DOE/OR/07-2179&D2/A2/R2
Primary Document

Addendum to the Work Plan for the Burial Grounds Operable Unit Remedial Investigation/Feasibility Study at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, Solid Waste Management Unit 4 Sampling and Analysis Plan

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Addendum to the Work Plan for the Burial Grounds Operable Unit Remedial Investigation/Feasibility Study at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, Solid Waste Management Unit 4 Sampling and Analysis Plan

Date Issued—June 2012

Prepared for the
U.S. DEPARTMENT OF ENERGY
Office of Environmental Management

Prepared by
LATA ENVIRONMENTAL SERVICES OF KENTUCKY, LLC
managing the
Environmental Remediation Activities at the
Paducah Gaseous Diffusion Plant
under contract DE-AC30-10CC40020

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QAPP WORKSHEETS

ACRONYMS

ARAR	applicable or relevant and appropriate requirement
BGOU	Burial Grounds Operable Unit
bgs	below ground surface
CA	corrective action
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
COC	contaminant of concern
COPC	chemical of potential concern
CRQL	contract-required quantitation limit
DCE	dichloroethene
DNAPL	dense nonaqueous-phase liquid
DOE	U.S. Department of Energy
DOECAP	DOE Consolidated Audit Program
DPT	direct-push technology
DQI	data quality indicator
DQO	data quality objective
ECD	electron capture device
EDD	electronic data deliverable
ELCR	excess lifetime cancer risk
EPA	U.S. Environmental Protection Agency
ERH	electrical resistance heating
eV	ionization potential
FFA	Federal Facility Agreement
FID	flame ionization detector
FS	feasibility study
FSP	field sampling plan
GPS	global positioning system
HI	hazard index
HSA	hollow stem auger
HSO	health and safety officer
HU	hydrogeologic unit
KDEP	Kentucky Department for Environmental Protection
LATA Kentucky	LATA Environmental Services of Kentucky, LLC
MBWA	management by walking around
MCL	maximum contaminant level
MDA	minimum detectable activity
MDC	minimum detectable concentration
MDL	method detection limit
NA	not applicable
NAL	no action level
NIST	National Institute of Standards and Technology
OREIS	Paducah Oak Ridge Environmental Information System
OVM	organic vapor monitor
PARCCS	precision, accuracy, representativeness, comparability, completeness, and sensitivity
PCB	polychlorinated biphenyl
PEMS	Project Environmental Measurements System
PGDP	Paducah Gaseous Diffusion Plant

PID	photoionization detector
PPE	personal protective equipment
PQL	project quantitation limit
PRG	preliminary remediation goal
PTW	principal threat waste
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RGA	Regional Gravel Aquifer
RI	remedial investigation
RPD	relative percent difference
SAP	sampling and analysis plan
SI	site investigation
SRM	standard reference materials
SOP	standard operating procedure
SVOA	semivolatile organic analyte
SVOC	semivolatile organic compound
SWMU	solid waste management unit
Tc-99	technetium-99
TBD	to be determined
TCE	trichloroethene
TCLP	toxicity characteristic leaching procedure
UCRS	Upper Continental Recharge System
UFP	Uniform Federal Policy
USEC	United States Enrichment Corporation
UV	ultraviolet
VOA	volatile organic analyte
VOC	volatile organic compound
WAG	waste area grouping
XRF	X-ray fluorescence

EXECUTIVE SUMMARY

This *Addendum to the Work Plan for the Burial Grounds Operable Unit Remedial Investigation/Feasibility Study at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, Solid Waste Management Unit 4 Sampling and Analysis Plan* is comprised of the Field Sampling Plan (FSP) and its companion, the Quality Assurance Project Plan (QAPP). Solid Waste Management Unit (SWMU) 4 is a component of the Burial Grounds Operable Unit (BGOU), at the Paducah Gaseous Diffusion Plant (PGDP) and is subject to a Remedial Investigation/Feasibility Study (RI/FS). The Sampling and Analysis Plan (SAP) supplements the approved RI for the BGOU, which was completed in February 2010 (DOE 2010a), and describes how additional sampling will optimize remedy selection.

The data collected from this sampling effort will be used to conduct a risk screening for the industrial worker; therefore, project action limits have been set to the industrial worker no action limits found in M*ethods for Conducting Risk Assessments and Risk Evaluation at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/LX/07-0107&D2/R1. For exposure to groundwater, however, the project action limits were set equal to the child resident exposure scenario because the no action levels for an industrial worker being exposed to groundwater have been established.

Optimization of remedy selection will be achieved by filling the listed data gaps that were jointly identified by U.S. Department of Energy (DOE), U.S. Environmental Protection Agency (EPA), and Kentucky Department for Environmental Protection.

- There are insufficient data at SWMU 4 to determine whether trichloroethene (TCE) is present in each of the burial cells, and the extent and mass of TCE contamination with sufficient accuracy to effectively and efficiently complete a remedial design for a TCE remedy in the burial cells;

- There are insufficient data at SWMU 4 to determine the extent and mass of TCE contamination with sufficient accuracy to effectively and efficiently complete a remedial design for TCE in the Upper Continental Recharge System (UCRS) (i.e., soils from ground surface to the top of the Regional Gravel Aquifer (RGA) not identified as burial cells);

- There are insufficient data at SWMU 4 to determine the extent and mass of TCE source term with sufficient accuracy to effectively and efficiently complete a remedial design for source term in the RGA;

- There are insufficient data at SWMU 4 to determine with sufficient certainty whether contaminants of concern (COCs) other than TCE in the five primary burial cells represent a migration risk to the RGA or principal threat waste (PTW);

- There are insufficient data at SWMU 4 to determine the extent and mass of COCs other than TCE with sufficient accuracy to effectively and efficiently select and design a remedy for the UCRS (i.e., not burial cells or geophysical anomalies);

- There are insufficient data at SWMU 4 to determine the extent and mass of COCs with sufficient accuracy to select and design a remedy for the geophysical anomalies identified in 1999 and 2010 geophysical surveys. Data should be of sufficient quantity and quality to determine whether COCs represent a migration risk to the RGA or PTW;

- The depth of the water table at SWMU 4 is uncertain. Specifically, is the buried material at SWMU 4 submerged in water;

- It is uncertain whether the bedding materials surrounding the raw water pipe in the southeastern portion of the SWMU has been impacted by site constituents and act as a preferential pathway for migration outside of the SWMU;

- Hydraulic conductivity of the RGA under SWMU 4, as a measure of groundwater velocity and flow direction, is uncertain; and

- There are insufficient data at SWMU 4 to determine the extent and mass of COCs in the surface soil within the SWMU 4 boundaries.

