

Reference 17-

WVDP Terrestrial Background Study (S&EC, 2014)

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**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**

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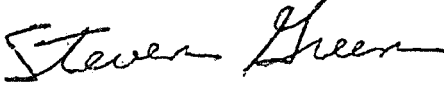
**West Valley Demonstration Project  
Terrestrial Background Study  
U.S. Department of Energy  
West Valley Demonstration Project  
West Valley, New York**

Contract No.: DE-EM0001242

**TBS APPROVALS**

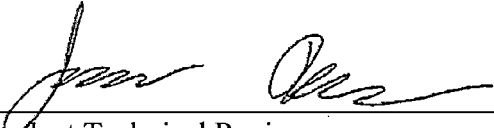
By their specific signature, the undersigned certify that they prepared, reviewed, or provided comments on this Terrestrial Background Study (TBS) for the DOE West Valley Demonstration Project, West Valley, New York.

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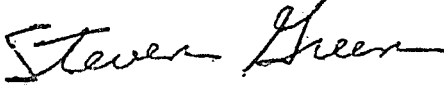
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**ABBREVIATIONS, ACRONYMS, AND SYMBOLS**

|                |   |
|----------------|---|
| 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 <sup>2</sup> | 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) |
|-----------------------|----------------|--|----------------------------------|
| <b>Primary ROIs</b>   |                |  |                                  |
| 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                              |
| <b>Secondary ROIs</b> |                |  |                                  |
| 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  $\pm$  a hundredth of a foot [ $\pm$  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<sup>2</sup>. Ten equally spaced locations representing 200 m<sup>2</sup> 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/<br>240 | Ra-226  | Ra-228  | Sr-90   | U-232    | U-233/<br>234 | U-235/<br>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 | -7.07e-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.<br>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 |

