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Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

08-AMRC-0200

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EDMC

Mr. Nicholas Ceto, Program Manager
Office of Environmental Cleanup
Hanford Project Office
U.S. Environmental Protection Agency
309 Bradley Blvd, Suite 115
Richland, Washington 99352

Dear Mr. Ceto:

TRANSMITTAL OF THE SAMPLING AND ANALYSIS PLAN FOR THE 618-10 AND 618-11 NONINTRUSIVE SAMPLING, DOE/RL-2008-27, DRAFT A

Attached for your review is the "Sampling and Analysis Plan for the 618-10 and 618-11 Noninstusive Sampling," Draft A. Submittal of this plan satisfies completion of Milestone M-016-67, "Submit a Characterization Sampling and Analysis Plan (SAP) to EPA." If you have questions, please contact me or your staff may contact Chris Smith, of my staff, on (509) 372-1544.

Sincerely,

Joe R. Franco, Assistant Manager
for the River Corridor

AMRC:DCS

Attachment

bcc w/attach:
A. L. Boyd, EPA
Administrative Record, H6-08

DOE/RL-2008-27
Draft A

Sampling and Analysis Plan for 618-10 and 618-11 Nonintrusive Sampling

For External Review

United States
Department of Energy

DOE/RL-2008-27
Draft A

Sampling and Analysis Plan for 618-10 and 618-11 Nonintrusive Sampling

June 2008

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ACRONYMS

CFR	*Code of Federal Regulations*
COC	contaminant of concern
COPC	contaminant of potential concern
DOT	U.S. Department of Transportation
DQO	data quality objective
EPA	U.S. Environmental Protection Agency
GEM	Glovebox Excavation Method
GM	Geiger-Mueller
GPR	ground-penetrating radar
GPS	global positioning system
HASQARD	*Hanford Analytical Services Quality Assurance Requirements Documents*
MDP	multidetector probe
NIST	National Institute for Standards and Technology
NTE	not to exceed
NTP	notice to proceed
PNNL	Pacific Northwest National Laboratory
QAPjP	quality assurance project plan
QC	quality control
RCT	radiological control technician
SAP	sampling and analysis plan
SAF	sample authorization form
TDEMI	time domain electromagnetic induction
VPU	vertical pipe unit
WCH	Washington Closure Hanford

1.0 INTRODUCTION

This sampling and analysis plan (SAP) directs nonintrusive characterization activities that will be performed at the 618-10 and 618-11 Burial Grounds in the 600 Area of the Hanford Site. The characterization activities prescribed will provide data and information needed for planning future intrusive characterization activities (if required) and/or remediation strategies for the vertical pipe units (VPUs), caissons, and trenches located in these burial grounds. Planning for intrusive characterization and/or remediation requires additional understanding of the quantity and condition of the material deposited in these burial grounds.

The scope of activities described in this SAP includes geophysical delineation, in situ radionuclide characterization using a multidetector probe (MDP) assembly, and soil sampling from below select VPU and caisson locations (no soil samples are proposed for the trenches). The data and information collected through this SAP will be used to develop decision logic to evaluate grouping strategies for intrusive sampling and possibly remediation tasks (e.g., grouping VPUs based on similarities such as high dose rates or construction methods). For example, VPU groupings developed using the data and information collected through this SAP could be used to determine the appropriate number of intrusive samples that may be included in future SAPs. For the purposes of this SAP, the term "nonintrusive" is meant to indicate that the VPUs, caissons, and trenches will not be opened or exposed in a manner in which the contents of these features will be accessible to personnel or the surface environment.

Unless otherwise referenced, the following background, location, description/history, and contaminant of concern (COC) information was derived from *618-10 and 618-11 Waste Burial Grounds Basis for Interim Operation* (FH 2003) and *600 Area Remediation Design Solution Waste Volume and Inventory* document (WCH 2007).

1.1 BACKGROUND

The 618-10 Burial Ground, also known as 300 North, 300 North Burial Ground, or 318-10 Waste Site, is located about 6.9 km (4.3 mi) northwest of the 300 Area. The 618-11 Burial Ground, also known as the Wye Burial Ground or 318-11, is located directly west of Energy Northwest's Columbia Generating Station. The burial grounds have been surface stabilized with at least 0.6 m (2 ft) of topsoil and vegetated with crested wheat grass. They are inside chainlink fences and are posted with underground radioactive material signs.

During the years that the 618-10 and 618-11 sites were active, they received low- to high-activity radioactive waste from the 300 Area laboratories and fuels development facilities. However, their disposal records did not include an inventory of waste content. Some of the waste that was disposed in trenches, VPUs, and caissons would likely be designated transuranic waste by current (2008) criteria.

1.2 618-10 AND 618-11 BURIAL GROUND LOCATIONS

The 618-10 and 618-11 Burial Grounds are located in the 600 Area of the Hanford Site in southeastern Washington State. Figure 1-1 shows the locations of the burial grounds.

1.3 DESCRIPTION AND HISTORY

The following sections provide a brief description of the burial grounds that will be investigated.

1.3.1 618-10 Burial Ground

The 618-10 site consists of 12 trenches and 94 VPUs. It was operated from March 1953 until September 1963, receiving an estimated 3,680 to 5,670 m^3 (4,800 to 7,400 yd^3) of waste. The 618-10 site was surface stabilized with 0.6 m (2 ft) of clean backfill material in 1983. A schematic drawing of the 618-10 Burial Ground is provided in Figure 1-2.

Limited records were kept of the burial ground disposal practices. The examination of available records indicates that the 618-10 Burial Ground wastes included radiologically contaminated laboratory instruments, bottles, boxes, filters, aluminum cuttings, irradiated fuel element samples, metallurgical samples, electrical equipment, lighting fixtures, barrels, laboratory equipment and hoods, and low- and high-level liquid waste sealed in containers.

The waste container exteriors were surveyed before they were transported to the 618-10 site. The actual contents of the containers are uncertain, but the radiological survey records indicate the number of waste shipments and the types of containers used. From mid-1950 to about 1960, the 618-10 trenches generally received low-level waste in cardboard boxes. Materials with higher radioactivity were packaged in "cement barrels" (concrete and lead-shielded drums). Around 1960, the radioactivity of the waste from the 325 and 327 Laboratory hot cells increased due to the examination of fuel rod and tank waste samples. Cardboard containers were replaced with remote-handled containers that were loaded into lead-shielded casks for transport to the burial grounds. The waste was then remotely released from the casks into the VPUs. Vertical pipe units were most commonly constructed by welding five 209 L (55-gal) bottomless drums together and then burying them vertically with about 3 m (10 ft) of space between them. A second form of VPU found in the 618-10 Burial Ground were 25 to 36 cm (12- to 14-in-.) diameter corrugated pipes that are 3 to 4 m (10 to 14 ft) long. The VPUs are open to the soil at the bottom (see Figure 1-3).

The 618-10 site had several documented unplanned releases during operation and one unplanned release during the addition of stabilization soil in 1983. After each release, the ground was either washed down with water or gravel was placed over the contaminated area to prevent the spread of contamination.

Figure 1-1. Location of the 618-10 and 618-11 Burial Grounds.

Figure 1-2. The 618-10 Burial Ground.

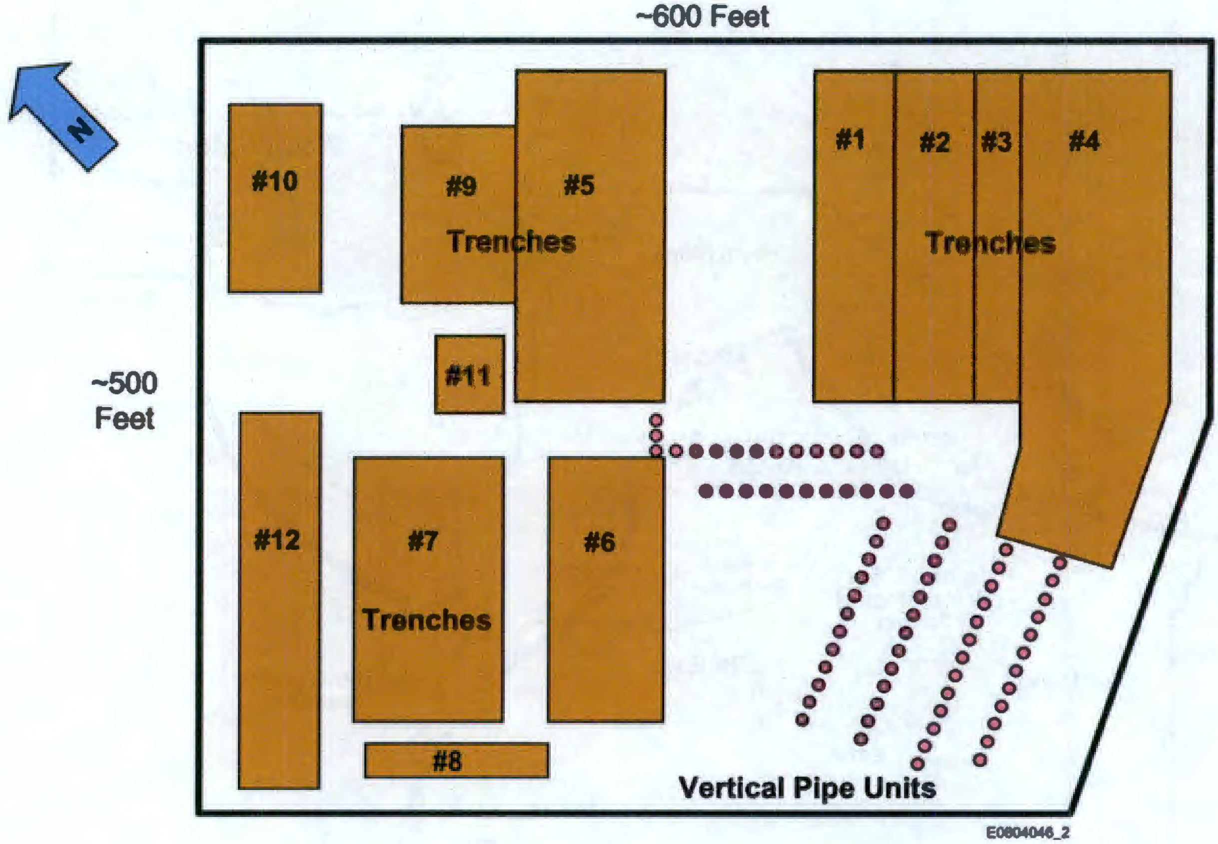
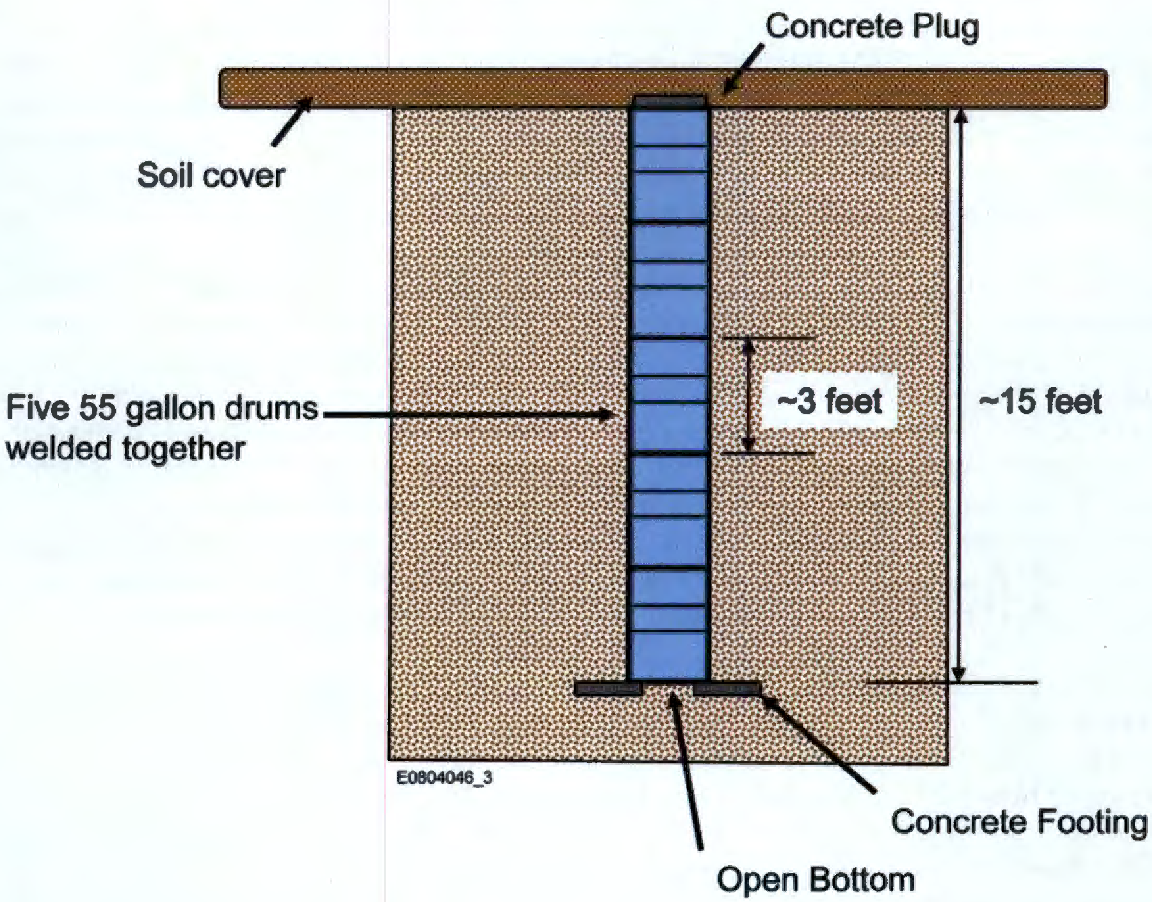


Figure 1-3. Typical 618-10 and 618-11 Site Vertical Pipe Unit.