This SAP describes a phased investigation designed to fill these data gaps; the investigation phases are described below. While the jointly identified data gaps specified TCE as the volatile organic compound (VOC) of interest, this SAP includes sampling and analysis for a broader range of VOCs.

- Sampling the surface soil (0-1 ft bgs) at SWMU 4 using a method similar to that used in the Soils Operable Unit remedial investigation conducted during the summer of 2010. This will entail collecting 5-point composite samples in a 45-ft grid over the entire surface of SWMU 4 and analyzing those samples for the full suite of analytes, except for VOCs.

- Deployment of passive soil gas samplers in an impartial grid pattern over SWMU 4, followed by analysis and development of a soil gas concentration map that shows areas of higher concentrations of VOCs. The specific vendor of the passive soil gas samplers will be determined based on ease of radiological decontamination, availability of sufficient modules to supply the project, turnaround time for analysis results, and relative ease of field installation.

- Advancement of borings to the bottom of the burial cells; boring locations will be biased toward the "hotter" areas from the passive soil gas samplers results. Samples from these borings will be submitted for analysis for VOCs, other COCs, and waste characterization parameters. If water is encountered in these borings, it will be sampled and submitted for VOC analysis. Furthermore, a minimum of one test pit in each burial cell will be utilized during this phase to help characterize the contents of the cell.

- Advancement of biased-location borings to the bottom of the UCRS. The boring locations will be biased toward the "hotter" areas from the passive soil gas samplers results. Samples from these borings will be submitted for analysis for both VOCs and other COCs. Where water is encountered, it will be sampled and submitted for VOC and technetium-99 (Tc-99) analysis.

- Installation of 10 borings advanced to the RGA/McNairy interface, sampling the RGA every 5 ft for VOCs and Tc-99.

- Installation of five monitoring wells into the RGA to provide data indicating constituents entering and leaving SWMU 4 and the flow direction of groundwater beneath SWMU 4.

Data from each of the six steps will be used to determine sampling and/or boring locations in subsequent steps. Historic data will be used considering the uncertainties of the data, especially regarding its age, and the changes that may have taken place in the *in situ* environmental media since collecting older data. Both the existing historical data and the data generated from the new analyses will be used to develop an estimate of the mass and distribution of VOCs remaining in the burial cells and underlying soils to support decision making. This program also will support characterization of wastes potentially generated from SWMU 4 under an excavation alternative. Finally, a full suite of analyses will be conducted on the soil samples to refine the previously derived estimates of contamination migration and to refine the associated decision making.

Engineering and design parameters that will be collected for soil samples include grain size data; air permeability; percolation test; electrical resistance; microbial community; molecular parameter; and natural oxidant demand. Engineering and design parameters that will be collected for water samples include chemical oxygen demand; total organic carbon; dissolved organic carbon; dissolved oxygen; pH; redox; temperature; specific conductance; and sulfate, chloride, calcium nitrate, and ferrous iron content.

This SAP summarizes the information known about SWMU 4 and describes how the additional investigation will fill the data gaps and support remedial decision making at SWMU 4.

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1. INTRODUCTION

The Field Sampling Plan (FSP), together with its companion Quality Assurance Project Plan (QAPP), constitutes this Sampling and Analysis Plan (SAP) for Solid Waste Management Unit (SWMU) 4 at the U.S. Department of Energy's (DOE) Paducah Gaseous Diffusion Plant (PGDP) in Paducah, Kentucky. Administratively, SWMU 4 is within the Burial Grounds Operable Unit (BGOU), which is a portion of the PGDP that is subject to a Remedial Investigation/Feasibility Study (RI/FS). This SAP supplements the approved RI for the BGOU. It describes how samples will be collected and subsequently analyzed in order to help optimize the remedy selection at SWMU 4. The newly acquired data will be used to fill the data gaps described in Section 4 of this document which were jointly identified by DOE, U.S. Environmental Protection Agency (EPA), and Kentucky Department for Environmental Protection (KDEP).

1.1 SWMU 4 LOCATION AND BACKGROUND

SWMU 4 consists of the C-747 Contaminated Burial Yard and the C-748-B Burial Area and is located in the western section of the PGDP secured area (Figure 1). SWMU 4 covers an area of approximately 286,700 ft^2 and is bounded on the north, east, and west by plant roads Virginia Avenue, 6^{th} Street, and 4^{th} Street, respectively, and on the south by an active railroad spur. This SWMU is an open field that, at one time, was used for the burial and disposal of various waste materials in designated burial cells. In 1982, the entire burial yard was covered (a 6-inch compacted clay cover and from 18 inches to 3 ft of compacted soil material) and seeded. A short, narrow, gravel road that enters from the west and a turnaround entry on the east side are nearly completely grass-covered. Except for these rarely used roads, the entire site is now covered with a variety of field grasses and clovers. The site typically is mowed once a month from April through September. SWMU 4 is bounded on three sides (north, east, and west) by shallow drainage swales that direct surface runoff to the northwest corner of the site. There is an elevation difference of approximately 10 ft between the highest point in the SWMU to the adjacent drainage swales.

The C-747 Burial Yard was in operation from 1951 to 1958 and used to dispose of radiologically contaminated and uncontaminated debris originating from the C-410 uranium hexafluoride feed plant.

The area originally consisted of two cells covering an area of approximately 8,300 ft^2 (50 ft by 15 ft and 50 ft by 150 ft) (Union Carbide 1978).

According to employee interviews, a majority of the contaminated metal was buried in the northern part of the C-747 Burial Yard. Some of the trash was burned before burial. Scrapped equipment with surface contamination from the enrichment process also was buried. When the yard was closed, a smaller cell was reported to have been dug for the disposal of radiologically contaminated scrap metal (Union Carbide 1978).