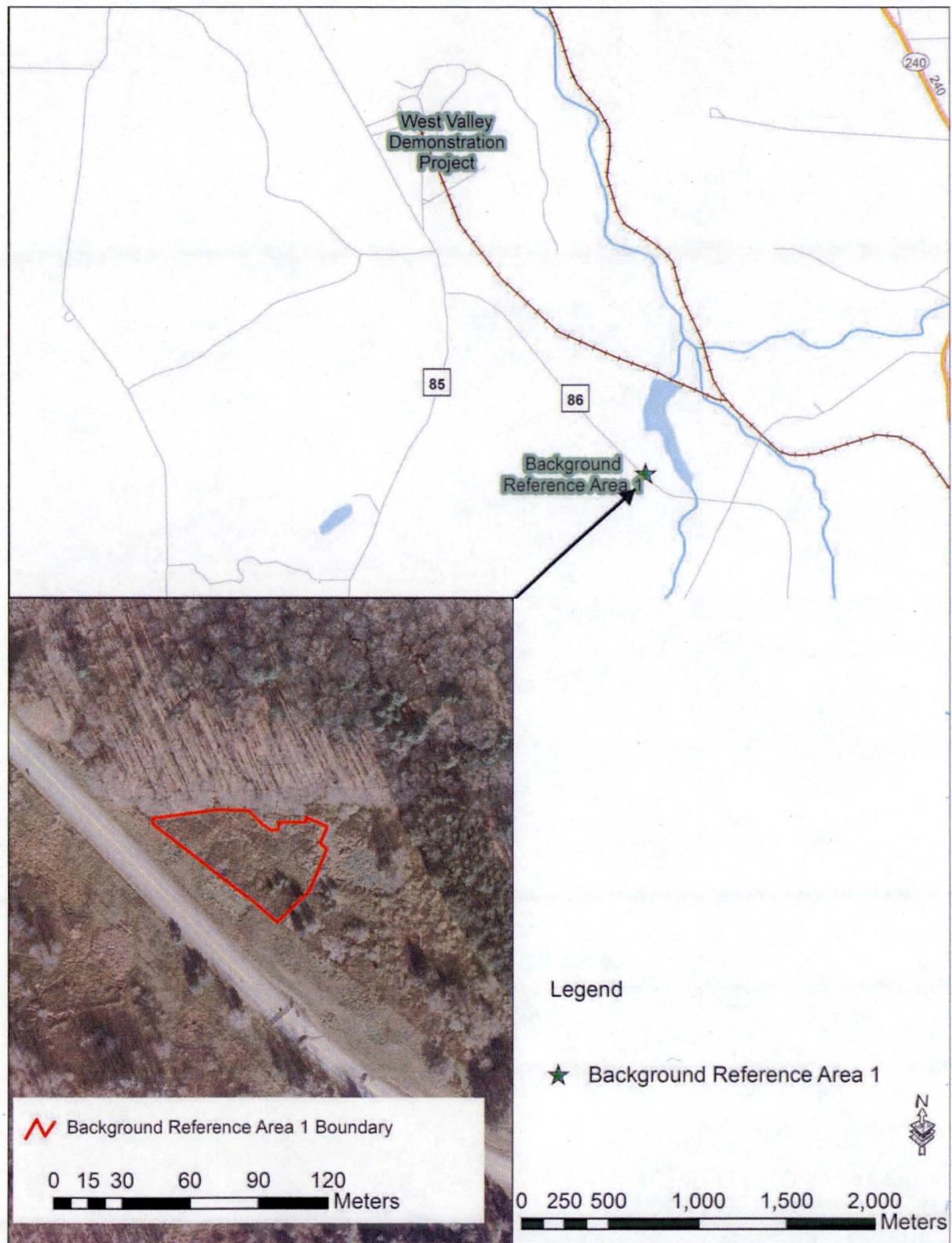


Figure 2-1. Background Reference Area 1



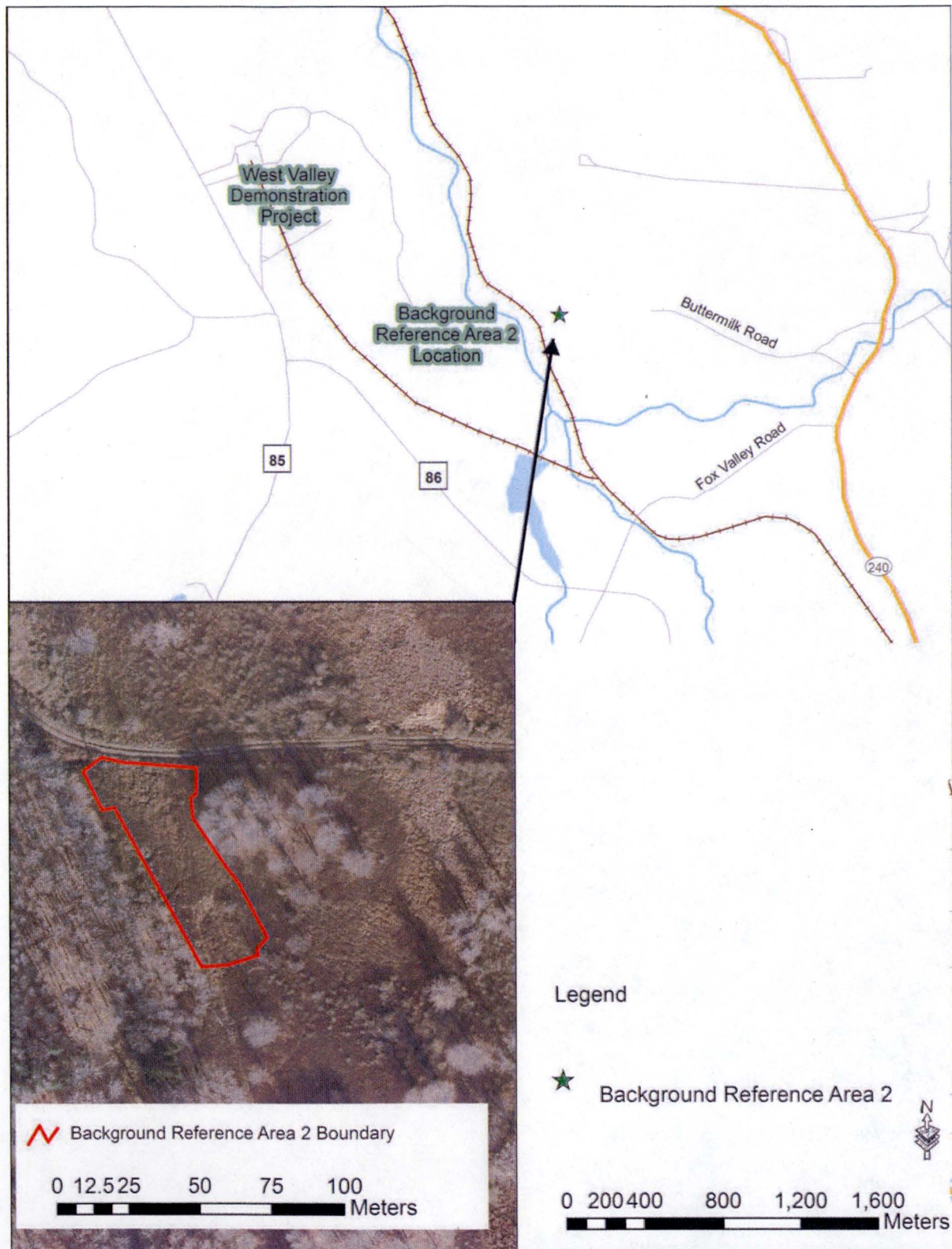


Figure 2-2. Background Reference Area 2

**Table 2-2. Background Reference Area 1 Radionuclide Concentrations**

| Radionuclide         | 0 – 15 cm<br>Average<br>Result<br>(pCi/g) | 0 – 15 cm<br>Standard<br>Deviation<br>(pCi/g) | 0 – 15 cm<br>UTL <sup>1</sup><br>(pCi/g) | 15 – 100 cm<br>Average<br>Result<br>(pCi/g) | 15 – 100 cm<br>Standard<br>Deviation<br>(pCi/g) | 15-100 cm<br>UTL <sup>1</sup><br>(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 <sup>2</sup>   |   |   |  |   |   |  |
| 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 <sup>3</sup> |   |   |  |   |   |  |
| 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 <sup>2</sup>  |   |   |  |   |   |  |
| 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                                    |

<sup>1</sup> Values calculated using the computer program ProUCL.

<sup>2</sup> I-129 and Pa-231 data were rejected during data validation. See *Radiological Interferences Technical Memorandum* for further information (SEC 2013).

<sup>3</sup> 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<sub>0</sub>: 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<br>Average<br>Result<br>(pCi/g) | 0 – 15 cm<br>Standard<br>Deviation<br>(pCi/g) | 