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Primary Document

Work Plan for the Burial Grounds Operable Unit Remedial Investigation/Feasibility Study at Paducah Gaseous Diffusion Plant Paducah, Kentucky

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U.S. DEPARTMENT OF ENERGY
Office of Environmental Management

Prepared by
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Paducah Gaseous Diffusion Plant
under contract DE-AC30-06W05001

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9. FIELD SAMPLING PLAN

The primary focus of the BGOU RI/FS will be to collect field and analytical data necessary to determine the nature and extent of any soil and groundwater contamination originating from, and immediately under, the burial cells; support the completion of a BHHRA and SERA; and evaluate appropriate remedial alternatives (if necessary) at each of the SWMUs. Figure 1.1 shows the location of the BGOU SWMUs relative to the various TCE plumes.

The existing data and identified data gaps are delineated in Section 5 of this work plan. The identified data gaps for each SWMU have been carried forward in this section and serve as the basis for the proposed investigative activities. For most of the SWMUs the primary data gap is the presence and extent of soil and groundwater contamination, if any, directly below the burial cells. To close this data gap, the sampling strategy is focused on collecting soil and groundwater samples from angle borings drilled adjacent to the burial cells (without penetrating the cells) and terminating under the burials cells and above the RGA.

The existing data for SWMU 4 was evaluated to be sufficient to evaluate nature and extent of contamination and provide data from under burial cells; therefore no additional samples are proposed for this SWMU. Borings were collected from under burial cells for SWMUs 5 and 6 in a previous investigation; however, not all cells were evaluated. For SWMU 5 additional borings will be collected from cells not previously targeted. For SWMU 6, physical constraints limited access to the area. During the previous investigation. Equipment has been removed from the area and it now is possible to collect samples and evaluate those cells.

Sampling activities will focus on the soils and groundwater beneath the burial pits down to a depth of 60 ft bgs. Surface and subsurface soils adjacent to but not beneath the burial pits are not part of this investigation and will be evaluated through the SOU. Likewise, the RGA is not part of this investigation and will be evaluated through the GWOU (with the exception of two borings advanced to the RGA to evaluate upgradient and downgradient contaminant levels at SWMUs 2 and 3. Borings adjacent to the NSDD will be advanced to a depth of 15 ft bgs to evaluate impacts from the pipeline that once discharged leachate from SWMU 3 into the NSDD.

9.1 SAMPLING MEDIA AND METHODS

This section identifies the different media to be sampled during the investigation and specifies methods for collecting the samples. Two types of sampling and data collection activities will be performed—nonintrusive data collection (surface geophysics) and intrusive media sampling (surface and subsurface soil, and groundwater). Investigation activities will use standard industry practices that are consistent with EPA procedures and protocols.

9.1.1 Non-Intrusive Data Collection – Geophysical Surveys

Geophysical surveys of SWMUs 7 and 30 and 145, using several methods, will be conducted prior to sampling activities. Because these SWMUs consist of one or more burial pits of various depths that are filled with a heterogeneous collection of wastes and backfill soils, the BGOU represents a difficult target for geophysical characterization. Magnetic properties of the metal drums and buried metal scrap offer the best contrast with the native soils for imaging.

First, an EM-61 magnetometer survey will be conducted at the surface of SWMUs 7 and 30 and 145 to delineate the burial pits exact location and extent. The EM-61 survey will be implemented along continuous lines spaced 4 to 5 ft apart, covering an area that will extend approximately 10 ft beyond the currently identified burial pit edges. A data logger or Ultrasonic Ranging and Data (USRAD) System will be employed for data acquisition.

If the EM-61 method proves ineffective for delineating the burial pits, a high-frequency Ground Penetrating Radar (GPR) survey will be conducted. With GPR, a low-frequency antenna (50 MHz) maximizes the depth of investigation, but reduces the quality of response. From previous use of GPR on-site, a resolution of 4 to 6 ft bgs is expected, which is adequate to delineate to the top of the waste cells. The GPR will be implemented using a towed array system over an area extending 10 ft beyond the SWMU boundary.

9.1.2 Intrusive Sampling

Various media samples will be collected to characterize areas that have been evaluated as having identified data gaps. The samples will be collected using DOE Prime Contractor-approved procedures and will be submitted to an SMO-approved, fixed-base, analytical laboratory for analysis. Field instruments will be used to screen media for VOCs and radiological contamination to evaluate conditions for the workers.

9.1.2.1 Subsurface soil sampling

Subsurface soil samples from soil borings will be collected in accordance with DOE Prime Contractor-approved procedures. The specific sample equipment selected will be dependent on the drilling technology being used. One potential method for angular boring is use of a track-mounted rig that is capable of both direct-push (DPT) and hollow-stem auger (HSA) drilling. This track-mounted drill rig utilizes auger flights to advance the borings to sample depth. Push rods then are used to advance an acetate tube beyond the augered depth to collect undisturbed soil samples. Soil samples for VOC analysis will be removed from the base of the acetate sleeve as soon as the sleeve is removed from the core barrel. Then the sleeve will be cut open and the lithology of the sample described and recorded. After the description of the lithology is completed, the soil will be placed in a clean bowl and mixed thoroughly to homogenize the sample. The resulting mixture will be placed in the appropriate sample jars for analysis. The acetate sleeve and any remaining soil will be handled as investigation-derived waste (IDW).

This track-mounted rig, capable of DPT and HSA, also is capable of drilling at an angle ranging from vertical (90°) to 27°. This range of versatility will be useful because it will facilitate greater penetration under the burial cells, especially in areas where surface obstructions limit drill rig placement adjacent to the burial cells. Subsurface soil samples will be collected from both vertical and angle borings.

Potential drilling methods for vertical borings include dual-wall reverse circulation (DWRC), HSA, and rotary sonic. Soil sampling methods would be similar to that described above.

Angle Borings

Subsurface soil samples from the angle borings will be collected generally from 8 to 10 ft, 13 to 15 ft, 28 to 30 ft, 43 to 45 ft, and 58 to 60 ft bgs (a total of five soil samples per boring). Sampling intervals for burial pits greater than 15 ft bgs will not begin until the angular boring is near 15 ft bgs. (Note: These sample depths represent vertical depth below the burial cells. Distance along the actual borehole will vary based on actual angle of penetration under each cell.) Sample collection from the angle borings will begin once the boring has penetrated the soil beneath each burial cell, based on the extent of set-back of the rig and the angle of penetration at each location. Set-back will be minimized as much as practical, but will be a consideration in order to avoid drilling into a burial cell. Field screening instruments [e.g., photoionization detectors (PIDs) and radiological pancake-type probes] will be used to measure VOC and radiological contamination of drill cuttings as the boring is advanced to evaluate conditions for the workers.

Use of a track-mounted drill rig capable of drilling and sampling with DPT and HSA will allow some variability in the angle of each boring - between 27° and 90°. This flexibility will allow for greater penetration under the burial cells where space to set the rig back permits. In areas where space adjacent to the burials cells is limited, or confined to immediately adjacent to the burial cell, steeper-angle borings may be advanced. The specific angle for each location will be determined in the field and will be based on information regarding the aerial extent and depth of the burial cell and the extent of space around the burial cell in which to position the rig. (In all cases, the intent will be to drill as close to the burial pit as reasonably feasible without actually penetrating the cell.)

If the angle of the boring is ~27° and the maximum depth that can be reached by the drilling equipment is 60 ft, then the horizontal distance the boring will reach from the edge of the disposal cell inwards is ~130 ft, assuming the drill rig is at the edge of the disposal cell. Soil borings will be abandoned by grouting with high solids bentonite (30% solids).

Vertical Borings

Samples collected from the vertical borings generally will be from the following depths: 0 to 1 ft, 3 to 5 ft, 8 to 10 ft, 13 to 15 ft, 28 to 30 ft, 43 to 45 ft, and 58 to 60 ft bgs (a total of seven soils samples per boring). Field screening instruments (e.g., PIDs and radiological pancake-type probes) will be used to measure VOC and radiological contamination of drill cuttings as the boring is advanced to evaluate conditions for the workers.

9.1.2.2 Groundwater sampling

Groundwater samples will be collected from multiple discrete depths within the UCRS and RGA using temporary borings at various locations. Water sampling in the UCRS will be dictated by the presence of water-bearing zones—typically one or two samples will be collected using a hydro-punch advanced ahead of the augers. Water sampling in the RGA will begin at the top of the RGA (approximately 60 ft bgs) and continue at 10 ft intervals to the base of the RGA (approximately 100 ft bgs). This strategy will result in a total of two to six water samples collected from each boring, depending on the presence of water-bearing zones in the UCRS and the thickness of the RGA present in the boring. The borings will be drilled using methods that allow collection of discrete-depth water samples with minimum vertical cross-contamination.

Discrete RGA groundwater samples will be collected as soon as each water sample depth is reached and drilling stops. A water-level indicator will be placed down the boring, and the water level will be monitored each minute for up to 15 minutes to determine how fast the water level returns to equilibrium. The faster the water level stabilizes, the more permeable the interval being sampled and the greater the potential for the interval to be a preferred pathway for contaminant migration. After the groundwater level stabilizes (or 15 minutes, whichever comes first), the sampling pump will be lowered into the boring and the sample collection process will begin. The first step will be to purge the drill pipe. A bladder pump may be used to purge the boring and to collect water samples. Purging is required to eliminate the impact of the drilling fluid (air for DWRC and potable water for rotary sonic or HSA) on the interval being sampled. Since sampling will take place immediately after drilling ceases, there will be no stagnant water to remove from the boring and, therefore, no minimum purge volume. The water sample will be collected after sufficient water has been purged to allow geochemical parameters (i.e., pH, dissolved oxygen, conductivity, and temperature) to stabilize within the boring and to return to original aquifer conditions, as measured in existing MWs in the area. The geochemical parameters will be considered stabilized when the following criteria are met:

- At least three measurements taken three minutes apart have consistent readings for temperature, conductivity, and pH;
- Temperature measurements agree within 1°C;
- Conductivity measurements agree within 10%; and
- pH measurements agree within 0.5 units.

Values from area wells will be referenced to confirm that the stabilized values represent groundwater values and are not the result of groundwater being displaced by a large volume of potable water invading the sample interval during drilling. There is some natural variance across the area, so values from existing wells will be used as indicators of aquifer conditions, but not as specific reference values to determine stabilization within an individual boring. The pH value is the most useful indicator since the pH of RGA groundwater is around 6.5 units, while the pH of the PGDP potable water that may be used during drilling is 7.5 to 8 units.

When the geochemical parameters have stabilized, the flow rate of the sampling pump will be adjusted to 200 mL/minute or less for sampling. Groundwater samples will be collected in accordance with SWMU-specific sampling plans. During each sampling event, the field parameters of depth to water, groundwater temperature, pH, specific conductance, oxidation reduction potential (Eh), and dissolved oxygen will be collected. After sampling is completed, the sample tubing and pump will be removed from the boring. The pump and tubing will be decontaminated in accordance with DOE Prime Contractor-approved procedures prior to its next use. Before drilling resumes, the groundwater level will be measured again to determine if any changes occurred during sampling. Filtered (dissolved) and unfiltered (suspended) groundwater samples will be analyzed for metals and radionuclides. Filtration with a 0.45 micron filter will occur prior to acidification. Both the suspended and dissolved phases will be analyzed to assess distribution in the system and the potential for a constituent to be transported via groundwater to a receptor.

An alternative groundwater sampling collection method is the HSA/DPT combination, which permits the use of DPT-type water sampling probes within the RGA. The drive-point water sampler is pushed or driven below the bottom of the augers, permitting collection of a relatively undisturbed water sample with minimal cross-contamination. When the drive-point sampler has reached the target depth, the mechanism allowing collection of a groundwater sample will be activated. Groundwater will be pumped to the surface, typically with an inertial pump or mechanical bladder pump, although some air- or inert gas-driven systems are available and are preferred. The small inner diameter of the drive-point sampler limits the types of pumps that can be used with this system. A small amount of water, typically less than a gallon, will be purged to reduce the initial turbidity of the water sample. Since sampling will take place immediately after drilling ceases, there will be no stagnant water to remove from the boring and, therefore, no minimum purge volume. The water sample will be collected after sufficient water has been purged, to allow geochemical parameters (i.e., pH, dissolved oxygen, conductivity, and temperature) to stabilize within the boring.

9.1.2.3 Lithologic description

The description of the physical appearance of the soils being sampled is a basic piece of information acquired from each new boring. Depth, color, grain size, and texture facilitate the development a three-dimensional picture of the subsurface sediments. Several methods are available for collecting samples for description, each dependent on the drilling method being used.

9.2 SAMPLE ANALYSIS

Sample analysis for this investigation consists of analysis of groundwater samples; analysis of sediment, surface, and subsurface soil samples; and characterization of project-generated waste materials. Specific analytical requirements, methods, and procedures are described in the Quality Assurance Project Plan (QAPP), Chapter 11.

When available and appropriate for the sample matrix, the latest versions of SW-846 methods adopted by the lab will be used. When not available, other nationally recognized methods, such as those of EPA, DOE, and the American Society for Testing and Materials (ASTM) will be used. A Nuclear Regulatory Commission-licensed, fixed-base laboratory will perform laboratory analyses.

9.3 SITE-SPECIFIC SAMPLING PLANS

A review of existing data for each of the BGOU SWMUs (Chapter 5) has been conducted to determine the following:

- SWMU-specific COCs,
- Extent and quality of existing data, and
- Sufficiency of data to support an FS for remedial options.