The C-748-B Burial Area, located on the west side of C-747, is identified as a "Proposed Chemical Landfill Site" in the 1973 Union Carbide document on waste disposal (Union Carbide 1973). The C-748-B Burial Area was incorporated into SWMU 4 starting in the mid-1990s as a result of the review of a geophysical survey. With this incorporation, the area of the SWMU was changed from 8,300 ft^2 to 286,700 ft^2 (6.58 acres), and this change was documented in a revised SWMU Assessment Report (DOE 2007a). In the fall of 1999, employee interviews led to the designation of the area as classified, and appropriate access restrictions were implemented.

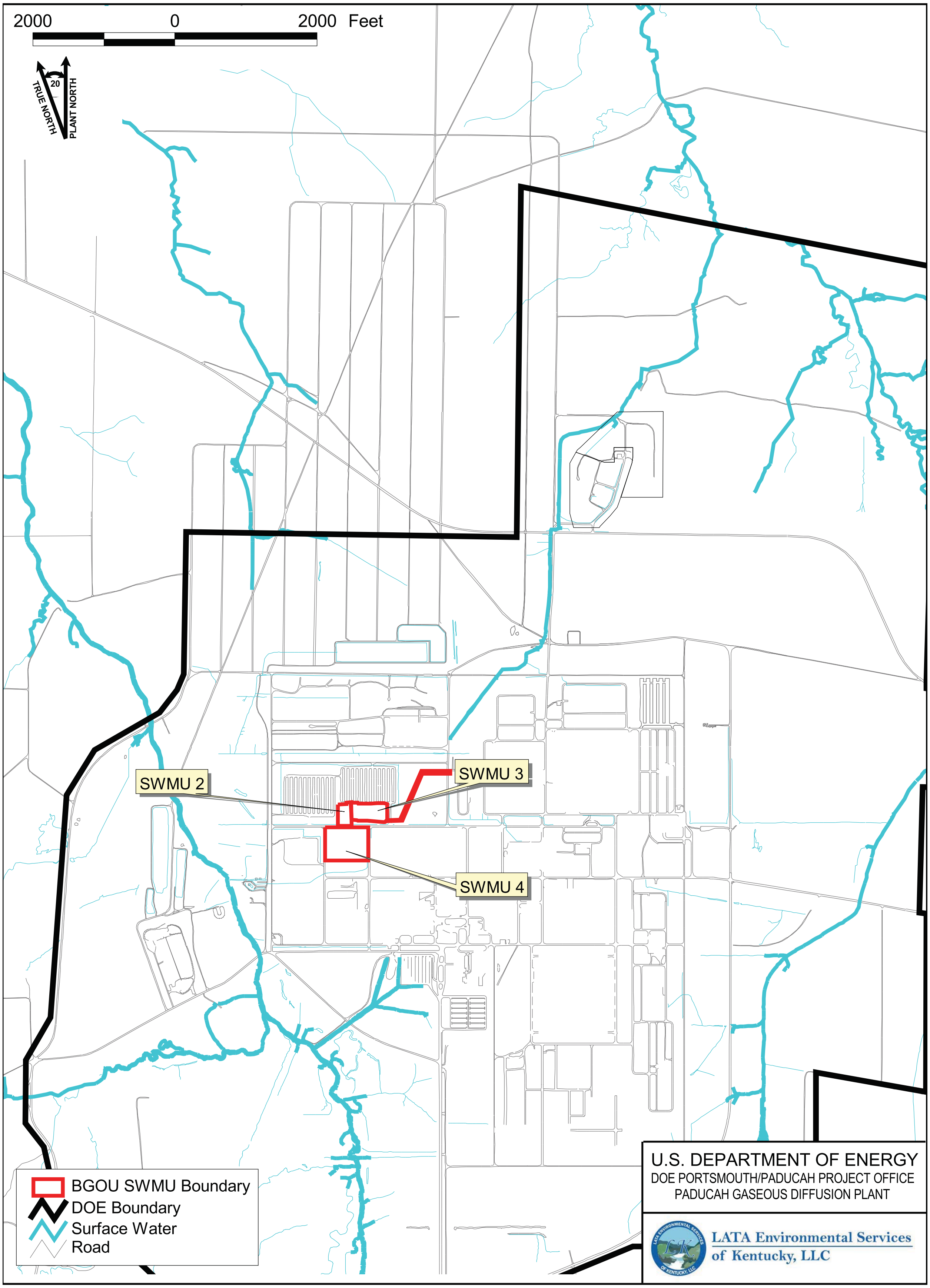

Figure No. \BGOU\SWMU4SAP.apr
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Figure 1. SWMU 4 Location at PGDP

An active subsurface raw water pipeline is present across the southeastern portion of the SWMU, traversing the SWMU diagonally (Figure 2). The pipeline gets as close as ~30 ft from the nearest delineated burial cell. The lowest point of the pipeline is at a depth of approximately 367 ft above mean sea level (amsl), which is approximately 8 to 10 ft below the current grade in the area (DOE 2010b).

Historical and process information indicates that the burial cells have a maximum depth of 15 to 18 ft below ground surface (bgs). The direct measurement of the depth of the water table beneath SWMU 4 reported in the Waste Area Grouping (WAG) 3 Report has the shallowest groundwater elevation at approximately 18 ft bgs; thus, SWMU 4 waste was not found to be in groundwater during the WAG 3 investigation. The stratigraphy and hydrogeologic setting of SWMU 4 is comparable to that of SWMU 2, which is located directly north of SWMU 4 (Figure 1) and has a water table depth of approximately 10 ft; therefore, given that groundwater elevations can change with time and levels of recent precipitation, there is potential for waste in the burial cells to be located beneath the water table at SWMU 4.

The total volume of waste disposed of at SWMU 4 is unknown. Contaminants associated with this SWMU include radionuclides, heavy metals, solvents, volatile organic compounds (VOCs), and polychlorinated biphenyls (PCBs) (DOE 2007b). Trichloroethene (TCE) has migrated from SWMU 4 sources to the primary groundwater unit in the area, the Regional Gravel Aquifer (RGA); while all contaminants of concern (COCs) are addressed by the data gaps discussed in this SAP, TCE is the primary focus of three of the ten data gaps.