0 – 15 cm<br>UTL <sup>1</sup><br>(pCi/g) | 15 – 100 cm<br>Average<br>Result<br>(pCi/g) | 15 – 100 cm<br>Standard<br>Deviation<br>(pCi/g) | 15-100 cm<br>UTL <sup>1</sup><br>(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 <sup>2</sup>   |   |   |  |   |   |  |
| 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                                    |
| U-238                | 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 <sup>3</sup> |   |   |  |   |   |  |
| 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 <sup>2</sup>  |   |   |  |   |   |  |
| 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                                     |

<sup>1</sup> Values calculated using the computer program ProUCL.

<sup>2</sup> I-129 and Pa-231 data were rejected during data validation. See *Radiological Interferences Technical Memorandum* for further information (SEC 2013).

<sup>3</sup> 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.<br>Ref. 1 | Great Valley Vs.<br>Ref. 2 | Ref. 1. Vs. Ref. 2<br>(0 – 15 cm depth) | Ref. 1. Vs. Ref. 2<br>(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.

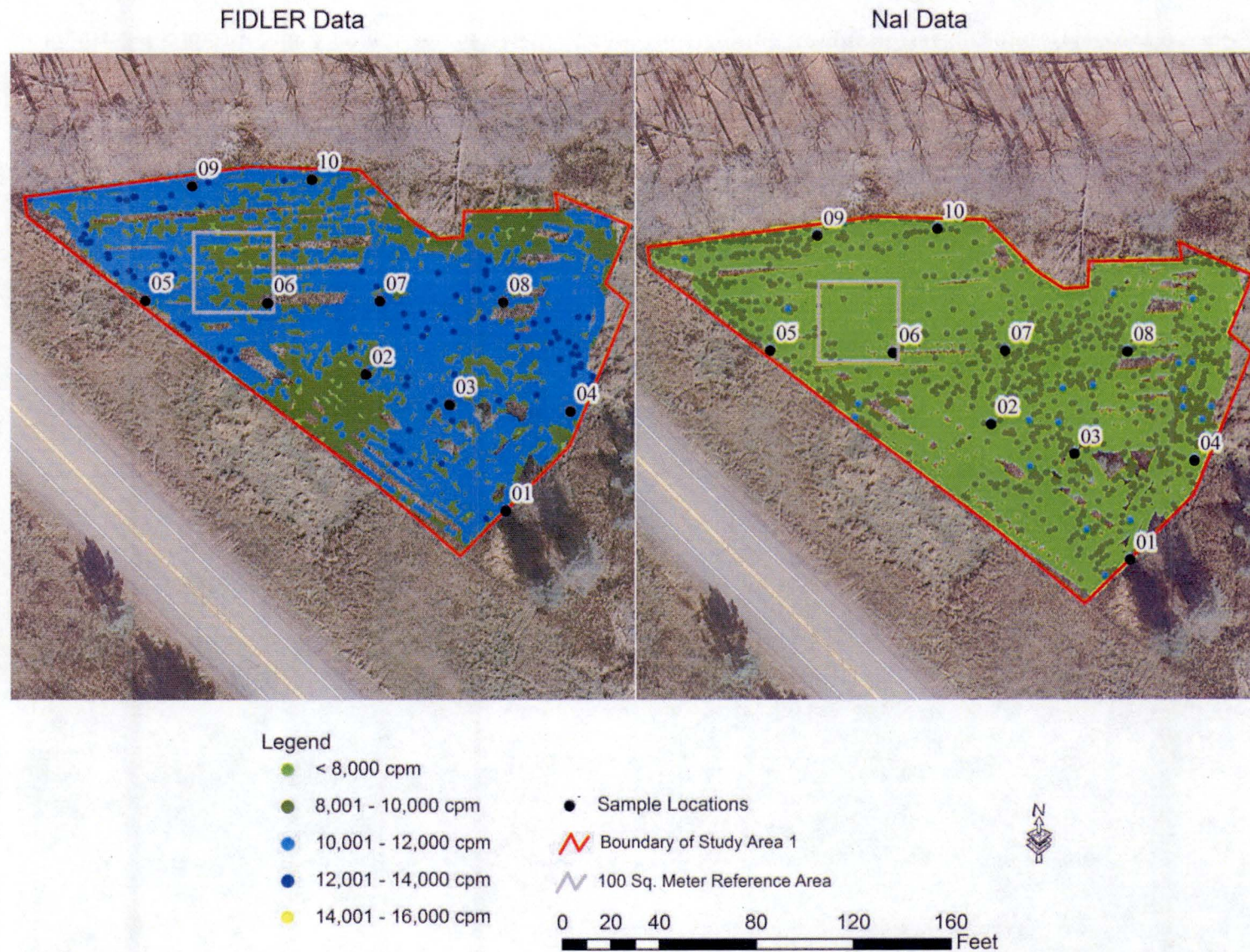
Figures 2-5 through 2-8 are plots of the count rates versus frequency of occurrence. The data are clearly normally distributed as would be expected for background data sets.

