/Bldg) WVDP Room/Area/Item Sample Location:Bkg. Area 01- Sample #01

Purpose of Survey: Down Hole Logging

Remarks: To 4 feet

Technician:	Michael Carlin		Badge N/A	Technician:	N/A		Badge N/A
Detector Type	Inst. Serial No.	Cal Due	Bkgd.	Detector Type	Inst. Serial No.	Cal Due	Bkgd.
2221/44-62	184010/PR212708	6/19/2013	305 cpm				

Item No.	Radiation Type	cpm	30 cm Dose Rate	General Area Dose Rate	Sample Location and/or Remarks
1 ft.	GAMMA	641	N/A	N/A	Bkg.-1-01
2 ft.	GAMMA	709			Bkg.-1-01
3 ft.	GAMMA	655			Bkg.-1-01
4 ft.	GAMMA	737			Bkg.-1-01

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Surveyed By _____ / _____ (Signature / Date)

Note: Any response of the instrument that is above the Critcal Detection Level (or Lc) is considered to be above background.

RADIOLOGICAL SURVEY FORM

Survey Type: ☐ Job Coverage ☐ Characterization ☐ Equipment ☐ Routine ☐ Uppost/Downpost ☑ Miscellaneous Page 1 of 1

Survey Number: WVDP-MIS-018-8212 Date: 8/2/2012 Time: 0910 RWP No: N/A

Survey Location (Site/Bldg) WVDP Room/Area/Item Sample Location:Bkg. Area 01- Sample #02

Purpose of Survey: Down Hole Logging

Remarks: To 4 feet

Technician:	Michael Carlin		Badge	N/A	Technician:	N/A		Badge	N/A
Detector Type	Inst. Serial No.	Cal Due	Bkgd.		Detector Type	Inst. Serial No.	Cal Due	Bkgd.	
2221/44-62	184010/PR212708	6/19/2013	361 cpm						

Item No.	Radiation Type	cpm	30 cm Dose Rate	General Area Dose Rate	Sample Location and/or Remarks
1 ft.	GAMMA	765	N/A	N/A	Bkg.-1-02
2 ft.	GAMMA	786			Bkg.-1-02
3 ft.	GAMMA	699			Bkg.-1-02
4 ft.	GAMMA	755			Bkg.-1-02

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Signature Date

Note: Any response of the instrument that is above the Critcal Detection Level (or Lc) is considered to be above background.

RADIOLOGICAL SURVEY FORM

Survey Type: ☐ Job Coverage ☐ Characterization ☐ Equipment ☐ Routine ☐ Uppost/Downpost ☑ Miscellaneous Page 1 of 1

Survey Number: WVDP-MIS-019-8212 Date: 8/2/2012 Time: 0930 RWP No: N/A

Survey Location (Site/Bldg) WVDP Room/Area/Item Sample Location:Bkg. Area 01- Sample #03

Purpose of Survey: Down Hole Logging

Remarks: To 4 feet

Technician:	Michael Carlin		Badge N/A	Technician:	N/A		Badge N/A
Detector Type	Inst. Serial No.	Cal Due	Bkgd.	Detector Type	Inst. Serial No.	Cal Due	Bkgd.
2221/44-62	184010/PR212708	6/19/2013	340 cpm				

Item No.	Radiation Type	cpm	30 cm Dose Rate	General Area Dose Rate	Sample Location and/or Remarks
1 ft.	GAMMA	625	N/A	N/A	Bkg.-1-03
2 ft.	GAMMA	688			Bkg.-1-03
3 ft.	GAMMA	788			Bkg.-1-03
4 ft.	GAMMA	750			Bkg.-1-03

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Note: Any response of the instrument that is above the Critcal Detection Level (or Lc) is considered to be above background.

RADIOLOGICAL SURVEY FORM

Survey Type: ☐ Job Coverage ☐ Characterization ☐ Equipment ☐ Routine ☐ Uppost/Downpost ☑ Miscellaneous Page 1 of 1

Survey Number: WVDP-MIS-020-8212 Date: 8/2/2012 Time: 0950 RWP No: N/A

Survey Location (Site/Bldg) WVDP Room/Area/Item Sample Location:Bkg. Area 01- Sample #04

Purpose of Survey: Down Hole Logging

Remarks: To 4 feet

Technician:	Michael Carlin		Badge	N/A	Technician:	N/A		Badge	N/A
Detector Type	Inst. Serial No.		Cal Due	Bkgd.	Detector Type	Inst. Serial No.		Cal Due	Bkgd.
2221/44-62	184010/PR212708		6/19/2013	363 cpm					

Item No.	Radiation Type	cpm	30 cm Dose Rate	General Area Dose Rate	Sample Location and/or Remarks
1 ft.	GAMMA	568	N/A	N/A	Bkg.-1-04
2 ft.	GAMMA	594			Bkg.-1-04
3 ft.	GAMMA	671			Bkg.-1-04
4 ft.	GAMMA	738			Bkg.-1-04

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Note: Any response of the instrument that is above the Critcal Detection Level (or Lc) is considered to be above background.

RADIOLOGICAL SURVEY FORM

Survey Type: ☐ Job Coverage ☐ Characterization ☐ Equipment ☐ Routine ☐ Uppost/Downpost ☑ Miscellaneous Page 1 of 1

Survey Number: WVDP-MIS-021-8212 Date: 8/2/2012 Time: 0840 RWP No: N/A

Survey Location (Site/Bldg) WVDP Room/Area/Item Sample Location:Bkg. Area 01- Sample #06

Purpose of Survey: Down Hole Logging

Remarks: To 4 feet

Technician:	Michael Carlin		Badge N/A	Technician:	N/A		Badge N/A
Detector Type	Inst. Serial No.	Cal Due	Bkgd.	Detector Type	Inst. Serial No.	Cal Due	Bkgd.
2221/44-62	184010/PR212708	6/19/2013	307 cpm				

Item No.	Radiation Type	cpm	30 cm Dose Rate	General Area Dose Rate	Sample Location and/or Remarks
1 ft.	GAMMA	568	N/A	N/A	Bkg.-1-06
2 ft.	GAMMA	748			Bkg.-1-06
3 ft.	GAMMA	647			Bkg.-1-06
4 ft.	GAMMA	654			Bkg.-1-06

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Note: Any response of the instrument that is above the Critcal Detection Level (or Lc) is considered to be above background.

RADIOLOGICAL SURVEY FORM

Survey Type: ☐ Job Coverage ☐ Characterization ☐ Equipment ☐ Routine ☐ Uppost/Downpost ☑ Miscellaneous Page 1 of 1

Survey Number: WVDP-MIS-022-8212 Date: 8/2/2012 Time: 0830 RWP No: N/A

Survey Location (Site/Bldg) WVDP Room/Area/Item Sample Location:Bkg. Area 01- Sample #05

Purpose of Survey: Down Hole Logging

Remarks: Due to hole collapsing, could not get readings.

Technician:	Michael Carlin		Badge N/A	Technician:	N/A		Badge N/A
Detector Type	Inst. Serial No.	Cal Due	Bkgd.	Detector Type	Inst. Serial No.	Cal Due	Bkgd.
2221/44-62	184010/PR212708	6/19/2013	399 cpm				

Item No.	Radiation Type	cpm	30 cm Dose Rate	General Area Dose Rate	Sample Location and/or Remarks
			N/A	N/A	

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Surveyed By _____/_____ Signature Date

RCT Supervisor Review _____/_____ Signature Date

Surveyed By _____/_____ Signature Date

Note: Any response of the instrument that is above the Critcal Detection Level (or Lc) is considered to be above background.