1.3.2 618-11 Burial Ground

The 618-11 Burial Ground consists of 3 slope-sided trenches, 3 to 5 large caissons, and 50 VPUs. It was opened in March 1962 and accepted waste into Trench 1 until October 1962, when it was taken out of service. While out of service, Trench 2 and 40 VPUs were added and the burial ground was brought back online in September 1963. Trench 3 had received waste only in the east and west ends when the site was closed in December 1967. A schematic drawing of the 618-11 Burial Ground is provided in Figure 1-4.

The trenches are 270 m (900 ft) long by 15 m (50 ft) wide and 7.6 m (25 ft) deep. The VPUs were constructed with five 209 L (55-gal-) bottomless drums, like those in the 618-10 Burial Ground. The caissons were constructed of 2.4 m (8-ft-) diameter corrugated metal pipe, 3 m (10 ft) long, with the top of the caisson being 4.6 m (15 ft) below grade, and connected to the surface by an offset 91 cm (36-in-) diameter pipe with a dome cap lid (see Figure 1-5). These units were buried with about 4.6 m (15 ft) of space between them. The caissons are also open to the soil at the bottom. The number of caissons (three to five) is questionable due to contradictions in site documentation. The burial ground received a minimum of 0.6 m (2 ft) of soil when it was closed. This was in addition to the soil cover used to close the trenches. An additional 0.6 m (2 ft) of topsoil was added to the site for surface stabilization in 1983.

The 618-11 Burial Ground contains a broad spectrum of low-level radioactive waste including fission products, byproduct waste (thorium and uranium), and plutonium, similar to 618-10. It was used for the disposal of 300 Area laboratory solid wastes. Low- to high-activity wastes were received from the 305, 306, 309, 313, 315, 317, 324, 325, 325-A, 325-B, 326, 327, 329, 340 Complex, 1171, 3700, 3706, 3707-C, 3708, 3718, and 3730 facilities. These facilities handled radioactively contaminated, or potentially contaminated, waste from operations or laboratory areas, including hot cells. Moderate- and high-activity (remote-handled) wastes were received from the 327 Building (radio metallurgy) hot cells, 325-A hot cells, the 325-B (analytical) hot cells, occasionally from the Plutonium Recycle Test Reactor 309 Building, and later from 324 hot cells.

The low- to moderate-activity wastes described above were disposed to trenches (with some exceptions), and the moderate- to high-activity wastes were disposed to VPUs and caissons. The 325-A hot cells disposed of moderate- to high-activity waste to the trenches in concrete lead-shielded drums. The 325-B hot cells also used concrete-shielded drums to dispose of hot cell waste, used laboratory containers and glassware, and spent instruments and equipment. Some plutonium residues from various organizations and facilities (including the 308 Building) were encapsulated in concrete and placed in lead and concrete-shielded drums for disposal at the 618-11 Burial Ground.

The 618-11 site had several documented unplanned releases during its operational life. After each release, the ground was either washed down with water or gravel was spread over the contaminated area to prevent the spread of contamination.

Figure 1-4. The 618-11 Burial Ground.

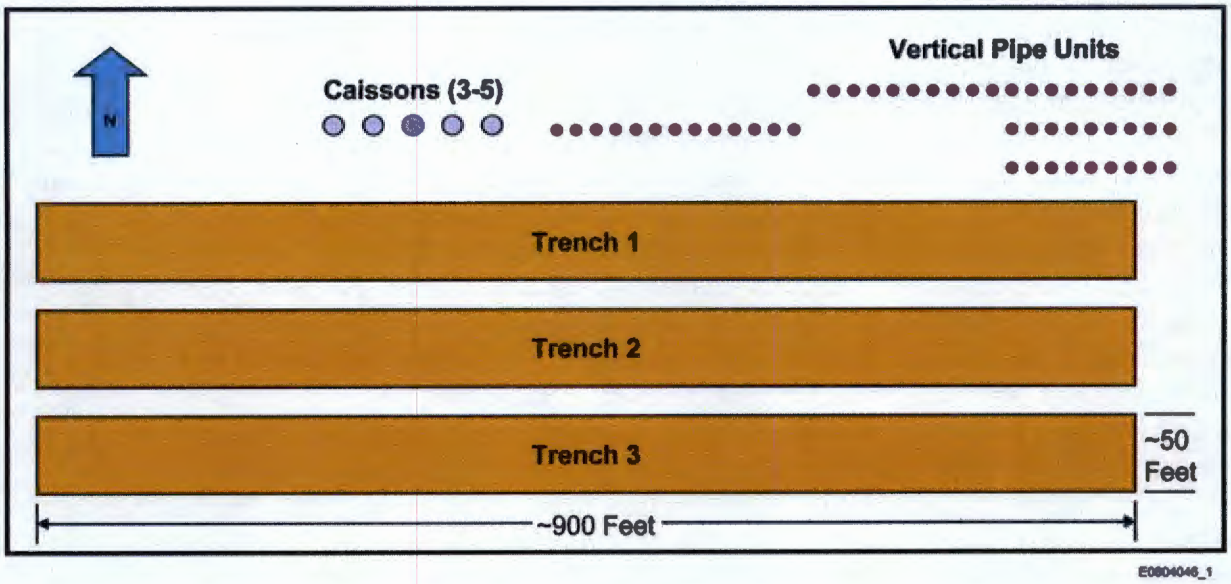
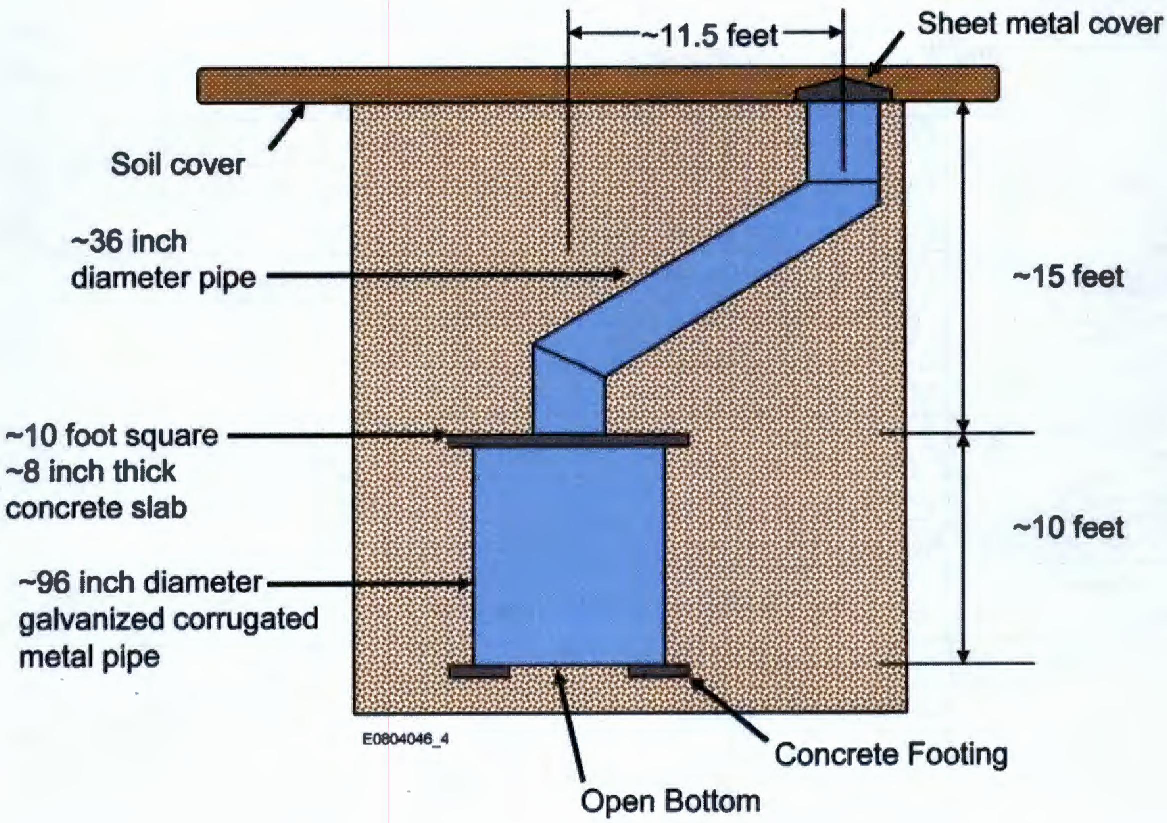


Figure 1-5. 618-11 Site Caisson.



1.4 CONTAMINANTS OF CONCERN

A list of COCs for the 618-10 and 618-11 Burial Ground nonintrusive sampling was developed using historical documents and records for the sites. Sample volumes will be limited by the sampling equipment. The list was screened to arrive at the list of COCs that will yield data for the largest spectrum of analytes with limited sample availability. Short-lived radionuclides (less than 5-year half-lives), extremely low-yield radionuclides (e.g., plutonium-242), chemicals with nonpersistence in the environment (e.g., hydrazine), and chemicals used in minute laboratory quantities (e.g., indicators) or that have no routine analytical method (e.g., water-soluble complexants) were removed from consideration. A limited number of radionuclides (e.g., plutonium-241) were removed because they require significant analytical resources and can be estimated from other radionuclides to be reported. The COCs identified for the nonintrusive sampling in the 618-10 and 618-11 Burial Grounds, including the rationale for their inclusion, are presented in Table 1-1. Field screening will be performed to monitor for volatile organic compounds. If detectable levels are noted, sampling for volatile organic compounds may be included. If an insufficient quantity of material is available in the probe sampling tool for the analysis of volatile organic compounds, a field determination will be made regarding the need to drive a second probe point for the purpose of collecting additional material.

Table 1-1. 618-10 and 618-11 Soil Contaminant of Concern List. (2 Pages)

Final COCs	Rationale for Inclusion
Radiological Constituents	
Americium-241	Known significant production from Hanford Site processes
Carbon-14	Known significant activation product from Hanford Site processes
Cesium-137	Known significant fission product from Hanford Site processes
Cobalt-60	Known significant activation/fission product from Hanford Site processes
Europium-152	Known significant fission product from Hanford Site processes
Europium-154	Known significant fission product from Hanford Site processes
Europium-155	Known significant fission product from Hanford Site processes.
Hydrogen-3	Known significant activation product from Hanford Site processes
Nickel-63	Known significant activation product from Hanford Site processes
Plutonium-238	Known significant production from Hanford Site processes
Plutonium-239/240	Known significant production from Hanford Site processes
Total radioactive strontium	Known significant fission product from Hanford Site processes
Technetium-99	Known significant fission product from Hanford Site processes
Uranium-234	Reactor fuel component
Uranium-235	Reactor fuel component
Uranium-238	Reactor fuel component

Table 1-1. 618-10 and 618-11 Soil Contaminant of Concern List. (2 Pages)

Final COCs	Rationale for Inclusion
Nonradiological Constituents – Metals	
Aluminum	Fuel cladding component
Arsenic	EPA Toxic
Barium	EPA Toxic
Cadmium	EPA Toxic metal used in lead-dipped cladding
Chromium	EPA Toxic reactor component
Chromium (VI)	EPA Toxic used for cleaning
Copper	Metal used in triple-dip process of cladding and cladding waste stream
Iron	Reactor component
Lead	EPA Toxic metal used in lead-dipped cladding and cladding waste stream
Mercury	EPA Toxic laboratory uses
Nickel	Reactor component
Selenium	EPA Toxic
Silver	EPA Toxic miscellaneous laboratory uses
Zinc	Reactor component
Nonradiological Constituents – General Inorganics	
Chloride	Several compounds contained chloride. The most widely used included ferrous chloride, which was used as a carrier and potassium/sodium chloride used as salting agents.
Nitrate	Most widely used included sodium nitrite (a salting agent during the cladding removal), nitric acid (used throughout the bismuth-phosphate process and URP), and bismuth subnitrate (used to create the bismuth-phosphate/plutonium solid during the first and second decontamination cycles).
Phosphate	Several compounds contained phosphate. The most widely used included phosphoric acid, which was used throughout bismuth-phosphate process.
Sulfate	Several compounds contained sulfate. The most widely used included sulfuric acid, which was used in the dissolving of the fuel rod during the bismuth-phosphate process. Many other sulfate complexes were used as carriers for various metals.
Organics	
Polychlorinated biphenyls (PCBs)	Extensive use in electrical equipment and as hydraulic fluids
Paraffin hydrocarbons -TPH	Extensive use in solvent extraction operation as the dilutant for tributyl phosphate (TBP)
TBP	Extensive use in solvent extraction operation as a complexant

COC = contaminant of concern
EPA = U.S. Environmental Protection Agency
TBP = tributyl phosphate
TPH = total petroleum hydrocarbons

1.4.1 Statement of the Problem

The 618-10 and 618-11 Burial Ground disposal records may not have been retained. Alpha-emitting radioactive waste was not separately regulated or segregated from the other waste types transported to the disposal sites. Some of the waste that was disposed of in trenches, VPUs, and caissons would be designated transuranic waste by current criteria. Additional understanding of the quantity and condition of the material deposited in these burial grounds will be needed if future intrusive characterization activities and remediation strategies for the VPUs, caissons, and trenches are required.