1.2 HISTORY OF EXISTING SWMU 4—RELATED SAMPLING AND DATA ACQUISITION

Previous source investigation work in and near SWMU 4 has included geophysical surveys, sampling of soils and groundwater, document research, and personnel interviews. The investigations of SWMU 4 include the Phase II Site Investigation (SI) (CH2M HILL 1992), the WAG 3 RI (DOE 2000a), the Data Gaps Investigation (DOE 2000b), and the Southwest Plume SI (DOE 2007b). The BGOU RI (DOE 2010a) summarizes the results from the previous investigations and uses these results to complete human health risk assessment and modeling of contaminant migration to the RGA.

In addition to the reports of previous investigations, the following documents provide historical context to plant operations and practices as they relate to on-site disposal of waste:

- *The Discard of Scrap Materials by Burial at the PGDP* (Union Carbide 1973);
- *The Disposal of Solid Waste at the PGDP* (Union Carbide 1978); and
- *Remedial Investigation Report for Waste Area Group 27 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1777/&D2 (DOE 1999).

Groundwater sampling conducted as part of the WAG 27 RI (DOE 1999) confirmed the existence of the Southwest Plume. Additional sampling during the Sitewide Evaluation for Source Areas Contributing to Off-Site Groundwater Contamination (commonly called “Data Gaps”) (DOE 2000b) and the WAG 3 RI (DOE 2000a) provided additional detail of the plume’s structure and identified a potential source at SWMU 4. Groundwater samples collected during the WAG 3 RI that were located below the primary burial cell, Cell 4, in SWMU 4, included 4 samples with concentrations greater than 10,000 µg/L TCE. Those samples were collected from borings 004-022, 004-024, 004-027, and 004-033 and are shown in Figure 3.

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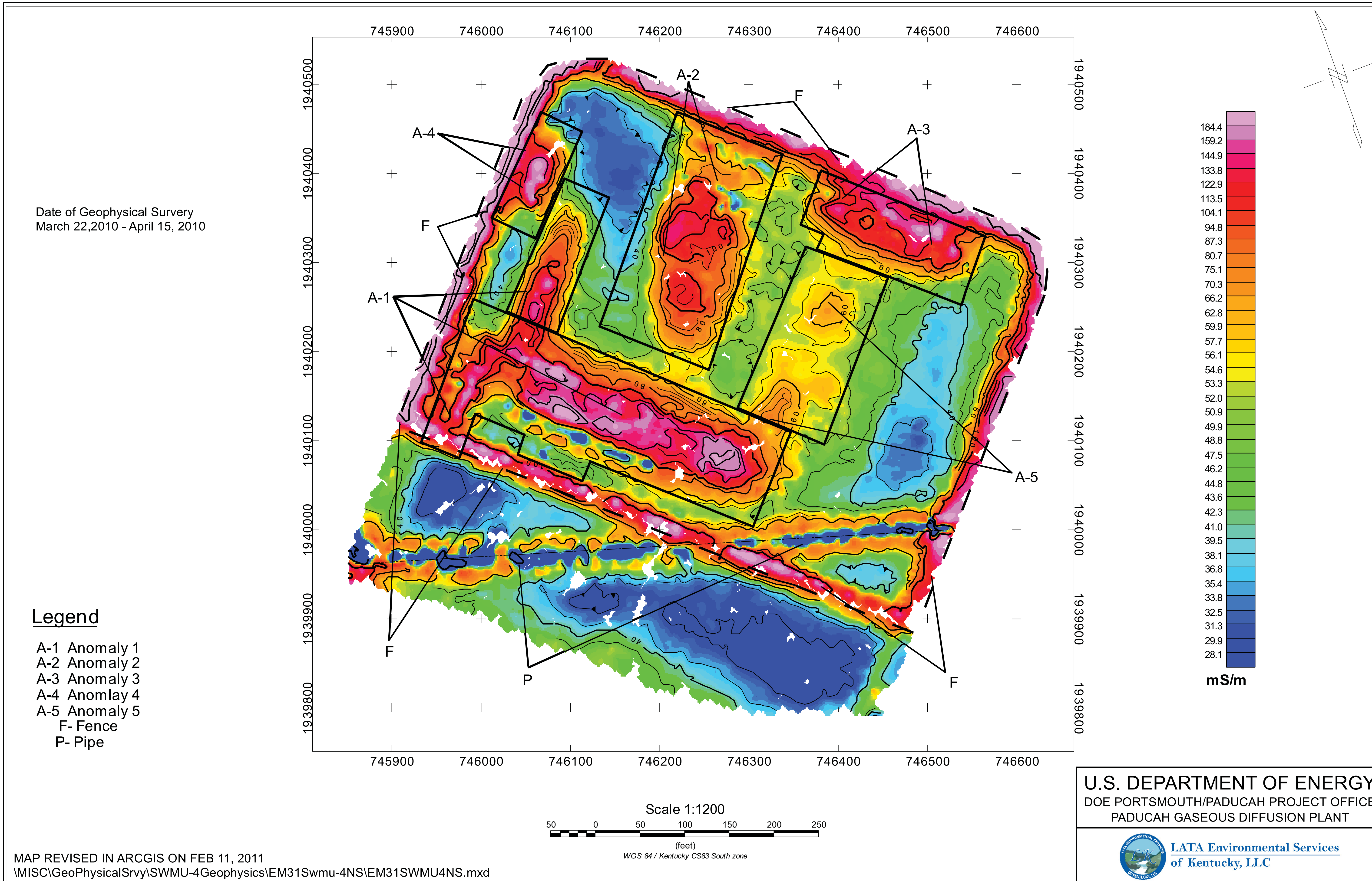

Figure 2. SWMU 4 EM31 Vertical Mode, Conductivity Component North-South Survey Lines

(Figure oriented to true north, not plant north.)