RADIOLOGICAL SURVEY FORM

Survey Type: ☐ Job Coverage ☐ Characterization ☐ Equipment ☐ Routine ☐ Uppost/Downpost ☑ Miscellaneous Page 1 of 1

Survey Number: WVDP-MIS-023-8212 Date: 8/2/2012 Time: 0850 RWP No: N/A

Survey Location (Site/Bldg) WVDP Room/Area/Item Sample Location:Bkg. Area 01- Sample #07

Purpose of Survey: Down Hole Logging

Remarks: To 4 feet

Technician:	Michael Carlin		Badge N/A	Technician:	N/A	Badge	N/A
Detector Type	Inst. Serial No.	Cal Due	Bkgd.	Detector Type	Inst. Serial No.	Cal Due	Bkgd.
2221/44-62	184010/PR212708	6/19/2013	330 cpm				

Item No.	Radiation Type	cpm	30 cm Dose Rate	General Area Dose Rate	Sample Location and/or Remarks
1 ft.	GAMMA	623	N/A	N/A	Bkg.-1-07
2 ft.	GAMMA	661			Bkg.-1-07
3 ft.	GAMMA	703			Bkg.-1-07
4 ft.	GAMMA	666			Bkg.-1-07

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Surveyed By _____ / _____ Signature Date

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Note: Any response of the instrument that is above the Critcal Detection Level (or Lc) is considered to be above background.

RADIOLOGICAL SURVEY FORM

Survey Type: ☐ Job Coverage ☐ Characterization ☐ Equipment ☐ Routine ☐ Uppost/Downpost ☑ Miscellaneous Page 1 of 1

Survey Number: WVDP-MIS-024-8212 Date: 8/2/2012 Time: 0900 RWP No: N/A

Survey Location (Site/Bldg) WVDP Room/Area/Item Sample Location:Bkg. Area 01- Sample #08

Purpose of Survey: Down Hole Logging

Remarks: To 4 feet

Technician:	Michael Carlin		Badge N/A	Technician:	N/A		Badge N/A
Detector Type	Inst. Serial No.	Cal Due	Bkgd.	Detector Type	Inst. Serial No.	Cal Due	Bkgd.
2221/44-62	184010/PR212708	6/19/2013	337 cpm				

Item No.	Radiation Type	cpm	30 cm Dose Rate	General Area Dose Rate	Sample Location and/or Remarks
1 ft.	GAMMA	719	N/A	N/A	Bkg.-1-08
2 ft.	GAMMA	695			Bkg.-1-08
3 ft.	GAMMA	710			Bkg.-1-08
4 ft.	GAMMA	694			Bkg.-1-08

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Signature Date

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Signature Date

Note: Any response of the instrument that is above the Critcal Detection Level (or Lc) is considered to be above background.

RADIOLOGICAL SURVEY FORM

Survey Type: ☐ Job Coverage ☐ Characterization ☐ Equipment ☐ Routine ☐ Uppost/Downpost ☑ Miscellaneous Page 1 of 1

Survey Number: WVDP-MIS-025-8212 Date: 8/2/2012 Time: 0810 RWP No: N/A

Survey Location (Site/Bldg) WVDP Room/Area/Item Sample Location:Bkg. Area 01- Sample #09

Purpose of Survey: Down Hole Logging

Remarks: Refusal at 4 ft.

Technician:	Michael Carlin		Badge	N/A	Technician:	N/A		Badge	N/A
Detector Type	Inst. Serial No.	Cal Due	Bkgd.		Detector Type	Inst. Serial No.	Cal Due	Bkgd.	
2221/44-62	184010/PR212708	6/19/2013	349 cpm						

Item No.	Radiation Type	cpm	30 cm Dose Rate	General Area Dose Rate	Sample Location and/or Remarks
1 ft.	GAMMA	584	N/A	N/A	Bkg.-1-09
2 ft.	GAMMA	614			Bkg.-1-09

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Surveyed By _____ / _____ Signature Date

RCT Supervisor Review _____ / _____ Signature Date

Surveyed By _____ / _____ Signature Date

Surveyed By _____ / _____ Signature Date

Note: Any response of the instrument that is above the Critcal Detection Level (or Lc) is considered to be above background.

RADIOLOGICAL SURVEY FORM

Survey Type: ☐ Job Coverage ☐ Characterization ☐ Equipment ☐ Routine ☐ Uppost/Downpost ☑ Miscellaneous Page 1 of 1

Survey Number: WVDP-MIS-026-8212 Date: 8/2/2012 Time: 0820 RWP No: N/A

Survey Location (Site/Bldg) WVDP Room/Area/Item Sample Location:Bkg. Area 01-Sample #10

Purpose of Survey: Down Hole Logging

Remarks: To 4 feet

Technician:	Michael Carlin		Badge N/A	Technician:	N/A		Badge N/A
Detector Type	Inst. Serial No.	Cal Due	Bkgd.	Detector Type	Inst. Serial No.	Cal Due	Bkgd.
2221/44-62	184010/PR212708	6/19/2013	337 cpm				

Item No.	Radiation Type	cpm	30 cm Dose Rate	General Area Dose Rate	Sample Location and/or Remarks
1 ft.	GAMMA	654	N/A	N/A	Bkg.-1-10
2 ft.	GAMMA	679			Bkg.-1-10
3 ft.	GAMMA	616			Bkg.-1-10
4 ft.	GAMMA	712			Bkg.-1-10
			↓	↓	

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Surveyed By _____ / _____ Signature Date

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RCT Supervisor Review _____ / _____ Signature Date

Surveyed By _____ / _____ Signature Date

Note: Any response of the Instrument that is above the Critcal Detection Level (or Lc) is considered to be above background.

RADIOLOGICAL SURVEY FORM

Survey Type: ☐ Job Coverage ☐ Characterization ☐ Equipment ☐ Routine ☐ Uppost/Downpost ☑ Miscellaneous Page 1 of 1

Survey Number: WVDP-MIS-027-8912 Date: 8/9/2012 Time: 0921 RWP No: N/A

Survey Location (Site/Bldg) WVDP Room/Area/Item Sample Location:Bkg. Area 02- Sample #01

Purpose of Survey: Down Hole Logging

Remarks: To 4 feet

Technician:	Michael Carlin		Badge N/A	Technician:	N/A		Badge N/A
Detector Type	Inst. Serial No.	Cal Due	Bkgd.	Detector Type	Inst. Serial No.	Cal Due	Bkgd.
2221/44-62	184010/PR212708	6/19/2013	321 cpm				

Item No.	Radiation Type	cpm	30 cm Dose Rate	General Area Dose Rate	Sample Location and/or Remarks
0.5 ft.	GAMMA	710	N/A	N/A	Bkg.-1-01
1 ft.	GAMMA	804			Bkg.-1-01
1.5 ft.	GAMMA	846			Bkg.-1-01
2 ft.	GAMMA	913			Bkg.-1-01
2.5 ft.	GAMMA	818			Bkg.-1-01
3 ft.	GAMMA	839			Bkg.-1-01
3.5 ft.	GAMMA	901			Bkg.-1-01
4 ft.	GAMMA	879			Bkg.-1-01

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Surveyed By _____/_____ Surveyed By _____/_____

Signature Date Signature Date

RCT Supervisor Review _____/_____ Surveyed By _____/_____

Signature Date Signature Date

Note: Any response of the Instrument that is above the Critcal Detection Level (or Lc) is considered to be above background.

RADIOLOGICAL SURVEY FORM

Survey Type: ☐ Job Coverage ☐ Characterization ☐ Equipment ☐ Routine ☐ Uppost/Downpost ☑ Miscellaneous Page 1 of 1

Survey Number: WVDP-MIS-028-8912 Date: 8/9/2012 Time: 0945 RWP No: N/A

Survey Location (Site/Bldg) WVDP Room/Area/Item Sample Location:Bkg. Area 02- Sample #02

Purpose of Survey: Down Hole Logging

Remarks: To 4 feet

Technician:	Michael Carlin		Badge N/A	Technician:	N/A		Badge N/A
Detector Type	Inst. Serial No.	Cal Due	Bkgd.	Detector Type	Inst. Serial No.	Cal Due	Bkgd.
2221/44-62	184010/PR212708	6/19/2013	409 cpm				

Item No.	Radiation Type	cpm	30 cm Dose Rate	General Area Dose Rate	Sample Location and/or Remarks
0.5 ft.	GAMMA	859	N/A	N/A	Bkg.-1-02
1 ft.	GAMMA	1065			Bkg.-1-02
1.5 ft.	GAMMA	1074			Bkg.-1-02
2 ft.	GAMMA	1038			Bkg.-1-02
2.5 ft.	GAMMA	1061			Bkg.-1-02
3 ft.	GAMMA	994			Bkg.-1-02
3.5 ft.	GAMMA	1028			Bkg.-1-02
4 ft.	GAMMA	1047			Bkg.-1-02

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Surveyed By _____ / _____ Signature Date

RCT Supervisor Review _____ / _____ Signature Date

Surveyed By _____ / _____ Signature Date

Surveyed By _____ / _____ Signature Date

Note: Any response of the instrument that is above the Critcal Detection Level (or Lc) is considered to be above background.