1.4.2 Sample Design Summary

The characterization activities prescribed for the 618-10 and 618-11 Burial Grounds include the following:

- Geophysical delineation of all VPUs and caissons
- In situ radionuclide characterization using a MDP assembly (gross gamma activity, low-level gamma isotopic activity, high-level gamma isotopic activity, and neutron detection probes)
  - Up to four equally spaced positions around the perimeter of each VPU
  - Up to six equally spaced positions around the perimeter of each caisson
  - Every 7.6 m (25 ft) along the approximate centerline of each trench
- Soil samples from below the base elevations of the VPUs and caissons
  - Select VPUs (up to 10% of the VPUs) would be sampled (one sample per VPU selected)
    - VPU locations selected based on MDP data and grouping logic
  - Two soil samples for each caisson
    - Caisson locations selected based on MDP data
  - No soil samples will be collected from the trenches.

The complete sample design for this initial phase of characterization is presented in Section 3.0.

The data and information collected through this SAP will be used to develop decision logic to evaluate grouping strategies for intrusive sampling and/or remediation tasks (e.g., grouping VPUs based on similarities such as high dose rates or construction methods). For example, VPU groupings developed using the data and information collected through this SAP could be used to determine which VPUs to select for intrusive sampling or exploratory remediation.

1.5 PROJECT SCHEDULE

A proposed project schedule for characterization activities is presented in Figure 1-6. The nonintrusive schedule was developed with extensive input from an expert in direct push probe technologies (e.g., Geoprobe or cone penetrometer) to develop task durations, expected production rates, and MDP analyses for the planned characterization activities. Similar tasks were performed for characterizing the 118-K-1 silos.

The schedule includes potential intrusive activities using "rough-order-of-magnitude" durations because of the expected influence the results of the nonintrusive characterization will have on the intrusive work tasks. Separate data quality objectives (DQO) and a SAP would be developed for the intrusive characterization. Alternatively, the nonintrusive characterization results may validate the 618-10/618-11 design solution assumptions to the extent that remedial design could proceed without intrusive sampling. The assumptions presented in Sections 1.5.2 and 1.5.3 would only apply if intrusive characterization is required. In the event that intrusive characterization is required, schedule modifications may be required.

1.5.1 Nonintrusive Schedule Assumptions for 618-10 and 618-11

1. Notice to proceed (NTP) and not to exceed (NTE) notifications for nonintrusive characterization will be received in time to start work on March 2, 2009.

2. No major difficulties will be encountered in setting up single source procurement.

3. Work packages developed for 618-10 will need only minor modifications for use at 618-11.

4. Quantities of VPUs and caissons will not be greater than the following:

    a. 94 VPUs at 618-10
    b. 50 VPUs and 5 caissons at 618-11

5. The number of subsurface probes installed will not exceed four per VPU, six per caisson, and one every 7.6 m (25 ft) in the trenches (plus 10% refusal: 47 at 618-10 and 34 at 618-11).

6. Soil sampling will occur only at up to 10% of the VPUs (one sample per VPU selected) and up to two samples at each of the caissons (up to 10 samples total from the caissons). Of the soil samples, only 20% will require analysis at the 222-S Laboratory and the remainder will be analyzed by offsite laboratories.

7. Access to 618-11 for direct-push probe installation will not require any special items or be unduly difficult.

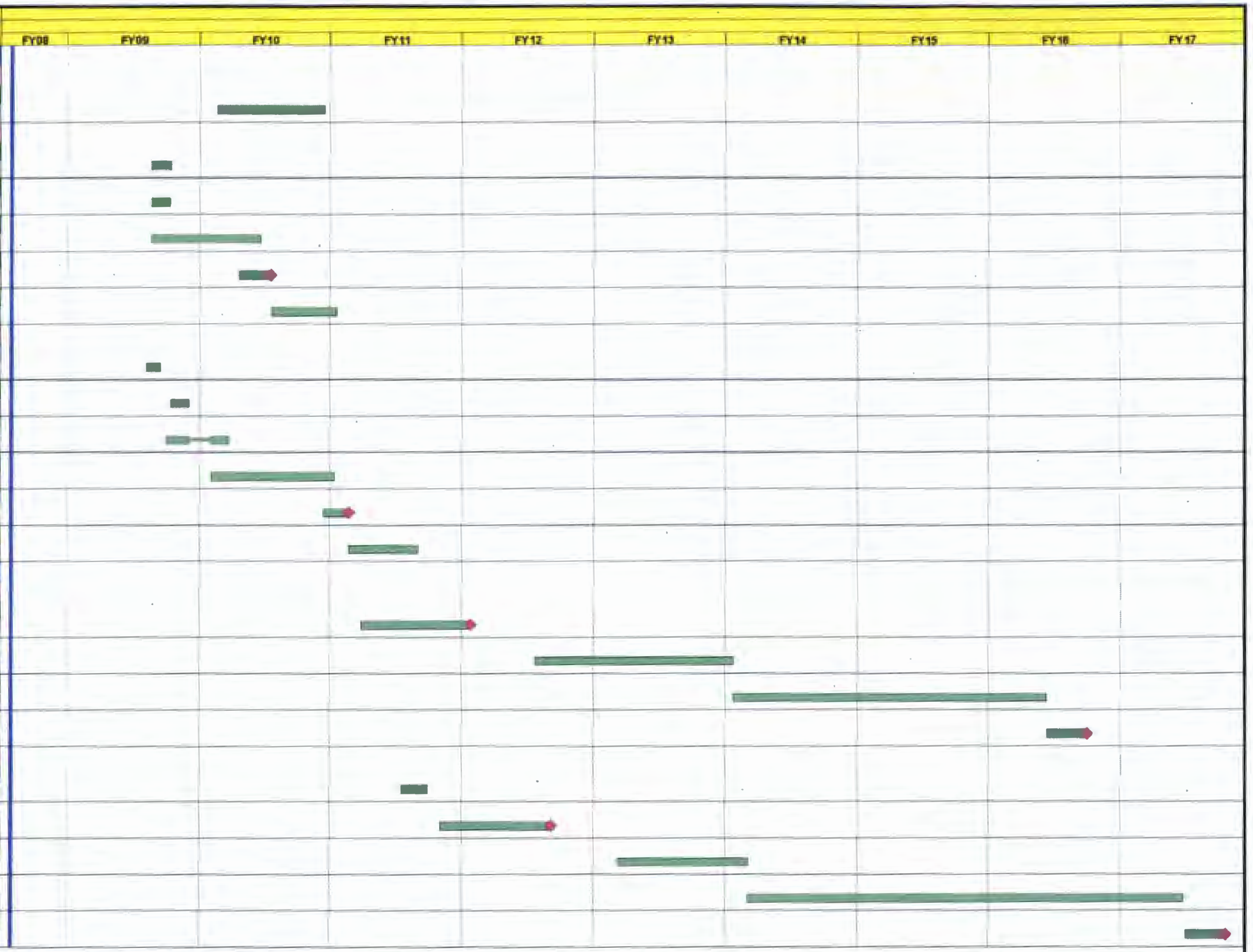
8. Energy Northwest will support the scheduled activities and will not delay the work crews.

9. Energy Northwest outages will not affect subsurface probe installation at 618-11.

10. Adequate funding will be provided to meet the schedule.

Figure 1-6. 618-10 and 618-11 Project Schedule.

Activity	Early Start	Early Finish
618-10/11 Characterization Non-Intrusive		
618-10/11 Common Tasks		
+ Enclosure Conceptual Design	17NOV09	14SEP10
618-10 Burial Ground		
+ 618-10 Surface Delineation	21MAY09	13JUL09
+ 618-10 Site Mobilization	21MAY09	08JUL09
+ 618-10 Characterization	21MAY09	18MAR10
+ 618-10 Characterization Report	21JAN10	15APR10
+ Evaluate Char Report/Workshops with RL & EPA	19APR10	18OCT10
618-11 Burial Ground		
+ Outages	08MAY09	15JUN09
+ 618-11 Surface Delineation	14JUL09	31AUG09
+ 618-11 Site Mobilization	01JUL09	21DEC09
+ 618-11 Characterization	03NOV09	11OCT10
+ 618-11 Characterization Report	14SEP10	22NOV10
+ Evaluate Char Report/Workshops with RL & EPA	23NOV10	31MAY11
618-10/11 Characterization Intrusive		
618-10 Burial Ground		
+ Prepare SAP	27DEC10	24OCT11
+ Intrusive Char. Design (Enclosure & Sampling)	24APR12	21OCT13
+ Intrusive Characterization Field Implementation	22OCT13	07MAR16
+ Intrusive Characterization Data Summary Report	08MAR16	29JUN16
618-11 Burial Ground		
+ Outages	16APR11	24JUN11
+ Prepare SAP	03AUG11	05JUN12
+ Intrusive Char. Design (Enclosure & Sampling)	03DEC12	02DEC13
+ Intrusive Characterization Field Implementation	03DEC13	23MAR17
+ Intrusive Characterization Data Summary Report	27MAR17	19JUL17



Sheet 1 of 1

1.5.2 Intrusive Schedule Assumptions for 618-10

1. NTP and NTE notifications for preparing the DQO and SAP for 618-10 intrusive characterization will be received by June 21, 2010. The SAP will be approved by the regulators by October 24, 2011.

2. The NTP and NTE notifications for proceeding with the 618-10 intrusive characterization design will be received by April 24, 2112.

3. The enclosure design criteria will permit using an enclosure similar to the one used on the Idaho National Laboratory Glovebox Excavation Method (GEM) project.

4. 618-10 intrusive characterization readiness activities will take 9 months to complete.

5. The proposed 618-10 field characterization activities will take 11 months to complete. This duration assumes 10 test pits in the trenches; 1 trench across the trenches at the northeast corner of the site; excavating, removing, sampling, and nondestructively examining the top two drums of 10 VPUs; 1 month to remove material for sampling, collect samples, and relocate the glovebox; and concurrent VPU and trench sampling.

6. Adequate funding will be provided to meet the schedule.

7. The nonintrusive data collected from 618-10 will be evaluated to determine if intrusive characterization of the VPUs and trenches is needed.

1.5.3 Intrusive Schedule Assumptions for 618-11

1. The NTP and NTE notifications for preparing the DQO and SAP for 618-11 intrusive characterization will be received by August 3, 2011. The SAP will be approved by the regulators by June 12, 2112.

2. The NTP and NTE notifications for proceeding with the 618-11 intrusive characterization design will be received by December 3, 2012.

3. The enclosure design criteria will permit using an enclosure similar to the one used on the Idaho GEM project.

4. 618-11 intrusive characterization readiness activities will take 9 months to complete.

5. The proposed 618-11 field characterization activities will take 10 months to complete. This duration assumes 10 test pits in the trenches; excavating, removing, sampling, and nondestructively examining the top two drums of two VPUs; evaluating the interior of each caisson with camera and dose instruments; 1 month to remove material for sampling, collect samples, and relocate the glovebox; and concurrent VPU, caisson, and trench sampling.

6. Adequate funding will be provided to meet the schedule.

7. The nonintrusive data collected from 618-11 will be evaluated to determine if intrusive characterization of the VPUs, caissons, and trenches is needed.

2.0 QUALITY ASSURANCE PROJECT PLAN

The quality assurance project plan (QAPjP) establishes the quality requirements for environmental data collection, including sampling, field measurements, and laboratory analysis. The QAPjP complies with the requirements of the following:

- *Hanford Analytical Services Quality Assurance Requirements Documents* (HASQARD) (DOE-RL 1998).

The QAPjP defines the basic quality requirements as listed below:

- **Analytical Performance.** Requirements for detection limits, precision, and accuracy are presented in Table 2-1. The analytical methods are also shown in this table.
- **Field Quality Control.** The frequency and type of quality control (QC) samples to be collected are addressed in Section 2.1.
- **Sample Preservation, Containers, and Holding Time.** The requirements for the specific test/laboratory methods are addressed in Section 2.3 and in Table 2-2.
- **Onsite Measurements Quality Control.** The specific types of QC samples for onsite measurements, including the frequency of collection and software quality assurance are addressed in Section 2.4.
- **Data Validation and Usability.** Specific validation requirements, including the frequency and level of validation, are addressed in Section 2.6.