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 Reference 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**



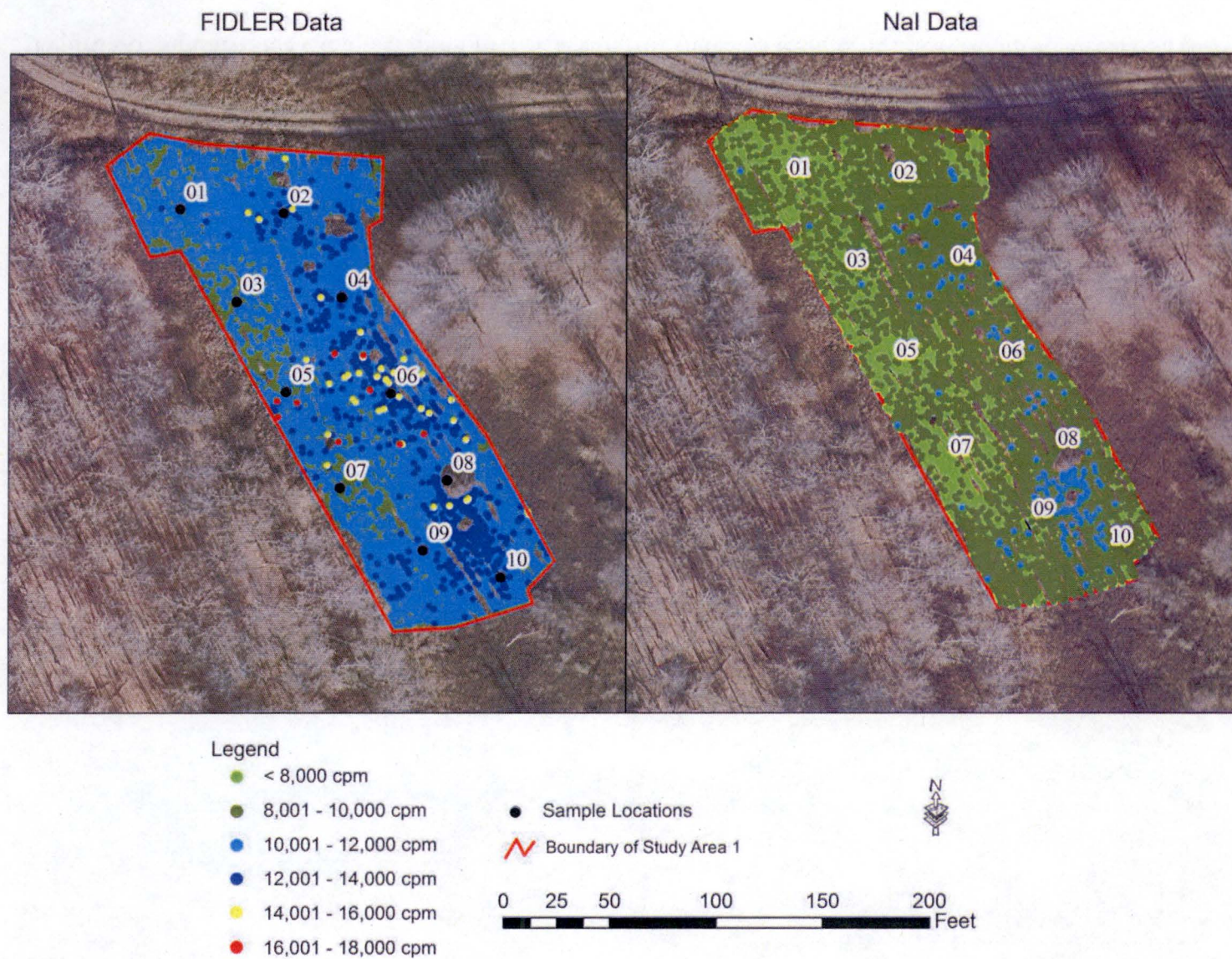
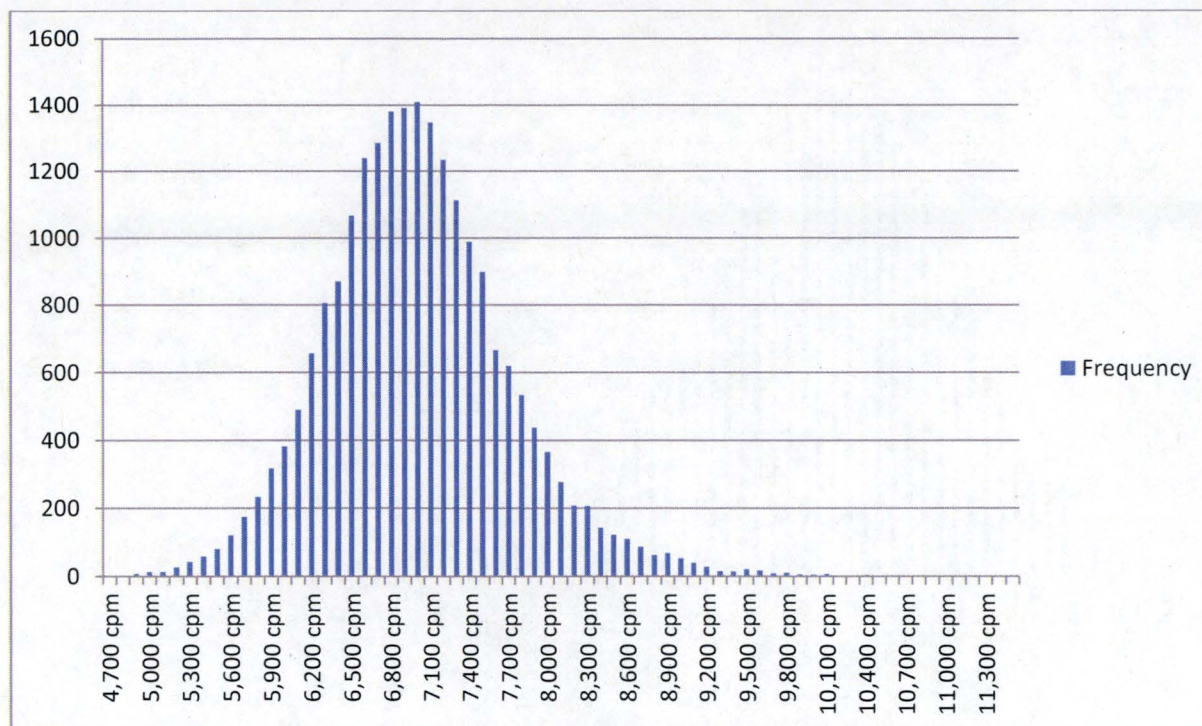
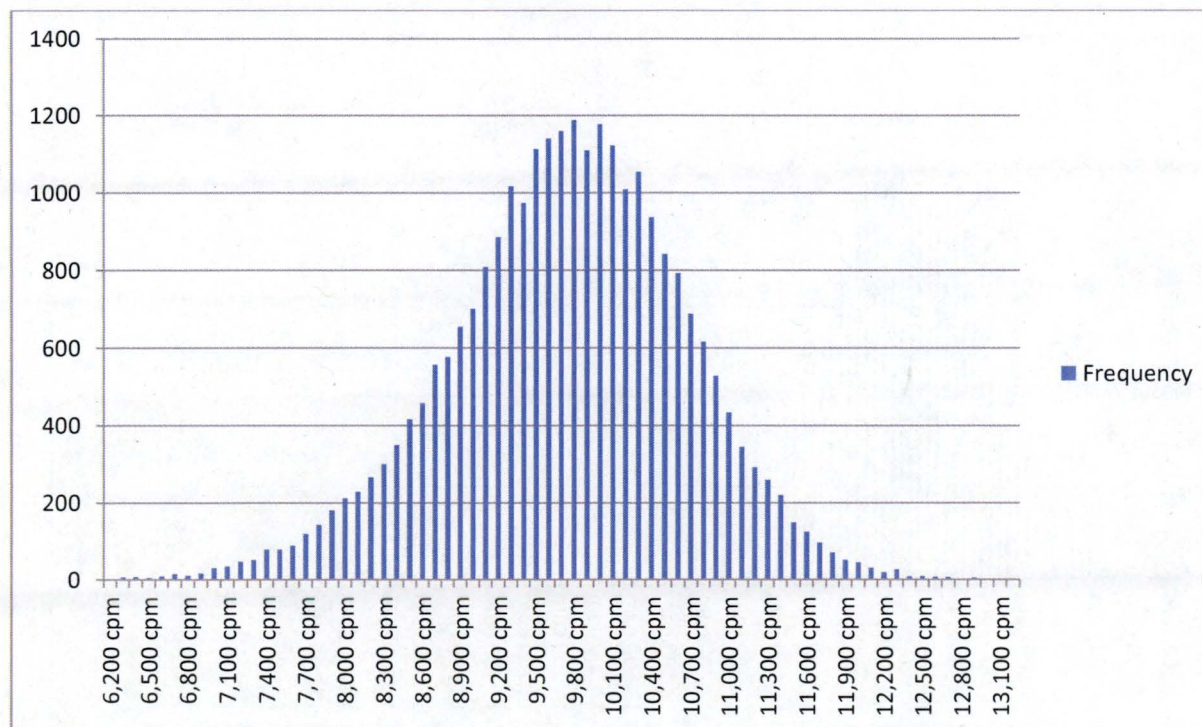