Where data are absent or insufficient to fully characterize the nature and extent of contamination and to support remedy selection, specific data gaps were identified. These data gaps are the basis for additional sampling under this work plan. The following sections address each SWMU individually.

Because sampling locations shown in the subsequent figures are estimated, it is probable that some of these locations will be adjusted based on geophysical survey results or other site information obtained. If any of the sampling locations shown for any of the SWMUs require adjustment (greater than ~16 ft), EPA and KDEP will be informed and their approval obtained prior to implementing the change.

Table 9.1 displays and summarizes the sampling strategy, including the total number of planned samples. Contingency samples are not included in the sample totals.

Table 9.1 BGOU Investigation and Sampling Summary

SWMU	Surface geophysics	Angle borings	Vertical borings	Soil samples	Groundwater samples	RGA wells (groundwater samples)
SWMU 2	No	2	1[1]	10	2	1 (4 samples)
				7[1]	6[3]	
SWMU 3	No	4	1[1]	20	4	1 (4 samples)
			6	31[2]	6[3]	
SWMU 4	No additional data required for BGOU RI					
SWMU 5	No	3	0	15	3	0
SWMU 6	No	4	0	20	4	0
SWMU 7 and 30	Yes	12	3	81	30	0
SWMU 145	Yes	7	0	35	7	0
TOTAL	NA	32	11	219	62	2 (8)

[1] Will be necessary only if current RGA groundwater wells are not acceptable and new wells are installed.
[2] Includes seven samples from one boring advanced to 60 ft and 24 samples from six borings advanced to 15 ft.
[3] Includes six samples from one boring advanced to 60 ft that will be necessary only if the existing MWs are not suitable.

9.3.1 SWMU 2

SWMU 2	**Data Gaps:** There are no soil or groundwater data at depth adjacent to the burial ground or from beneath the burial ground. Evaluate if additional contaminants (other than what have been identified in previous investigations) seeping from the bottom of the burial cell is unknown. Soils immediately beneath the burial pits may have become contaminated and are now a secondary contaminant source is unknown. The SWMU is located above a TCE plume; however, upgradient and downgradient data are not available that might indicate whether SWMU 2 is contributing to this plume. **Sampling Strategy:** Drill two angle borings under the burial area and collect soil samples and UCRS groundwater samples (if sufficient amount of groundwater is available). Sample existing RGA upgradient and downgradient wells, or install and sample new upgradient and downgradient wells. These wells will be upgradient and downgradient to SWMUs 2 and 3.

9.3.1.1 Data gaps

- There are no soil or groundwater data at depth adjacent to the burial ground or from beneath the burial ground.
- Evaluate if additional contaminants (other than what have been identified in previous investigations) seeping from the bottom of the burial cell.
- Soils immediately beneath the burial pits may have become contaminated and are now a secondary contaminant source is unknown.
- The SWMU is located above a TCE plume; however, upgradient and downgradient data are not available that might indicate whether SWMU 2 is contributing to this plume.

9.3.1.2 Sampling plan

The sampling approach has been designed to determine if there have been releases from the bottom of the burial ground and, if so, if these releases are contributing to the TCE plume. The following paragraphs outline the sampling and analytical requirements for SWMU 2 and summarize the rationale for the locations selected. Figure 9.1 shows the proposed sampling locations for the site and displays various cross-sections of the burial cell and the maximum penetration possible for the angle borings. (Note this and subsequent figures for each successive SWMU are intended to graphically represent the extent of penetration under each cell, but are not intended to display graphically each proposed boring. Unique configurations of set-back and boring angles are presented.)

Soil Boring Locations. Two angle soil borings and one vertical soil boring during the installation of a new monitoring well will be drilled under or alongside the burial ground, as shown on Table 9.1. (Note the vertical boring will be drilled only if the existing monitoring well is determined unsuitable (criteria described on page 9-11) as an RGA groundwater monitoring well.) Surface and subsurface soil samples will be collected from these borings and analyzed for the selected VOCs, radionuclides, and metals, including uranium metal listed in Table 9.2.

An attempt will be made to collect a UCRS groundwater sample from each angle boring, depending on the presence of groundwater. Groundwater sample aliquots will be collected for the parameters listed in Table 9.3

If the vertical boring is necessary for the installation of a new monitoring well, groundwater samples will be collected from multiple discrete depths within the UCRS and RGA. Water sampling in the UCRS will be dictated by the presence of water-bearing zones—typically one or two samples will be collected using a hydro-punch advanced ahead of the augers. Water sampling in the RGA will begin at the top of the RGA (approximately 60 ft bgs) and continue at 10 ft intervals to the base of the RGA (approximately 100 ft bgs). This strategy will result in a total of two to six water samples collected from each boring, depending on the presence of water-bearing zones in the UCRS and the thickness of the RGA present in the boring. Groundwater sample aliquots will be collected for the parameters listed in Table 9.3

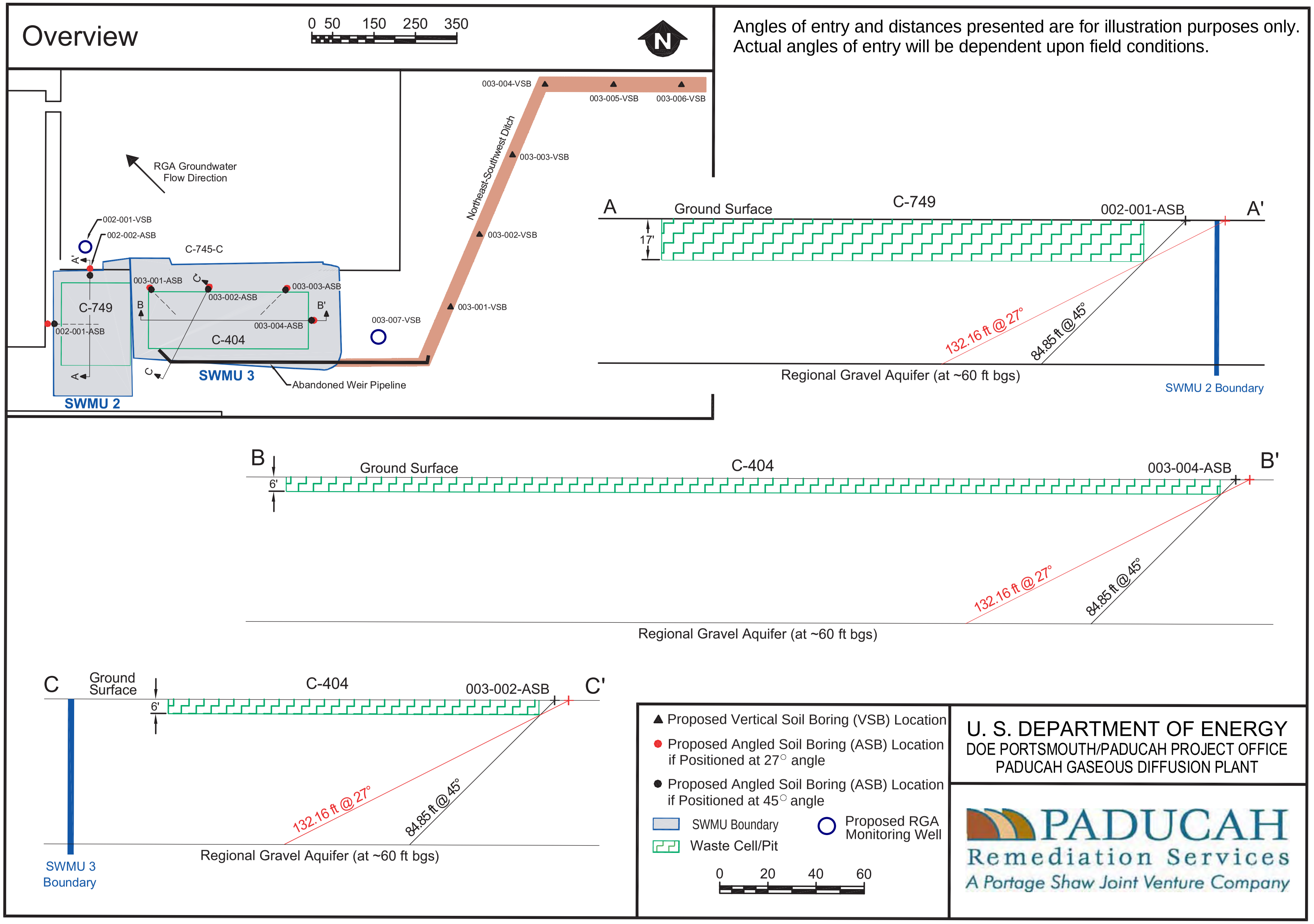


Figure 9.1. SWMUs 2 and 3 BGOU RI/FS Proposed Sampling Locations

Table 9.2 SWMUs 2 and 3 Soil Analyte and Method Detection List

Reporting Limit (μg/kg)	Target Compound List volatiles SW-846, 8260		
10	Benzene	1,1-Dichloroethane	Tetrachloroethene
	Bromodichloromethane	1,2-Dichloroethane	Toluene
	Bromoform	1,1-Dichlorethene	trans-1,2-Dichloropropene
	Carbon disulfide	cis-1,2-Dichloroethene	trans-1,4-Dichloro-2-butene (100)
	Carbon tetrachloride	1,2-Dichloropropane	1,1,1-Trichloroethane
	Chlorobenzene	Ethyl methacrylate	1,1,2-Trichloroethane
	Chloroform	Ethyl benzene	Trichloroethene
	cis-1,3 Dichloroprene	Iodomethane	Trichlorofluoromethane
	trans-1,3-Dichloropropene	Methylene chloride	1,2,3-Trichloropropane
	cis-1,3-Dichloropropene	Styrene	trans-1,2 Dichloroethene
	Dibromochloromethane	Dichlorodifluoromethane	*m,p-* xylene (20 ug/kg)
	Dibromomethane	1,1,2,2-Tetrachoroethane	*o-* xylene
	1,2-Dibromomethane	1,1,1,2-Tetrachloroethane	Chloromethane
	Bromomethane	2-Chloroethyl vinyl ether	Vinyl chloride
	Chloroethane	2-Butanone	Vinyl acetate
	4-Methyl-2-pentanone	Acrolein	2-Hexanone
	Acetone	Acrylonitrile	
(mg/kg)	**TCL PCBs SW-846, 8082**		
0.1	Aroclor-1016	Aroclor-1242	Aroclor-1254
	Aroclor-1221	Aroclor-1248	Aroclor-1260
	Aroclor-1232		Total PCBs

(pCi/g)	Radionuclides	Method
5	Gross alpha	EPA-900
5	Gross beta	EPA-900
3	Uranium-234	Alpha Spec
2	Uranium-235	Alpha Spec
2	Uranium-238	Alpha Spec
8	Technetium-99	Liquid Scintillation
3	Thorium-228	Alpha Spec
4	Thorium-230	Alpha Spec
3	Thorium-232	Alpha Spec
3	Neptunium-237	Alpha Spec
6	Plutonium-238	Alpha Spec
4	Plutonium-239/240	Alpha Spec
3	Americium-241	Alpha Spec
0.5	Cesium-137	Gamma Spec
(mg/kg)	**Metals**	**Method**
20	Aluminum	6010
10	Antimony	6010
2.5	Barium	6010
0.5	Beryllium	6010
2	Cadmium	6010
100	Calcium	6010
2.5	Chromium	6010
2.5	Cobalt	6010
2.5	Copper	6010
20	Iron	6010
20	Lead	6010
5	Magnesium	6010
2.5	Manganese	6010
5	Molybdenum	6010
5	Nickel	6010
2.5	Silver	6010
200	Sodium	6010
2	Thallium	6020
1	Uranium	6010

Table 9.2 SWMUs 2 and 3 Soil Analyte and Method Detection List (continued)

Reporting Limit, cont. (mg/kg)	Metals, cont.	Method, cont.
2.5	Vanadium	6010
20	Zinc	6010
1	Arsenic	6020
20	Selenium	6010
0.02	Mercury	7471

Table 9.3 SWMUs 2 and 3 Groundwater Analyte and Method Detection List

Reporting Limit (µg/L)	Target Compound List volatiles SW-846, 8260		
5	Benzene	Dichlorodifluoromethane	Tetrachloroethene
	Bromodichloromethane	1,1-Dichloroethane	Toluene
	Bromoform	1,2-Dichloroethane	trans-1,2-Dichloropropene
	Carbon disulfide	1,1-Dichlorethene	trans-1,4-Dichloro-2-butene (100)
	Carbon tetrachloride	cis-1,2-Dichloroethene	1,1,1-Trichloroethane
	Chlorobenzene	1,2-Dichloropropane	1,1,2-Trichloroethane
	Chloroform	Ethyl methacrylate	Trichloroethene
	cis-1,3-Dichloroprene	Ethyl benzene	Trichlorofluoromethane
	trans-1,3-Dichloropropene	Iodomethane	1,2,3-Trichloropropane
	cis-1,3-Dichloropropene	Methylene chloride	trans-1,2 Dichloroethene
	Dibromochloromethane	Styrene	*m,p-* xylene (20 ug/L)
	Dibromomethane	1,1,2,2-Tetrachoroethane	*o-* xylene
	1,2-Dibromomethane	1,1,1,2-Tetrachloroethane	Vinyl chloride (2 ug/L)
10	Bromomethane Chloroethane	2-Chloroethyl vinyl ether	Chloromethane
50	2-Hexanone	4-Methyl-2-pentanone	Vinyl acetate
100	Acetone Acrolein	Acrylonitrile	2-Butanone
(µg/L)	**TCL PCBs SW-846, 8082**		
0.1	Aroclor-1016 Aroclor-1221 Aroclor-1232	Aroclor-1242 Aroclor-1248	Aroclor-1254 Aroclor-1260 Total PCBs
(pCi/L)	**Radionuclides**		**Method**
3	Gross alpha		EPA-900
3	Gross beta		EPA-900
0.4	Uranium-234 (Filtered and Unfiltered)		Alpha Spec
0.4	Uranium-235 (Filtered and Unfiltered)		Alpha Spec
0.4	Uranium-238 (Filtered and Unfiltered)		Alpha Spec
1	Technetium-99		Liquid Scintillation
0.4	Thorium-228		Alpha Spec
0.4	Thorium-230		Alpha Spec
0.4	Thorium-232		Alpha Spec
0.5	Neptunium-237		Alpha Spec
0.4	Plutonium-238		Alpha Spec
0.4	Plutonium-239/240		Alpha Spec
0.4	Americium-241		Alpha Spec
0.4	Cesium-137		Gamma Spec