2.1 FIELD QUALITY CONTROL

Field QC samples shall be collected to evaluate the potential for cross-contamination.

2.1.1 Equipment Blanks

Equipment blanks shall be collected at the frequency of 1 in 20 samples, and are used to verify the adequacy of sampling equipment decontamination procedures. The analytical lead may request that additional equipment blanks be taken. Equipment blanks consist of silica sand (or other suitable media) run through decontaminated sampling equipment and placed in containers identical to those used for actual field samples.

Equipment blank analyses are as follows:

- Gamma spectroscopy
- Metals (excluding hexavalent chromium and mercury)
- Anions.

These analytes are considered to be the best indicators of decontamination effectiveness.

2.1.2 Prevention of Cross-Contamination

Special care should be taken to prevent cross-contamination of soil samples. Particular care will be exercised to avoid the following common ways in which cross-contamination or background contamination may compromise the samples:

- Improperly storing or transporting sampling equipment and sample containers
- Contaminating the equipment or sample bottles by setting them on or near potential contamination sources, such as uncovered ground
- Handling bottles or equipment with dirty hands
- Improperly decontaminating equipment before sampling or between sampling events.

2.2 QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA

Quality objectives and criteria for screening soil measurement data are presented in Table 2-1.

Table 2-1. Analytical Performance Requirements. (3 Pages)

Data Type	Analyte	Analytical Method	Detection Limit Goals[a]	Accuracy Req't[b] (% Recovery)	Precision Req't[b] (% RPD)
Performance Requirements for Direct Field Measurements					
Rad	Gross beta/gamma	GM	5 mR/hr to 500 R /hr	NA	NA
Rad	Low-level gamma	NaI(Tl)	Gamma-emitting isotope identification	NA	NA
Rad	High-level gamma	CZT	Gamma-emitting isotope identification >2 R/hr – common fuel and activation products	NA	NA
Rad	Neutron detection	He^3 and BF_3	Presence of U-235/Pu-239	NA	NA
Chem	Volatile	Portable detectors	Presence of organic vapors	NA	NA

Table 2-1. Analytical Performance Requirements. (3 Pages)

Data Type	Analyte	Analytical Method	Detection Limit Goals[a]	Accuracy Req't[b] (% Recovery)	Precision Req't[b] (% RPD)
Performance Requirements for Laboratory Measurements of Soil Samples					
Rad	Am-241	Am AEA	1	70-130[c]	±30[c]
Rad	C-14	C-14 Chem sep/liq scintillation	5	70-130[c]	±30[c]
Rad	Co-60	GEA (HPGe or GeLi)	0.05	70-130[c]	±30[c]
Rad	Ce-137	GEA (HPGe or GeLi)	0.05	70-130[c]	±30[c]
Rad	Eu-152	GEA (HPGe or GeLi)	0.1	70-130[c]	±30[c]
Rad	Eu-154	GEA (HPGe or GeLi)	0.1	70-130[c]	±30[c]
Rad	Eu-155	GEA (HPGe or GeLi)	0.1	70-130[c]	±30[c]
Rad	H-3	H-3 Distillation liq separation	10	70-130[c]	±30[c]
Rad	Ni-63	Ni-63 Chem sep/liq scintillation	30	70-130[c]	±30[c]
Rad	Pu-238	Pu AEA	1	70-130[c]	±30[c]
Rad	Pu-239/240	Pu AEA	1	70-130[c]	±30[c]
Rad	Total Radioactive-|Sr	Rad-Sr	1	70-130[c]	±30[c]
Rad	Tc-99	Tc-99 Chem sep/liq scintillation	30	70-130[c]	±30[c]
Rad	U-233/234	U AEA	1	70-130[c]	±30[c]
Rad	U-238	U AEA	1	70-130[c]	±30[c]
Chem	Ag	EPA 6010 – ICP Trace	0.2	70-130[d]	±30[d]
Chem	As	EPA 6010 - ICP	10	70-130[d]	±30[d]
Chem	Ba	EPA 6010 - ICP	20	70-130[d]	±30[d]
Chem	Cd	EPA 6010 – ICP Trace	0.2	70-130[d]	±30[d]
Chem	Cr(total)	EPA 6010 - ICP	1	70-130[d]	±30[d]
Chem	Cr^{+6}	EPA 7196	0.5	70-130[d]	±30[d]
Chem	Hg	EPA 7471	0.2	70-130[d]	±30[d]
Chem	Pb	EPA 6010 - ICP	5	70-130[d]	±30[d]
Chem	Se	EPA 6010 – ICP Trace	1	70-130[d]	±30[d]
Chem	Al	EPA 6010 - ICP	5	70-130[d]	±30[d]
Chem	Cu	EPA 6010 - ICP	1	70-130[d]	±30[d]
Chem	Fe	EPA 6010 - ICP	5	70-130[d]	±30[d]
Chem	Ni	EPA 6010 - ICP	4	70-130[d]	±30[d]
Chem	Zn	EPA 6010 - ICP	1	70-130[d]	±30[d]
Chem	Opportunistic[e]	EPA 6010 - ICP	10[f]	70-130[d]	±30[d]
Chem	Nitrate	EPA 300.0	2.5	70-130[d]	±30[d]
Chem	Sulfate	EPA 300.0	2.5	70-130[d]	±30[d]
Chem	Phosphate	EPA 300.0	2.5	70-130[d]	±30[d]
Chem	Chloride	EPA 300.0	2.5	70-130[d]	±30[d]
Chem	TPH	EPA 8015M/418.1	200	50-150[g]	±30[g]
Chem	PCBs	EPA 8082	0.02	50-150[g]	±30[g]

Table 2-1. Analytical Performance Requirements. (3 Pages)

Data Type	Analyte	Analytical Method	Detection Limit Goals[a]	Accuracy Req't [b] (% Recovery)	Precision Req't [b] (% RPD)
Chem	SVOA (to include TPB)	EPA 8270	0.66[h]	50-150[g]	±30 [g]

[a] Units are in pCi/g or mg/kg unless otherwise specified. Detection limits shown are for standard fixed laboratory methods for low contamination soils. Significant levels of contamination may affect achievable detection limits due to the need to reduce sample sizes, increase dilution, or due to interference effects.

[b] Accuracy and precision criteria shown are for standard fixed laboratory methods for low contamination soils. Significant levels of contamination may affect achievable precision and accuracy due to the need to reduce sample sizes, increase dilution or due to interference effects. Field instrumentation will undergo operability checks to ensure sensitivity ranges have not changed and that isotope identification is correct for gamma spectral methods.

[c] The accuracy criteria shown is for associated batch laboratory control sample percent recoveries. Except for GEA analysis, additional accuracy criteria include analysis-specific evaluations preformed for matrix spike, tracer, and/or carrier recoveries as appropriate to the method. The precision criterion shown is for batch laboratory replicate sample RPDs.

[d] The accuracy criteria specified is for calculated percent recoveries for associated analytical batch matrix spike samples. Additional accuracy evaluation based on statistical control limits for analytical batch laboratory control samples is also performed. The precision criteria shown is for batch laboratory replicate matrix spike or replicate sample RPDs.

[e] Analysis will be performed for a broad spectrum of elements routinely analyzed by ICP methodology.

[f] Detection limits shown is a "nominal" maximum. Most analytes reported will achieve this or a lower detection limit. A limited number will have higher detection limits.

[g] The accuracy criteria shown is the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control if more stringent. Additional accuracy criteria include analyte-specific evaluations preformed for matrix spike, and surrogate recoveries as appropriate to the method. The precision criteria shown is for batch laboratory replicate matrix spike analysis RPDs.

[h] Analysis will be performed for a broad spectrum of SVOA compounds routinely analyzed by Method 8270. SVOA detection limit shown is a "nominal" maximum. Most analytes will achieve this or a lower detection limit. A limited number will have higher detection limits.

AEA = chemical separation followed by alpha energy analysis
BF3 = boron fluoride detectors
CZT = cadmium zinc telluride detectors
EPA = EPA SW-846 methodology except for 300.0 and 418.1, which are from 600/4-79-020
GEA = gamma energy analysis
GeLi = lithium drifted germanium detectors
GM = Geiger-Mueller detector
He3 = Helium–3 detectors
HPGE = high-purity germanium detectors
ICP = inductively coupled plasma
ICP-Trace = axial-based ICP analytical method yielding a lower detection limit
NA = not applicable
NaI(Tl) = thalium-doped sodium iodide detectors
PCB = polychlorinated biphenyls (reporting will be for commercial Aroclor mixtures)
RPD = relative percent difference
SVOA = semivolatile organic analysis (a broad spectrum analysis reporting a minimum of 66 common organic compounds)
TPH = total petroleum hydrocarbons

2.3 SAMPLE PRESERVATION, CONTAINERS, AND HOLDING TIMES

Typical soil sample preservation, containers, and holding times for chemical and radiological analytes of interest and physical property test are presented in Table 2-2. Final sample collection requirements will be identified on the sample authorization form (SAF).

Table 2-2. Sample Preservation, Container, and Holding Time Guidelines.

Analytical Method	Matrix	Bottle		Amount[a,b]	Preservation	Packing Requirements	Holding Time
		Number	Type				
Radionuclides							
Am AEA	Soil	1	G/P	10-1000 g	None	None	6 months
C-14 Chem sep/liq scintillation	Soil	1	G/P	10-1000 g	None	None	6 months
GEA (HPGe or GeLi)	Soil	1	G/P	100-1500 g	None	None	6 months
H-3 Distillation liq separation	Soil	1	G	100-500 g	None	None	6 months
Ni-63 Chem sep/liq scintillation	Soil	1	G/P	10-1000 g	None	None	6 months
Pu AEA	Soil	1	G/P	10-1000 g	None	None	6 months
Rad-Sr	Soil	1	G/P	10-1000 g	None	None	6 months
Tc-99 Chem sep/liq scintillation	Soil	1	G/P	10-1000 g	None	None	6 months
U AEA	Soil	1	G/P	10-1000 g	None	None	6 months
Chemicals							
EPA 300.0 (anions)	Soil	1	G/P	50-500 g	None	None	28 days/ 48 hours
EPA 6010 – ICP & ICP Trace (metals)	Soil	1	G/P	10-500 g	None	None	6 months
EPA 7196 (Cr VI)	Soil	1	G/P	5-500 g	None	Cool 4°C	30 days
EPA 7471 (Hg)	Soil	1	G	5-125 g	None	None	28 days
EPA 8270 (SVOA)	Soil	1	aG	125-1000 g	None	Cool 4°C	14/40 days
EPA 8082 (PCB)	Soil	1	aG	125-1000 g	None	Cool 4°C	14/40 days
EPA 8015M/.418.1 (TPH)	Soil	1	G	10-50 g	None	Cool 4°C	14 days

[a] Optimal volumes, which may be adjusted downward to accommodate the possibility of retrieval of small amount of sample. Minimum sample size will be defined on the sample authorization form.

[b] Mixed soil samples may be obtained and submitted to the analytical laboratory for analyses for specific analytes including: _Radionuclides_-100 g of soil for all radionuclides (except carbon-14, tritium, and technetium-99; they require approx. 10 g each sample); _Chemicals_-a 10-g soil sample is required for all ICP analysis, 10-g soil sample is required for IC anion analysis, 5-g soil sample for hexavalent chromium analysis, 10-g soil sample for CA analysis, 10-g soil sample for 8015M/418.1 analysis, and 125-g soil samples for each 8270 and PCB analyses.

aG = amber glass
G = glass
P = plastic
PCBs = polychlorinated biphenyls (reporting will be for commercial Aroclor mixtures)
SV = semivolatile organic analysis (a broad spectrum analysis reporting a minimum of 66 common organic compounds)
TP = total petroleum hydrocarbons

2.4 ONSITE MEASUREMENTS QUALITY CONTROL

Each user of the measuring equipment is responsible to ensure the equipment is functioning as expected, properly handled, and receives calibration before expiration in accordance with procedures governing the control of the measuring equipment. Hardware system calibration and software configuration control along with structured programming are the two most important quality assurance/QC elements for the MDP system used for in situ characterization at the 618-10 and 618-11 Burial Grounds. The system calibration process requires that calibration be traceable to the National Institute for Standards and Technology (NIST) and that regular performance checks be conducted in the field to ensure operability. Instrument calibration verifies the operability and performance of a system. For in situ characterization, performance of the MDP system will be further verified in a test to qualify the system operability in the 618-10 and 618-11 Burial Grounds. The MDP system qualification test will verify the MDP performance under simulated field conditions in a controlled laboratory environment for the detection of transuranic and spent fuel related radionuclides potentially found in the VPUs.