Figure 2-4. Side-by-Side Comparison of FIDLER and NaI Detector Results at Background Reference Area 2



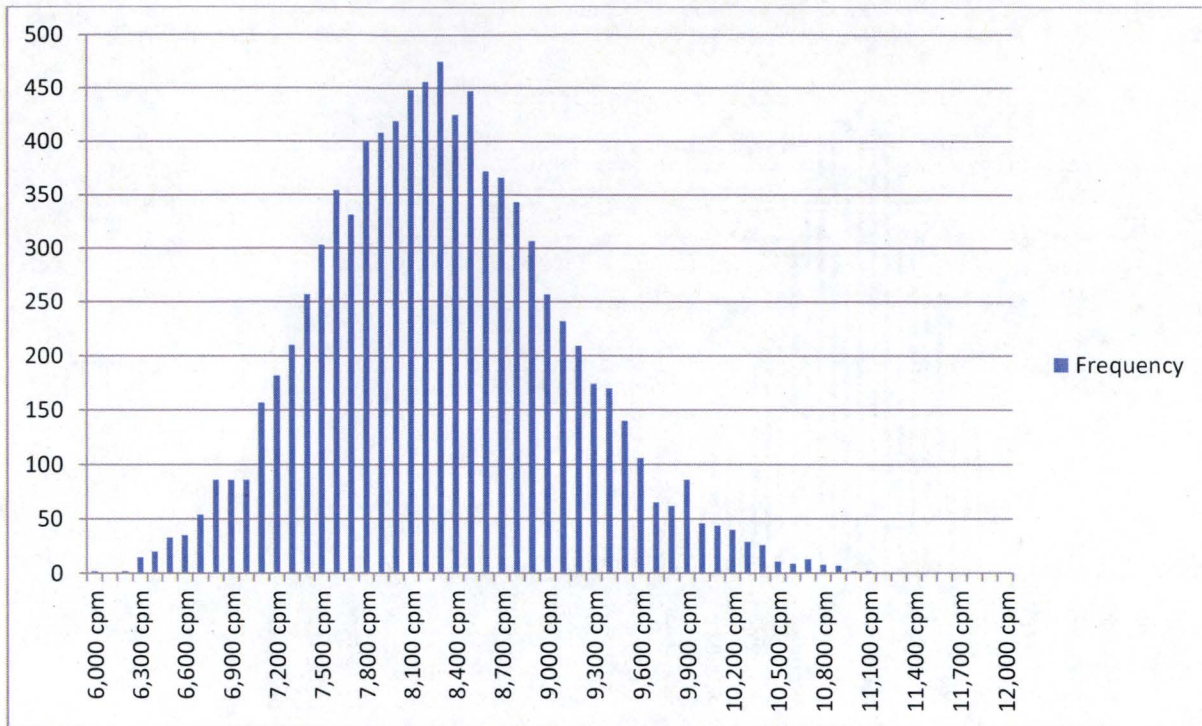


**Figure 2-5. Background Reference Area 1 NaI Distribution**

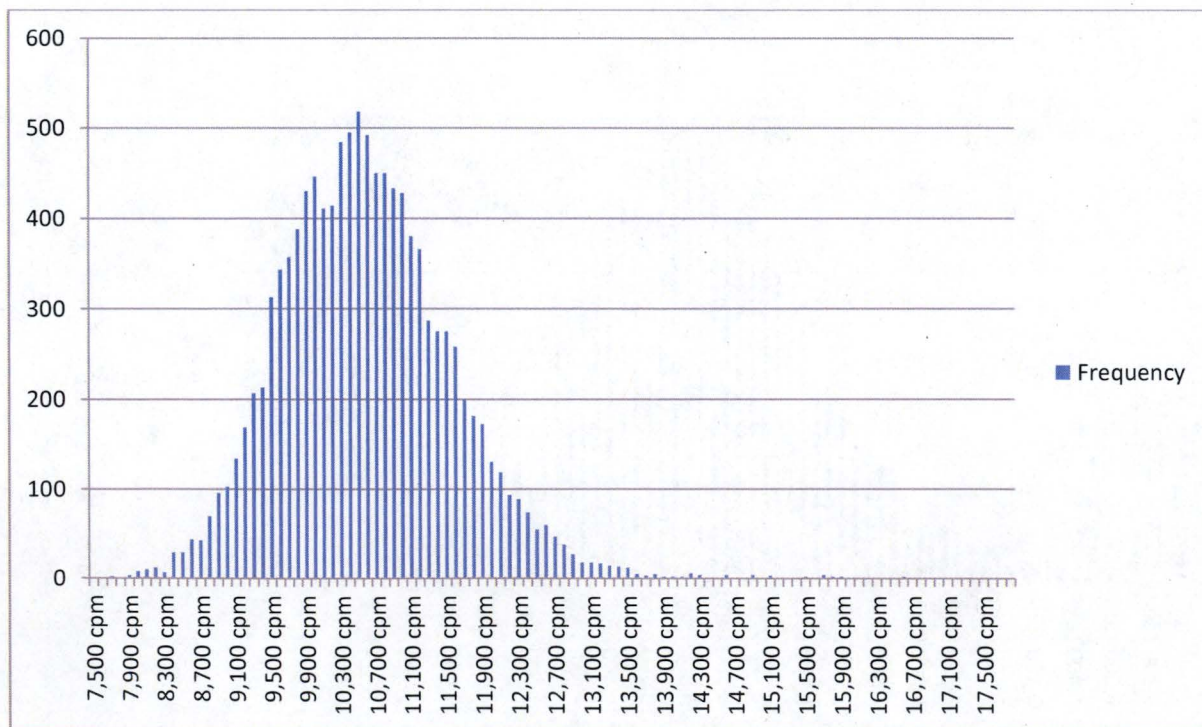


**Figure 2-6. Background Reference Area 1 FIDLER Distribution**





**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**

| <b>Location</b>                    | <b>FIDLER (cpm)</b> | <b>NaI (cpm)</b> | <b>Northing (ft)</b> | <b>Easting (ft)</b> | <b>Elevation (ft)</b> |
|------------------------------------|---------------------|------------------|----------------------|---------------------|-----------------------|
| <b>Background Reference Area 1</b> |                     |                  |                      |                     |                       |
| 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              |
| <b>Background Reference Area 2</b> |                     |                  |                      |                     |                       |
| 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:

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

Where:

m = First measurement value,  
M = Second measurement value, and  
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<br>Result | U-233/ 234<br>Result | U-238<br>Result | Ra-226<br>Result | Ra-228<br>Result | Th-232<br>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            |
| <b>RPD</b>                      | <b>5.07</b>      | <b>60.72</b>         | <b>75.09</b>    | <b>8.44</b>      | <b>6.95</b>      | <b>6.95</b>      |
| <b>CV</b>                       | <b>3.59</b>      | <b>42.93</b>         | <b>53.10</b>    | <b>5.96</b>      | <b>4.91</b>      | <b>4.91</b>      |

| Sample ID                       | ROI            |                  |                         | PROIs           |                  |                  |                  |
|---------------------------------|----------------|------------------|-------------------------|-----------------|------------------|------------------|------------------|
|                                 | C-14<br>Result | Cs-137<br>Result | U-233/<br>234<br>Result | U-238<br>Result | Ra-226<br>Result | Ra-228<br>Result | Th-232<br>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            |
| <b>RPD</b>                      | <b>8.42</b>    | <b>0.71</b>      | <b>5.58</b>             | <b>7.24</b>     | <b>13.74</b>     | <b>10.37</b>     | <b>10.37</b>     |
| <b>CV</b>                       | <b>5.95</b>    | <b>0.50</b>      | <b>3.95</b>             | <b>5.12</b>     | <b>9.72</b>      | <b>7.33</b>      | <b>7.33</b>      |

### 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:

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

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  |               | TO 05 PROI |               |
|------------|---------------|------------|---------------|
| Nuclide    | Percent Valid | Nuclide    | Percent Valid |
| Am-241     | 97.5          | Ac-227     | 100           |
| C-14       | 100           | Co-60      | 100           |
| Cm-243/244 | 97.5          | Cd-113m    | 100           |
| Cs-137     | 100           | Eu-154     | 100           |
| I-129      | 0.00          | H-3        | 95            |
| Np-237     | 100           | Pa-231     | 0.00          |
| Pu-238     | 97.5          | Ra-226     | 100           |
| Pu-239/240 | 97.5          | Ra-228     | 100           |
| Pu-241     | 100           | Sb-125     | 100           |
| Sr-90      | 100           | Sn-126     | 100           |
| Tc-99      | 100           | Th-229     | 75            |
| U-232      | 100           | Th-232     | 100           |
| U-233/234  | 100           |            |               |
| U-235      | 97.5          |            |               |
| U-238      | 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  $\pm 20$  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  $\pm 20$  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<sup>2</sup> 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<sup>2</sup> 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<sup>2</sup> test plot are shown in Table 3-4. Now that the 100-m<sup>2</sup> 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)**

| Rateometer /<br>Detector SN | Calibration<br>Due Date | Date of<br>Survey | Number of<br>Measurements | Minimum | Maximum | Average | Std. Dev. |
|-----------------------------|-------------------------|-------------------|---------------------------|---------|---------|---------|-----------|
| <b>FIDLER</b>               |                         |                   |                           |         |         |         |           |
| 119204 /<br>071211A         | 6/13/13                 | 08/02/12          | 576                       | 7,098   | 12,547  | 9,629   | 876       |
| 183995 /<br>091806A1        | 7/24/13                 | 08/02/12          | 389                       | 7,119   | 13,148  | 10,181  | 858       |
| <b>NaI</b>                  |                         |                   |                           |         |         |         |           |
| 216510 /<br>PR242829        | 08/02/12                | 08/02/12          | 383                       | 5,594   | 8,423   | 6,966   | 500       |
| 262318 /<br>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  $\pm 2,000$  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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11. SEC 2013. *Radiological Interferences Technical Memorandum*, February.

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

<sup>1</sup> Units are pCi/g.

<sup>2</sup> Error is total propagated uncertainty at two standard deviations.

<sup>3</sup> Shaded results were rejected during data validation.



**Table B-1. Reference Area 1 Sample ROIs**

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

<sup>1</sup> Units are pCi/g.

<sup>2</sup> Error is total propagated uncertainty at two standard deviations.

<sup>3</sup> Shaded results were rejected during data validation.



**Table B-1. Reference Area 1 Sample ROIs**

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

<sup>1</sup> Units are pCi/g.

<sup>2</sup> Error is total propagated uncertainty at two standard deviations.

<sup>3</sup> Shaded results were rejected during data validation.



**Table B-1. Reference Area 1 Sample ROIs**

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

<sup>1</sup> Units are pCi/g.

<sup>2</sup> Error is total propagated uncertainty at two standard deviations.



**Table B-1. Reference Area 1 Sample ROIs**

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

<sup>1</sup> Units are pCi/g.

<sup>2</sup> Error is total propagated uncertainty at two standard deviations.



**Table B-2. Reference Area 1 Sample PROIs**

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

<sup>1</sup> Units are pCi/g.

<sup>2</sup> Error is total propagated uncertainty at two standard deviations.



**Table B-2. Reference Area 1 Sample PROIs**

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

<sup>1</sup> Units are pCi/g.

<sup>2</sup> Error is total propagated uncertainty at two standard deviations.

<sup>3</sup> Shaded results were rejected during data validation.



**Table B-2. Reference Area 1 Sample PROIs**

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

<sup>1</sup> Units are pCi/g.

<sup>2</sup> Error is total propagated uncertainty at two standard deviations.



**Table B-2. Reference Area 1 Sample PROIs**

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

<sup>1</sup> Units are pCi/g.

<sup>2</sup> Error is total propagated uncertainty at two standard deviations.

<sup>3</sup> Shaded results were rejected during data validation.



**Table B-3. Reference Area 2 Sample ROIs**

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

<sup>1</sup> Units are pCi/g.

<sup>2</sup> Error is total propagated uncertainty at two standard deviations.



**Table B-3. Reference Area 2 Sample ROIs**

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

<sup>1</sup> Units are pCi/g.