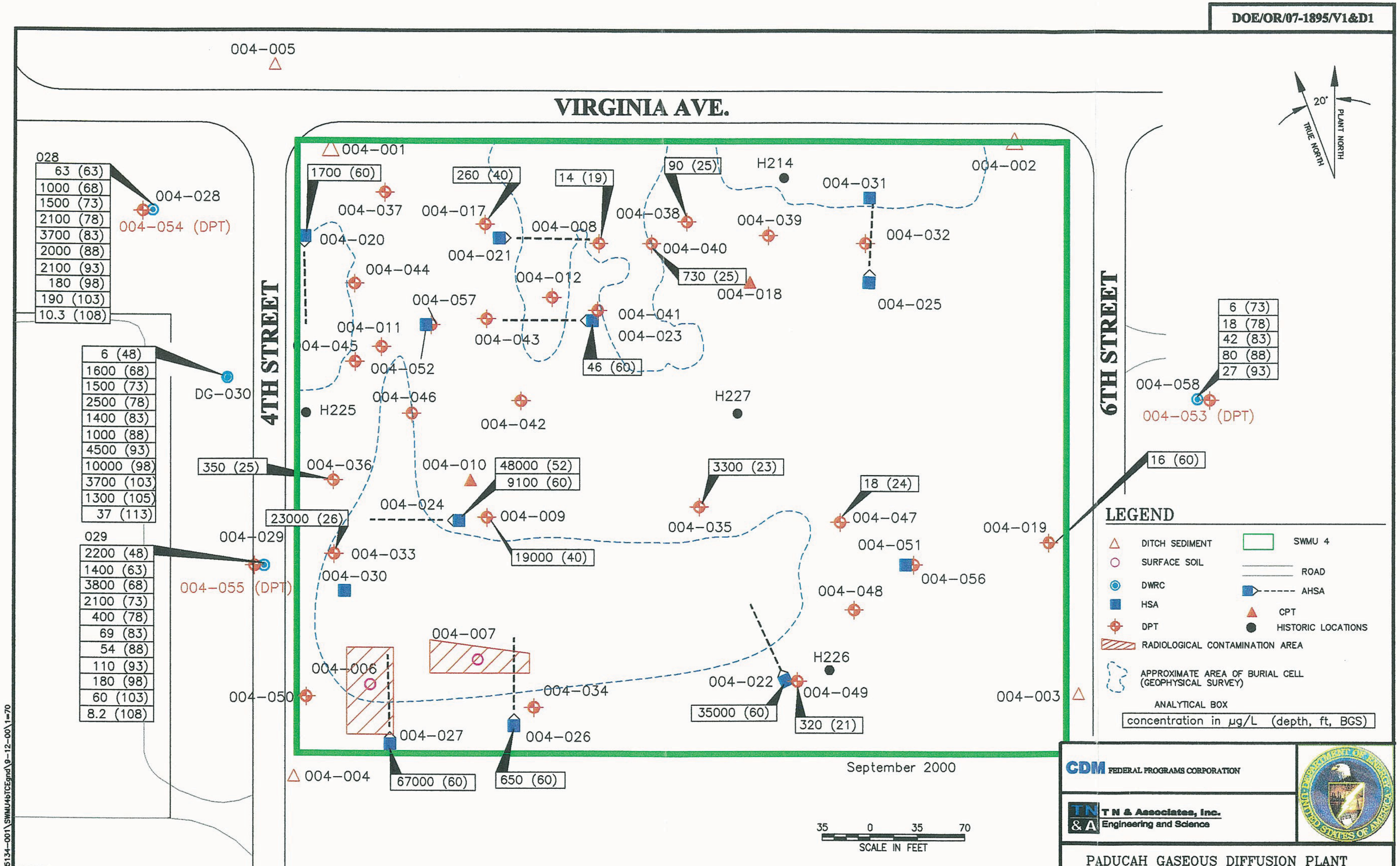

Figure 3. TCE in Groundwater at SWMU 4 Collected during the WAG 3 RI

(Reprinted from the WAG 3 RI Report, Figure 4-10)

During 2008, a BGOU RI was conducted. At that time of the BGOU RI Work Plan scoping meetings, it was concluded that sufficient analytical data existed to support decision making for SWMU 4; therefore, no new samples were acquired from SWMU 4 as part of the RI.

1.3 EVALUATION OF A REMOVAL ACTION

Although included as part of the BGOU RI/FS, DOE evaluated the potential for applying a removal action to the SWMU 4 waste, as described in the Draft *Engineering Evaluation/Cost Analysis for the C-747 Burial Yard and C-748-B Burial Area (Solid Waste Management Unit 4) at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/LX/07-0335&D1 (DOE 2010b). This removal action anticipated removing buried wastes from SWMU 4 to allow for a remedial action consisting of treatment by electrical resistance heating (ERH) of the TCE present beneath the burial cells in SWMU 4. These actions were evaluated because SWMU 4 is a known source of TCE migration to the Southwest Plume. In the same time period, TCE in the C-400 area at PGDP was being remediated using ERH; therefore, it was presumed that ERH would be a suitable remedy at SWMU 4. In order for ERH to be effective, the metallic debris in the disposal cells and other areas of SWMU 4 would need to be removed. Consequently, it was assumed that the removal action at SWMU 4 would encompass excavation of the buried metallic and associated wastes to a depth of up to 20 ft.

As the BGOU RI/FS process continued, so did the ERH project at the C-400 facility at PGDP. Two lessons were learned from that project that impacted the evaluation of ERH’s application at SWMU 4. First, the cost-effectiveness of an ERH remedy is less sensitive to TCE concentration than to the volume of contaminated soil (i.e., the area to be treated, not the TCE concentration, is the primary influence on cost). Review of the SWMU 4 information identified an uncertainty in the mass of the TCE due in part to the relatively few data points collected from the burial cells. It was concluded that there may be alternatives that are more cost-effective for treating small masses of TCE, and a better estimation of the mass of TCE was needed to support an evaluation of the suitability of ERH as a remedy for SWMU 4. The second lesson from the C-400 project was that ERH is much less cost effective in the RGA than in the Upper Continental Recharge System (UCRS). This emphasized the need to determine if TCE treatment in the RGA would be required; additional sample points are needed to make this determination. As a result of these developments, the Engineering Evaluation/Cost Analysis discussed in the previous paragraph was not submitted for an approval and the parties to the Federal Facility Agreement (FFA) agreed that the response action for SWMU 4 would follow the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Remedial Action process rather than the CERCLA Removal Action process.

Additional sampling would support characterization of potentially-generated wastes, should excavation alternatives be selected for any portion of SWMU 4. The review of the historical data indicated that the higher concentrations of TCE were found to be associated with Burial Cell 4. This finding, if confirmed, may allow for a treatment alternative that targets only portions of SWMU 4.

In 2010, a second geophysical survey also was conducted at SWMU 4. Results of this survey are further discussed in subsequent sections and in the Appendix. These results were used to support development of this SAP.