The software used in the MDP system will be verified HASQARD compliant and will be managed in accordance with the software quality assurance requirements of DOE O 414.1C. These standard practices will require that the software used to support Washington Closure Hanford (WCH) follows proper software quality assurance work activities, including identifying and classifying software that may have a safety impact, documenting system requirements, verifying and testing that system requirements have been satisfied, identifying error reporting processes, and managing the software configuration to ensure consistent results. In addition, testing will include verifying that all internal calculations are correct by the use of hand calculations and/or suitable third-party commercial software packages. Because measurements from the MDP probes will be somewhat unknown prior to field deployment, the MDP software was designed such that all internal calculations could be reconstructed by reanalyzing the spectral information collected by the various detectors that make up the MDP. Therefore, special attention will be taken to address the storage of spectral data and ancillary data such as tool depth and location during the data acquisition process.

Onsite work will be performed under controlled conditions using controlled documents such as approved plans, procedures, work instructions, and permits. Those activities not covered by procedures will be evaluated and may be performed under special permits or other work control documents as determined by the 618-10 and 618-11 project manager. For in situ characterization, operability of the MDP will be checked at the beginning of each day using radiation sources traceable to NIST. At the end of each day, the MDP will be checked again using the same sources to confirm that the system operated properly.

2.5 DATA MANAGEMENT

Data packages will be used to document the process of analyzing and interpreting onsite measurements and sampling results. A data package provides a permanent record of the data analysis used for a particular data set. It presents sufficient information to allow a technical reviewer or other user of data to understand the data set that is being interpreted, analysis methods used, formulas and equations used in the data analysis process, computer software used (if any), and any assumptions made in the analysis process. When computer software or manual calculations are used, then information sufficient to allow the calculations performed to be repeated (excluding reintegration of peak areas) if necessary shall be retained, submitted, and become part of the final body of record data requiring formal retention.

Analytical data packages and any supplemental information required for formal retention resulting from the implementation of this QAPjP will be received by, managed, transmitted, and submitted for storage by WCH Environmental Services (Sampling and Characterization), in accordance with internal sample management procedures. Electronic data access, when appropriate, will be via a database (e.g., Stewardship Information System). Where electronic data are not available, hard copies will be provided, as appropriate, in accordance with Section 9.6 of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1989).

2.6 VALIDATION AND VERIFICATION OF ANALYTICAL RESULTS

At the direction of the task lead, data analysis packages developed from onsite measurements and sampling data will be subject to independent review for verification purposes prior to their submittal to regulatory agencies or inclusion in reports. Subject matter experts will perform the role of independent technical reviewers of each data analysis package. The technical reviewer(s) shall be an individual(s) who did not perform the original analysis and who is competent in the subject matter.

Validation is not required for the analyses performed for this investigation.

2.7 TECHNICAL SPECIFICATIONS

Soil sampling and onsite environmental measurements will be performed according to the HASQARD (DOE-RL 1998).

2.7.1 Sample Location

Sample locations (e.g., probe points and soil samples) will be staked and labeled before starting the activity. After the locations have been staked, minor adjustments to the location may be made to mitigate unsafe conditions, avoid structural interferences, or bypass utilities. Locations will be identified during or after sampling following HASQARD requirements. See Section 3.2 of this SAP for a detailed discussion of sample location tasks.

2.7.2 Sample Identification

The WCH Sample and Data Tracking database will be used to issue sample numbers and track the samples through the collection and laboratory analysis process. The Stewardship

Information System database is the repository for the laboratory analytical results. Each chemical/radiological and physical properties sample will be identified and labeled with a unique sample number. The sample location, depth, and corresponding sample numbers will be documented in the sampler's field logbook.

Each sample container will be labeled with the following information using a waterproof marker on firmly affixed, water-resistant labels:

- Sample Data Tracking-generated sample number
- Sample collection date/time
- Name/initials of person collecting the sample
- Analysis required
- Preservation method, if applicable.

2.7.3 Field Sampling Log

All information pertinent to field sampling and analysis will be recorded in bound logbooks in accordance with HASQARD requirements. The sampling team will be responsible for recording all relevant sampling information. Entries made in the logbook will be dated and signed by the individual who made the entry.

2.7.4 Sample Custody

A chain-of-custody record will be initiated in the field at the time of sampling and will accompany each set of samples (cooler) shipped to any laboratory in accordance with HASQARD requirements. The analyses requested for each sample will be indicated on the accompanying chain-of-custody form. Chain-of-custody procedures will be followed throughout sample collection, transfer, analysis, and disposal to ensure that sample integrity is maintained. Each time responsibility for custody of the sample changes, the new and previous custodians will sign the record and note the date and time. The sampler will make a copy of the signed record before sample shipment and transmit it to WCH Sample Management within 24 hours of shipping, following HASQARD requirements.

A custody seal (i.e., evidence tape) shall be affixed to the lid of each sample jar. The container seal will be inscribed with the sampler's initials and the date sealed. For any sample jars collected inside the glovebag or glovebox and "bagged out," the evidence tape may be affixed to the seal of the bag to demonstrate that tampering has not occurred. This will eliminate problems associated with contaminated soils adhering to the custody tape while inside the glovebox.

2.7.5 Sample Containers and Preservatives

Level I U.S. Environmental Protection Agency (EPA) pre-cleaned sample containers will be used for soil samples collected for chemical and radiological analysis. Container sizes may vary depending on laboratory-specific volumes needed to meet analytical detection limits. If, however, the dose rate on the outside of a sample jar or the curie content exceeds levels acceptable by an offsite laboratory, the sampling lead and task lead can send smaller volumes to the laboratory after consultation with WCH Sample Management to determine acceptable volumes. Preliminary container types and volumes are identified in Table 2-2. Final types and volumes will be provided on the SAF.

2.7.6 Sample Shipping

The outside of each sample jar will be surveyed by the radiological control technician (RCT) to verify that the container is free of smearable surface contamination. The RCT will also measure the radiological activity on the outside of the sample container. All samples will have total activity analysis performed by the Radiological Counting Facility or other suitable onsite laboratory before shipment. This information, along with other data that may pre-qualify the samples, will be used to select proper packaging, marking, labeling, and shipping paperwork in accordance with U.S. Department of Transportation (DOT) regulations (49 *Code of Federal Regulations* [CFR]) and to verify that the sample can be received by the offsite analytical laboratory in accordance with the laboratory's acceptance criteria. The sampler will send copies of the shipping documentation to WCH Sample Management within 24 hours of shipping, following HASQARD requirements.

As a general rule, samples with activities <1 mR/hr will be shipped to an offsite laboratory. Samples with activities between 1 mR/hr and 10 mR/hr may be shipped to an offsite laboratory; samples with activities in this range will be evaluated on a case-by-case basis by WCH Sample Management. Samples with activities >10 mR/hr will most likely be sent to an onsite laboratory arranged by Sample Management. Potential impacts of onsite laboratory measurements are discussed in footnote "a" of Table 2-1.

3.0 FIELD SAMPLING PLAN

3.1 SAMPLING OBJECTIVES

The primary objective of this SAP is to clearly identify and describe in situ measurement and sampling and analysis activities that will be conducted so that further characterization and/or, eventually, remediation activities can be planned and performed. Available chemical and radiological characterization data for the 618-10 and 618-11 Burial Grounds are limited and additional data are needed to safely conduct intrusive site characterization and remediation activities. Because only limited data are available for these burial grounds, and because it is likely that materials which pose a significant safety risk may be present in these burial grounds, only nonintrusive characterization activities will be performed during this initial field investigation.

The VPUs, caissons, and trenches will be evaluated using an in situ radiological MDP through sealed, metal-cased probe points located just outside each of the VPUs and caissons, and within the boundaries of each trench structure. Up to four probe points will be installed at approximately equally spaced positions outside the perimeter of each VPU, and up to six equally spaced probe points will be installed outside the perimeter of the caissons for radiological logging purposes. Each of these probe points will be installed as close as possible to the VPUs and caissons. Sealed, metal-cased probe points will also be installed along the approximate centerline of each of the trenches. Geophysical surveys will be performed to precisely locate each of the VPUs and caissons, and geophysics data from surveys previously performed at the sites will be used to locate the approximate centerlines of the trenches.

Based on the geophysics survey and in situ MDP data, up to 10% of the VPUs will be selected as locations for soil sampling. One soil sample will be collected for radiological and chemical analysis from below each of the selected VPUs. Two soil samples will be collected from beneath each of the caissons. The soil sample locations at each caisson will be selected based on the in situ radiological monitoring data. Probe points with removable drive tips will be used to access the soils immediately outside the perimeter and approximately 0.6 m (2 ft) below the bottom of the VPU and caisson structures. Soil samples will not be collected from within the footprint of the trenches during this characterization effort because insufficient data exist to determine the necessary contamination controls that may be necessary.

Four main phases of work are to be performed under this SAP. These include the following:

- Delineate burial ground structures using geophysical methods to locate in situ measurement and soil sampling points
- Install cased probe points near or within subsurface burial ground structures

- Collect in situ radiological measurements from within the installed probe points using a MDP assembly
- Collect soil samples from the perimeter of the VPUs and caissons at depths below the bottom of these structures.

These phases of work are to be completed in the order presented above for each of the VPUs, caissons, and trenches at the 618-10 and 618-11 Burial Grounds. Sections 3.2, 3.3, 3.4, and 3.5 provide details regarding field implementation aspects of this characterization activity. Actual field implementation details may vary slightly from what is contained in this SAP. Field work packages that describe the details of the performance of this work will be prepared and made available to the lead regulatory agency. There will be no changes in the sampling requirements unless approved by the lead regulatory agency. It will be necessary to evaluate the data collected during each phase of the work so that decisions can be made regarding the specifics of how the following phase of work is to be performed. As each phase is completed the collected data will be evaluated with respect to safety considerations and to optimize the type and quantity of information that will be collected during this investigation.

A report will be prepared at the completion of these field activities and upon the receipt of laboratory data. This report can then be used during the development of future SAPs for intrusive characterization activities and in planning for the remediation of these sites.

3.2 GEOPHYSICAL DELINEATION

The first step in performing characterization activities within the 618-10 and 618-11 Burial Grounds will consist of performing geophysical surveys to delineate the VPUs and caissons, and to evaluate existing geophysics data from the trench areas so the probe and soil sampling points can be located. It is important that the VPU and caisson probe points are located as close to the perimeter of these structures as possible to help attain the maximum level of accuracy possible from the MDP. A three-step process will be used for the VPUs and caissons. Geophysical surveys with sufficient detail to locate the probing locations have previously been performed in the trench areas. These data will be evaluated to finalize probing locations at the trenches.

3.2.1 Vertical Pipe Unit and Caisson Geophysical Surveys

The delineation of the VPUs and caissons will be determined using the following three-step geophysical survey approach:

- Reconnaissance-level magnetic field survey (if existing documentation proves incomplete or inconsistent)
- Detailed level magnetic and time domain electromagnetic induction (TDEMI) survey
- Ground-penetrating radar (GPR) survey.

The objective of the reconnaissance-level survey is to identify and stake the general locations of features of interest and to map the area for further evaluation. The reconnaissance-level survey will use a magnetic field mapping instrument (magnetometer) that detects changes in the earth's magnetic field caused by buried objects. The path locations will be established using fiberglass measuring tapes and visual guide markers. Vertical pipe unit/caisson position information will be controlled using an optical encoder.

The detailed magnetic surveys will consist of two parts. The first part uses the above described magnetic survey technique at a reduced grid pattern. The second part is a TDEMI survey that measures the intensity of magnetic eddy currents as a function of time. Computer modeling then creates a horizontal layered resistivity model of the subsurface.

In the final step of the geophysical delineation of the VPUs and caissons, the position and boundary of the subsurface features will be determined using GPR. Ground-penetrating radar profile locations will be determined based on the magnetic and TDEMI data collected during the first two steps described above.

All the survey data will be downloaded into a computer and electronically overlaid to determine the best fit. When this is completed, the final centerline coordinates of each buried object will be identified. Using these coordinates, field personnel will stake the probe point locations, which will be documented with civil survey and GPS coordinates.

3.2.2 Trench Geophysical Surveys

Extensive geophysical survey data that can be used to locate the probe points in the areas of the 618-10 and 618-11 trenches have been collected during previous mapping activities at these sites. The earlier geophysical work included detailed GPR and magnetometer surveys. The results of these activities were documented onsite maps using global positioning system (GPS)-generated coordinates. Figure 3-1 shows the trench locations at the 618-10 Burial Ground, and Figure 3-2 shows the trench locations at the 618-11 Burial Ground, based on earlier geophysics data.

These data can be used to determine the approximate centerlines of the trenches and to identify any areas that may be of special interest. The data will be reviewed prior to determining the final placement of the probe points and the locations will be staked in the field using GPS survey techniques based on mapped coordinates. It is anticipated that no additional geophysical survey data will be needed in the areas of the trenches.

Figure 3-1. 618-10 Geophysics Survey Map (Source: BHI-00291, Rev. 00).