RADIOLOGICAL SURVEY FORM

Survey Type: ☐ Job Coverage ☐ Characterization ☐ Equipment ☐ Routine ☐ Uppost/Downpost ☑ Miscellaneous Page 1 of 1

Survey Number: WVDP-MIS-029-8912 Date: 8/9/2012 Time: 0904 RWP No: N/A

Survey Location (Site/Bldg) WVDP Room/Area/Item Sample Location:Bkg. Area 02- Sample #03

Purpose of Survey: Down Hole Logging

Remarks: To 4 feet

Technician:	Michael Carlin		Badge N/A	Technician:	N/A		Badge N/A
Detector Type	Inst. Serial No.	Cal Due	Bkgd.	Detector Type	Inst. Serial No.	Cal Due	Bkgd.
2221/44-62	184010/PR212708	6/19/2013	393 cpm				

Item No.	Radiation Type	cpm	30 cm Dose Rate	General Area Dose Rate	Sample Location and/or Remarks
0.5 ft.	GAMMA	636	N/A	N/A	Bkg.-1-03
1 ft.	GAMMA	785			Bkg.-1-03
1.5 ft.	GAMMA	761			Bkg.-1-03
2 ft.	GAMMA	868			Bkg.-1-03
2.5 ft.	GAMMA	965			Bkg.-1-03
3 ft.	GAMMA	1094			Bkg.-1-03
3.5 ft.	GAMMA	1108			Bkg.-1-03
4 ft.	GAMMA	1101			Bkg.-1-03
			↓	↓	

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RCT Supervisor Review _____ / _____ Signature Date

Surveyed By _____ / _____ Signature Date

Note: Any response of the instrument that is above the Critical Detection Level (or Lc) is considered to be above background.

RADIOLOGICAL SURVEY FORM

Survey Type: ☐ Job Coverage ☐ Characterization ☐ Equipment ☐ Routine ☐ Uppost/Downpost ☑ Miscellaneous Page 1 of 1

Survey Number: WVDP-MIS-030-8912 Date: 8/9/2012 Time: 0845 RWP No: N/A

Survey Location (Site/Bldg) WVDP Room/Area/Item Sample Location:Bkg. Area 02- Sample #04

Purpose of Survey: Down Hole Logging

Remarks: To 4 feet

Technician:	Michael Carlin		Badge	N/A	Technician:	N/A		Badge	N/A
Detector Type	Inst. Serial No.	Cal Due	Bkgd.		Detector Type	Inst. Serial No.	Cal Due	Bkgd.	
2221/44-62	184010/PR212708	6/19/2013	411 cpm						

Item No.	Radiation Type	cpm	30 cm Dose Rate	General Area Dose Rate	Sample Location and/or Remarks
0.5 ft.	GAMMA	808	N/A	N/A	Bkg.-1-04
1 ft.	GAMMA	906			Bkg.-1-04
1.5 ft.	GAMMA	1073			Bkg.-1-04
2 ft.	GAMMA	971			Bkg.-1-04
2.5 ft.	GAMMA	1087			Bkg.-1-04
3 ft.	GAMMA	1036			Bkg.-1-04
3.5 ft.	GAMMA	1131			Bkg.-1-04
4 ft.	GAMMA	1011			Bkg.-1-04

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Surveyed By _____/_____ Signature Date

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RCT Supervisor Review _____/_____ Signature Date

Surveyed By _____/_____ Signature Date

Note: Any response of the instrument that is above the Critcal Detection Level (or Lc) is considered to be above background.

RADIOLOGICAL SURVEY FORM

Survey Type: ☐ Job Coverage ☐ Characterization ☐ Equipment ☐ Routine ☐ Uppost/Downpost ☑ Miscellaneous Page 1 of 1

Survey Number: WVDP-MIS-031-8912 Date: 8/9/2012 Time: 0823 RWP No: N/A

Survey Location (Site/Bldg) WVDP Room/Area/Item Sample Location:Bkg. Area 02- Sample #05

Purpose of Survey: Down Hole Logging

Remarks: To 4 feet

Technician:	Michael Carlin		Badge N/A	Technician:	N/A		Badge N/A
Detector Type	Inst. Serial No.	Cal Due	Bkgd.	Detector Type	Inst. Serial No.	Cal Due	Bkgd.
2221/44-62	184010/PR212708	6/19/2013	411 cpm				

Item No.	Radiation Type	cpm	30 cm Dose Rate	General Area Dose Rate	Sample Location and/or Remarks
0.5 ft.	GAMMA	645	N/A	N/A	Bkg.-1-05
1 ft.	GAMMA	693			Bkg.-1-05
1.5 ft.	GAMMA	708			Bkg.-1-05
2 ft.	GAMMA	705			Bkg.-1-05
2.5 ft.	GAMMA	696			Bkg.-1-05
3 ft.	GAMMA	728			Bkg.-1-05
3.5 ft.	GAMMA	821			Bkg.-1-05
4 ft.	GAMMA	739			Bkg.-1-05

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Note: Any response of the instrument that is above the Critcal Detection Level (or Lc) is considered to be above background.

RADIOLOGICAL SURVEY FORM

Survey Type: ☐ Job Coverage ☐ Characterization ☐ Equipment ☐ Routine ☐ Uppost/Downpost ☑ Miscellaneous Page 1 of 1

Survey Number: WVDP-MIS-032-8912 Date: 8/9/2012 Time: 0807 RWP No: N/A

Survey Location (Site/Bldg) WVDP Room/Area/Item Sample Location:Bkg. Area 02- Sample #06

Purpose of Survey: Down Hole Logging

Remarks: To 4 feet

Technician:	Michael Carlin		Badge N/A	Technician:	N/A		Badge N/A
Detector Type	Inst. Serial No.	Cal Due	Bkgd.	Detector Type	Inst. Serial No.	Cal Due	Bkgd.
2221/44-62	184010/PR212708	6/19/2013	411 cpm				

Item No.	Radiation Type	cpm	30 cm Dose Rate	General Area Dose Rate	Sample Location and/or Remarks
0.5 ft.	GAMMA	800	N/A	N/A	Bkg.-1-06
1 ft.	GAMMA	890			Bkg.-1-06
1.5 ft.	GAMMA	869			Bkg.-1-06
2 ft.	GAMMA	822			Bkg.-1-06
2.5 ft.	GAMMA	832			Bkg.-1-06
3 ft.	GAMMA	749			Bkg.-1-06
3.5 ft.	GAMMA	721			Bkg.-1-06
4 ft.	GAMMA	783			Bkg.-1-06
			↓	↓	

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Note: Any response of the instrument that is above the Critcal Detection Level (or Lc) is considered to be above background.