Table 9.3 SWMUs 2 and 3 Groundwater Analyte and Method Detection List (continued)

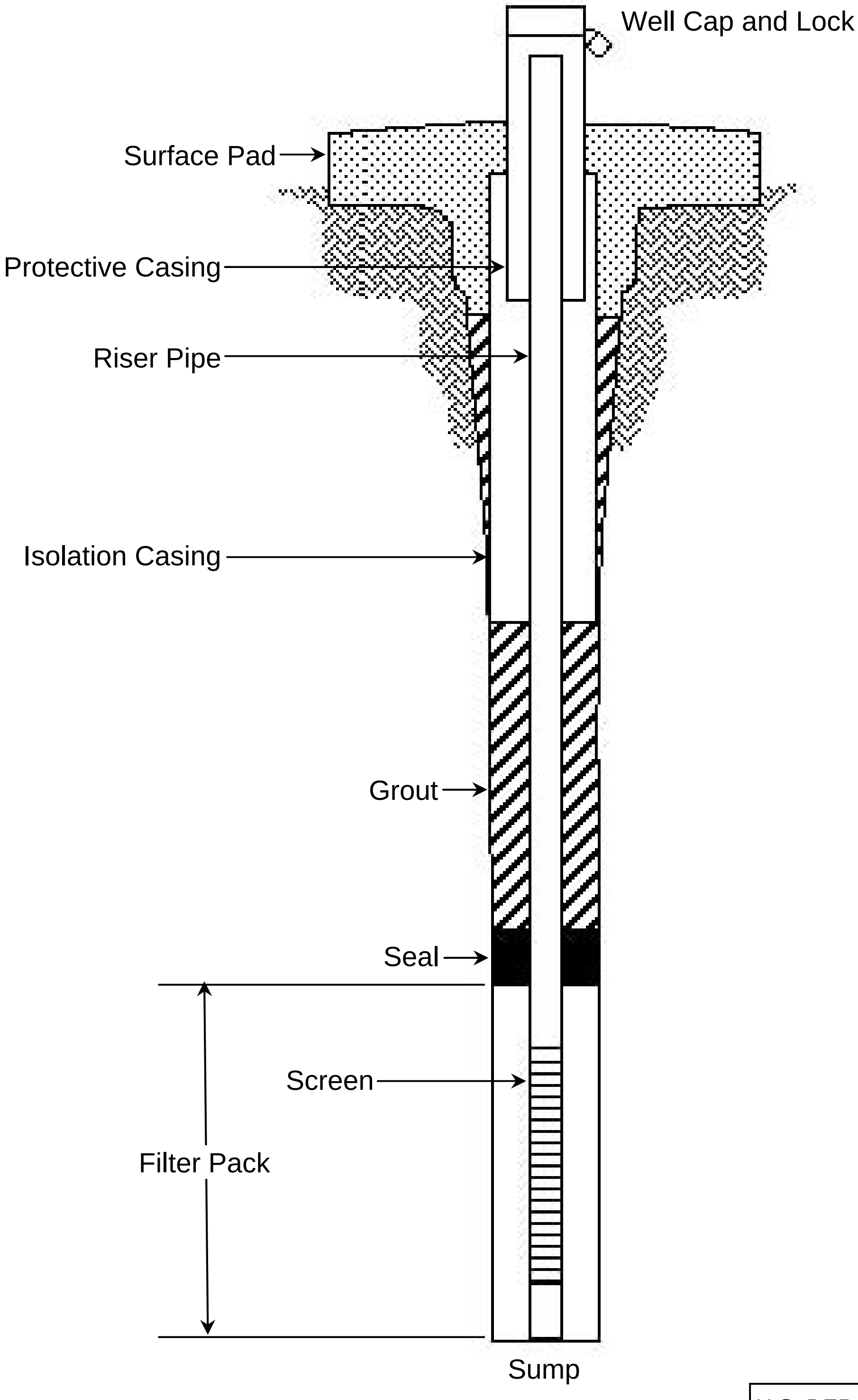
(mg/L)	Metals (Filtered and Unfiltered)	Method
0.2	Aluminum	6010
0.005	Antimony	6010
0.01	Barium	6010
0.005	Beryllium	6010
0.0006	Cadmium	6010
5	Calcium	6010
0.01	Chromium	6010
0.01	Cobalt	6010
0.025	Copper	6010
0.05	Iron	6010
0.0013	Lead	6010
0.5	Magnesium	6010
0.01	Manganese	6010
0.001	Molybdenum	6010
0.04	Nickel	6010
0.01	Silver	6010
0.5	Sodium	6010
0.002	Thallium	6010
0.001	Uranium	6010
0.02	Vanadium	6010
0.02	Zinc	6010
0.001	Arsenic	6020
0.04	Selenium	6010
0.00001	Mercury	7471

Groundwater MWs. Two existing MWs at SWMUs 2 and 3 (MW 67 and MW 76) will be evaluated during this RI to determine if they are suitable to serve as upgradient and downgradient control points. The criteria listed below will be applied, in order, to each of the wells for determining the well's suitability. Should a well fail to positively meet any of these criteria, the well no longer will be considered for the investigation and installation of a new well will be scheduled.

- Evaluation of groundwater flow to determine gradient direction with respect to well location;
- Review of well construction details and surrounding lithology to determine well's adequate placement in the RGA; and
- Downhole video camera inspection to determine existence/extent of biofouling and integrity of well casing and screen.

If the well positively meets the criteria, it will be rehabilitated and redeveloped, if needed, to attain appropriate RI-quality samples for the parameters listed in Table 9.3.

If these wells are determined not to be suitable, then one RGA groundwater monitoring well will be installed downgradient and one RGA groundwater MW will be installed upgradient. Specifications for these wells will meet the requirements of 401 KAR 48:300. Data collected during the angle boring sampling will be used to determine the placement of these wells. Based on these data, a determination of the depth to set screens will be made and an MW will be installed. After development, these wells will be sampled for the parameters listed in Table 9.3. (Note, that the data from these well also will be used to address the same data gap at SWMU 3). Figure 9.2 is a diagram of the construction of the proposed MWs.



U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

Figure 9.2. Example Monitoring Well Diagram

PADUCAH Remediation Services
A Portage Shaw Joint Venture Company

9.3.2 SWMU 3

SWMU 3	**Data Gaps:** There are no soil data at depth immediately adjacent to the impoundment or from beneath the impoundment. Because the SWMU is located above a TCE plume, upgradient and downgradient data are not available that might indicate whether SWMU 3 is contributing to this plume; however, the current well network is being impacted by the existing TCE plume. There is no information on potential subsurface soil contamination directly beneath the burial cell. The potential for additional contaminants (other than what have been identified in previous investigations) seeping from the bottom of the burial cell is unknown. The potential that the soils immediately beneath the burial cell may have become contaminated and are now a secondary contaminant source is unknown. There are no surface or subsurface soil historical data along the ditches around SWMU 3 and in the ditch leading to the NSDD. **Sampling Strategy:** Drill four angle borings around, and under, the burial cell, and collect soil samples and UCRS groundwater samples (if sufficient amount of groundwater is available). Sample existing RGA upgradient and downgradient wells (not part of the current network), or install and sample new upgradient and downgradient wells. These wells will be upgradient and downgradient to SWMUs 2 and 3. Collect surface and shallow subsurface soil samples from six vertical borings from the ditches and along the ditch leading to the NSDD.

9.3.2.1 Data gaps

- There are no soil data at depth immediately adjacent to the impoundment or from beneath the impoundment. Because the SWMU is located above a TCE plume, upgradient and downgradient data are not available that might indicate whether SWMU 3 is contributing to this plume; however, the current well network is being impacted by the existing TCE plume.

- There is no information on potential subsurface soil contamination directly beneath the burial cell.

- The potential for additional contaminants (other than what have been identified in previous investigations) seeping from the bottom of the burial cell is unknown.

- The potential that the soils immediately beneath the burial cell may have become contaminated and are now a secondary contaminant source is unknown.

- There are no surface or subsurface soil historical data along the ditches around SWMU 3 and in the ditch leading to the NSDD.

9.3.2.2 Sampling plan

The sampling approach has been designed to evaluate whether there have been releases from the bottom of the impoundment and, if so, if these releases are contributing to the TCE plume and if there is subsurface contamination along the ditch areas.

The following paragraphs outline the sampling and analytical requirements for SWMU 3 and summarize the rationale for the locations selected. Figure 9.1 shows the proposed sampling locations for the site. Figure 9.1 displays a cross-section of the burial cell and the maximum penetration possible of the angle borings.

Soil Boring Locations. Four angle soil borings will be drilled under the impoundment and one vertical boring will be advanced upgradient of the burial cell during the installation of an MW. (Note the vertical boring will be drilled only if the existing MW is determined unsuitable (criteria described on page 9-11) as an RGA groundwater MW.) Six vertical borings (using DPT) will be advanced to a depth of 15 ft bgs along the ditch areas. Soil samples will be collected from each of the soil borings and will be analyzed for parameters listed in Table 9.2.

An attempt will be made to collect a UCRS groundwater sample from each angle boring, depending on the presence of groundwater. Groundwater sample aliquots will be collected for the parameters listed in Table 9.3.

If the vertical boring is necessary for the installation of a new MW, groundwater samples will be collected from multiple discrete depths within the UCRS and RGA. Water sampling in the UCRS will be dictated by the presence of water-bearing zones—typically one or two samples will be collected using a hydro-punch advanced ahead of the augers. Water sampling in the RGA will begin at the top of the RGA (approximately 60 ft bgs) and continue at 10 ft intervals to the base of the RGA (approximately 100 ft bgs). This strategy will result in a total of two to six water samples collected from each boring, depending on the presence of water-bearing zones in the UCRS and the thickness of the RGA present in the boring. Groundwater sample aliquots will be collected and analyzed for the parameters listed in Table 9.3.

No groundwater samples will be collected from the vertical borings advanced along the ditches.

Groundwater MWs. As described in Section 9.3.1.2, RGA samples will be collected from existing wells. If there are no existing wells suitable for sampling, then new RGA wells will be installed and sampled.

9.3.3 SWMU 4

SWMU 4	**Data Gaps:** None identified. The site has been characterized sufficiently to meet RI/FS goals.

9.3.3.1 Data gaps

For purposes of conducting the BGOU RI, the nature and extent of contamination at SWMU 4 have been adequately characterized. No additional data are required during the RI, and future data needs regarding remedy selection can be identified and collected during the FS and subsequent treatability studies (if required).

9.3.3.2 Sampling plan

Additional sampling is not recommended for SWMU 4 at this time, based on sampling data collected during the WAG 3 RI/FS and the Southwest Plume Groundwater SI.

9.3.4 SWMU 5

SWMU 5	**Data Gaps:** Previous investigations did not fully characterize the waste stream, based on existing records of waste disposal. **Sampling Strategy:** Drill three angle borings around SWMU 5, in targeted areas. Collect soil samples and UCRS groundwater samples (if sufficient amount of groundwater is available).

9.3.4.1 Data gaps

Previous investigations did not fully characterize the SWMU 5 waste stream, based on existing records of waste disposal

9.3.4.2 Sampling plan

The sampling approach has been designed to evaluate whether there have been releases from the bottom of the burial cells along the northern edge of the SWMU where the pits contents are unknown and at the southeast corner where the earliest waste is thought to have been placed.

The following paragraphs outline the sampling and analytical requirements for SWMU 5. Figure 9.3 shows the proposed sampling locations for the site.

Soil Boring Locations. Three angle borings will be drilled under the burial cells to collect soils from beneath the waste disposal cells. The angled borings will be drilled perpendicular to the SWMU boundary in order to optimize sampling beneath the cells. Soil samples will be collected from each of the angle soil borings and will be analyzed for selected radionuclides and metals (including uranium) identified in Table 9.4.