In January 2011, representatives from DOE, EPA, and the Commonwealth of Kentucky met to discuss SWMU 4 project-related data gaps and associated data quality objectives (DQOs) for a sampling and analysis program to be conducted. Section 4 of this document presents these data gaps and DQOs. Chapter 5 of the document discusses the FSP that has been developed to address the data gaps and DQOs.

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2. REVIEW OF EXISTING DATA

Data relevant to SWMU 4 have been collected in several investigations including the following:

- Phase II SI;
- WAG 3 RI;
- WAG 27 RI;
- Data Gaps;
- Southwest Plume SI; and
- Geophysical Survey of SWMU 4.

Additional data relevant to SWMU 4 have been collected as part of the environmental monitoring program for the site and reported in the *Trichloroethene and Technetium-99 Groundwater Contamination in the Regional Gravel Aquifer for Calendar Year 2010 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, PAD/ENR/0130, (DOE 2011a) and other documents, including groundwater data for wells located around SWMU 4 and a potentiometric surface map generated from synoptic water level measurements collected in December 2010 and January 2011.

2.1 WAG 3 INVESTIGATION

The WAG 3 Investigation included results of soil and groundwater sampling performed around the perimeter of the SWMU 4 disposal cells; however, relatively little data exist from samples taken from within the cells themselves. Figure 4 displays the sampling locations from the WAG 3 investigation. Information from the diagonal borings advanced beneath the burial zones indicates the presence of TCE and other COCs at depth in the UCRS; however, relatively few of the samples have TCE concentrations greater than 1 mg/kg. There are only 12 sets of soil samples (out of 200+ sample locations) with TCE concentrations greater than 1 mg/kg. Only 3 locations had a reported concentration greater than 10 mg/kg, with a maximum reported soil concentration of 41 mg/kg; the soil screen level for groundwater protection [soil screening level (SSL) 20] in the Risk Methods document is 3.31 E-04 mg/kg, calculated using PGDP no action values.

The WAG 3 RI documented that likely there are multiple sources of TCE in SWMU 4; however, there is no evidence of large, contiguous source(s) of TCE. This finding is accompanied by an uncertainty due to the fact that there were few samples taken directly from the cells. The samples that were collected beneath the cells were obtained from diagonal borings; thus, these samples could not be obtained immediately below the cells.

During the WAG 3 investigation, four primary subsurface buried waste cells were identified based on the geophysical investigation of the SWMU. The geophysical investigation also identified other smaller metallic anomalies in the subsurface not associated with the four primary cells. A 2010 geophysical survey confirmed the general location of the previously determined four burial cells. Additionally, a potential fifth burial cell also was delineated (Figure 2). The geophysical response from wastes/disturbed soils buried in the fifth cell indicates this anomaly is well pronounced only in the electromagnetometer (EM) 31 conductivity mode and not in the in-phase mode; this could indicate that there are high conductive soils (55 mS/m to 65 mS/m) in comparison to background values ranging from 32 mS/m to 50 mS/m. Since the EM61 data for all three time gates indicate there are some anomalous high responses that are not well defined, it may indicate that there is buried metal, but at deeper depths, or something other than metal is buried below the ground surface. Nevertheless, this SAP is being developed to incorporate