RADIOLOGICAL SURVEY FORM

Survey Type: ☐ Job Coverage ☐ Characterization ☐ Equipment ☐ Routine ☐ Uppost/Downpost ☑ Miscellaneous Page 1 of 1

Survey Number: WVDP-MIS-033-8912 Date: 8/9/2012 Time: 0759 RWP No: N/A

Survey Location (Site/Bldg) WVDP Room/Area/Item Sample Location:Bkg. Area 02- Sample #07

Purpose of Survey: Down Hole Logging

Remarks: To 4 feet

Technician:	Michael Carlin		Badge N/A	Technician:	N/A		Badge N/A
Detector Type	Inst. Serial No.	Cal Due	Bkgd.	Detector Type	Inst. Serial No.	Cal Due	Bkgd.
2221/44-62	184010/PR212708	6/19/2013	333 cpm				

Item No.	Radiation Type	cpm	30 cm Dose Rate	General Area Dose Rate	Sample Location and/or Remarks
0.5 ft.	GAMMA	583	N/A	N/A	Bkg.-1-07
1 ft.	GAMMA	565			Bkg.-1-07
1.5 ft.	GAMMA	659			Bkg.-1-07
2 ft.	GAMMA	695			Bkg.-1-07
2.5 ft.	GAMMA	802			Bkg.-1-07
3 ft.	GAMMA	787			Bkg.-1-07
3.5 ft.	GAMMA	721			Bkg.-1-07
4 ft.	GAMMA	722			Bkg.-1-07
			↓	↓	

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Note: Any response of the instrument that is above the Critcal Detection Level (or Lc) is considered to be above background.

RADIOLOGICAL SURVEY FORM

Survey Type: ☐ Job Coverage ☐ Characterization ☐ Equipment ☐ Routine ☐ Uppost/Downpost ☑ Miscellaneous Page 1 of 1

Survey Number: WVDP-MIS-034-8912 Date: 8/9/2012 Time: 0752 RWP No: N/A

Survey Location (Site/Bldg) WVDP Room/Area/Item Sample Location:Bkg. Area 02- Sample #08

Purpose of Survey: Down Hole Logging

Remarks: To 4 feet

Technician:	Michael Carlin		Badge	N/A	Technician:	N/A		Badge	N/A
Detector Type	Inst. Serial No.	Cal Due	Bkgd.		Detector Type	Inst. Serial No.	Cal Due	Bkgd.	
2221/44-62	184010/PR212708	6/19/2013	514 cpm						

Item No.	Radiation Type	cpm	30 cm Dose Rate	General Area Dose Rate	Sample Location and/or Remarks
0.5 ft.	GAMMA	762	N/A	N/A	Bkg.-1-08
1 ft.	GAMMA	802			Bkg.-1-08
1.5 ft.	GAMMA	756			Bkg.-1-08
2 ft.	GAMMA	794			Bkg.-1-08
2.5 ft.	GAMMA	792			Bkg.-1-08
3 ft.	GAMMA	714			Bkg.-1-08
3.5 ft.	GAMMA	684			Bkg.-1-08
4 ft.	GAMMA	688			Bkg.-1-08

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Signature Date Signature Date

Note: Any response of the instrument that is above the Critcal Detection Level (or Lc) is considered to be above background.

RADIOLOGICAL SURVEY FORM

Survey Type: ☐ Job Coverage ☐ Characterization ☐ Equipment ☐ Routine ☐ Uppost/Downpost ☑ Miscellaneous Page 1 of 1

Survey Number: WVDP-MIS-035-8912 Date: 8/9/2012 Time: 0730 RWP No: N/A

Survey Location (Site/Bldg) WVDP Room/Area/Item Sample Location:Bkg. Area 02- Sample #09

Purpose of Survey: Down Hole Logging

Remarks: To 4 feet

Technician:	Michael Carlin		Badge N/A	Technician:	N/A		Badge N/A
Detector Type	Inst. Serial No.	Cal Due	Bkgd.	Detector Type	Inst. Serial No.	Cal Due	Bkgd.
2221/44-62	184010/PR212708	6/19/2013	474 cpm				

Item No.	Radiation Type	cpm	30 cm Dose Rate	General Area Dose Rate	Sample Location and/or Remarks
0.5 ft.	GAMMA	976	N/A	N/A	Bkg.-1-09
1 ft.	GAMMA	1035			Bkg.-1-09
1.5 ft.	GAMMA	1060			Bkg.-1-09
2 ft.	GAMMA	1157			Bkg.-1-09
2.5 ft.	GAMMA	1141			Bkg.-1-09
3 ft.	GAMMA	1068			Bkg.-1-09
3.5 ft.	GAMMA	1222			Bkg.-1-09
4 ft.	GAMMA	1125			Bkg.-1-09

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Signature Date

Note: Any response of the Instrument that is above the Critcal Detection Level (or Lc) is considered to be above background.

RADIOLOGICAL SURVEY FORM

Survey Type: ☐ Job Coverage ☐ Characterization ☐ Equipment ☐ Routine ☐ Uppost/Downpost ☑ Miscellaneous Page 1 of 1

Survey Number: WVDP-MIS-036-8912 Date: 8/9/2012 Time: 0742 RWP No: N/A

Survey Location (Site/Bldg) WVDP Room/Area/Item Sample Location:Bkg. Area 02- Sample #10

Purpose of Survey: Down Hole Logging

Remarks: To 4 feet

Technician:	Michael Carlin		Badge N/A	Technician:	N/A		Badge N/A
Detector Type	Inst. Serial No.	Cal Due	Bkgd.	Detector Type	Inst. Serial No.	Cal Due	Bkgd.
2221/44-62	184010/PR212708	6/19/2013	405 cpm				

Item No.	Radiation Type	cpm	30 cm Dose Rate	General Area Dose Rate	Sample Location and/or Remarks
0.5 ft.	GAMMA	874	N/A	N/A	Bkg.-1-10
1 ft.	GAMMA	925			Bkg.-1-10
1.5 ft.	GAMMA	930			Bkg.-1-10
2 ft.	GAMMA	997			Bkg.-1-10
2.5 ft.	GAMMA	872			Bkg.-1-10
3 ft.	GAMMA	908			Bkg.-1-10
3.5 ft.	GAMMA	981			Bkg.-1-10
4 ft.	GAMMA	925			Bkg.-1-10
			↓	↓	

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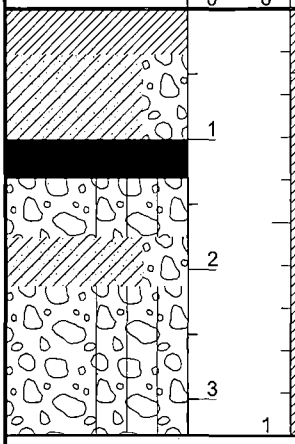
Signature Date Signature Date

RCT Supervisor Review _____ / _____ Surveyed By _____ / _____
Signature Date Signature Date

Note: Any response of the Instrument that is above the Critcal Detection Level (or Lc) is considered to be above background.

PROJECT: West Valley Demonstration Project		**BOREHOLE:** BKG-01-01	**Page 1 of 1**
PHASE/TASK: 05 Balance of Site Facilities Radiological Characterization		**SURVEY UNIT:** Background Area 1	
DRILLING METHOD: Direct Push	**BOREHOLE DEPTH:** 3.3 ft	**Borehole Diameter:** 2.25 inches	
LOGGED BY: Eric Koenig	**DATE STARTED:** 8/1/2012	**DATE COMPLETED:** 8/1/2012	
X: 1133639.664 ft[1]	**Y:** 885995.229 ft[1]	**ELEVATION:** 1440.243 ft MSL	

GRAPHIC LOG	DEPTH (ft)	DEPTH (m)	SAMPLE INTERVAL	U.S.C.S.	MATERIAL DESCRIPTION	REMARKS
	0	0		CL	**Clay**, medium plasticity, trace gravel, subround, up to 1/2 inch (1.3 cm), subround, 10YR3/3 Dark Brown.	
	1			SC	**Clayey Sand with Gravel**, medium plasticity, gravel up to 3/4 inch, subround to subangular.	
					Dark, organic matter	
				GP-GM	**Gravel with Silt and Sand**, subround to subangular, up to 3/4 inch.	
	2			SC	**Clayey Sand with Gravel**, medium plasticity.	
	3	1		GP-GM	**Gravel with Silt and Sand**, up to 3/4 inch, subround to subangular; 2.5Y4/3 Olive Brown	

Bottom of borehole at 3.3 feet (1.0 m).