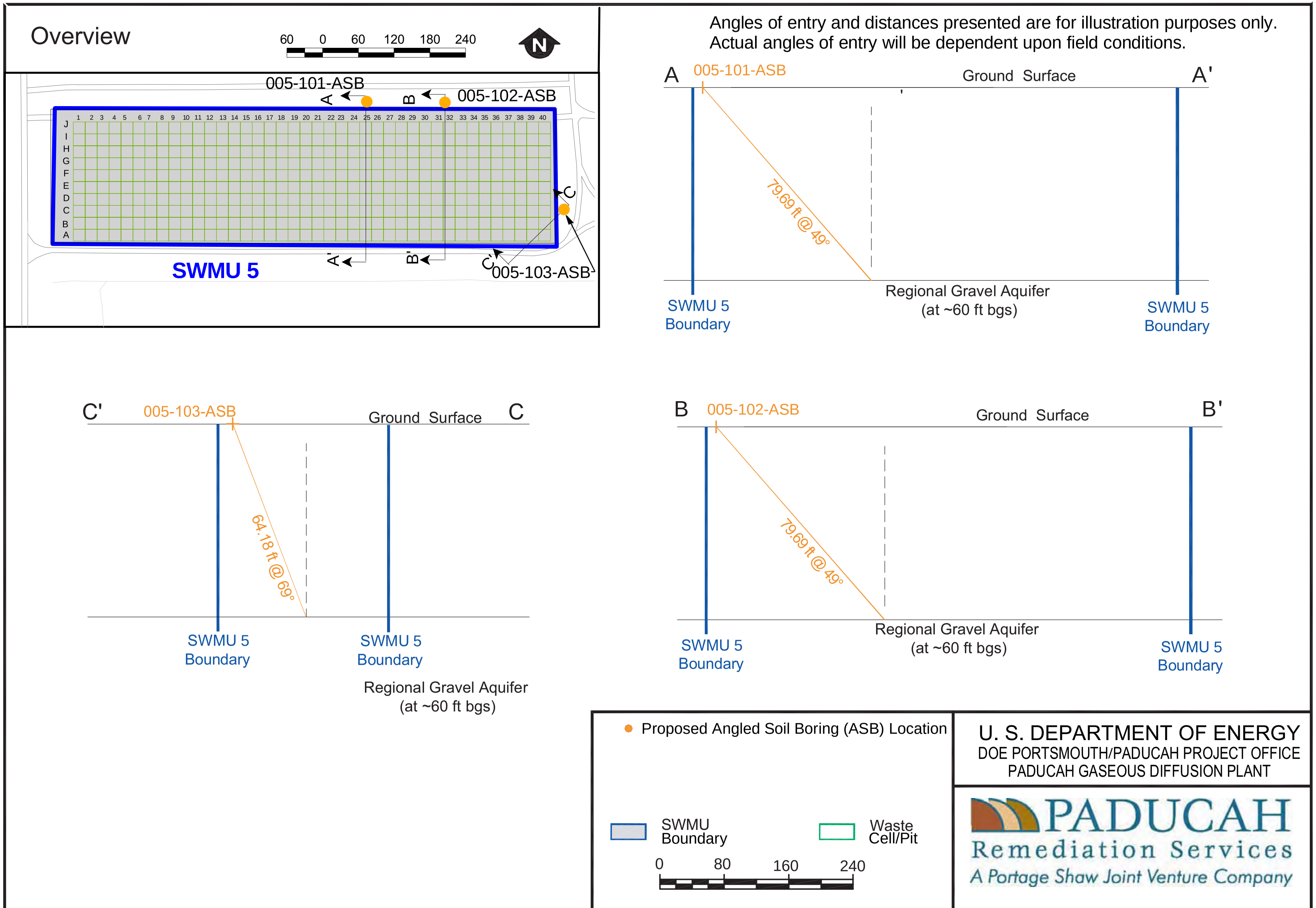


Figure 9.3. SWMU 5 BGOU RI/FS Proposed Sampling Locations

Table 9.4 SWMU 5 Soil Analyte and Method Detection List

Reporting Limit (mg/kg)	TCL PCBs SW-846, 8082		
0.1	Aroclor-1016	Aroclor-1242	Aroclor-1254
	Aroclor-1221	Aroclor-1248	Aroclor-1260
	Aroclor-1232		Total PCBs
Reporting Limit (pCi/g)	**Radionuclides**		**Method**
5	Gross alpha		EPA-900
5	Gross beta		EPA-900
3	Uranium-234		Alpha Spec
2	Uranium-235		Alpha Spec
2	Uranium-238		Alpha Spec
8	Technetium-99		Liquid Scintillation
3	Thorium-228		Alpha Spec
4	Thorium-230		Alpha Spec
3	Thorium-232		Alpha Spec
3	Neptunium-237		Alpha Spec
6	Plutonium-238		Alpha Spec
4	Plutonium-239/240		Alpha Spec
3	Americium-241		Alpha Spec
0.5	Cesium-137		Gamma Spec
Reporting Limit (mg/kg)	**Metals**		**Method**
20	Aluminum		6010
10	Antimony		6010
2.5	Barium		6010
0.5	Beryllium		6010
2	Cadmium		6010
100	Calcium		6010
2.5	Chromium		6010
2.5	Cobalt		6010
2.5	Copper		6010
20	Iron		6010
20	Lead		6010
5	Magnesium		6010
2.5	Manganese		6010
5	Molybdenum		6010
5	Nickel		6010
2.5	Silver		6010
200	Sodium		6010
2	Thallium		6020
1	Uranium		6010
2.5	Vanadium		6010
20	Zinc		6010
1	Arsenic		6020
20	Selenium		6010
0.02	Mercury		7471

An attempt also will be made to collect UCRS groundwater samples from each boring, depending on the presence of groundwater. Groundwater sample aliquots will be collected for parameters listed in Table 9.5.

Table 9.5 SWMU 5 Groundwater Analyte and Method Detection List

Reporting Limit (μg/L)	TCL PCBs SW-846, 8082		
0.1	Aroclor-1016	Aroclor-1242	Aroclor-1254
	Aroclor-1221	Aroclor-1248	Aroclor-1260
	Aroclor-1232		Total PCBs

Reporting Limit (pCi/L)	Radionuclides	Method
3	Gross alpha	EPA-900
3	Gross beta	EPA-900
0.4	Uranium-234 (Filtered and Unfiltered)	Alpha Spec
0.4	Uranium-235 (Filtered and Unfiltered)	Alpha Spec
0.4	Uranium-238 (Filtered and Unfiltered)	Alpha Spec
1	Technetium-99	Liquid Scintillation
0.4	Thorium-228	Alpha Spec
0.4	Thorium-230	Alpha Spec
0.4	Thorium-232	Alpha Spec
0.5	Neptunium-237	Alpha Spec
0.4	Plutonium-238	Alpha Spec
0.4	Plutonium-239/240	Alpha Spec
0.4	Americium-241	Alpha Spec
0.4	Cesium-137	Gamma Spec

Reporting Limit (mg/L)	Metals (Filtered and Unfiltered)	Method
0.2	Aluminum	6010
0.005	Antimony	6010
0.01	Barium	6010
0.005	Beryllium	6010
0.0006	Cadmium	6010
5	Calcium	6010
0.01	Chromium	6010
0.01	Cobalt	6010
0.025	Copper	6010
0.05	Iron	6010
0.0013	Lead	6010
0.5	Magnesium	6010
0.01	Manganese	6010
0.001	Molybdenum	6010
0.04	Nickel	6010
0.01	Silver	6010
0.5	Sodium	6010
0.002	Thallium	6010
0.001	Uranium	6010
0.02	Vanadium	6010
0.02	Zinc	6010
0.001	Arsenic	6020
0.04	Selenium	6010
0.00001	Mercury	7471

9.3.5 SWMU 6

SWMU 6	**Data Gaps:** Areas have not been evaluated where there was radiologically-contaminated equipment stored during previous investigations. **Sampling Strategy:** Drill four angle borings near the location where the highest contamination was found previously. Collect soil samples and UCRS groundwater samples (if sufficient amount of groundwater is available).

9.3.5.1 Data gaps

- Areas have not been evaluated where there was radiologically-contaminated equipment stored during previous investigations.

9.3.5.2 Sampling plan

The sampling approach has been designed to evaluate whether there have been releases from the bottom of the burial cells in the southern half of the SWMU and to determine if the sporadic detects of radionuclide contamination in Burial Pit J are isolated occurrences or indicative of widespread contamination.

The following paragraphs outline the sampling and analytical requirements for SWMU 6 and summarize the rationale for the locations selected. Figure 9.4 shows the proposed sampling locations for the site.

Soil Boring Locations. Four angle borings will be drilled under the burial cells to collect soils from beneath the waste disposal cells. Soil samples will be collected from each of the angle soil borings and will be analyzed for selected radionuclides, metals (including uranium), and PCBs identified in Table 9.6.

An attempt also will be made to collect UCRS groundwater samples from each boring, depending on the presence of groundwater. Groundwater sample aliquots will be collected for parameters listed in Table 9.7.

Tables 9.6 and 9.7 can be found on the following pages.

Table 9.6 SWMU 6 Soil Analyte and Method Detection List

Reporting Limit (mg/kg)	TCL PCBs SW-846, 8082		
0.1	Aroclor-1016	Aroclor-1242	Aroclor-1254
	Aroclor-1221	Aroclor-1248	Aroclor-1260
	Aroclor-1232		Total PCBs

Reporting Limit (pCi/g)	Radionuclides	Method
5	Gross alpha	EPA-900
5	Gross beta	EPA-900
3	Uranium-234	Alpha Spec
2	Uranium-235	Alpha Spec
2	Uranium-238	Alpha Spec
8	Technetium-99	Liquid Scintillation
3	Thorium-228	Alpha Spec
4	Thorium-230	Alpha Spec
3	Thorium-232	Alpha Spec
3	Neptunium-237	Alpha Spec
6	Plutonium-238	Alpha Spec
4	Plutonium-239/240	Alpha Spec
3	Americium-241	Alpha Spec
0.5	Cesium-137	Gamma Spec

Reporting Limit (mg/kg)	Metals	Method
20	Aluminum	6010
10	Antimony	6010
2.5	Barium	6010
0.5	Beryllium	6010
2	Cadmium	6010
100	Calcium	6010
2.5	Chromium	6010
2.5	Cobalt	6010
2.5	Copper	6010
20	Iron	6010
20	Lead	6010
5	Magnesium	6010
2.5	Manganese	6010
5	Molybdenum	6010
5	Nickel	6010
2.5	Silver	6010
200	Sodium	6010
2	Thallium	6020
1	Uranium	6010
2.5	Vanadium	6010
20	Zinc	6010
1	Arsenic	6020
20	Selenium	6010
0.02	Mercury	7471

TCL = Target Compound List

Table 9.7 SWMU 6 Groundwater Analyte and Method Detection List

Reporting Limit (µg/L)	TCL PCBs SW-846, 8082		
0.1	Aroclor-1016	Aroclor-1242	Aroclor-1254
	Aroclor-1221	Aroclor-1248	Aroclor-1260
	Aroclor-1232		Total PCBs

Reporting Limit (pCi/L)	Radionuclides	Method
3	Gross alpha	EPA-900
3	Gross beta	EPA-900
0.4	Uranium-234 (Filtered and Unfiltered)	Alpha Spec
0.4	Uranium-235 (Filtered and Unfiltered)	Alpha Spec
0.4	Uranium-238 (Filtered and Unfiltered)	Alpha Spec
1	Technetium-99	Liquid Scintillation
0.4	Thorium-228	Alpha Spec
0.4	Thorium-230	Alpha Spec
0.4	Thorium-232	Alpha Spec
0.5	Neptunium-237	Alpha Spec
0.4	Plutonium-238	Alpha Spec
0.4	Plutonium-239/240	Alpha Spec
0.4	Americium-241	Alpha Spec
0.4	Cesium-137	Gamma Spec

Reporting Limit (mg/L)	Metals (Filtered and Unfiltered)	Method
0.2	Aluminum	6010
0.005	Antimony	6010
0.01	Barium	6010
0.005	Beryllium	6010
0.0006	Cadmium	6010
5	Calcium	6010
0.01	Chromium	6010
0.01	Cobalt	6010
0.025	Copper	6010
0.05	Iron	6010
0.0013	Lead	6010
0.5	Magnesium	6010
0.01	Manganese	6010
0.001	Molybdenum	6010
0.04	Nickel	6010
0.01	Silver	6010
0.5	Sodium	6010
0.002	Thallium	6010
0.001	Uranium	6010
0.02	Vanadium	6010
0.02	Zinc	6010
0.001	Arsenic	6020
0.04	Selenium	6010
0.00001	Mercury	7471