<sup>2</sup> Error is total propagated uncertainty at two standard deviations.

<sup>3</sup> Shaded results were rejected during data validation.



**Table B-3. Reference Area 2 Sample ROIs**

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

<sup>1</sup> Units are pCi/g.

<sup>2</sup> Error is total propagated uncertainty at two standard deviations.



**Table B-3. Reference Area 2 Sample ROIs**

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

<sup>1</sup> Units are pCi/g.

<sup>2</sup> Error is total propagated uncertainty at two standard deviations.



**Table B-3. Reference Area 2 Sample ROIs**

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

<sup>1</sup> Units are pCi/g.

<sup>2</sup> Error is total propagated uncertainty at two standard deviations.

<sup>3</sup> Shaded results were rejected during data validation.



**Table B-4. Reference Area 2 Sample PROIs**

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

<sup>1</sup> Units are pCi/g.

<sup>2</sup> Error is total propagated uncertainty at two standard deviations.



**Table B-4. Reference Area 2 Sample PROIs**

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

<sup>1</sup> Units are pCi/g.

<sup>2</sup> Error is total propagated uncertainty at two standard deviations.

<sup>3</sup> Shaded results were rejected during data validation.



**Table B-4. Reference Area 2 Sample PROIs**

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

<sup>1</sup> Units are pCi/g.

<sup>2</sup> Error is total propagated uncertainty at two standard deviations.



**Table B-4. Reference Area 2 Sample PROIs**

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

<sup>1</sup> Units are pCi/g.

<sup>2</sup> Error is total propagated uncertainty at two standard deviations.

<sup>3</sup> 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 ☐ Uppest/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

[illegible]

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 Critical Detection Level (or  $L_c$ ) is considered to be above background.

UNCONTROLLED DOCUMENT



# RADIOLOGICAL SURVEY FORM

Survey Type: ☐ Job Coverage ☐ Characterization ☐ Equipment ☐ Routine ☐ Uppest/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

[illegible]

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 Critical Detection Level (or  $L_c$ ) is considered to be above background.

UNCONTROLLED DOCUMENT

## RADIOLOGICAL SURVEY FORM

**Survey Type:**    ☐ Job Coverage    ☐ Characterization    ☐ Equipment    ☐ Routine    ☐ Uppest/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

[illegible]

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 Critical Detection Level (or  $L_c$ ) is considered to be above background.

UNCONTROLLED DOCUMENT

# RADIOLOGICAL SURVEY FORM

**Survey Type:** ☐ Job Coverage ☐ Characterization ☐ Equipment ☐ Routine: ☐ Uppest/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

[illegible]

Surveyed By \_\_\_\_\_ Signature \_\_\_\_\_ Date \_\_\_\_\_

Surveyed By \_\_\_\_\_ / \_\_\_\_\_  
Signature Date

RCT Supervisor Review \_\_\_\_\_ / \_\_\_\_\_  
Signature Date

Surveyed By \_\_\_\_\_  
Signature Date

**Note:** Any response of the Instrument that is above the Critical Detection Level (or  $L_c$ ) is considered to be above background.

# RADIOLOGICAL SURVEY FORM

**Survey Type:** ☐ Job Coverage ☐ Characterization ☐ Equipment ☐ Routine ☐ Uppest/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

[illegible]

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 Critical Detection Level (or  $L_c$ ) is considered to be above background.

UNCONTROLLED DOCUMENT

# RADIOLOGICAL SURVEY FORM

Survey Type: ☐ Job Coverage ☐ Characterization ☐ Equipment ☐ Routine ☐ Uppest/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.

[illegible]

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 Critical Detection Level (or  $L_c$ ) is considered to be above background.

UNCONTROLLED DOCUMENT

Survey Type: ☐ Job Coverage ☐ Characterization ☐ Equipment ☐ Routine ☐ Uppest/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

[illegible]

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 Critical Detection Level (or  $L_c$ ) is considered to be above background.

UNCONTROLLED DOCUMENT



# RADIOLOGICAL SURVEY FORM

Survey Type: ☐ Job Coverage ☐ Characterization ☐ Equipment ☐ Routine ☐ Uppest/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

[illegible]

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 Critical Detection Level (or  $Lo$ ) is considered to be above background.

UNCONTROLLED DOCUMENT

## RADIOLOGICAL SURVEY FORM

Survey Type: ☐ Job Coverage ☐ Characterization ☐ Equipment ☐ Routine ☐ Uppest/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.

[illegible]

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 Critical Detection Level (or  $L_c$ ) is considered to be above background.

UNCONTROLLED DOCUMENT

## RADIOLOGICAL SURVEY FORM

Survey Type: ☐ Job Coverage ☐ Characterization ☐ Equipment ☐ Routine ☐ Uppest/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

[illegible]

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 Critical Detection Level (or  $L_c$ ) is considered to be above background.

UNCONTROLLED DOCUMENT

# RADIOLOGICAL SURVEY FORM

Survey Type: ☐ Job Coverage ☐ Characterization ☐ Equipment ☐ Routine ☐ Uppest/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

[illegible]

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 Critical Detection Level (or  $L_c$ ) is considered to be above background.

UNCONTROLLED DOCUMENT

# RADIOLOGICAL SURVEY FORM

Survey Type: ☐ Job Coverage ☐ Characterization ☐ Equipment ☐ Routine ☐ Uppest/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

[illegible]

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 Critical Detection Level (or  $L_c$ ) is considered to be above background.

UNCONTROLLED DOCUMENT

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

[illegible]

Surveyed By \_\_\_\_\_ / \_\_\_\_\_  
Signature Date

Surveyed By \_\_\_\_\_ / \_\_\_\_\_  
Signature Date

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

UNCONTROLLED DOCUMENT 1

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

[illegible]

RCT Supervisor Review \_\_\_\_\_ / \_\_\_\_\_  
Signature Date

Surveyed By \_\_\_\_\_ / \_\_\_\_\_  
Signature Date

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

UNCONTROLLED DOCUMENT



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

[illegible]

RCT Supervisor Review \_\_\_\_\_ / \_\_\_\_\_  
Signature Date

Surveyed By \_\_\_\_\_ / \_\_\_\_\_  
Signature Date

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

UNCONTROLLED DOCUMENT

## RADIOLOGICAL SURVEY FORM

|                             |                                       |   |  |                                  |  |   |                           |
|-----------------------------|---------------------------------------|---|--|----------------------------------|--|---|---------------------------|
| Survey Type:                | <input type="checkbox"/> Job Coverage | <input type="checkbox"/> Characterization | <input type="checkbox"/> Equipment               | <input type="checkbox"/> Routine | <input type="checkbox"/> Uppest/Downpost | <input checked="" type="checkbox"/> Miscellaneous | Page <u>1</u> of <u>1</u> |
| Survey Number:              | <u>WVDP-MIS-032-8912</u>              | Date:                                     | <u>8/9/2012</u>                                  | Time:                            | <u>0807</u>                              | RWP No:   | <u>N/A</u>                |
| Survey Location (Site/Bldg) | <u>WVDP</u>                           | Room/Area/Item                            | <u>Sample Location: Bkg. Area 02- Sample #06</u> |                                  |  |   |                           |
| Purpose of Survey:          | <u>Down Hole Logging</u>              |   |  |                                  |  |   |                           |
| Remarks:                    | <u>To 4 feet</u>                      |   |  |                                  |  |   |                           |

[illegible]

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 Critical Detection Level (or  $L_c$ ) is considered to be above background.