[1] **US State Plane, New York West 3103, NAD83 (feet)**

NOTES:

PROJECT: West Valley Demonstration Project	**BOREHOLE:** BKG-01-02	**Page 1 of 1**
PHASE/TASK: 05 Balance of Site Facilities Radiological Characterization	**SURVEY UNIT:** Background Area 1	
DRILLING METHOD: Direct Push / **BOREHOLE DEPTH:** 3.3 ft	**Borehole Diameter:** 2.25 inches	
LOGGED BY: Eric Koenig / **DATE STARTED:** 8/1/2012	**DATE COMPLETED:** 8/1/2012	
X: 1133582.488 ft[1] / **Y:** 886051.765 ft[1]	**ELEVATION:** 1440.075 ft MSL	

GRAPHIC LOG	DEPTH (ft)	DEPTH (m)	SAMPLE INTERVAL	U.S.C.S.	MATERIAL DESCRIPTION	REMARKS
	0	0		CL	**Clay with Gravel and Organic Matter**, low- to medium plasticity; gravel subround, up to 3/4 inch (1.9 cm); 10YR3/2, Very Dark Grayish Brown.	
					Clay, medium plasticity; trace gravel; 2.5Y3/1 Very Dark Gray.	
	1			SC	**Clayey Sand with gravel**, medium plasticity.	
				CL	**Clay**, medium plasticity; trace gravel; 2.5Y3/2 Very Dark Grayish Brown.	
	2				Gravel horizon	
				CL	**Clay**, medium plasticity, 5Y3/1 Very Dark Gray.	
	3	1				

Bottom of borehole at 3.3 feet (1.0 m).

[1] **US State Plane, New York West 3103, NAD83 (feet)**

NOTES:

PROJECT: West Valley Demonstration Project	**BOREHOLE:** BKG-01-03	**Page 1 of 1**
PHASE/TASK: 05 Balance of Site Facilities Radiological Characterization	**SURVEY UNIT:** Background Area 1	
DRILLING METHOD: Direct Push	**BOREHOLE DEPTH:** 3.3 ft	**Borehole Diameter:** 2.25 inches
LOGGED BY: Eric Koenig	**DATE STARTED:** 7/31/2012	**DATE COMPLETED:** 7/31/2012
X: 1133616.68 ft[1]	**Y:** 886039.346 ft[1]	**ELEVATION:** 1440.304 ft MSL

GRAPHIC LOG	DEPTH (ft)	DEPTH (m)	SAMPLE INTERVAL	U.S.C.S.	MATERIAL DESCRIPTION	REMARKS
	0	0		SC-SM	**Silty Clayey Sand**, low plasticity, medium grained; trace gravel, subround, up to 3/4 inch (1.9 cm); 10YR3/3 Dark Brown.	
	1			SM	**Silty Sand with Gravel**, medium- to coarse grained, non-plastic; gravel subround to subangular, up to 1 inch (2.5 cm); 2.5Y3/3 Dark Olive Brown.	
	2				Gravel horizon, subangular, up to 1 inch (2.5 cm).	
	3			SM	**Silty Sand with Gravel**, medium- to coarse grained; gravel subround, up to 1/2 inch (1.3 cm).	
		1			Bottom of borehole at 3.3 feet (1.0 m).	

[1] **US State Plane, New York West 3103, NAD83 (feet)**

NOTES:

PROJECT: West Valley Demonstration Project		**BOREHOLE:** BKG-01-04	**Page 1 of 1**
PHASE/TASK: 05 Balance of Site Facilities Radiological Characterization		**SURVEY UNIT:** Background Area 1	
DRILLING METHOD: Direct Push	**BOREHOLE DEPTH:** 3.3 ft	**Borehole Diameter:** 2.25 inches	
LOGGED BY: Eric Koenig	**DATE STARTED:** 7/31/2012	**DATE COMPLETED:** 7/31/2012	
X: 1133666.498 ft[1]	**Y:** 886036.537 ft[1]	**ELEVATION:** 1438.849 ft MSL	

GRAPHIC LOG	DEPTH (ft)	DEPTH (m)	SAMPLE INTERVAL	U.S.C.S.	MATERIAL DESCRIPTION	REMARKS
	0	0		CL	**Clay with Gravel and Organic Matter**, low to medium plasticity; gravel subround, up to 3/4 inch (1.9cm); 10YR3/2 Very Dark Grayish Brown.	
	1			SC	**Clayey Sand with Gravel**, low- to medium plasticity; gravel subround to subangular, up to 1/2 inch (1.3 cm); 10YR4/2 Dark Grayish Brown	
	2					
	3	1		SM	**Silty Sand with Gravel**, non-plastic, medium to coarse; gravel subround to subangular, up to 1/2 inch (1.3 cm); 10YR4/4 Dark Yellowish Brown.	

Bottom of borehole at 3.3 feet (1.0 m).

[1] **US State Plane, New York West 3103, NAD83 (feet)**

NOTES:

PROJECT: West Valley Demonstration Project		**BOREHOLE:** BKG-01-05	**Page 1 of 1**
PHASE/TASK: 05 Balance of Site Facilities Radiological Characterization		**SURVEY UNIT:** Background Area 1	
DRILLING METHOD: Direct Push	**BOREHOLE DEPTH:** 3.3 ft	**Borehole Diameter:** 2.25 inches	
LOGGED BY: Eric Koenig	**DATE STARTED:** 7/31/2012	**DATE COMPLETED:** 7/31/2012	
X: 1133491.662 ft[1]	**Y:** 886082.253 ft[1]	**ELEVATION:** 1440.165 ft MSL	

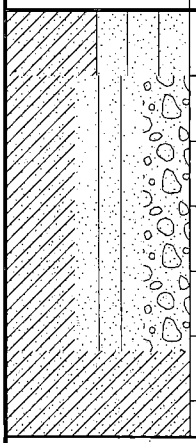
GRAPHIC LOG	DEPTH (ft)	DEPTH (m)	SAMPLE INTERVAL	U.S.C.S.	MATERIAL DESCRIPTION	REMARKS
	0	0		SC-SM	**Silty Clayey Sand and Organic Matter**, medium grained, low plasticity; trace gravel, subround, up to 1 inch (2.5 cm); 10YR3/2 Very Dark Grayish Brown.	
	1			SC-SM	**Silty Clayey Sand**, medium- to coarse grained, low plasticity; trace gravel, subround to subangular, up to 3/4 inch (1.9 cm); 10YR4/4 Dark Yellowish Brown.	
	2					
	3	1		GP-GM	**Gravel, Poorly Graded, with Silt and Sand**, angular, up to 3/4 inch (1.9 cm); 2.5Y4/4 Olive Brown.	

Bottom of borehole at 3.3 feet (1.0 m).

[1] **US State Plane, New York West 3103, NAD83 (feet)**

NOTES:

PROJECT: West Valley Demonstration Project		**BOREHOLE:** BKG-01-06
PHASE/TASK: 05 Balance of Site Facilities Radiological Characterization		**SURVEY UNIT:** Background Area 1
DRILLING METHOD: Direct Push	**BOREHOLE DEPTH:** 3.3 ft	**Borehole Diameter:** 2.25 inches
LOGGED BY: Eric Koenig	**DATE STARTED:** 7/31/2012	**DATE COMPLETED:** 7/31/2012
X: 1133542.178 ft[1]	**Y:** 886081.266 ft[1]	**ELEVATION:** 1440.282 ft MSL

GRAPHIC LOG	DEPTH (ft)	DEPTH (m)	SAMPLE INTERVAL	U.S.C.S.	MATERIAL DESCRIPTION	REMARKS
	0	0		SC-SM	**Silty Clayey Sand and Organic Matter,** low plasticity; little gravel, subround to subangular, up to 1/2 inch (1.3 cm); 2.5Y3/2 Very Dark Grayish Brown.	
	1				**Silty Clayey Sand with Gravel,** low plasticity; gravel subround to subangular, up to 1 inch (2.5 cm).	
	2					
	3			SC	**Clayey Sand**, medium plasticity, medium- to coarse grained; trace gravel, subround, up to 3/4 inch (1.9cm); 2.5Y3/3 Dark Olive Brown.	
		1				

Bottom of borehole at 3.3 feet (1.0 m).