TCL = Target Compound List

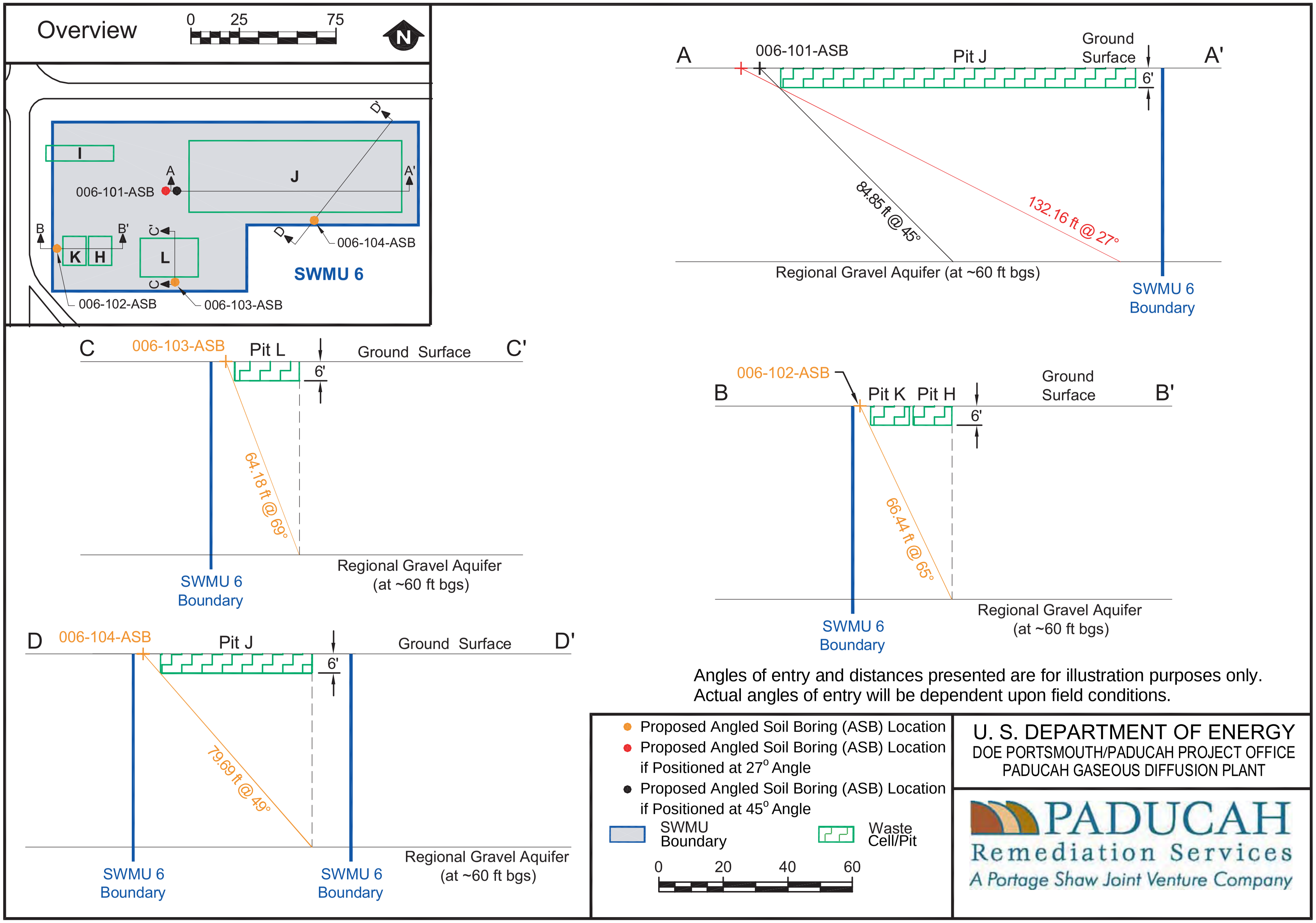


Figure 9.4. SWMU 6 BGOU RI/FS Proposed Sampling Locations

9.3.6 SWMUs 7 and 30

SWMUs 7 and 30	**Data Gaps:** There is no information on potential subsurface soil contamination directly beneath the burial pits. The potential for additional contaminants (other than what have been identified in previous investigations) seeping from the bottom of the burial cell is unknown. The potential that the soils immediately beneath the burial pits may have become contaminated and are now a secondary contaminant source is unknown. The lateral extent of the burial pits is not definitively known. **Sampling Strategy:** Conduct a geophysical survey to determine the pit boundaries where uncertainties have been identified and to define the anomalous areas. Drill twelve angle borings (one under each pit) and collect soil samples and UCRS groundwater samples (if sufficient amount of groundwater is available). Drill one vertical boring at the former Drum Mountain location and collect soil samples and UCRS groundwater samples (if sufficient amount of groundwater is available). Drill two vertical borings north of the pits and collect soil samples and groundwater samples to evaluate TCE contamination in shallow groundwater.

9.3.6.1 Data gaps

All boring information is from vertical borings that have been drilled beside or along the edges of the site or, in select instances, within the burial pits.

- There is no information on potential subsurface soil contamination directly beneath the burial pits.
- The potential for additional contaminants (other than what have been identified in previous investigations) seeping from the bottom of the burial cell is unknown.
- The potential that the soils immediately beneath the burial pits may have become contaminated and are now a secondary contaminant source is unknown.
- The lateral extent of the burial pits is not definitively known.

9.3.6.2 Sampling plan

The sampling approach has been designed to evaluate whether there have been releases from the bottom of the burial cells at SWMUs 7 and 30 and to characterize the nature and extent of the contamination in the subsurface soils and groundwater if there have been releases.

The following paragraphs outline the sampling and analytical requirements for SWMUs 7 and 30 and summarize the rationale for the locations selected. Figures 9.5 and 9.6 show the proposed sampling locations for the sites. Because of the prevalence of metals, PAHs, PCBs, VOCs, and various radionuclides (though all at low levels), samples will be analyzed for these contaminants.

Surface Geophysical Survey. The exact boundaries of the burial pits are not defined. Several geophysical methods are proposed; however, site-specific properties (e.g., fences, utilities, etc.) can interfere with the instruments.

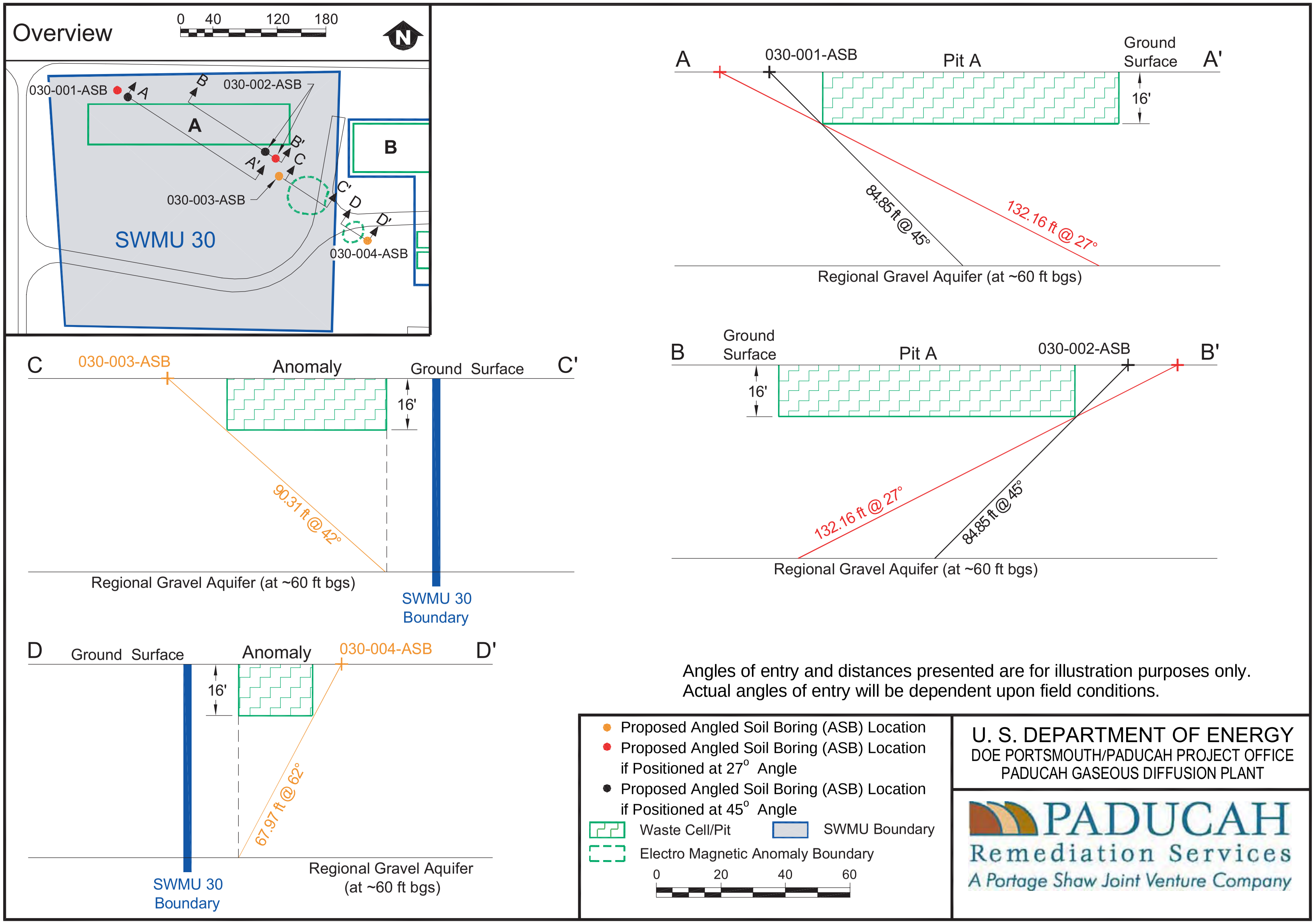


Figure 9.5. SWMU 30 BGOU RI/FS Proposed Sampling Locations

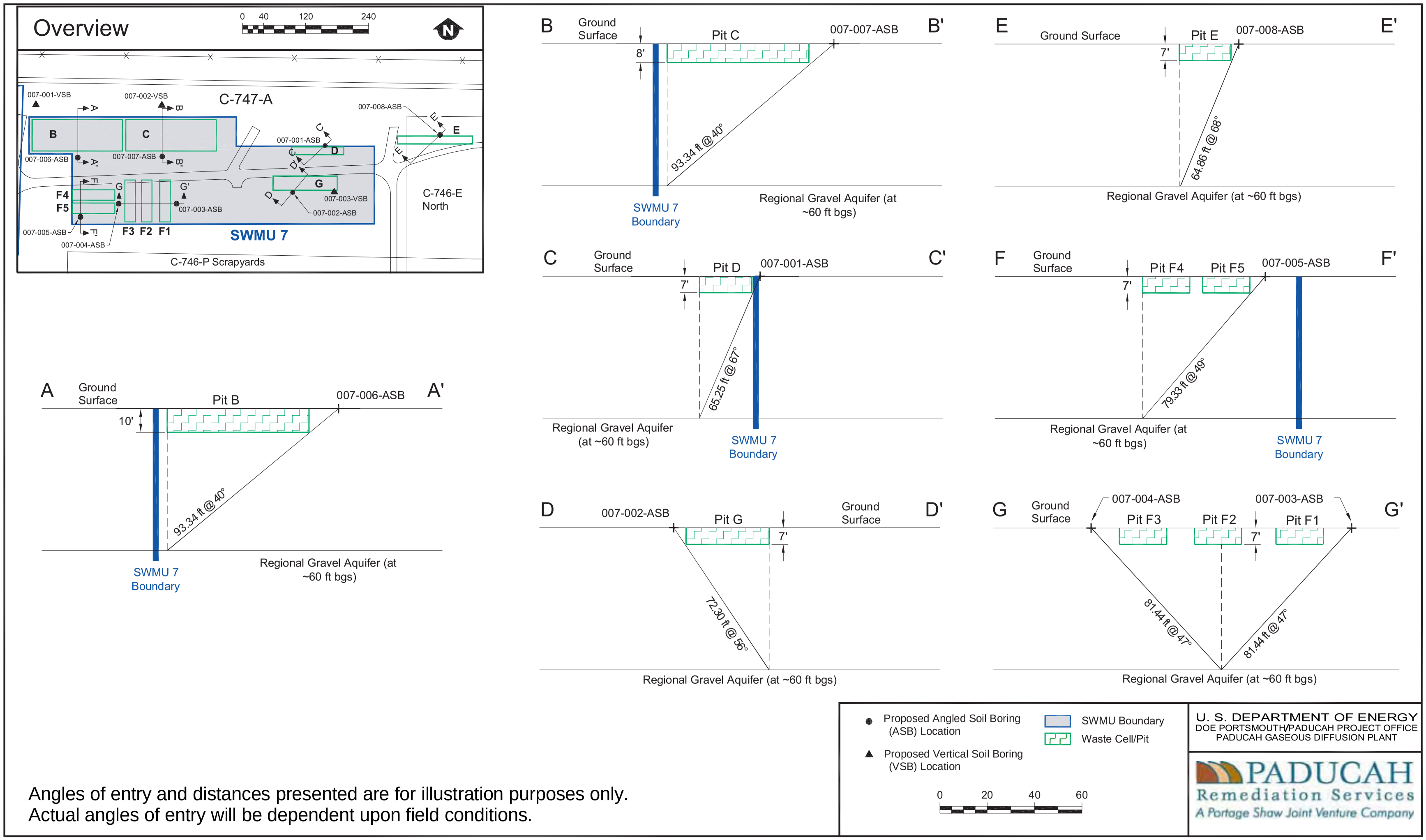


Figure 9.6. SWMU 7 BGOU RI/FS Proposed Sampling Locations

A terrain conductivity survey will be conducted using a Geonics EM-61 (or equivalent) that is capable of detecting objects to a depth of 20 ft bgs. This technique is preferred; however, fencing present in a portion of the site may cause excessive interference. If results are inconclusive following the terrain conductivity survey, magnetometer and/or GPR will be used in an attempt to define the extent of the burial pits. GPR is preferred because the magnetometer also may be affected by fencing. To prepare the site for the geophysical survey, a 20-ft by 20-ft grid will be established across the site. Grid spacing in areas where anomalous measurements are recorded will be reduced to a 10-ft interval or less to further delineate boundaries of the anomaly. Grid spacing was selected based on the shortest dimension of the smallest anomaly (approximately 20–25 ft) previously identified at the site.