UNCONTROLLED DOCUMENT

# 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

[illegible]

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 Critical Detection Level (or  $L_c$ ) is considered to be above background.

UNCONTROLLED DOCUMENT

# RADIOLOGICAL SURVEY FORM

**Survey Type:** ☐ Job Coverage ☐ Characterization ☐ Equipment ☐ Routine ☐ Uppest/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

[illegible]

Surveyed By \_\_\_\_\_ / \_\_\_\_\_  
Signature Date

Surveyed By \_\_\_\_\_ / \_\_\_\_\_  
Signature Date

RCT Supervisor Review \_\_\_\_\_  
Signature \_\_\_\_\_ Date \_\_\_\_\_

Surveyed By: \_\_\_\_\_  
Signature Date

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

UNCONTROLLED DOCUMENT



# RADIOLOGICAL SURVEY FORM

Survey Type: ☐ Job Coverage ☐ Characterization ☐ Equipment ☐ Routine ☐ Uppest/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

[illegible]

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 Critical Detection Level (or  $L_c$ ) is considered to be above background.

UNCONTROLLED DOCUMENT

# RADIOLOGICAL SURVEY FORM

Survey Type: ☐ Job Coverage ☐ Characterization ☐ Equipment ☐ Routine ☐ Uppest/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

[illegible]

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 Critical Detection Level (or  $L_c$ ) is considered to be above background.

UNCONTROLLED DOCUMENT

# UNCONTROLLED DOCUMENT

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




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

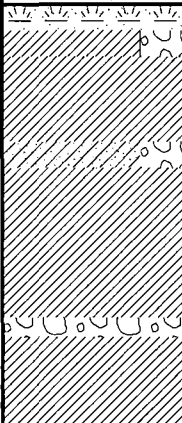
Bottom of borehole at 3.3 feet (1.0 m).

<sup>1</sup> US State Plane, New York West 3103, NAD83 (feet)

## NOTES:

# UNCONTROLLED DOCUMENT

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

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


Bottom of borehole at 3.3 feet (1.0 m).

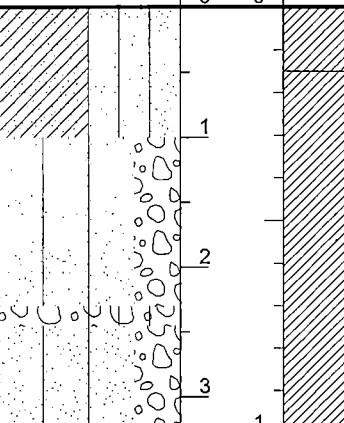
<sup>1</sup> US State Plane, New York West 3103, NAD83 (feet)

**NOTES:**



# UNCONTROLLED DOCUMENT

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


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

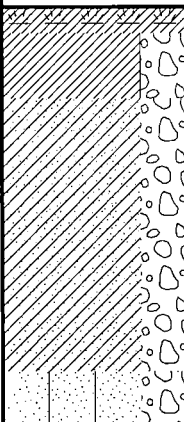
Bottom of borehole at 3.3 feet (1.0 m).

<sup>1</sup> US State Plane, New York West 3103, NAD83 (feet)

**NOTES:**

# UNCONTROLLED DOCUMENT

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


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

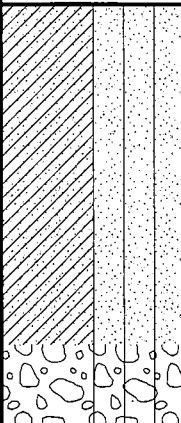
Bottom of borehole at 3.3 feet (1.0 m).

<sup>1</sup> US State Plane, New York West 3103, NAD83 (feet)

**NOTES:**

# UNCONTROLLED DOCUMENT

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


| GRAPHIC LOG  | DEPTH (ft) | DEPTH (m) | SAMPLE INTERVAL | U.S.C.S. | MATERIAL DESCRIPTION   | REMARKS |
|--|------------|-----------|-----------------|----------|--|---------|
|  | 0          | 0         |                 |          |  |         |
|  | 1          |           |                 | 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.      |         |
|  | 2          |           |                 | 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. |         |
|  | 3          |           |                 | GP-GM    | Gravel, Poorly Graded, with Silt and Sand, angular, up to 3/4 inch (1.9 cm); 2.5Y4/4 Olive Brown.  |         |

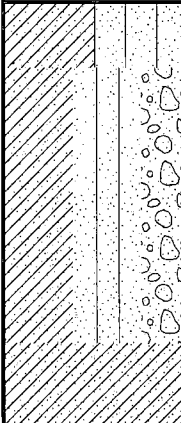
Bottom of borehole at 3.3 feet (1.0 m).

<sup>1</sup> US State Plane, New York West 3103, NAD83 (feet)

**NOTES:**

# UNCONTROLLED DOCUMENT

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

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


Bottom of borehole at 3.3 feet (1.0 m).


<sup>1</sup> US State Plane, New York West 3103, NAD83 (feet)

## NOTES:



# UNCONTROLLED DOCUMENT

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

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

Bottom of borehole at 3.3 feet (1.0 m).

<sup>1</sup> US State Plane, New York West 3103, NAD83 (feet)

**NOTES:**

# UNCONTROLLED DOCUMENT

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




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

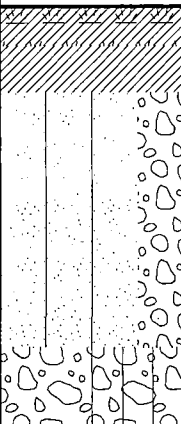
Bottom of borehole at 3.3 feet (1.0 m).

<sup>1</sup> US State Plane, New York West 3103, NAD83 (feet)

## NOTES:

# UNCONTROLLED DOCUMENT

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


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

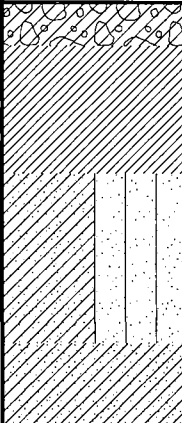
Bottom of borehole at 3.3 feet (1.0 m).

<sup>1</sup> US State Plane, New York West 3103, NAD83 (feet)

**NOTES:**

# UNCONTROLLED DOCUMENT

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

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


Bottom of borehole at 3.3 feet (1.0 m).


<sup>1</sup> US State Plane, New York West 3103, NAD83 (feet)

**NOTES:**



# UNCONTROLLED DOCUMENT

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

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

Bottom of borehole at 4.0 feet (1.2 m).

<sup>1</sup> US State Plane, New York West 3103, NAD83 (feet)

**NOTES:** Background Area 2 is in the Lavery Till

# UNCONTROLLED DOCUMENT

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




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


Bottom of borehole at 4.0 feet (1.2 m).

<sup>1</sup> US State Plane, New York West 3103, NAD83 (feet)

**NOTES:** Background Area 2 is in the Lavery Till

# UNCONTROLLED DOCUMENT

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


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

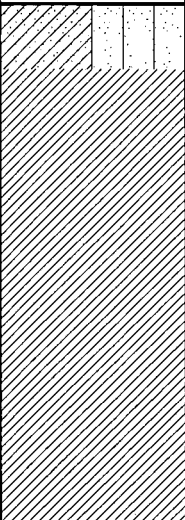
Bottom of borehole at 4.0 feet (1.2 m).