[1] **US State Plane, New York West 3103, NAD83 (feet)**

NOTES:

PROJECT: West Valley Demonstration Project		**BOREHOLE:** BKG-01-07	**Page 1 of 1**
PHASE/TASK: 05 Balance of Site Facilities Radiological Characterization		**SURVEY UNIT:** Background Area 1	
DRILLING METHOD: Direct Push	**BOREHOLE DEPTH:** 3.3 ft	**Borehole Diameter:** 2.25 inches	
LOGGED BY: Eric Koenig	**DATE STARTED:** 7/31/2012	**DATE COMPLETED:** 7/31/2012	
X: 1133588.142 ft[1]	**Y:** 886082.093 ft[1]	**ELEVATION:** 1439.567 ft MSL	

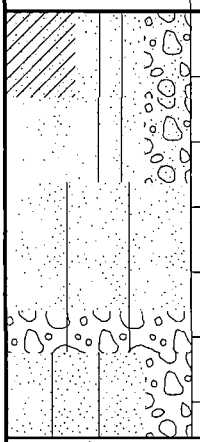
GRAPHIC LOG	DEPTH (ft)	DEPTH (m)	SAMPLE INTERVAL	U.S.C.S.	MATERIAL DESCRIPTION	REMARKS
	0	0		CL	**Clay and Organic Matter**, low plasticity; trace gravel, subround to subangular, up to 3/4 inch (1.9 cm); 2.5Y3/2 Very Dark Grayish Brown.	
	1			SC	**Clayey Sand with Gravel**, medium plasticity; gravel subangular, up to 3/4 inch (1.9 cm).	
	2			GP-GM	**Gravel, Poorly Graded, with Silt and Sand**, subangular, up to 1 inch (2.5 cm).	
	3			CL	**Clay**, medium plasticity; trace gravel up to 1/2 inch (1.3 cm).	
		1				

Bottom of borehole at 3.3 feet (1.0 m).

[1] **US State Plane, New York West 3103, NAD83 (feet)**

NOTES:

PROJECT: West Valley Demonstration Project	**BOREHOLE:** BKG-01-08	**Page 1 of 1**
PHASE/TASK: 05 Balance of Site Facilities Radiological Characterization	**SURVEY UNIT:** Background Area 1	
DRILLING METHOD: Direct Push	**BOREHOLE DEPTH:** 3.3 ft	**Borehole Diameter:** 2.25 inches
LOGGED BY: Eric Koenig	**DATE STARTED:** 7/31/2012	**DATE COMPLETED:** 8/1/2012
X: 1133638.764 ft[1]	**Y:** 886081.674 ft[1]	**ELEVATION:** 1439.738 ft MSL

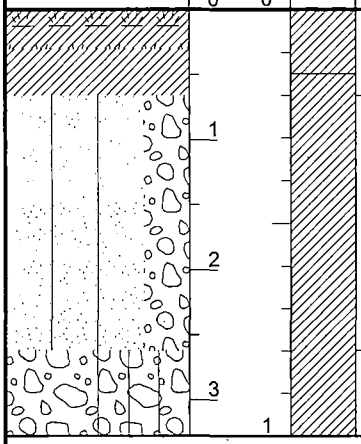
GRAPHIC LOG	DEPTH (ft)	DEPTH (m)	SAMPLE INTERVAL	U.S.C.S.	MATERIAL DESCRIPTION	REMARKS
	0	0		SC-SM	**Silty Clayey Sand with Gravel**, medium- to coarse grained, low plasticity; gravel subround to subangular, up to 1.5 inches (3.8 cm); 10YR3/2 Very Dark Grayish Brown.	
	1			SP-SM	**Sand, Poorly Graded, with Silt and Gravel**, coarse.	
	2			SM	**Silty Sand**, non-plastic, coarse; 10YR 3/4 Dark Yellowish Brown.	
				GM	**Silty Gravel with Sand**; gravel poorly graded, angular, up to 1 inch (2.5 cm).	
	3	1		SM	**Silty Sand with Gravel**, medium- to coarse grained, non-plastic; gravel subround to subangular, up to 3/4 inch (1.9 cm).	

Bottom of borehole at 3.3 feet (1.0 m).

[1] **US State Plane, New York West 3103, NAD83 (feet)**

NOTES:

PROJECT: West Valley Demonstration Project	**BOREHOLE:** BKG-01-09	**Page 1 of 1**
PHASE/TASK: 05 Balance of Site Facilities Radiological Characterization	**SURVEY UNIT:** Background Area 1	
DRILLING METHOD: Direct Push	**BOREHOLE DEPTH:** 3.3 ft	**Borehole Diameter:** 2.25 inches
LOGGED BY: Eric Koenig	**DATE STARTED:** 8/1/2012	**DATE COMPLETED:** 8/1/2012
X: 1133511.149 ft[1]	**Y:** 886129.596 ft[1]	**ELEVATION:** 1438.671 ft MSL

GRAPHIC LOG	DEPTH (ft)	DEPTH (m)	SAMPLE INTERVAL	U.S.C.S.	MATERIAL DESCRIPTION	REMARKS
	0	0		CL	**Clay and Organic Matter**, low- to medium plasticity, trace coarse sand/finegravel up to 2 inches (5.1 cm); 10YR3/3 Dark Brown.	
	1			SM	**Silty Sand with Gravel**, fine- to medium grained; gravel round to subround, up to 2 inches (5.1 cm); 10YR4/4 Dark Yellowish Brown.	
	2					
	3			GP-GM	**Gravel, Poorly Graded, with Silt and Sand**, up to 2 inches (5.1 cm), round to subround; 2.5Y4/4 Olive Brown.	
		1				

Bottom of borehole at 3.3 feet (1.0 m).

[1] **US State Plane, New York West 3103, NAD83 (feet)**

NOTES:

PROJECT: West Valley Demonstration Project	**BOREHOLE:** BKG-01-10	**Page 1 of 1**
PHASE/TASK: 05 Balance of Site Facilities Radiological Characterization	**SURVEY UNIT:** Background Area 1	
DRILLING METHOD: Direct Push	**BOREHOLE DEPTH:** 3.3 ft	**Borehole Diameter:** 2.25 inches
LOGGED BY: Eric Koenig	**DATE STARTED:** 7/31/2012	**DATE COMPLETED:** 7/31/2012
X: 1133560.343 ft[1]	**Y:** 886132.389 ft[1]	**ELEVATION:** 1439.345 ft MSL

GRAPHIC LOG	DEPTH (ft)	DEPTH (m)	SAMPLE INTERVAL	U.S.C.S.	MATERIAL DESCRIPTION	REMARKS
	0	0		GC	**Clayey Gravel and Organic Material**, poorly graded, subround up to 2 inches (5.1 cm); 10YR3/3 Dark Brown.	
	1			CL	**Clay**, low- to medium plasticity, trace gravel up to 1 inch (2.5 cm); 10 YR3/3 Dark Brown.	
	2			SC-SM	**Silty Clayey Sand**, fine- to medium grained, low plasticity; trace gravel up to 1 inch (2.5 cm); 10YR4/4 Dark Yellowish Brown.	
	3	1		SC	**Clayey Sand**, low- to medium plasticity; 10YR3/4 Dark Yellowish Brown.	

Bottom of borehole at 3.3 feet (1.0 m).