Soil Boring Locations. Twelve angle soil borings will be drilled under the burial cells to collect soils from beneath the waste disposal cells. The final determination for exact placement of these borings will be made by DOE or DOE's Prime Contractor after an evaluation of the surface geophysical survey. The angle borings will be located as close to identified anomalies as possible, maximizing the extent of penetration under the buried wastes. Three vertical borings will be drilled in areas of potential or identified contamination where there is no burial cell located. Two borings are proposed north of SWMU 7 and one is in the area where the former "Drum Mountain" was located. Samples will be analyzed for parameters shown in Table 9.8.

Table 9.8 SWMUs 7 and 30 Soil Analyte and Method Detection List

Reporting Limit (µg/kg)		**TCL volatiles SW-846, 8260**	
10	Benzene	1,1-Dichloroethane	Tetrachloroethene
	Bromodichloromethane	1,2-Dichloroethane	Toluene
	Bromoform	1,1-Dichlorethene	trans-1,2-Dichloropropene
	Carbon disulfide	cis-1,2-Dichloroethene	trans-1,4-Dichloro-2-butene (100)
	Carbon tetrachloride	1,2-Dichloropropane	
	Chlorobenzene	Ethyl methacrylate	1,1,1-Trichloroethane
	Chloroform	Ethyl benzene	1,1,2-Trichloroethane
	cis-1,3-Dichloroprene	Iodomethane	Trichloroethene
	trans-1,3-Dichloropropene	Methylene chloride	Trichlorofluoromethane
	cis-1,3-Dichloropropene	Styrene	1,2,3-Trichloropropane
	Dibromochloromethane	Dichlorodifluoromethane	trans-1,2 Dichloroethene
	Dibromomethane	1,1,2,2-Tetrachoroethane	*m,p-* xylene (20 ug/kg)
	1,2-Dibromomethane	1,1,1,2-Tetrachloroethane	*o-* xylene
	Bromomethane	2-Chloroethyl vinyl ether	Chloromethane
	Chloroethane	2-Butanone	Vinyl chloride
	4-Methyl-2-pentanone	Acrolein	Vinyl acetate
	Acetone	Acrylonitrile	2-Hexanone

Table 9.8 SWMUs 7 and 30 Soil Analyte and Method Detection List (continued)

Reporting Limit (µg/kg)	TCL semivolatiles SW-846, 8270		
660	Acenapthene	Dibenzo(a,h)anthracene	Isophorone
	Acenaphthylene	Dibenzofuran	2-Methylnaphthalene
	Anthracene	1,2-Dichlorobenzene	2-Methylphenol (o-cresol)
	Benzo(a)anthracene	1,3-Dichlorobenzene	4-Methylphenol (p-cresol)
	Benzo(b)fluoranthene	1,4-Dichlorobenzene	Naphthalene
	Benzo(k)fluoroanthene	2,4-Dichlorophenol	Nitrobenzene
	Benzo(a)pyrene	Diethylphthalate	2-Nitrophenol
	Benzo(g,h,i)perylene	2,4-Dimethylphenol	N-Nitroso-di-n-dipropylamine
	bis(2-Chloroisopropyl)ether	Dimethylphthalate	
	bis(2-Chloroethoxy)methane	2,4-Dinitrotoluene	N-Nitrosodiphenylamine
	bis(2-Chloroethyl)ether	2,6-Dinitrotoluene	Phenanthrene
	bis(2-Ethylhexyl)phthalate	Fluoranthene	Phenol
	4-Bromophenyl-phenylether	Fluorene	Pyrene
	Butylbenzylphthalate	Hexachlorobenzene	1,2,4-Trichlorobenzene
	2-Chloronaphthalene	Hexachlorobutadiene	2,4,5-Trichlorophenol
	2-Chlorophenol	Hexachlorocyclopentadiene	2,4,6-Trichlorophenol
	di-N-butylphthalate	Hexachlorethane	4-Chlorophenyl-phenylether
	di-N-octylphthalate	Indeno(1,2,3-cd)pyrene	Chrysene
1300	Benzyl alcohol	4-Chloroanaline	3,3-Dichlorobenzidine
	4-Chloro-3-methylphenol		
3300	Benzoic acid	2-Nitroanaline	4-Nitrophenol
	4,6-Dinitro-2-methylphenol	3-Nitroanaline	Pentachlorophenol
	2,4-Dinitrophenol	4-Nitroanaline	
Reporting Limit (mg/kg)	**TCL PCBs SW-846, 8082**		
0.1	Aroclor-1016	Aroclor-1242	Aroclor-1254
	Aroclor-1221	Aroclor-1248	Aroclor-1260
	Aroclor-1232		Total PCBs

Reporting Limit (pCi/g)	Radionuclides	Method
5	Gross alpha	EPA-900
5	Gross beta	EPA-900
3	Uranium-234	Alpha Spec
2	Uranium-235	Alpha Spec
2	Uranium-238	Alpha Spec
8	Technetium-99	Liquid Scintillation
3	Thorium-228	Alpha Spec
4	Thorium-230	Alpha Spec
3	Thorium-232	Alpha Spec
3	Neptunium-237	Alpha Spec
6	Plutonium-238	Alpha Spec
4	Plutonium-239/240	Alpha Spec
3	Americium-241	Alpha Spec
0.5	Cesium-137	Gamma Spec

Table 9.8 SWMUs 7 and 30 Soil Analyte and Method Detection List (continued)

Reporting Limit (mg/kg)	Metals	Method
20	Aluminum	6010
10	Antimony	6010
2.5	Barium	6010
0.5	Beryllium	6010
2	Cadmium	6010
100	Calcium	6010
2.5	Chromium	6010
2.5	Cobalt	6010
2.5	Copper	6010
20	Iron	6010
20	Lead	6010
5	Magnesium	6010
2.5	Manganese	6010
5	Molybdenum	6010
5	Nickel	6010
2.5	Silver	6010
200	Sodium	6010
2	Thallium	6020
1	Uranium	6010
2.5	Vanadium	6010
20	Zinc	6010
1	Arsenic	6020
20	Selenium	6010
0.02	Mercury	7471

TCL = Target Compound List

An attempt also will be made to collect UCRS groundwater samples from angle borings, depending on the presence of groundwater. Groundwater samples will be collected from vertical borings from multiple discrete depths within the UCRS and RGA. Water sampling in the UCRS will be dictated by the presence of water-bearing zones—typically one or two samples will be collected using a hydro-punch advanced ahead of the augers. Water sampling in the RGA will begin at the top of the RGA (approximately 60 ft bgs) and continue at 10 ft intervals to the base of the RGA (approximately 100 ft bgs). This strategy will result in a total of two to six water samples collected from each boring, depending on the presence of water-bearing zones in the UCRS and the thickness of the RGA present in the boring.

Groundwater sample aliquots will be collected and analyzed for the parameters listed in Table 9.9.

Table 9.9 SWMUs 7 and 30 Groundwater Analyte and Method Detection List

Reporting Limit (µg/L)		TCL volatiles SW-846, 8260	
5	Benzene	1,1-Dichloroethane	Tetrachloroethene
	Bromodichloromethane	1,2-Dichloroethane	Toluene
	Bromoform	1,1-Dichlorethene	trans-1,2-Dichloropropene
	Carbon disulfide	cis-1,2-Dichloroethene	trans-1,4-Dichloro-2-butene (100)
	Carbon tetrachloride	1,2-Dichloropropane	1,1,1-Trichloroethane
	Chlorobenzene	Ethyl methacrylate	1,1,2-Trichloroethane
	Chloroform	Ethyl benzene	Trichloroethene
	cis-1,3-Dichloroprene	Iodomethane	Trichlorofluoromethane
	trans-1,3-Dichloropropene	Methylene chloride	1,2,3-Trichloropropane
	cis-1,3-Dichloropropene	Styrene	trans-1,2 Dichloroethene
	Dibromochloromethane	1,1,2,2-Tetrachoroethane	*m,p-* xylene (20 ug/L)
	Dibromomethane	1,1,1,2-Tetrachloroethane	*o-* xylene
	1,2-Dibromomethane		Vinyl chloride (2 ug/L)
	Dichlorodifluoromethane		
10	Bromomethane	2-Chloroethyl vinyl ether	Chloromethane
	Chloroethane		
50	2-Hexanone	4-Methyl-2-pentanone	Vinyl acetate
100	Acetone	2-Butanone	
	Acrolein	Acrylonitrile	
Reporting Limit (µg/L)		**TCL semivolatiles SW-846, 8270**	
10	Acenapthene	Dibenzo(a,h)anthracene	Isophorone
	Acenaphthylene	Dibenzofuran	2-Methylnaphthalene
	Anthracene	1,2-Dichlorobenzene	2-Methylphenol (o-cresol)
	Benzo(a)anthracene	1,3-Dichlorobenzene	4-Methylphenol (p-cresol)
	Benzo(b)fluoranthene	1,4-Dichlorobenzene	Naphthalene
	Benzo(k)fluoroanthene	2,4-Dichlorophenol	Nitrobenzene
	Benzo(a)pyrene	Diethylphthalate	2-Nitrophenol
	Benzo(g,h,i)perylene	2,4-Dimethylphenol	N-Nitroso-di-n-dipropylamine
	bis(2-Chloroisopropyl)ether	Dimethylphthalate	N-Nitrosodiphenylamine
	bis(2-Chloroethoxy)methane	2,4-Dinitrotoluene	Phenanthrene
	bis(2-Chloroethyl)ether	2,6-Dinitrotoluene	Phenol
	bis(2-Ethylhexyl)phthalate	Fluoranthene	Pyrene
	4-Bromophenyl-phenylether	Fluorene	1,2,4-Trichlorobenzene
	Butylbenzylphthalate	Hexachlorobenzene	2,4,5-Trichlorophenol
	2-Chloronaphthalene	Hexachlorobutadiene	2,4,6-Trichlorophenol
	2-Chlorophenol	Hexachlorocyclopentadiene	4-Chlorophenyl-phenylether
	di-N-butylphthalate	Hexachlorethane	Chrysene
	di-N-octylphthalate	Indeno(1,2,3-cd)pyrene	
20	Benzyl alcohol	4-Chloroanaline	3,3-Dichlorobenzidine
	4-Chloro-3-methylphenol		
50	Benzoic acid	2-Nitroanaline	4-Nitrophenol
	4,6-Dinitro-2-methylphenol	3-Nitroanaline	Pentachlorophenol
	2,4-Dinitrophenol	4-Nitroanaline	

Table 9.9 SWMUs 7 and 30 Groundwater Analyte and Method Detection List (continued)

Reporting Limit (µg/L)	**TCL PCBs SW-846, 8082**		
0.1	Aroclor-1016	Aroclor-1242	Aroclor-1254
	Aroclor-1221	Aroclor-1248	Aroclor-1260
	Aroclor-1232		Total PCBs
Reporting Limit (pCi/L)	**Radionuclides**		**Method**
3	Gross alpha		EPA-900
3	Gross beta		EPA-900
0.4	Uranium-234 (Filtered and Unfiltered)		Alpha Spec
0.4	Uranium-235 (Filtered and Unfiltered)		Alpha Spec
0.4	Uranium-238 (Filtered and Unfiltered)		Alpha Spec
1	Technetium-99		Liquid Scintillation
0.4	Thorium-228		Alpha Spec
0.4	Thorium-230		Alpha Spec
0.4	Thorium-232		Alpha Spec
0.5	Neptunium-237		Alpha Spec
0.4	Plutonium-238		Alpha Spec
0.4	Plutonium-239/240		Alpha Spec
0.4	Americium-241		Alpha Spec
0.4	Cesium-137		Gamma Spec
Reporting Limit (mg/L)	**Metals (Filtered and Unfiltered)**		**Method**
0.2	Aluminum		6010
0.005	Antimony		6010
0.01	Barium		6010
0.005	Beryllium		6010
0.0006	Cadmium		6010
5	Calcium		6010
0.01	Chromium		6010
0.01	Cobalt		6010
0.025	Copper		6010
0.05	Iron		6010
0.0013	Lead		6010
0.5	Magnesium		6010
0.01	Manganese		6010
0.001	Molybdenum		6010
0.04	Nickel		6010
0.01	Silver		6010
0.5	Sodium		6010
0.002	Thallium		6010
0.001	Uranium		6010
0.02	Vanadium		6010
0.02	Zinc		6010
0.001	Arsenic		6020
0.04	Selenium		6010
0.00001	Mercury		7471

TCL = Target Compound List

9.3.7 SWMU 145

SWMU 145	**Data Gaps:** There is no information on potential subsurface soil contamination directly beneath the burial pits. The potential for additional contaminants (other than what have been identified in previous investigations) seeping from the bottom of the burial cell is unknown. The potential that the soils immediately beneath the burial pits may have become contaminated and are now a secondary contaminant source is unknown. The exact location of burial cells within the SWMU is unknown. **Sampling Strategy:** Conduct a geophysical survey to determine the pit boundaries where uncertainties have been identified Drill seven angle borings and collect soil samples and UCRS groundwater samples (if sufficient amount of groundwater is available). If geophysical survey does not determine appropriate pits to angle beneath, then angle and boring location may be placed so as not to endanger the environment or the safety of the workers.