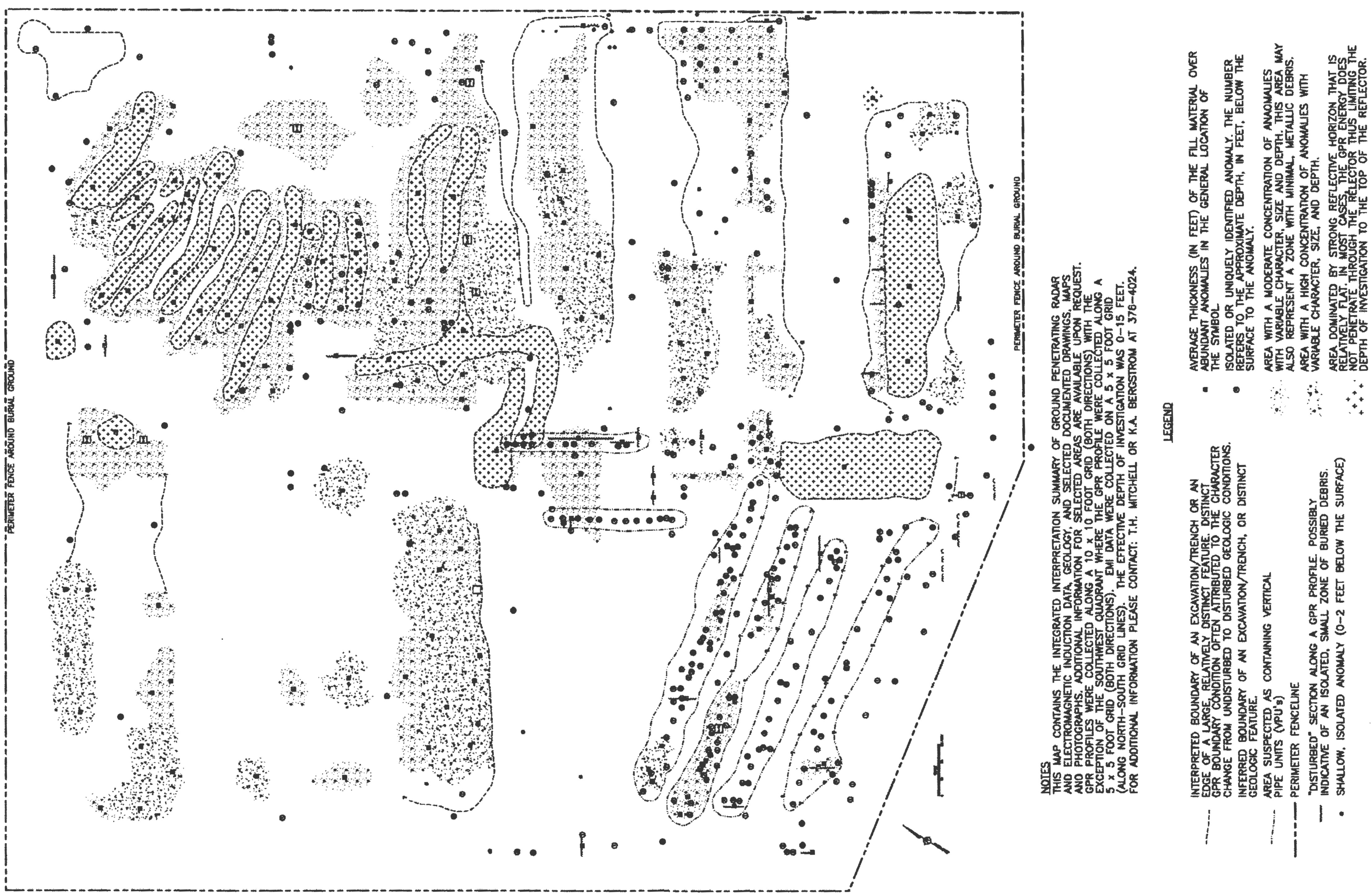
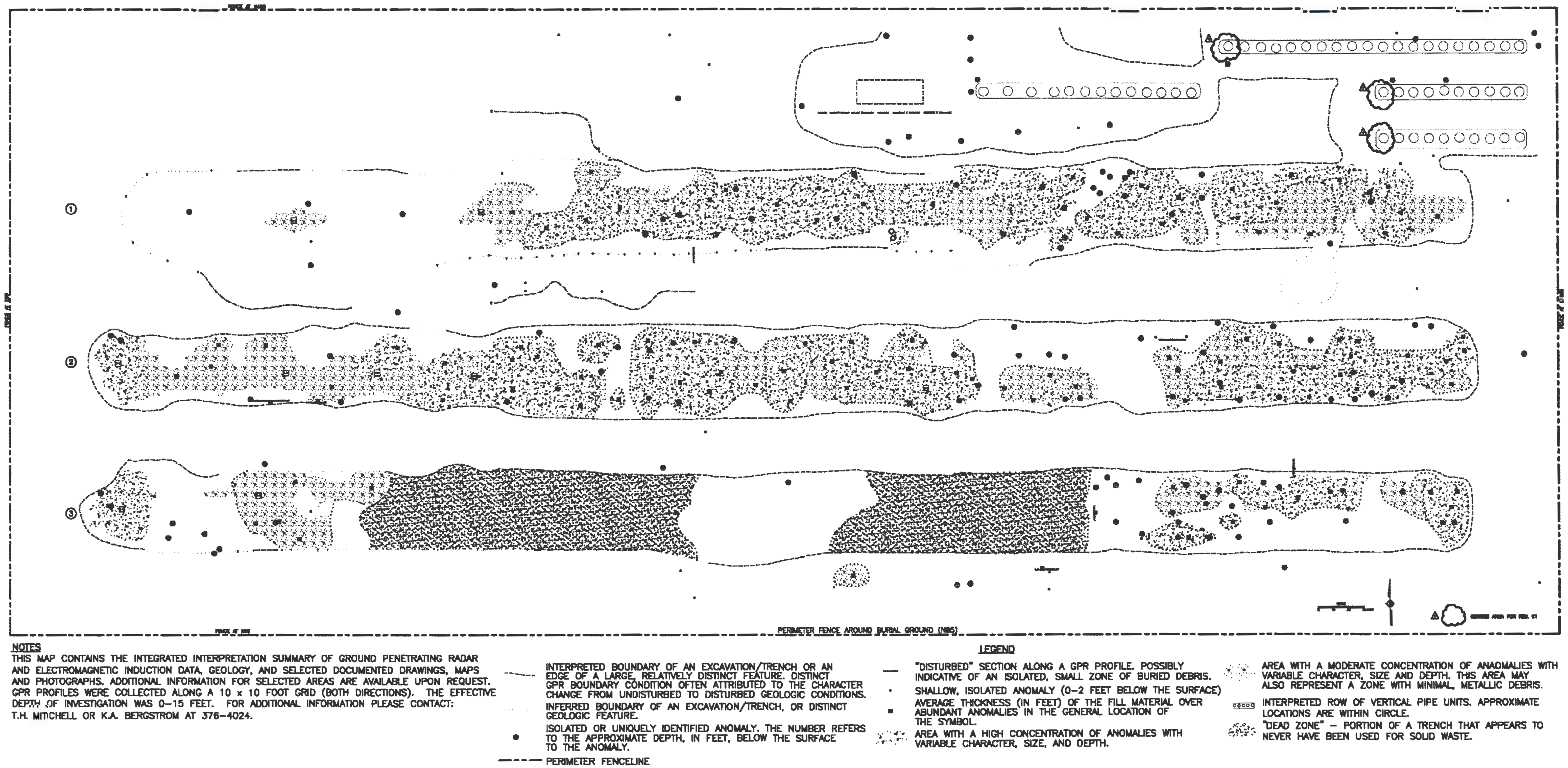


Figure 3-2. 618-11 Geophysics Survey Map (Source: BHI-00291, Rev. 00).



3.3 PROBE POINT INSTALLATION FOR MULTIDETECTOR PROBE LOGGING

Direct-push probe points are to be installed at the perimeter of the VPUs and caissons and lengthwise along the centerline of the trenches. These probe points will be used to access the subsurface of the 618-10 and 618-11 Burial Grounds with a MDP to collect in situ radiological characterization data from the burial ground structures.

The probe points are to be installed using a direct-push method. Unlike conventional drilling methods, direct-push methods allow for the installation of probe rods without having to drill and remove soil to make a path for the rods. Each probe point will consist of a string of threaded rods that will be driven or pushed into the ground using truck-mounted equipment. A conical-shaped steel tip will be threaded onto the down-hole end of the rod string to help facilitate the advancement of and seal the down-hole end of the rods. The probe rods will accommodate the MDP logging tool.

The probing rods are advanced by fitting a conical tip to the down-hole end of the initial rod(s) and a drive cap to the upper end of the rod string. The initial rod is positioned beneath the drive head of the probe equipment, checked to verify that it is plumb, and pushed into the ground using the drive head until another section of rod must be added to advance the string further. An RCT will be present to check for contamination at the top end of the drill string each time the drive cap is to be removed and a new section of probe rod is to be added.

The position and total depth of probe points will be as described in Sections 3.3.1, 3.3.2, and 3.3.3. During the installation of the probe points it is possible that obstructions will prevent the advancement of the rods to the target depths (refusal). Should the operator encounter refusal, the project engineer will determine if the depth achieved at refusal is acceptable or if the probe point needs to be repositioned to achieve the desired depth. It is also possible that the probing equipment operator will have indications of obstructions that can be advanced beyond or voids while probing (as indicated by probing speed or equipment gauge readings). Should these conditions be encountered, the project engineer will be contacted to verify that the probing location is acceptable.

The upper end of the rods will be temporarily sealed. The probe points will remain in place until further characterization or remediation activities take place.

3.3.1 Vertical Pipe Unit Probe Point Installation

Documentation available for the 618-10 and 618-11 Burial Grounds indicates that there are 94 VPUs at the 618-10 Burial Ground (Figure 1-2) and 50 VPUs at the 618-11 Burial Ground (Figure 1-4). The VPUs typically consist of five open-ended, 209 L (55-gal) drums that have been welded together end-to-end. Historical information indicates that each drum measured approximately 55.9 cm (22 in.) in diameter and 0.9 m (3 ft) long. There is also historical documentation indicating that up to 10 of the VPUs at the 618-10 site were constructed using 3.1 m (10-ft-) long sections of approximately 0.3 m (12-in.-) diameter corrugated metal pipe. The VPUs were installed vertically, and historical documentation indicates that they likely were positioned on a concrete footing. The upper portion of the VPUs was likely capped with a concrete plug (see Figure 1-3). Approximately 0.6 to 1.8 m (2 to 6 ft) of cover material has been placed over the VPUs for access and contamination control. This cover depth will be identified using the geophysics data described in Section 3.2.1.

Up to four probe points are to be installed at each VPU for the purposes of collecting MDP data. The probe points will be installed at approximately equally spaced positions outside the perimeter of each VPU. The probe points are to be installed as close as possible to the VPUs to obtain the highest resolution possible from the MDP logging tool. If refusal is encountered at shallow depths, the probe point will be stepped out until the rods can be advanced to the desired depth. Each of the MDP probe points will be installed to an approximate target depth of 0.9 m (3 ft) below the bottom of the VPU structures.

3.3.2 Caisson Probe Point Installation

Based on limited available documentation, three to five caissons are present only at the 618-11 Burial Ground. According to historical information, each caisson was constructed of a 3 m (10-ft-) long section of 2.4 m (8-ft-) diameter corrugated metal pipe that was oriented vertically and positioned on a concrete footing. The top of the caisson was positioned ~4.6 m (15 ft) below the ground surface at the time the burial ground was in operation. The top of the caisson is likely covered with an ~3 m (10-ft-) square, 20.3 cm (8-in.-) thick concrete top. The caisson was connected to the ground surface through an offset 91.4 cm (36-in.) metal chute. The top of the chute was capped with a domed metal lid (see Figure 1-5).

Up to six equally spaced probe points are to be installed at each caisson for the purpose of collecting MDP data. If the chute position can be determined by the geophysical surveys, one of the probe points will be located near and along the side of the chute. The other probe point locations will be determined based on the position of this probe point. As with the VPUs, the probe points will be positioned as close as possible to the caissons outside the perimeter of the structures.

If refusal is encountered at shallow depths, the probe point will be stepped out until the rods can be advanced to the desired depth.

An attempt will be made to drive each probe point to a depth of 0.9 m (3 ft) below the bottom of the caissons. Up to 0.9 m (3 ft) of cover material has been placed over the caisson locations. This cover depth will be identified using the geophysics data described in Section 3.2.1. It is possible that the caisson footing will be encountered prior to reaching this depth and the probe point will reach refusal. If refusal is encountered at depth, the project engineer will determine if the depth obtained is sufficient or if additional attempts are required.

3.3.3 Trench Probe Point Installations

Based on the geophysical delineation of the trenches, probe points will be positioned along the entire length of each trench at the approximate centerline. These probe points will be spaced at approximately 7.6 m (25-ft) intervals unless areas of interest or objects of concern indicate that adjustments to this spacing are necessary. If areas of concern or interest are identified in the trenches it may be necessary to either increase or decrease the spacing of the MDP probe points. The project engineer will determine if spacing adjustments are required.