[1] **US State Plane, New York West 3103, NAD83 (feet)**

NOTES:

PROJECT: West Valley Demonstration Project		**BOREHOLE:** BKG-02-01	**Page 1 of 1**
PHASE/TASK: 05 Balance of Site Facilities Radiological Characterization		**SURVEY UNIT:** Background Area 2	
DRILLING METHOD: Direct Push	**BOREHOLE DEPTH:** 4.0 ft	**Borehole Diameter:** 2.25 inches	
LOGGED BY: Eric Koenig	**DATE STARTED:** 8/9/2012	**DATE COMPLETED:** 8/9/2012	
X: 1134457.852 ft[1]	**Y:** 890110.917 ft[1]	**ELEVATION:** 1394.762 ft MSL	

GRAPHIC LOG	DEPTH (ft)	DEPTH (m)	SAMPLE INTERVAL	U.S.C.S.	MATERIAL DESCRIPTION	REMARKS
	0	0		CL-ML	**Silty Clay with Organic Material**, low plasticity; 10YR3/2 Very Dark Grayish Brown.	
	1			CL	**Clay with Sand**, medium plasticity; trace gavel,up to 3/4 inch (1.9 cm); 10YR4/3 Brown.	
	2			CL	**Clay**, medium plasticity, firm to stiff; 2.5Y4/3 Olive Brown.	
	3	1		SC	**Clayey Sand with Gravel**, medium plasticity.	
	4			CL	**Clay**, medium plasticity, firm to stiff; 2.5Y4/3 Olive Brown.	

Bottom of borehole at 4.0 feet (1.2 m).

[1] **US State Plane, New York West 3103, NAD83 (feet)**

NOTES: Background Area 2 is in the Lavery Till

PROJECT: West Valley Demonstration Project	**BOREHOLE:** BKG-02-02	**Page 1 of 1**
PHASE/TASK: 05 Balance of Site Facilities Radiological Characterization	**SURVEY UNIT:** Background Area 2	
DRILLING METHOD: Direct Push	**BOREHOLE DEPTH:** 4.0 ft	**Borehole Diameter:** 2.25 inches
LOGGED BY: Eric Koenig	**DATE STARTED:** 8/9/2012	**DATE COMPLETED:** 8/9/2012
X: 1134506.751 ft[1]	**Y:** 890108.926 ft[1]	**ELEVATION:** 1395.245 ft MSL

GRAPHIC LOG	DEPTH (ft)	DEPTH (m)	SAMPLE INTERVAL	U.S.C.S.	MATERIAL DESCRIPTION	REMARKS
	0	0		CL	**Clay and Organic Matter**, medium plasticity, soft; 10YR4/2 Dark Grayish Brown.	
	1				**Clay**, medium plasticity, firm to stiff, trace gravel; 2.5Y4/1 Dark Gray.	
	2					
	3					
		1				
	4					

Bottom of borehole at 4.0 feet (1.2 m).

[1] **US State Plane, New York West 3103, NAD83 (feet)**

NOTES: Background Area 2 is in the Lavery Till

PROJECT: West Valley Demonstration Project		**BOREHOLE:** BKG-02-03	**Page 1 of 1**
PHASE/TASK: 05 Balance of Site Facilities Radiological Characterization		**SURVEY UNIT:** Background Area 2	
DRILLING METHOD: Direct Push	**BOREHOLE DEPTH:** 4.0 ft	**Borehole Diameter:** 2.25 inches	
LOGGED BY: Eric Koenig	**DATE STARTED:** 8/8/2012	**DATE COMPLETED:** 8/8/2012	
X: 1134484.737 ft[1]	**Y:** 890066.994 ft[1]	**ELEVATION:** 1395.508 ft MSL	

GRAPHIC LOG	DEPTH (ft)	DEPTH (m)	SAMPLE INTERVAL	U.S.C.S.	MATERIAL DESCRIPTION	REMARKS
	0	0		SC-SM	**Silty Clayey Sand with Organic Matter**, low plasticity; 2.5Y3/2 Very dark Grayish Brown.	
	1			SC	**Clayey Sand**, medium plasticity; trace fine rounded gravel up to 1/4 inch (0.6 cm); 2.5Y 4/3 Olive Brown.	
	2					
	3	1		CL	**Clay**, medium plasticity, firm to stiff; variegated Dark Gray and Dark Grayish Brown.	
	4					

Bottom of borehole at 4.0 feet (1.2 m).

[1] **US State Plane, New York West 3103, NAD83 (feet)**

NOTES: Background Area 2 is in the Lavery Till

PROJECT: West Valley Demonstration Project		**BOREHOLE:** BKG-02-04	**Page 1 of 1**
PHASE/TASK: 05 Balance of Site Facilities Radiological Characterization		**SURVEY UNIT:** Background Area 2	
DRILLING METHOD: Direct Push	**BOREHOLE DEPTH:** 4.0 ft	**Borehole Diameter:** 2.25 inches	
LOGGED BY: Eric Koenig	**DATE STARTED:** 8/8/2012	**DATE COMPLETED:** 8/8/2012	
X: 1134534.07 ft[1]	**Y:** 890069.027 ft[1]	**ELEVATION:** 1395.804 ft MSL	

GRAPHIC LOG	DEPTH (ft)	DEPTH (m)	SAMPLE INTERVAL	U.S.C.S.	MATERIAL DESCRIPTION	REMARKS
	0	0		SC-SM	**Silty Clayey Sand with Organic Material**, low plasticity; 2.5Y3/2 Very Dark Grayish Brown.	
	1			CL	**Clay**, medium plasticity, firm to stiff, variegated Dark Gray to Dark Grayish Brown.	
	2					
	3	1				
	4					

Bottom of borehole at 4.0 feet (1.2 m).

[1] **US State Plane, New York West 3103, NAD83 (feet)**

NOTES: Background Area 2 is in the Lavery Till

PROJECT: West Valley Demonstration Project		**BOREHOLE:** BKG-02-05	**Page 1 of 1**
PHASE/TASK: 05 Balance of Site Facilities Radiological Characterization		**SURVEY UNIT:** Background Area 2	
DRILLING METHOD: Direct Push	**BOREHOLE DEPTH:** 4.0 ft	**Borehole Diameter:** 2.25 inches	
LOGGED BY: Eric Koenig	**DATE STARTED:** 8/8/2012	**DATE COMPLETED:** 8/8/2012	
X: 1134507.902 ft[1]	**Y:** 890024.338 ft[1]	**ELEVATION:** 1396.154 ft MSL	

GRAPHIC LOG	DEPTH (ft)	DEPTH (m)	SAMPLE INTERVAL	U.S.C.S.	MATERIAL DESCRIPTION	REMARKS
	0	0		CL-ML	**Silty Clay and Organic Material**, low plasticity, 2.5Y3/3 Dark Olive Brown.	
	1			CL-ML	**Silty Clay**, low plasticity, 2.5Y5/4 Light Olive Brown.	
	2					
	3	1		ML	**Silt**, grading to **Silty Clay with Fine Sand**, 2.5Y4/3 Olive Brown.	
	4			CL-ML		

Bottom of borehole at 4.0 feet (1.2 m).

[1] **US State Plane, New York West 3103, NAD83 (feet)**

NOTES: Background Area 2 is in the Lavery Till

PROJECT: West Valley Demonstration Project	**BOREHOLE:** BKG-02-06	**Page 1 of 1**
PHASE/TASK: 05 Balance of Site Facilities Radiological Characterization	**SURVEY UNIT:** Background Area 2	
DRILLING METHOD: Direct Push	**BOREHOLE DEPTH:** 8.0 ft	**Borehole Diameter:** 2.25 inches
LOGGED BY: Eric Koenig	**DATE STARTED:** 8/8/2012	**DATE COMPLETED:** 8/8/2012
X: 1134557.031 ft[1]	**Y:** 890023.73 ft[1]	**ELEVATION:** 1396.098 ft MSL

GRAPHIC LOG	DEPTH (ft)	DEPTH (m)	SAMPLE INTERVAL	U.S.C.S.	MATERIAL DESCRIPTION	REMARKS
	0	0		CL-ML	**Silty Clay with Organic Matter**, low plasticity.	
				CL	**Clay**, medium plasticity, firm to stiff; Olive Brown grading to Dark Grayish Brown.	
	1					
	2					
	3	1		SC	**Clayey Sand with Gravel**, medium-to coarse grained, medium plasticity; gravel round to subangular; up to 3/4 inch (1.9 cm); 2.5Y4/2 Dark Grayish Brown.	
	4					
	5					
	6	2		CL	**Clay**, medium plasticity, 2.5Y4/1 Dark Gray.	
	7					
	8			SP	**Sand, Poorly Graded**, medium grained.	