Aerial photographs dating to the 1950s, and other historical data, generally delineate the outlines of the SWMU 145 burial cell. The cell is bounded to the south and to the west by preexisting roads. The aerial photographs indicate the extent of clearing associated with disposal operations to the north and east.

Sampling activities during the late 1990s identified PGDP plant waste material at or near the surface in the southwest corner of this SWMU. Subsequent radiological scans of this material determined that it was radiologically contaminated. This area (approximately 200 ft^2) was covered and roped off to prevent exposure.

9.3.7.1 Data gaps

All boring information is from vertical borings that have been drilled beside or along the edges of the site.

- There is no information on potential subsurface soil contamination directly beneath the burial pits.
- The potential is unknown for additional contaminants (other than what have been identified in previous investigations) seeping from the bottom of the burial cell.
- The potential is unknown that the soils immediately beneath the burial pits may have become contaminated and are now a secondary contaminant source.
- The exact location of burial cells within the SWMU is unknown.

9.3.7.2 Sampling plan

The sampling approach has been designed to evaluate whether there have been releases from the bottom of the burial cells at SWMU 145, to characterize the nature and extent of the contamination in the subsurface soils and groundwater if there have been releases and whether these releases are contributing to TCE contamination in the RGA, and to identify any other areas of surface radiological contamination.

The following paragraphs outline the sampling and analytical requirements for SWMU 145 and summarize the rationale for the locations selected. Figure 9.7 shows the proposed sampling locations for this SWMU.

Surface Geophysical Survey. The exact boundaries of the burial pits are not defined, so a surface geophysical survey will be conducted along the northern and eastern boundaries to identify the burial areas. Several methods are proposed, because site-specific properties (e.g., fences, utilities, etc.) can interfere with the instruments. Three types of instruments (terrain conductivity meter, magnetometer, and GPR) will be available on-site to provide information about any anomalies present.

A terrain conductivity survey will be conducted using a Geonics EM-61 (or equivalent) that is capable of detecting objects to a depth of 20 ft bgs. This technique is preferred; however, fencing present in a portion of the site may cause excessive interference. If results are inconclusive following the terrain conductivity survey, either magnetometer and/or GPR will be used in an attempt to define the extent of the burial pits. GPR is preferred, because the magnetometer also may be affected by fencing. To prepare the site for the geophysical survey, a 4 to 5 ft grid will be established.

Soil Boring Locations. Seven angle soil borings will be drilled around the perimeter of the waste disposal cells to collect soils from beneath the waste disposal cells. The final determination for exact placement of these borings will be made after an evaluation of the surface geophysical data. The angle borings will be located as close to identified anomalies as possible, maximizing the extent of penetration under the buried wastes. Samples will be analyzed for the parameters shown in Table 9.10.

Table 9.10 SWMU 145 Soil Analyte and Method Detection List

Reporting Limit (µg/kg)		**TCL volatiles SW-846, 8260**	
10	Benzene	1,1-Dichloroethane	Tetrachloroethene
	Bromodichloromethane	1,2-Dichloroethane	Toluene
	Bromoform	1,1-Dichlorethene	trans-1,2-Dichloropropene
	Carbon disulfide	cis-1,2-Dichloroethene	trans-1,4-Dichloro-2-butene
	Carbon tetrachloride	1,2-Dichloropropane	1,1,1-Trichloroethane
	Chlorobenzene	Ethyl methacrylate	1,1,2-Trichloroethane
	Chloroform	Ethyl benzene	Trichloroethene
	cis-1,3-Dichloroprene	Iodomethane	Trichlorofluoromethane
	trans-1,3-Dichloropropene	Methylene chloride	1,2,3-Trichloropropane
	cis-1,3-Dichloropropene	Styrene	trans-1,2 Dichloroethene
	Dibromochloromethane	Dichlorodifluoromethane	*m,p-* xylene (20 ug/kg)
	Dibromomethane	1,1,2,2-Tetrachoroethane	*o-* xylene
	1,2-Dibromomethane	1,1,1,2-Tetrachloroethane	Chloromethane
	Bromomethane	2-Chloroethyl vinyl ether	Vinyl chloride
	Chloroethane	2-Butanone	Vinyl acetate
	4-Methyl-2-pentanone	Acrolein	2-Hexanone
	Acetone	Acrylonitrile	
Reporting Limit (mg/kg)		**TCL PCBs SW-846, 8082**	
0.1	Aroclor-1016	Aroclor-1242	Aroclor-1254
	Aroclor-1221	Aroclor-1248	Aroclor-1260
	Aroclor-1232		Total PCBs

Table 9.10 SWMU 145 Soil Analyte and Method Detection List (continued)

Reporting Limit (pCi/g)	Radionuclides	Method
5	Gross alpha	EPA-900
5	Gross beta	EPA-900
3	Uranium-234	Alpha Spec
2	Uranium-235	Alpha Spec
2	Uranium-238	Alpha Spec
8	Technetium-99	Liquid Scintillation
3	Thorium-228	Alpha Spec
4	Thorium-230	Alpha Spec
3	Thorium-232	Alpha Spec
3	Neptunium-237	Alpha Spec
6	Plutonium-238	Alpha Spec
4	Plutonium-239/240	Alpha Spec
3	Americium-241	Alpha Spec
0.5	Cesium-137	Gamma Spec
Reporting Limit (mg/kg)	**Metals**	**Method**
20	Aluminum	6010
10	Antimony	6010
2.5	Barium	6010
0.5	Beryllium	6010
2	Cadmium	6010
100	Calcium	6010
2.5	Chromium	6010
2.5	Cobalt	6010
2.5	Copper	6010
20	Iron	6010
20	Lead	6010
5	Magnesium	6010
2.5	Manganese	6010
5	Molybdenum	6010
5	Nickel	6010
2.5	Silver	6010
200	Sodium	6010
2	Thallium	6020
1	Uranium	6010
2.5	Vanadium	6010
20	Zinc	6010
1	Arsenic	6020
20	Selenium	6010
0.02	Mercury	7471

TCL = Target Compound List

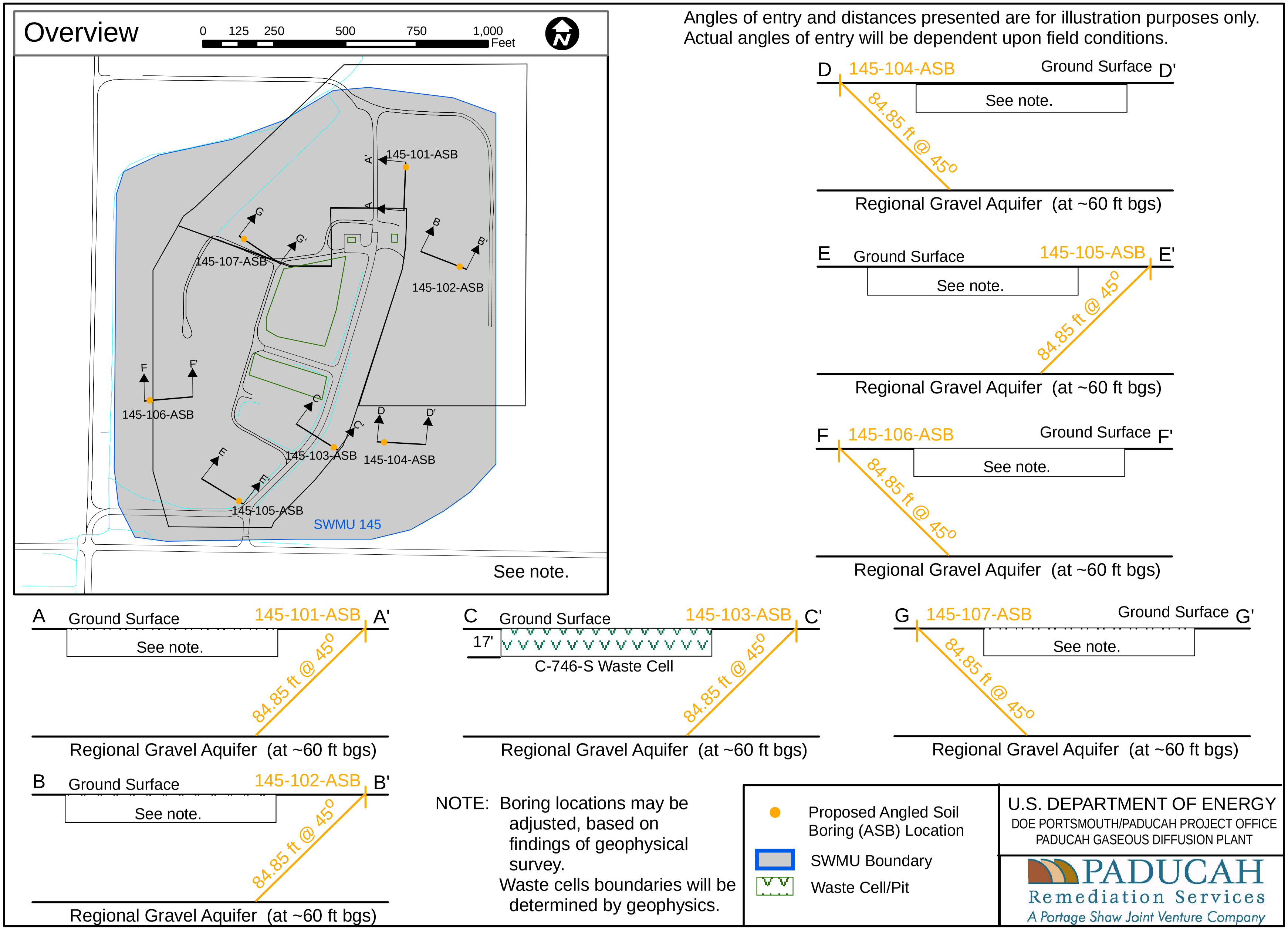


Figure 9.7. SWMU 145 BGOU RI/FS Proposed Sampling Locations

An attempt also will be made to collect UCRS groundwater samples from each angle boring, depending on the presence of groundwater. Groundwater sample aliquots will be collected and analyzed for the parameters listed in Table 9.11.

Table 9.11 SWMU 145 Groundwater Analyte and Method Detection List

Reporting Limit (µg/L)		**TCL volatiles SW-846, 8260**	
5	Benzene Bromodichloromethane Bromoform Carbon disulfide Carbon tetrachloride Chlorobenzene Chloroform cis-1,3-Dichloroprene trans-1,3-Dichloropropene cis-1,3-Dichloropropene Dibromochloromethane Dibromomethane 1,2-Dibromomethane Dichlorodifluoromethane	1,1-Dichloroethane 1,2-Dichloroethane 1,1-Dichlorethene cis-1,2-Dichloroethene 1,2-Dichloropropane Ethyl methacrylate Ethyl benzene Iodomethane Methylene chloride Styrene 1,1,2,2-Tetrachoroethane 1,1,1,2-Tetrachloroethane	Tetrachloroethene Toluene trans-1,2-Dichloropropene trans-1,4-Dichloro-2-butene 1,1,1-Trichloroethane 1,1,2-Trichloroethane Trichloroethene Trichlorofluoromethane 1,2,3-Trichloropropane trans-1,2 Dichloroethene *m,p-* xylene (20 ug/L) *o-* xylene Vinyl chloride (2 ug/L)
10	Bromomethane Chloroethane	2-Chloroethyl vinyl ether	Chloromethane
50	2-Hexanone	4-Methyl-2-pentanone	Vinyl acetate
100	Acetone Acrolein	2-Butanone Acrylonitrile	
Reporting Limit (µg/L)		**TCL PCBs SW-846, 8082**	
0.1	Aroclor-1016 Aroclor-1221 Aroclor-1232	Aroclor-1242 Aroclor-1248	Aroclor-1254 Aroclor-1260 Total PCBs

Reporting Limit (pCi/L)	**Radionuclides**	**Method**
3	Gross alpha	EPA-900
3	Gross beta	EPA-900
0.4	Uranium-234 (Filtered and Unfiltered)	Alpha Spec
0.4	Uranium-235 (Filtered and Unfiltered)	Alpha Spec
0.4	Uranium-238 (Filtered and Unfiltered)	Alpha Spec
1	Technetium-99	Liquid Scintillation
0.4	Thorium-228	Alpha Spec
0.4	Thorium-230	Alpha Spec
0.4	Thorium-232	Alpha Spec
Reporting Limit (pCi/L)	**Radionuclides**	**Method**
0.5	Neptunium-237	Alpha Spec
0.4	Plutonium-238	Alpha Spec
0.4	Plutonium-239/240	Alpha Spec
0.4	Americium-241	Alpha Spec
0.4	Cesium-137	Gamma Spec

Table 9.11 SWMU 145 Groundwater Analyte and Method Detection List (continued)

Reporting Limit (mg/L)	Metals (Filtered and Unfiltered)	Method
0.2	Aluminum	6010
0.005	Antimony	6010
0.01	Barium	6010
0.005	Beryllium	6010
0.0006	Cadmium	6010
5	Calcium	6010
0.01	Chromium	6010
0.01	Cobalt	6010
0.025	Copper	6010
0.05	Iron	6010
0.0013	Lead	6010
0.5	Magnesium	6010
0.01	Manganese	6010
0.001	Molybdenum	6010
0.04	Nickel	6010
0.01	Silver	6010
0.5	Sodium	6010
0.002	Thallium	6010
0.001	Uranium	6010
0.02	Vanadium	6010
0.02	Zinc	6010
0.001	Arsenic	6020
0.04	Selenium	6010
0.00001	Mercury	7471

TCL = Target Compound List

9.4 SAMPLING PROCEDURES

Fieldwork and sampling at PGDP will be conducted in accordance with DOE Prime Contractor-approved medium-specific work instructions or procedures consistent with *Environmental Investigation Standard Operating Procedure and Quality Assurance Manual*, EPA Region 4, November 2001. DOE or its DOE Prime Contractor will approve any deviations from these work instructions and procedures. The DOE Prime Contractor will document changes on Field Change Request forms as detailed in the QAPP. Table 9.12 provides an example list of investigation activities that may require work instructions or procedures.