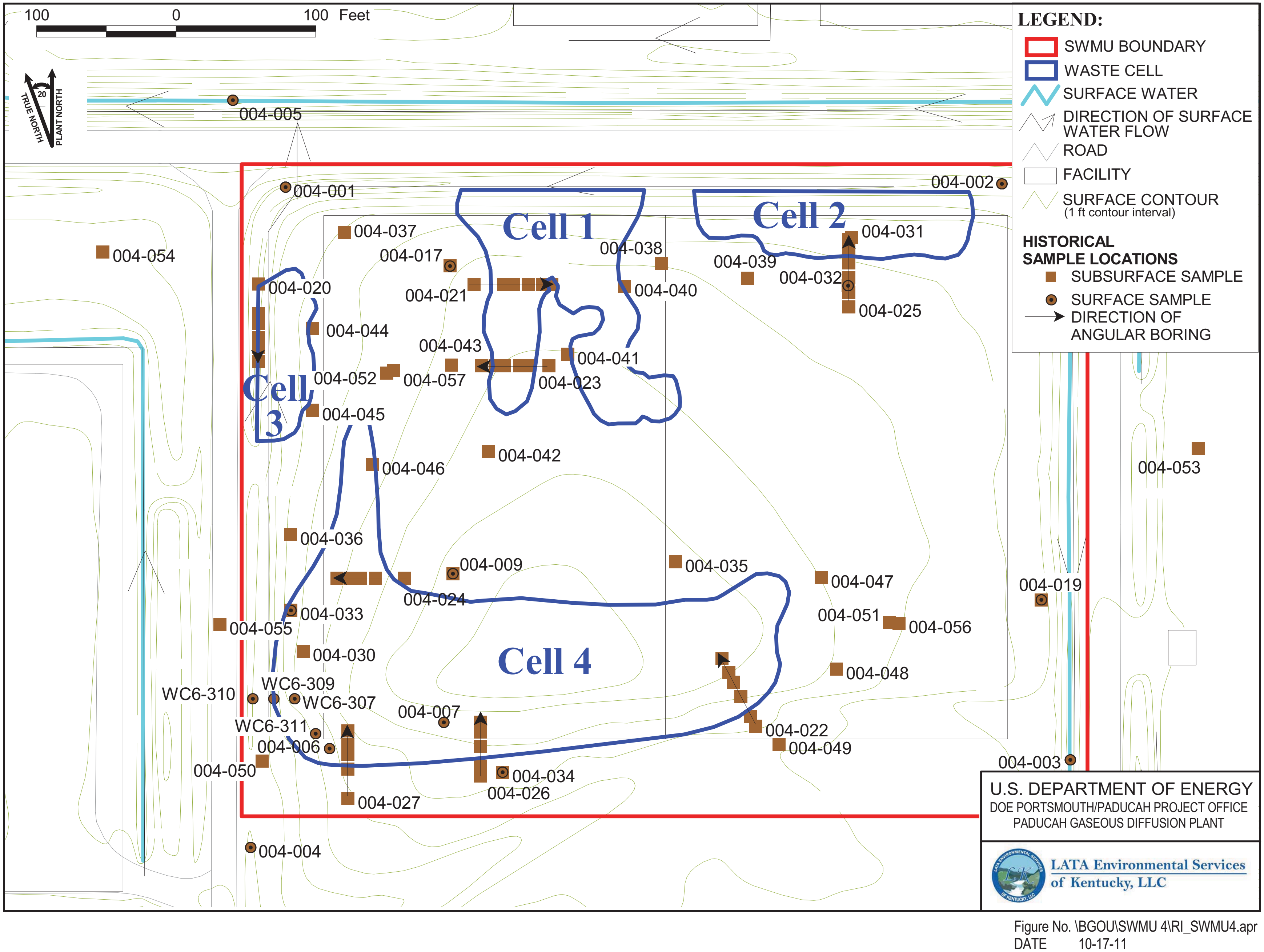

Figure 4. WAG 3 RI Sampling Locations at SWMU 4

(Note: Waste Cell Boundaries Based on 2001 Geophysical Information) the results of this potential fifth cell. The Appendix presents a draft of the 2010 geophysical survey report. Figure 4 and Figure 5 present the approximate areas of the five primary cells based on geophysical interpretations and also delineates the administrative boundary of SWMU 4.

The WAG 3 RI Work Plan indicates that SWMU 4 may have received sludges designated for disposal at the C-404 Burial Ground (DOE 1998a). The source(s) of these sludges is unknown, but according to the WAG 3 RI, the sludges potentially included uranium-contaminated solid waste and Tc-99-contaminated magnesium fluoride.

The WAG 3 investigation indicated that soils within SWMU 4 (and within the disposal cells) contained some contamination from PCBs, radionuclides, and VOCs, with the primary VOC being TCE and its degradation products. The principal mobile contaminant was TCE. Samples were taken from the compacted clay cover and the compacted soil cover material, as well as at depths ranging to 30 to 60 ft bgs. Soil and groundwater samples collected during WAG 3 RI indicate that the southern burial cell, defined by geophysical surveys as an area measuring approximately 100 x 350 ft (and 15 ft deep), is a source of TCE and its degradation products. Significant levels of several PCB Aroclors (PCB-1260, -1248, -1254, and -1016) were encountered at depths between 3 and 11 ft bgs. Concentrations ranged up to 27,000 µg/kg and were scattered throughout the SWMU (Figure 6). Significant levels of volatile organic analytes (VOAs) were encountered during the WAG 3 investigation at depths ranging from 25 ft to greater than 50 ft. Major contaminants included TCE, vinyl chloride, and *cis*-1, 2-dichlorothene (DCE). In general, the concentrations of these contaminants increased with depth and were most prevalent in angled hollow stem auger (HSA) borings under the burial cell 4. The TCE contamination in subsurface soils at SWMU 4 is depicted in Figure 7. The WAG 3 investigation also revealed concentrations of several semivolatile organic analytes (SVOAs) that were detected in subsurface soils collected from SWMU 4.

The WAG 3 investigation revealed that TCE existed in detectable concentrations in UCRS groundwater at SWMU 4. Major contaminants included TCE and its degradation products. TCE was detected at levels significantly above the analytical reporting limits in 13 borings. The shallowest depth at which TCE was detected was 21 ft bgs; the detectable concentrations continued to the base of the UCRS. TCE was detected in the RGA groundwater samples collected during the WAG 3 RI. The depths at which TCE was detected ranged from 60 to 113 ft bgs, as shown in Figure 8.

During the course of the WAG 3 RI, from March through October 1999, while a subcontractor was collecting a water sample, a worker noticed an odor coming from the augers. The area was evacuated and the safety officer took readings of the borehole using an organic vapor monitor (OVM). The OVM reading was 2,009 ppm.

During the evacuation of the area, the worker felt dizzy and weak. The field crew assisted the worker in the removal of his personal protective equipment (PPE), and he was monitored for radiation contamination. The worker was transported to the PGDP C-200 First Aid station and then to Western Baptist Hospital in Paducah, KY, where he was treated and released to regular duty the same day. The boring was closed later in the day by PGDP Emergency Squad personnel wearing Level B PPE. Several days later, the boring was reopened by personnel wearing level B PPE and readings were taken that indicated the presence of volatile organics in the breathing zone. The groundwater sample collected from that well indicated the presence of TCE, *cis*-1,2-DCE, with trace amounts of vinyl chloride and chloroform. Air samples collected from within the borehole indicated concentrations of the same organics; carbon tetrachloride and 4-methyl-2-pentanone also were detected. As a result of the conditions observed during this event, the PPE requirements were upgraded.

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Figure 5. Revised Interpretation of SWMU 4 Primary Burial Cells