<sup>1</sup> US State Plane, New York West 3103, NAD83 (feet)

**NOTES:** Background Area 2 is in the Lavery Till

# UNCONTROLLED DOCUMENT

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

| GRAPHIC LOG  | DEPTH (ft) | DEPTH (m) | SAMPLE INTERVAL | U.S.C.S. | MATERIAL DESCRIPTION  | REMARKS |
|--|------------|-----------|-----------------|----------|---|---------|
|  | 0          | 0         |                 | SC-SM    | <b>Silty Clayey Sand with Organic Material</b> , low plasticity; 2.5Y3/2 Very Dark Grayish Brown. |         |
|  | 1          | 0.3       |                 | CL       | <b>Clay</b> , medium plasticity, firm to stiff, variegated Dark Gray to Dark Grayish Brown.       |         |
|  | 2          | 0.6       |                 |          |   |         |
|  | 3          | 0.9       |                 |          |   |         |
|  | 4          | 1.2       |                 |          |   |         |


Bottom of borehole at 4.0 feet (1.2 m).

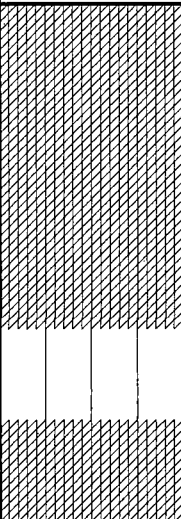
<sup>1</sup> US State Plane, New York West 3103, NAD83 (feet)

**NOTES:** Background Area 2 is in the Lavery Till



# UNCONTROLLED DOCUMENT

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


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

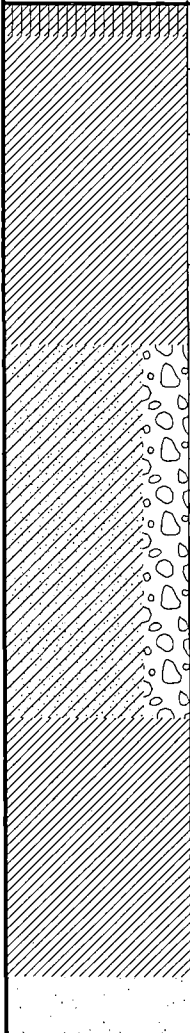
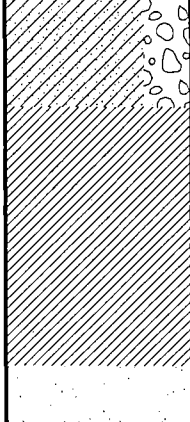
Bottom of borehole at 4.0 feet (1.2 m).

<sup>1</sup> US State Plane, New York West 3103, NAD83 (feet)

**NOTES:** Background Area 2 is in the Lavery Till

# UNCONTROLLED DOCUMENT

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


| GRAPHIC LOG   | DEPTH (ft)<br>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; Olive Brown grading to Dark Grayish Brown.   |         |
|   | 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.   |         |

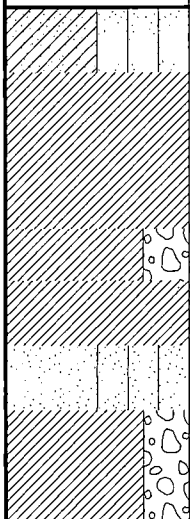
Bottom of borehole at 8.0 feet (2.4 m).

<sup>1</sup> US State Plane, New York West 3103, NAD83 (feet)

**NOTES:** Background Area 2 is in the Lavery Till

# UNCONTROLLED DOCUMENT

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

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

Bottom of borehole at 4.0 feet (1.2 m).

<sup>1</sup> US State Plane, New York West 3103, NAD83 (feet)

**NOTES:** Background Area 2 is in the Lavery Till

# UNCONTROLLED DOCUMENT

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



| GRAPHIC LOG | DEPTH (ft) | DEPTH (m) | SAMPLE INTERVAL | U.S.C.S.    | MATERIAL DESCRIPTION   | REMARKS |
|-------------|------------|-----------|-----------------|-------------|--|---------|
|             | 0          | 0         |                 | SC          | Clayey Sand with Organic Matter, low plasticity.                                     |         |
|             | 1          |           |                 | CL          | Clay, medium plasticity, variegated Dark Grayish Brown to Dark Gray.                 |         |
|             | 2          |           |                 | CL          | Clay with Gravel and Coarse Sand, medium plasticity; gravel up to 1/2 inch (1.3 cm). |         |
|             | 3          |           |                 | CL-ML<br>SP | Silty Clay, low plasticity, soft, gray.<br>Sand, Poorly Graded, medium grained.      |         |
|             | 4          |           |                 | CL          | Clay, medium plasticity, firm, 2.5Y4/1 Dark Gray.                                    |         |
|             | 5          |           |                 | CL          |  |         |
|             | 6          |           |                 |             |  |         |
|             | 7          |           |                 |             |  |         |
|             | 8          |           |                 |             |  |         |


Bottom of borehole at 8.0 feet (2.4 m).

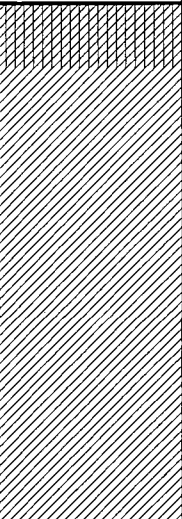
<sup>1</sup> US State Plane, New York West 3103, NAD83 (feet)

**NOTES:** Background Area 2 is in the Lavery Till



# UNCONTROLLED DOCUMENT

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


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

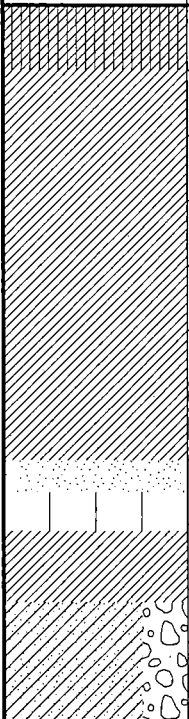
Bottom of borehole at 4.0 feet (1.2 m).

<sup>1</sup> US State Plane, New York West 3103, NAD83 (feet)

**NOTES:** Background Area 2 is in the Lavery Till

# UNCONTROLLED DOCUMENT

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

| GRAPHIC LOG  | DEPTH (ft) | DEPTH (m) | SAMPLE INTERVAL | U.S.C.S. | MATERIAL DESCRIPTION  | REMARKS  |
|--|------------|-----------|-----------------|----------|---|--|
| 0  | 0          |           |                 |          |   |  |
|  | 1          |           |                 | CL-ML    | Silty Clay with Organic Matter, low plasticity.                             | Run 2 (4 to 8 ft/ 1.2 to 2.4 m), recovery ~40% |
|  | 2          |           |                 | CL       | Clay, medium plasticity, firm to stiff; 2.5Y4/2 Dark Grayish Brown.         |  |
|  | 3          |           |                 |          |   |  |
|  | 4          |           |                 | SP       | Sand, Poorly Graded, medium grained.  |  |
|  | 5          |           |                 | ML       | Silt, grading to Clay, wet.   |  |
|  | 6          |           |                 | CL       |   |  |
|  | 7          |           |                 | SC       | Clayey Sand with Gravel, medium plasticity, gravel up to 2 inches (5.1 cm). |  |
|  | 8          |           |                 |          |   |  |
|  | 9          |           |                 |          |   |  |
|  | 10         |           |                 |          |   |  |

Bottom of borehole at 8.0 feet (2.4 m).

<sup>1</sup> 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.