Table 9.12 Example Fieldwork and Sampling Activities Requiring Work Instructions or Procedures

Investigation Activity
Use of Field Logbooks
Lithologic Logging
Labeling, Packaging, and Shipping of Environmental Field Samples
Groundwater Sampling Procedures: Water Level Measurements
Monitoring Well Purging and Groundwater Sampling
Filter Pack and Screen Selection for Wells and Piezometers
Monitoring Well Installation
Monitoring Well Development
Field Measurement Procedures: pH, Temperature, and Conductivity, Dissolved Oxygen, and Eh (Oxidation Reduction Potential)
Sampling of Containerized Wastes
Opening Containerized Waste
On-Site Handling and Disposal of Waste Materials
Identification and Management of Waste Not From a Radioactive Material Management Area
Paducah Contractor Records Management Program
Quality Assured Data
Chain-of-Custody
Field Quality Control
Data Management Coordination Equipment Decontamination
Off-Site Decontamination Pad Operating Procedures
Cleaning and Decontaminating Sample Containers and Sampling Equipment
Environmental Radiological Screening
Pumping Liquid Wastes Into Tankers
Archival of Environmental Data Within the ER Program
Data Entry
Data Validation
Well and Temporary Boring Abandonment

9.5 DOCUMENTATION

Field documentation will be maintained throughout the BGOU RI/FS in various types of documents and formats, including the field logbooks, sample labels, sample tags, chain-of-custody forms, and field data sheets. The following general guidelines for maintaining field documentation will be implemented. Additional information is contained in the DMIP (Chapter 12). Documentation requirements are listed below. Entries will be written clearly and legibly using indelible ink.

- Corrections will be made by striking through the error with a single line that does not obliterate the original entry. Corrections will be dated and initialed.
- Dates and times will be recorded using the format “mm/dd/yy” for the date and the military (i.e., 24-hour) clock for the time.
- Zeroes will be recorded with a slash (/) to distinguish them from letter Os.
- Blank lines are prohibited. Information should be recorded on each line or a blank line should be lined out, initialed, and dated.
- No documents will be altered, destroyed, or discarded, even if they are illegible or contain inaccuracies that require correction.

- Information blocks on field data forms will be completed or a line will be drawn through the unused section, and the area will be dated and initialed.

- Unused logbook pages will be marked with a diagonal line drawn from corner to corner and a signature and date must be placed on the line.

- Security of logbooks will be maintained by storing them in a secured (e.g., locked) area when not in use.

- Photocopies of logbooks, field data sheets, and chain-of-custody forms will be made weekly and stored in the project file.

9.5.1 Field Logbooks

Field team personnel will use bound field logbooks with sequentially numbered pages for the maintenance of field records and for documenting any information pertinent to field activities. Field forms will be numbered sequentially or otherwise controlled. A designated field team member will record in the field logbooks sampling activities and information from site exploration and observation. Field documentation will conform to approved procedures for use of field logbooks. An integral component of QA/QC for the field activities will be the maintenance of accurate and complete field records and the collection of appropriate field data forms. The primary purpose of the logbook is to document each day's field activities; the personnel on each sampling team; and any administrative occurrences, conditions, or activities that may have affected the fieldwork or data quality of any environmental samples for any given day. The level of detail of the information recorded in the field logbook should be such that an accurate reconstruction of the field events can be created from the logbook. The project name, logbook number, client, contract number, task number, document control number, activity or site name, and the start and completion dates will be listed on each logbook's front cover. Important phone numbers, radio call numbers, emergency contacts, and a return address should be recorded on the inside of the front cover.

9.5.2 Sample Log Sheets

A sample log sheet will contain sample-specific information for each field sample collected, including field QC samples. Generally, sample log sheets will be preprinted from the data management system with the following information:

- Name of sampler;

- Project name and number;

- Sample identification number;

- Sampling location, station code, and description;

- Sample medium or media;

- Sample collection date;

- Sample collection device;

- Sample visual description;

- Collection procedure;

- Sample type;
- Analysis; and
- Preservative.

In addition, specific analytical requests will be preprinted from the data management system and will include the following for each analytical request:

- Analysis/method,
- Container type,
- Number of containers,
- Container volume,
- Preservative (type/volume), and
- Destination laboratory.

During sample collection, a field team member will record the remaining required information and will sign and date each sample log sheet. The following information will be recorded for each sample, whether or not the sample was collected:

- The date and time of collection;
- The name of the collector;
- Collection methods and/or procedures;
- Required field measurements and measurement units;
- Instrumentation documentation, including the date of last calibration;
- Adherence to, or deviation from, the procedure and the BGOU work plan;
- Weather conditions at the time of sample collection;
- Activities in the area that could impact subsequent data evaluation;
- General field observations that could assist in subsequent data evaluation;
- Lot number of the sample containers used during sample collection;
- Sample documentation and transportation information, including unique chain-of-custody form number, airbill number, and container lot number; and
- Relevant and associated field QC samples (for each sample).

If preprinted sample log sheets are not used, information will be recorded manually. A member of the field sampling team (other than the recorder) will perform a QA review of each sample log sheet and document the review by signing and dating the log sheet. Notations of deviations will be initialed by the FTM as part of his/her review of the logbook.

9.5.3 Field Data Sheets

Field data sheets will be maintained, as appropriate, for the following types of data:

- Water level measurements,
- Soil boring logs,
- MW construction logs,
- Sample log sheets,
- Well development logs,
- Well purging logs,
- Groundwater sampling logs,
- Chain-of-custody forms,
- Instrument calibration logs,
- Temperature monitoring sheets, and
- VOC concentrations and radiological values recorded for each sample collected.

Data to be recorded will include such information as the location, sampling depth, sampling station, and applicable sample analysis to be conducted. Field-generated data forms will be prepared, if necessary, based on the appropriate requirements. The same information may be included in the field logbook or, if not, the field logbook should reference the field data sheet. If preprinted field data sheets are not used, information will be recorded manually in the field logbook.

9.5.4 Sample Identification, Numbering, and Labeling

In addition to field logbooks and field data sheets, the sampling team will use labels to track sample holding times, to provide sample traceability, and to initiate the chain-of-custody record for the environmental samples. A pressure-sensitive gummed label (or equivalent) will be secured to each sample container at the time of collection, including duplicates and trip or field blanks, at or before the completion of sample collection.

Sample labels will be waterproof or will be sealed to the sample container with clear acetate tape after all information has been recorded on the label. Generally, sample labels will be preprinted with information from the data management system and will contain the following information:

- Station name,
- Sample identification number,
- Sample matrix,

- Sample type (grab or composite),
- Type or types of analysis required,
- Sample preservation (if required), and
- Destination laboratory.

A field sampling team member will complete the remaining information during sample collection, including these items:

- Date and time of collection, and
- Initials of sampler.

The sample numbers will be recorded in the field logbook along with the time of collection and descriptive information previously discussed.

9.5.5 Sample Chain-of-Custody

Chain-of-custody procedures will document sample possession from the time of collection, through transfers of custody, to receipt at the laboratory and subsequent analysis. Chain-of-custody records will accompany each packaged lot of samples; the laboratory will not analyze samples that are not accompanied by a correctly prepared chain-of-custody record. A sample will be considered under custody if it is (1) in the possession of the sampling team; (2) in view of the sampling team; or (3) transferred to a secured (i.e., locked) location. Chain-of-custody records will follow the requirements as specified in a DOE Prime Contractor-approved procedure for keeping records. This form will be used to collect and track samples from collection until transfer to the laboratory. Copies of the signed chain-of-custody records will be faxed or delivered to the DOE Prime Contractor SMO within three days of sample delivery.

The Sampling Team Leader is responsible for reviewing and confirming the accuracy and completeness of the chain-of-custody form and for the custody of samples in the field until they have been properly transferred to the Sample Coordinator. The Sample Coordinator is responsible for sample custody until the samples are properly packaged, documented, and released to a courier or directly to the analytical laboratory. If samples are not immediately transported to the analytical laboratory, they will remain in the custody of the Sample Coordinator, where they will be refrigerated and secured either by locking the refrigerator or by placing custody seals on the individual containers.

Each chain-of-custody form will be identified by a unique number located in the upper-right corner, and recorded on the sample log sheet at the time of sample collection. The laboratory chain-of-custody will be the "official" custody record for the samples. Each chain-of-custody form will contain the following information:

- The sample identification for each sample;
- Collection data for each sample;
- Number of containers of each sample;
- Description of each sample (i.e., environmental matrix/field QC type) and analyses required for each sample; and

- Blocks to be signed as custody is transferred from one individual to another.

The airbill number will be recorded on the chain-of-custody form, if applicable. The laboratory chain-of-custody form will be sealed in a resealable plastic bag and taped to the inside of the cooler lid if the samples are to be shipped off-site. A copy will be retained in the laboratory, and the original will be returned to the Sample Manager with the completed data packages.

At each point of transfer, the individuals relinquishing and receiving custody of the samples will sign in the appropriate blocks and record the date and time of transfer. When the laboratory sample custodian receives the samples, he or she will document receipt of the samples, record the time and date of receipt, and note the condition of the samples (e.g., cooler temperature, whether the seals are intact) in the comments section. The laboratory then will forward appropriate information to the Sample Manager. This information may include the following:

- A cover memo stating sample receipt date and any problems noted at the time of receipt; and

- A report showing the field sample identification number, the laboratory identification number, and the analyses scheduled by the laboratory for each sample.

9.5.6 Sample Shipment

Aliquots of investigative samples will be screened by an on-site laboratory before shipment to an off-site laboratory. Results from the screening process will be recorded in Paducah's Project Environmental Measurements System (PEMS) and will be reviewed prior to preparation for sample shipment off-site. Sample containers will be placed in the shipping container and packed with ice and absorbent packing for liquids. The completed chain-of-custody form will be placed inside the shipping container, unless otherwise noted. The container then will be sealed. In general, sample containers will be packed according to the following procedures:

- Glass sample containers will be wrapped in plastic insulating material to prevent contact with other sample containers or the inner walls of the container.

- Logbook entries, sample tags and labels, and chain-of-custody forms will be completed with sample data collection information and names of persons handling the sample in the field before packaging.

- Samples, temperature blanks, and trip blanks will be placed in a thermal-insulated cooler along with ice that is packed in resealable plastic bags. After the cooler is filled, the appropriate chain-of-custody form will be placed in the cooler in a resealable plastic bag attached to the inside of the cooler lid.

- Samples will be classified according to U.S. Department of Transportation (DOT) regulations pursuant to 49 CFR 173. All samples will be screened for radioactivity to determine that DOT limits of 2.0 nCi/mL for liquid waste and 2.0 nCi/g for solid waste are not exceeded.

9.5.7 Field Planning Meeting

A field planning meeting will occur before work begins at the site, so that all involved personnel will be informed of the requirements of the fieldwork associated with the project. Additional planning meetings will be held whenever new personnel join the field team or if the scope of work changes significantly. Each meeting will have a written agenda and attendees must sign an attendance sheet, which will be maintained on-site and in the project files. The following example topics will be discussed at these meetings:

- Project- and site-specific health and safety, objectives and scope of the fieldwork, equipment and training requirements;
- Procedures;
- Required QC measures; and
- Documents covering on-site fieldwork.

9.5.8 Readiness Checklist

Before implementation of the field program, project personnel will review the work control documents to identify field activities and materials required to complete the activities, including the following items:

- Task deliverables,
- Required approvals and permits,
- Personnel availability,
- Training,
- Field equipment,
- Sampling equipment,
- Site facilities and equipment, and
- Health and safety equipment.

Before fieldwork begins, appropriate DOE Prime Contractor personnel will concur that readiness has been achieved.

9.6 SAMPLE LOCATION SURVEY

Surveying of sampling locations will be conducted upon completion of RI/FS field activities. Where possible, temporary markers consisting of flagging or of wooden or metal stakes will be used to mark boring locations. Brass markers will be incorporated as part of pad installation for any MWs; however, a thorough description of each location will be made during field sampling activities and will be documented using field maps. This documentation will be used for the survey effort if permanent sampling location markers are disturbed or if permanent markers cannot be placed at the time of sampling. A member of the field sampling crew will accompany the survey crew to provide information regarding the location of sampling points. Each sample point will be surveyed for its horizontal and vertical location using the PGDP coordinate system for horizontal control. Additionally, State Plane Coordinates will be provided using the U.S. Coast and Geodetic Survey North American Datum of 1983. The datum for vertical control will be the U.S. Coast and Geodetic Survey North American Vertical Datum of 1988. Accuracy for this work will be that of a Class 1 First Order survey. Work will be performed by or under responsible charge of a Professional Land Surveyor registered in the Commonwealth of Kentucky. Coordinates will be entered into Paducah PEMS and will be transferred with the station's ready-to-load (RTL) file to Paducah OREIS.

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