Bottom of borehole at 8.0 feet (2.4 m).

[1] **US State Plane, New York West 3103, NAD83 (feet)**

NOTES: Background Area 2 is in the Lavery Till

PROJECT: West Valley Demonstration Project	**BOREHOLE:** BKG-02-07	**Page 1 of 1**
PHASE/TASK: 05 Balance of Site Facilities Radiological Characterization	**SURVEY UNIT:** Background Area 2	
DRILLING METHOD: Direct Push / **BOREHOLE DEPTH:** 4.0 ft	**Borehole Diameter:** 2.25 inches	
LOGGED BY: Eric Koenig / **DATE STARTED:** 8/8/2012	**DATE COMPLETED:** 8/8/2012	
X: 1134533.251 ft[1] / **Y:** 889979.098 ft[1]	**ELEVATION:** 1396.364 ft MSL	

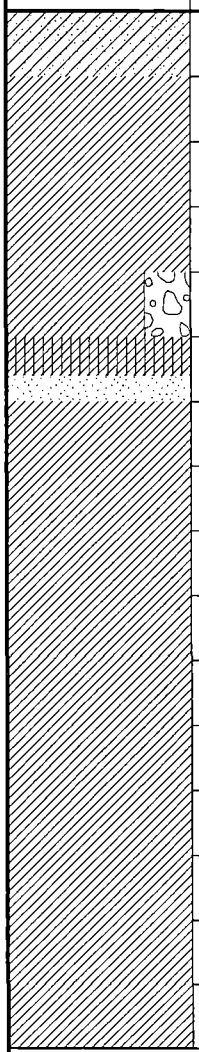
GRAPHIC LOG	DEPTH (ft)	DEPTH (m)	SAMPLE INTERVAL	U.S.C.S.	MATERIAL DESCRIPTION	REMARKS
	0	0		SC-SM	**sSilty Clayey Sand with Organic Matter**, low plasticity, 2.5Y3/2 Very Dark Grayish Brown.	
	1			CL	**Clay with Sand**, medium plasticity, variegated gray and rust brown.	
	2				**Clay with Gravel**, medium plasticity; gravel angular, up to 3/4 inch (1.9 cm); 2.5Y4/3 Olive Brown.	
					Clay, medium plasstícity, firm to stiff; 2.5Y4/1 Dark Gray.	
	3			SP-SM	**Sand, Poorly Graded, with Silt**, medium grained.	
		1		CL	**Clay with Sand and Gravel**, medium plasticity.	
	4					

Bottom of borehole at 4.0 feet (1.2 m).

[1] **US State Plane, New York West 3103, NAD83 (feet)**

NOTES: Background Area 2 is in the Lavery Till

PROJECT: West Valley Demonstration Project	**BOREHOLE:** BKG-02-08	**Page 1 of 1**
PHASE/TASK: 05 Balance of Site Facilities Radiological Characterization	**SURVEY UNIT:** Background Area 2	
DRILLING METHOD: Direct Push	**BOREHOLE DEPTH:** 8.0 ft	**Borehole Diameter:** 2.25 inches
LOGGED BY: Eric Koenig	**DATE STARTED:** 8/8/2012	**DATE COMPLETED:** 8/8/2012
X: 1134583.566 ft[1]	**Y:** 889982.845 ft[1]	**ELEVATION:** 1396.743 ft MSL



DEPTH (ft)	DEPTH (m)	SAMPLE INTERVAL	U.S.C.S.	MATERIAL DESCRIPTION	REMARKS
0	0		SC	**Clayey Sand with Organic Matter**, low plasticity.	
			CL	**Clay**, medium plasticity, variegated Dark Grayish Brown to Dark Gray.	
			CL	**Clay with Gravel and Coarse Sand**, medium plasticity; gravel up to 1/2 inch (1.3 cm).	
			CL-ML	**Silty Clay**, low plasticity, soft, gray.	
			SP	**Sand, Poorly Graded**, medium grained.	
	1		CL	**Clay**, medium plasticity, firm, 2.5Y4/1 Dark Gray.	
	2				
8				Bottom of borehole at 8.0 feet (2.4 m).	

[1] **US State Plane, New York West 3103, NAD83 (feet)**

NOTES: Background Area 2 is in the Lavery Till

PROJECT: West Valley Demonstration Project		**BOREHOLE:** BKG-02-09	**Page 1 of 1**
PHASE/TASK: 05 Balance of Site Facilities Radiological Characterization		**SURVEY UNIT:** Background Area 2	
DRILLING METHOD: Direct Push	**BOREHOLE DEPTH:** 4.0 ft	**Borehole Diameter:** 2.25 inches	
LOGGED BY: Eric Koenig	**DATE STARTED:** 8/8/2012	**DATE COMPLETED:** 8/8/2012	
X: 1134572.237 ft[1]	**Y:** 889949.628 ft[1]	**ELEVATION:** 1396.449 ft MSL	

GRAPHIC LOG	DEPTH (ft)	DEPTH (m)	SAMPLE INTERVAL	U.S.C.S.	MATERIAL DESCRIPTION	REMARKS
	0	0		CL-ML	**Silty Clay with Organic Material,** low plasticity, trace fine gravel up to 1/4 inch (0.6 cm).	
	1			CL	**Clay,** medium plasticity, firm to stiff, variegated Dark Grayish Brown to Dark Gray.	
	2					
	3	1				
	4					

Bottom of borehole at 4.0 feet (1.2 m).

[1] **US State Plane, New York West 3103, NAD83 (feet)**

NOTES: Background Area 2 is in the Lavery Till

PROJECT: West Valley Demonstration Project		**BOREHOLE:** BKG-02-10	**Page 1 of 1**
PHASE/TASK: 05 Balance of Site Facilities Radiological Characterization		**SURVEY UNIT:** Background Area 2	
DRILLING METHOD: Direct Push	**BOREHOLE DEPTH:** 8.0 ft	**Borehole Diameter:** 2.25 inches	
LOGGED BY: Eric Koenig	**DATE STARTED:** 8/8/2012	**DATE COMPLETED:** 8/8/2012	
X: 1134608.726 ft[1]	**Y:** 889936.75 ft[1]	**ELEVATION:** 1396.773 ft MSL	

GRAPHIC LOG	DEPTH (ft)	DEPTH (m)	SAMPLE INTERVAL	U.S.C.S.	MATERIAL DESCRIPTION	REMARKS
	0	0		CL-ML	**Silty Clay with Organic Matter**, low plasticity.	
	1			CL	**Clay**, medium plasticity, firm to stiff; 2.5Y4/2 Dark Grayish Brown.	
	2					
	3	1				
	4			SP	**Sand, Poorly Graded**, medium grained.	
				ML	**Silt, grading to Clay**, wet.	Run 2 (4 to 8 ft/ 1.2 to 2.4 m), recovery ~40%
	5			CL		
				SC	**Clayey Sand with Gravel**, medium platicity, gravel up to 2 inches (5.1 cm).	
	6	2				
	7					
	8					

Bottom of borehole at 8.0 feet (2.4 m).

[1] **US State Plane, New York West 3103, NAD83 (feet)**

NOTES: Background Area 2 is in the Lavery Till

APPENDIX D

Detector Control Charts

APPENDIX D

Detector Control Charts

Example Source and Background Control Charts

Example control charts for the FIDLER detector for source checks and background checks are shown here. Detectors are taken out of service if the source or background checks are not within the required tolerance of 20 percent. If a detector does not pass the morning daily check, the data from the previous day is evaluated for use. The data is not used if erratic readings outside that previously collected for the area used are identified.

One FIDLER detector was taken out of service because it failed the background check above the upper tolerance. The detector was damaged and the failure was due to a light leak. The detector was not returned to service.