Each of the probe points will be driven to a total depth of approximately 9.2 m (30 ft) below the existing ground surface. If refusal is encountered prior to reaching the target depth at any location, the project engineer will determine if additional attempts are to be made at other locations near where the refusal was encountered.

3.4 MULTIDETECTOR PROBE MEASUREMENTS

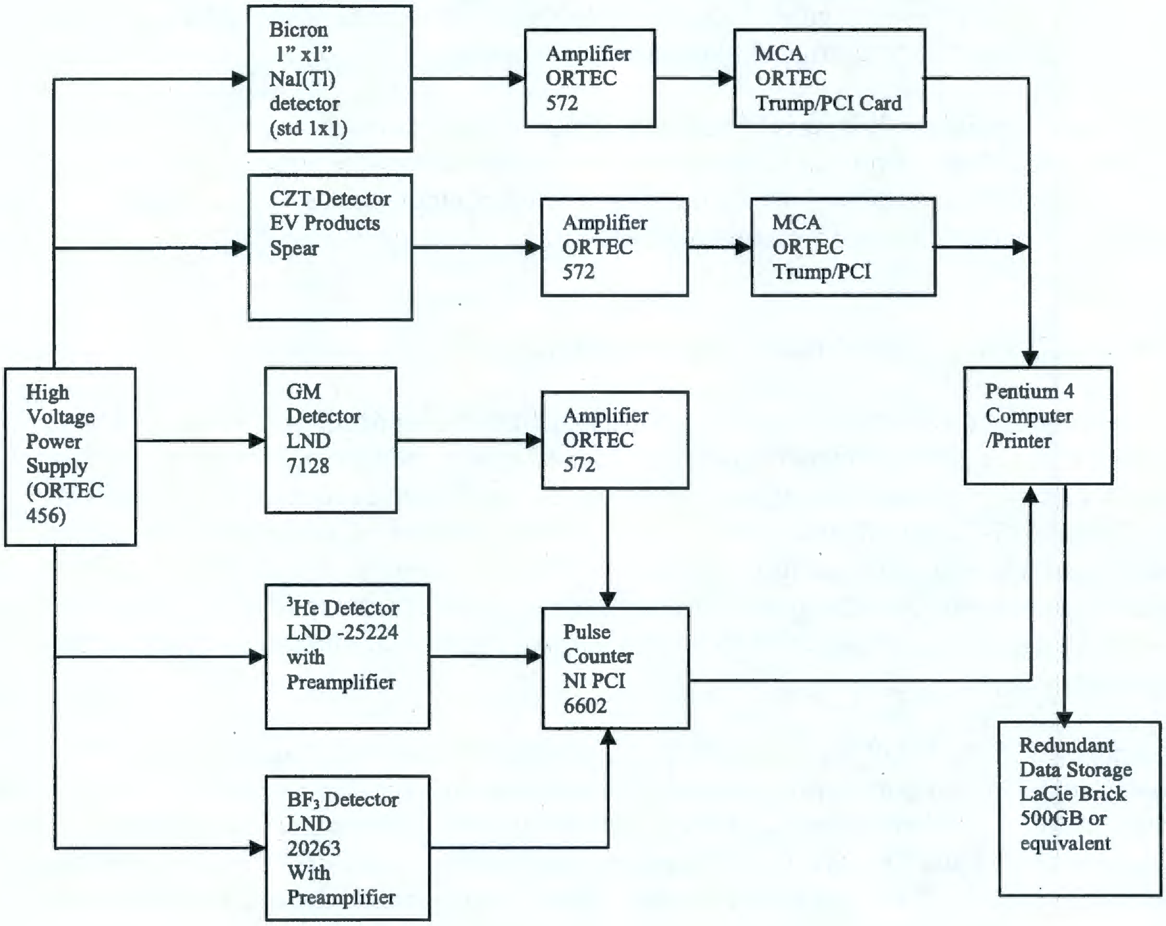
Each of the planned direct-push locations will be logged using an MDP instrument that is configured with two gamma-ray detectors that are used as spectrometers, two neutron detectors, and a gross gamma detector. The MDP system was designed for use in characterizing VPUs at the 618-10 and 618-11 Burial Grounds. The detectors are configured to measure a broad range of radiation sources and activities through the wall of a steel direct push rod. These detectors are incorporated into a single assembly with integral shielding to restrict the field of view of some of the detectors, improve efficiency, and locate the vertical position of radiation sources within the material being logged.

The components of the MDP are primarily standard radiation measurement modules with associated software elements to provide an integrated approach for data acquisition, analysis, and archiving. Additional elements include daily performance checks using radioactive sources to verify system operability. Figure 3-3 is a modular description of the MDP detectors and data acquisition hardware. The five detectors in the MDP system perform the following functions.

- *Gross Gamma Activity* – An energy-compensated Geiger-Mueller (GM) detector, with a nominal 0.8 in. diameter, has a sensitivity range from a few mR/hr to about 500 R/hr. Detecting gross gamma activity assists in defining the depths where the MDP NaI(Tl) and cadmium zinc telluride (CZT) detectors will be most effective for isotopic characterization of the waste.

- *Low-Level Gamma Isotopic Activity* – A thallium-doped sodium iodide NaI(Tl) detector (1 in. diameter by 1 in. long) is used as one of the gamma spectrometers for analyses for the primary isotopes expected in the Hanford Site wastes. The primary detectable radionuclides that are associated with irradiated fuels or activated materials include cesium-137, europium-154, europium-152, and cobalt-60.

Figure 3-3. MDP Detectors and Data Acquisition Hardware.



- *High-Level Gamma Isotopic Activity* – The second gamma detector for spectrometry, used for high-level (>2 R/hr) isotopic measurements, uses a CZT detector (0.5 in. by 3.5 in.). This detector provides reasonable resolution and is more sensitive at the lower gamma-ray energies (<1.0 MeV). This probe provides good resolution for many long-lived radionuclides and has been used previously to detect and quantify irradiated fuel materials and activation products in a number of environments.

- *Neutron Detection* – Spontaneous neutron production occurs from plutonium-239 and uranium-235. Helium (^3He) and boron triflouride (BF_3) detectors are used to assess the presence of quantities of neutron-generating fissile radioactive materials that may not be directly detectable using gamma spectrometry methods. Although the high-pressure ^3He detector is more sensitive to neutron detection than BF_3, the BF_3 detector is less sensitive to gamma radiation interference and is more suitable for neutron detection within higher gamma radiation fields.

- *Gamma Probe* - Although not an integral part of the MDP system, a second gross gamma detector (GM probe) is used to log the holes prior to inserting the MDP into the casings for system data collection. This hand-held GM probe provides preliminary estimates of exposure rates and hot-spot locations prior to data collection using the MDP.

3.4.1 Field Measurements

In situ characterization using the MDP system to perform field measurements consists of the following activities:

- Deploy GM Probe

  The MDP operator lowers the GM probe to the bottom of the direct-push rod casing and raises the GM probe at 0.3 m (1-ft) increments to record detector measurements at various elevations. After readings are recorded and the preliminary exposure rates and hot spots are noted, the MDP operator removes the GM probe and has it surveyed for radioactive contamination by the RCT.

- Perform Source Check

  Prior to field operation, the MDP system undergoes a calibration process using radioactive sources traceable to the NIST. At the beginning and end of each field measurement day, the MDP operator performs source checks to ensure system operability. A gamma-emitting radioactive source traceable to NIST will be used for the source checks. A cesium-137, barium-133, or other similar source with an activity of approximately 10 μCi will be used as a check standard. The MDP operator places the source in the holder, and the computer connected to the MDP performs data acquisition and analysis and will indicate whether the MDP system is acceptable for operation. If the source performance check is unacceptable, the computer will ask for a second check prior to indicating that the system is out of calibration. The MDP system will only be used after the source check indicates acceptability.

- Perform Radiological Assay

  Measurements are performed starting at the bottom of the probe point casing and taken in 0.3 m (1-ft) increments until the instrument has reached the ground surface. The MDP operator lowers the MDP to the bottom of the direct-push rod casing and ensures that the MDP is properly configured to perform measurements. The operator then initiates the integrated software program and begins radiological assay. The computer program will perform system countdown during measurements indicating the time remaining to complete the measurement at that interval. Upon completion of the measurements, the site supervisor and the MDP operator will confirm that all required elevations have been surveyed. The MDP operator will then remove the MDP from the direct-push rod casing, have it surveyed for radioactive contamination, and cap the casing after withdrawing the MDP. At the completion of the MDP measurements, the computer will process the data, show graphics of the activity for all detectors, and automatically print out the analysis results.

- Back Up Data

  Upon completion of the field measurements and data processing, the MDP operator will save the logging data to a backup storage device. The frequency for backing up electronic field data will be determined by the site supervisor.

3.4.2 Data Analysis and Storage

Data obtained from the MDP field measurements are acquired, analyzed, interpreted, and stored as follows:

- Data Acquisition

  Figure 3-4 shows a schematic of the software application for data acquisition and initial analysis.

- Data Analysis and Storage

  The MDP system relies on a number of commercial off-the-shelf software applications that have been integrated to provide a fully automated data acquisition and analysis system. The primary software integrator is the LabView 8 code. This code functions as the system interface and controls other software elements including data acquisition and analysis. The following text describes the specific functions of each of the codes used in the MDP system:

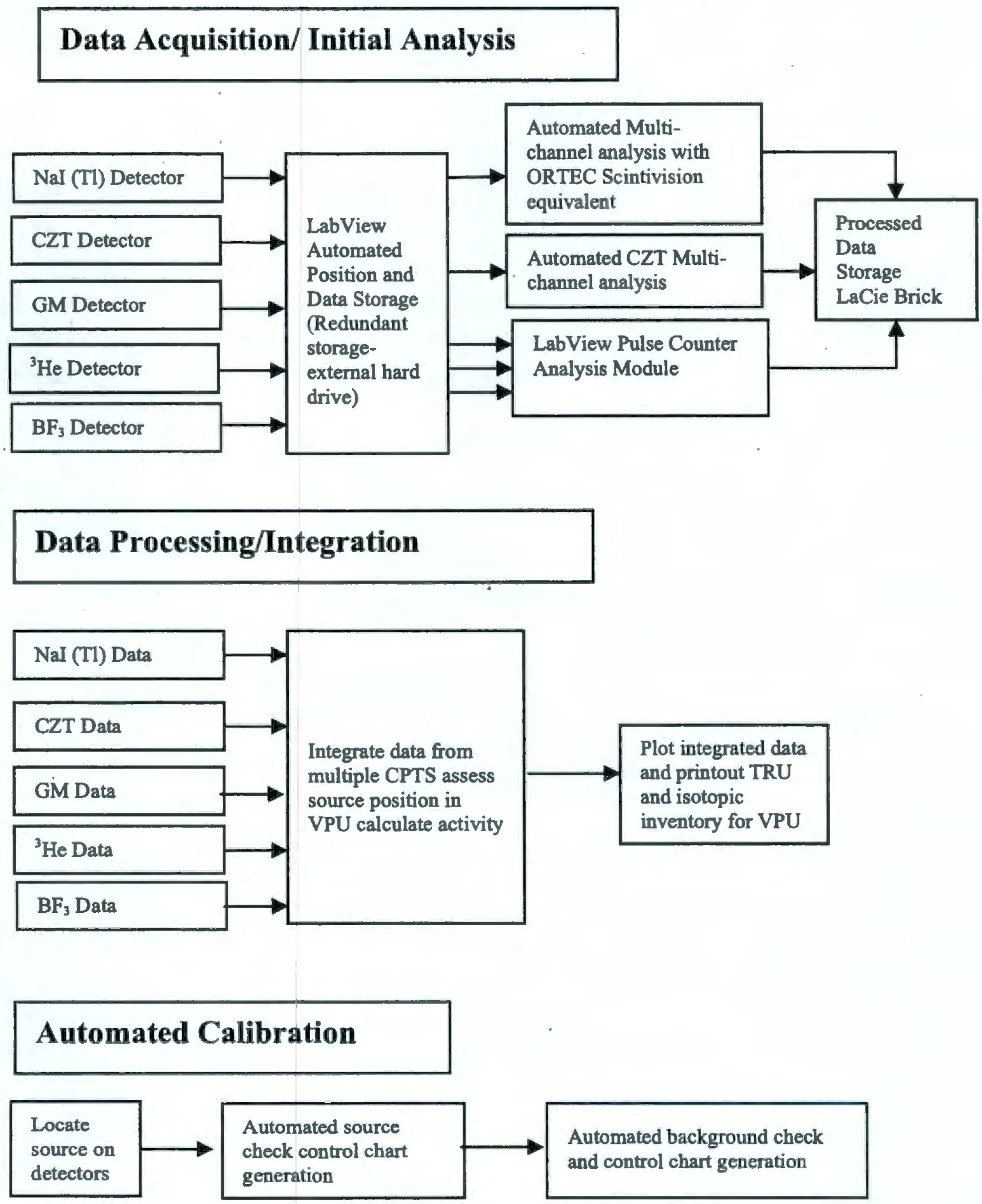
  - LabView 8.0

    - Graphic interface
    - Control of data acquisition and analysis functions
    - Control NIDAQ software for data acquisition from NI 6602 pulse counter system
    - Calibration and background error functions and control charts
    - Calculate results from analysis codes
    - Control automated backup routine
    - Analyze results to determine source location and activity
    - Calculate source activities including transuranic and define uncertainties

  - ORTEC ScintiVision – Standard multi-channel analysis code suitable for sodium iodide spectra. This is an embedded code controlled by LabView.

  - Surfer – Visual graphics code used to develop graphic data views.

Figure 3-4. Software for Data Acquisition and Analysis.



– MicroShield 5.03 – Analysis code used to calculate the effects of mass attenuation and source activities. Primarily used in an offline approach during calibration to provide data to develop monograms that can be included in the LabView code to determine source activity with a known amount of mass attenuation.

The MDP system uses a redundant storage approach to provide assurance that no data will be lost in the event of a hard drive failure on the primary computer. In this case, an embedded

LabView software module provides automated backup to an external hard drive. The primary elements backed up include all acquired spectra, analysis results, and intermediate data.

3.5 SOIL SAMPLING AND ANALYSIS

The primary purpose for collecting and analyzing soil samples will be to assess the vertical distribution of contaminants in the soils directly beneath the VPUs and caissons. This information may be useful in determining if liquid contaminants have migrated into the soil column. One soil sample will be collected from beneath up to 10% of the VPUs at each site, and two soil samples will be collected from beneath each of the caissons at the 618-11 Burial Ground. These data will be used to support the planning for subsequent characterization and remediation activities.

A summary of the number and types of samples for laboratory analysis is presented in Table 3-1.

Table 3-1. Summary of Projected Sample Collection Requirements.

	618-10 Burial Ground	618-11 Burial Ground
Vertical Pipe Unit Soil Samples		
Samples for chemical and radiological analysis	10	5
Equipment blanks[a]	1	1
Caisson Soil Samples		
Samples for chemical and radiological analysis	N/A	6 to 10
Equipment blanks[a]	N/A	1
Total Number of Soil Samples Planned	11	13 to 17

[a] Equipment blanks are to be prepared using silica sand and will be analyzed for gamma energy analysis, metals (excluding hexavalent chromium and mercury), and anions.

N/A = not applicable

3.5.1 Vertical Pipe Unit Soil Sampling

The intent of the sampling philosophy will be to obtain the most diverse potential information from a limited sampling activity. The VPU soil sampling locations will be selected based on the physical position of the VPUs in the burial grounds, structural characteristics as determined using the geophysics survey data, and their radiological signatures as indicated from the MDP logging data.

The VPUs that were constructed using 0.5 m (22-in.-) diameter drums may represent wastes disposed during a different time period that the waste in the VPUs that were constructed using the approximately 0.3 m (12-in.-) diameter corrugated metal pipe. At least one soil sample will be collected from below each type of VPU if the different construction types can be determined using geophysics data.

The VPUs were constructed in distinct rows at each of the burial grounds. Since it is possible that the rows were constructed at different times and may represent different time periods when waste was disposed at the burial ground, at least one VPU from each row will be selected for soil sampling. Unless the other location selection criteria indicate otherwise, the positions for sampling within each row will be varied for each row.

The MDP radiological surveys will be used to develop dose rate ranges and estimated radionuclide compositions that can be used to group the VPUs. Soil sample locations at the VPUs will be selected based on these groupings to evaluate different dose rates or differing radionuclides and to target locations where mobile radiological contaminants may exist.

Locations that exhibit low or no activity during the MDP surveys may indicate VPUs that are empty and did not receive waste. These locations will be given the lowest priority for soil sampling.

Direct-push soil samples at the VPUs will be collected from a depth interval that starts at approximately 0.6 m (2 ft) below the bottom of the VPUs and that extends to approximately 1.8 m (6 ft) below the bottom of the VPUs. Sample recovery rates will determine the actual depth intervals. Target depths for the samples will be determined based on geophysics and MDP data.

3.5.2 Caisson Soil Sampling

Two locations near the perimeter of each caisson will be selected for direct-push soil sampling based on information collected while driving the MDP probe points and the data from the MDP logging data. The data will be evaluated to determine the positions around the perimeter of the caissons where contamination is most likely to be encountered and to identify locations where the direct-push soil sampling tools are likely to reach the desired sampling depths. If there appears to be no variation in the MDP data for a caisson or if based on the MDP data it appears that a caisson had not received waste, two locations on opposite sides of the caisson will be selected based on the likelihood that the soils beneath the caisson can be reached with the direct-push soil sampling tools. It will be preferable that opposite sides of the caisson are sampled if there is no variation in the MDP data; however, the accessibility of soils beneath the caissons may prevent this.

Direct-push soil samples at the caissons will be collected from a depth interval that starts at approximately 0.6 m (2 ft) below the bottom of the caissons and that extends to approximately 1.8 m (6 ft) below the bottom of the caissons. Sample recovery rates will determine the actual depth intervals. Target depths for the samples will be determined based on geophysics and MDP data.

3.5.3 Direct-Push Sampling Methods

Samples will be collected using direct-push sampling tools in accordance with the direct-push equipment manufacturers instructions; HASQARD, Volume 2, *Sampling Technical Requirements* (DOE-RL 1998). The direct-push sampling tool consists primarily of a sample barrel that is lined with a removable plastic liner. The down-hole end of the barrel is fitted with a removable tip and cutting shoe and the upper end of the tool is attached to the direct-push rods. The tool will be pushed to the top of the desired sampling interval, the tip will be pulled to open the cutting shoe, the sample barrel installed, and the sampling tool advanced to fill the sampling barrel. The direct-push equipment operator will use care not to overdrive the device. The sample material recovered in the barrel is then removed from the cased hole and cut open to containerize the sample media.. If an insufficient quantity of material is obtained for the analysis required a new liner is placed in the sample barrel and the process is repeated.

Sample material and equipment removed from the direct-push hole will be contained using plastic sleeving. Initial sample handling and processing will be performed in a table-mounted glovebag following the radiological controls established by the project radiological engineer. Final sample handling and processing may be performed outside the glovebag if the radiological engineer determines that glovebag containment is not necessary based on field instrument readings.

Once the plastic sample liner is cut open the material will be placed in a decontaminated stainless steel bowl. The soils will then be screened by the RCT and Industrial Health technician, and these measurements will be recorded in the analytical lead's logbook. The material in the bowl will be homogenized using a clean stainless steel scoop or spoon, and the sample material will be placed in sample containers according to the requirements of the SAF.

Once the sample containers have been filled, label information on the containers will be completed and the sample containers will be custody sealed. Chain-of-custody documentation will also be completed at this time.

After sampling has been completed at a direct-push location, the open hole will be abandoned in accordance with the requirements specified in *Washington Administrative Code* 173-160.

3.5.4 Field Documentation

A controlled field logbook will be maintained by the analytical lead in accordance with HASQARD, Volume 2, *Sampling Technical Requirements* (DOE-RL 1998). Logbook records will include information regarding direct-push methods and progress, sampling locations and depth intervals, site conditions that may impact sample quality, and sample handling and storage information. Any technical observations made by the analytical lead that may assist with the interpretation of laboratory data will also be recorded in the field logbook.

3.5.5 Chain-of-Custody Documentation

Chain-of-custody documentation will be completed in accordance with HASQARD, Volume 2, *Sampling Technical Requirements* (DOE-RL 1998). Chain-of-custody records will be used to document the possession of samples from the time of collection through receipt at the laboratory(ies). Sample identification numbers, collection dates and times, preservation methods, container types, and container volumes will also be documented on the chain-of-custody documentation.

3.5.6 Equipment Decontamination

All reusable stainless steel sampling tools and direct-push sampling devices that will come in contact with the sampling media will be decontaminated prior to use. Sampling tools will be decontaminated in accordance with HASQARD requirements.

If single-use, disposable sampling tools such as scoops or trowels are used during sample collection, the items will be new and will remain in the manufacturer's original sealed packaging until needed.

3.5.7 Sample Storage

Sample storage will be compliant with HASQARD, Volume 2, *Sampling Technical Requirements* (DOE-RL 1998). All soil samples will be stored in a manner such that sample custody is maintained and preservation requirements are met. Low-activity samples that do not exceed the radiological control limits of the WCH Sample Storage and Shipping facility Radiological Material Area will be transported to that location for storage prior to shipment to the laboratory(ies). If higher activity samples exceed the Sample Storage and Shipping Facility Radiological Material Area limits, they will be stored at the project site in a locked, limited access location.

3.5.8 Sample Shipping

A representative portion of each sample to be shipped to a laboratory for analysis will be screened at the project location or submitted to the WCH Radiological Counting Facility for total activity analysis prior to shipment. Total activity screening will be utilized to determine the appropriate DOT shipping requirements and to verify that the samples meet the laboratory acceptance criteria. Samples that slightly exceed the offsite laboratory criterion discussed in Section 2.7.6 may be reduced in volume to allow offsite shipment. Onsite and offsite laboratories will be identified prior to initiating field activities and will be mutually acceptable to the Sample and Data Management group and to the task lead.

All sample shipments will be made in accordance with 49 CFR 100 through 185, "Transportation" regulations; HASQARD, Volume 2, *Sampling Technical Requirements*.

Packaging that allows for sample preservation by cooling will be selected whenever possible, if required by the analytical method. Because of the potential for sample shipments to require the use of DOT specification packaging that will not allow for sample cooling, it is possible that this preservation method will not be possible for some samples during transportation to the laboratory. When this will occur, sample preservation will be maintained immediately prior to sample shipment and upon receipt by the laboratory, and the lack of cooling during sample shipment will be documented on the chain-of-custody documentation.

3.6 CIVIL SURVEYING

The direct-push soil sampling and MDP logging locations will be surveyed and the coordinates will be recorded after the sampling and abandonment and MDP logging activities are completed. Survey data will be recorded in the North American Vertical Datum of 1988 (NAVD 1988) and the Washington State Plane (South Zone) North American Datum of 1983 (NAD 1983), with the 1991 adjustment for horizontal coordinates. All survey and GPS data will be reported in meters and feet. See Section 3.2 for a detailed discussion of sample survey tasks.

3.7 WASTE MANAGEMENT SAMPLING

Waste generated during sample collection will consist primarily of disposable items such as scoops, gloves, poly bags and sleeving, wipes or towels, and personal protective equipment. Some direct-push tools and equipment may also need to be dispositioned as waste. Analytical data and Radiological Controls screening information obtained from the soil samples will be used to disposition any waste generated during sample collection activities.

3.8 SCIENCE AND TECHNOLOGY PROGRAM SAMPLING REQUIREMENTS

Several contacts have been made with the U.S. Department of Energy, Headquarters and the Pacific Northwest National Laboratory (PNNL) regarding possible science and technology investigations that could be added to the scope presented in this SAP. The following activities are under consideration, with resolution on their inclusion in the SAP expected prior to its approval:

- Use of ultrasound to determine the presence of liquids in the VPUs and caissons (B. Greenwood, PNNL)
- Additional soil sample analyses to advance 600 Area geochemical knowledge (B. Hanson and E. Dresel/PNNL)
- Soil gas sampling/analyses to better identify the source(s) of the 618-11 tritium plume and plutonium measurements (K. Olsen/PNNL).

4.0 HEALTH AND SAFETY

All field operations will be performed in accordance with WCH health and safety requirements and the requirements of the *Hanford Site Radiological Control Manual* (DOE-RL 1996).

Work planning, hazards analysis, and contingency planning will be conducted in accordance with contractor-established work control processes. The project work packages will include a job hazard analysis, site-specific health and safety plan, and applicable radiological work permits.

The sampling procedures and associated activities will consider exposure reduction and contamination control techniques that will minimize the radiation exposure to the sampling team.

5.0 MANAGEMENT OF WASTE

Waste generated by characterization activities will be managed in accordance with a project-specific waste control plan. Management of waste, minimization practices, and the control of waste types applicable to the 618-10 and 618-11 Burial Grounds will be described in the waste control plan.

Waste generated during sample collection will consist primarily of disposable items such as scoops, gloves, poly bags and sleeving, wipes or towels, and personal protective equipment. Some direct-push tools and equipment may also need to be dispositioned as waste. Analytical data and Radiological Controls screening information obtained from the soil samples will be used to disposition any waste generated during sample collection activities.

Unused samples and associated laboratory waste for the analysis will be dispositioned in accordance with the laboratory contract. Any unused samples that cannot be dispositioned by the laboratory because of specific radionuclide concentrations, dose rates, and/or unique chemical hazards will be returned to the project per Section 3.7 of this SAP. Sample returns will be managed through the Sample Management organization and will not be returned until concurrence is received from the project waste services lead. Per 40 CFR 300.440(a)(5), EPA approval is required before returning unused samples or waste from off-site laboratories. Approval of this SAP constitutes EPA approval for shipment of offsite and onsite laboratory sample waste back to the waste site.

6.0 REFERENCES

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