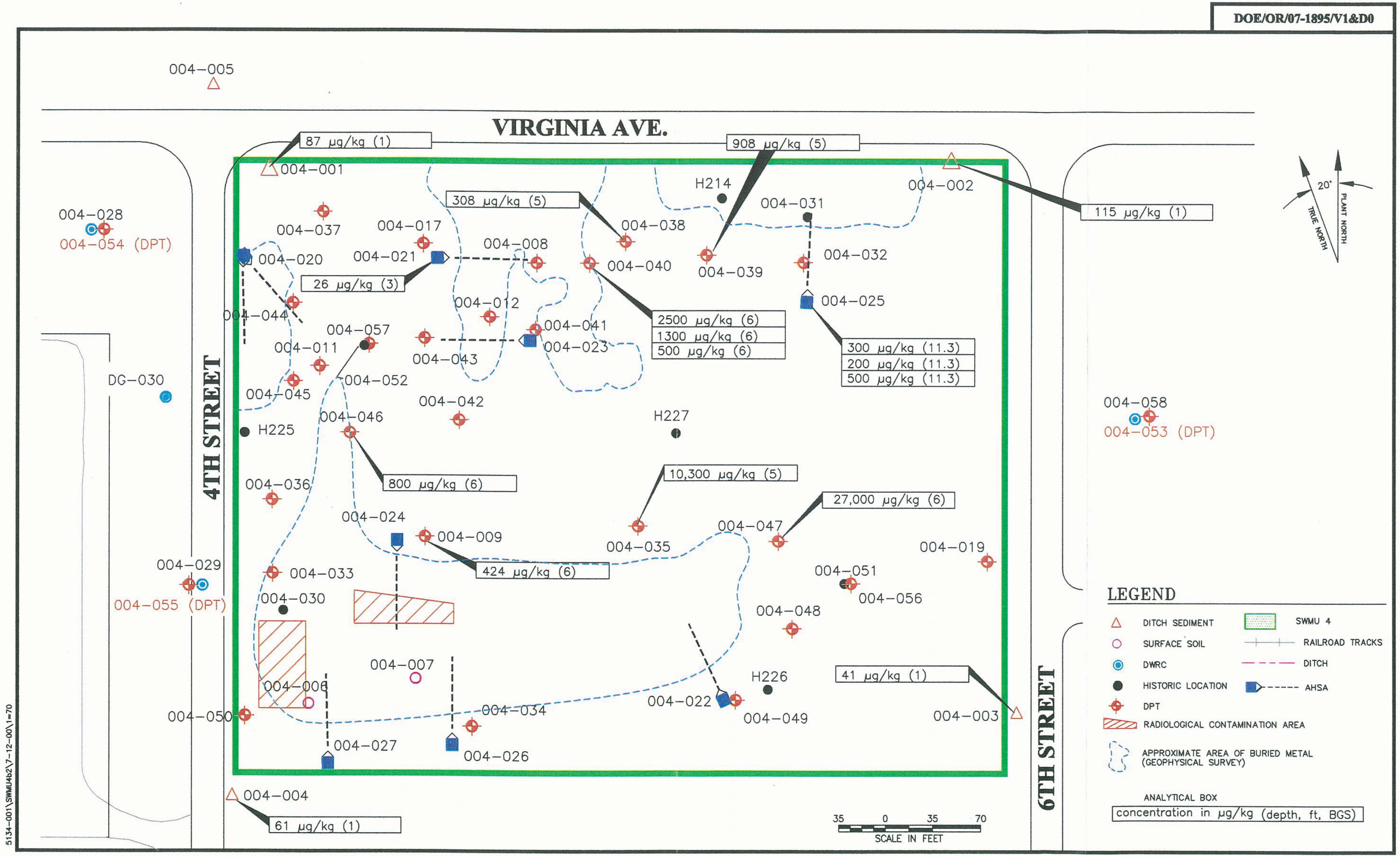

Figure 6. PCBs in Subsurface Soil at SWMU 4

(Reprinted from the WAG 3 RI Report)

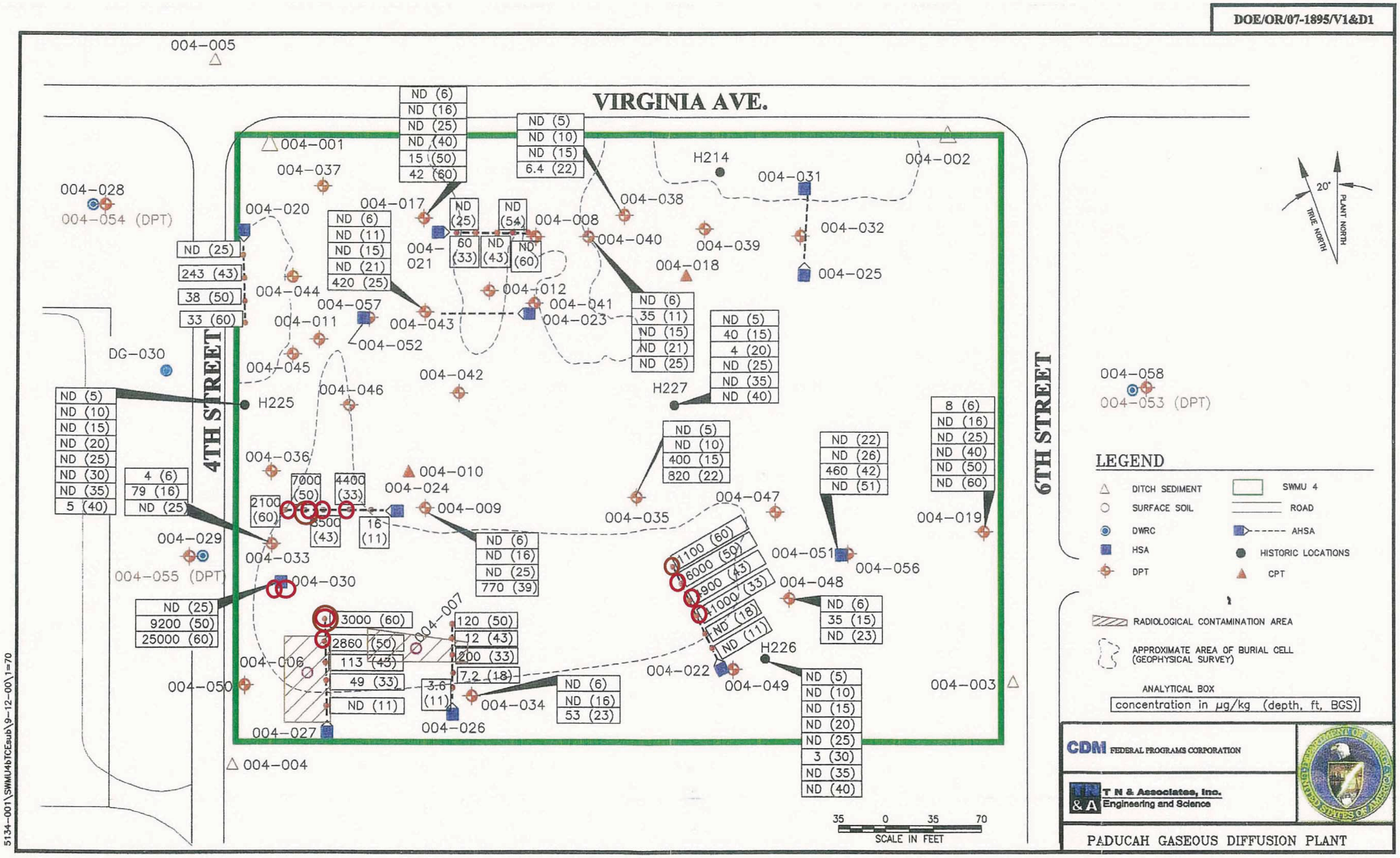

Figure 7. TCE Concentrations in RGA Groundwater from Temporary Boring Samples near SWMU 4

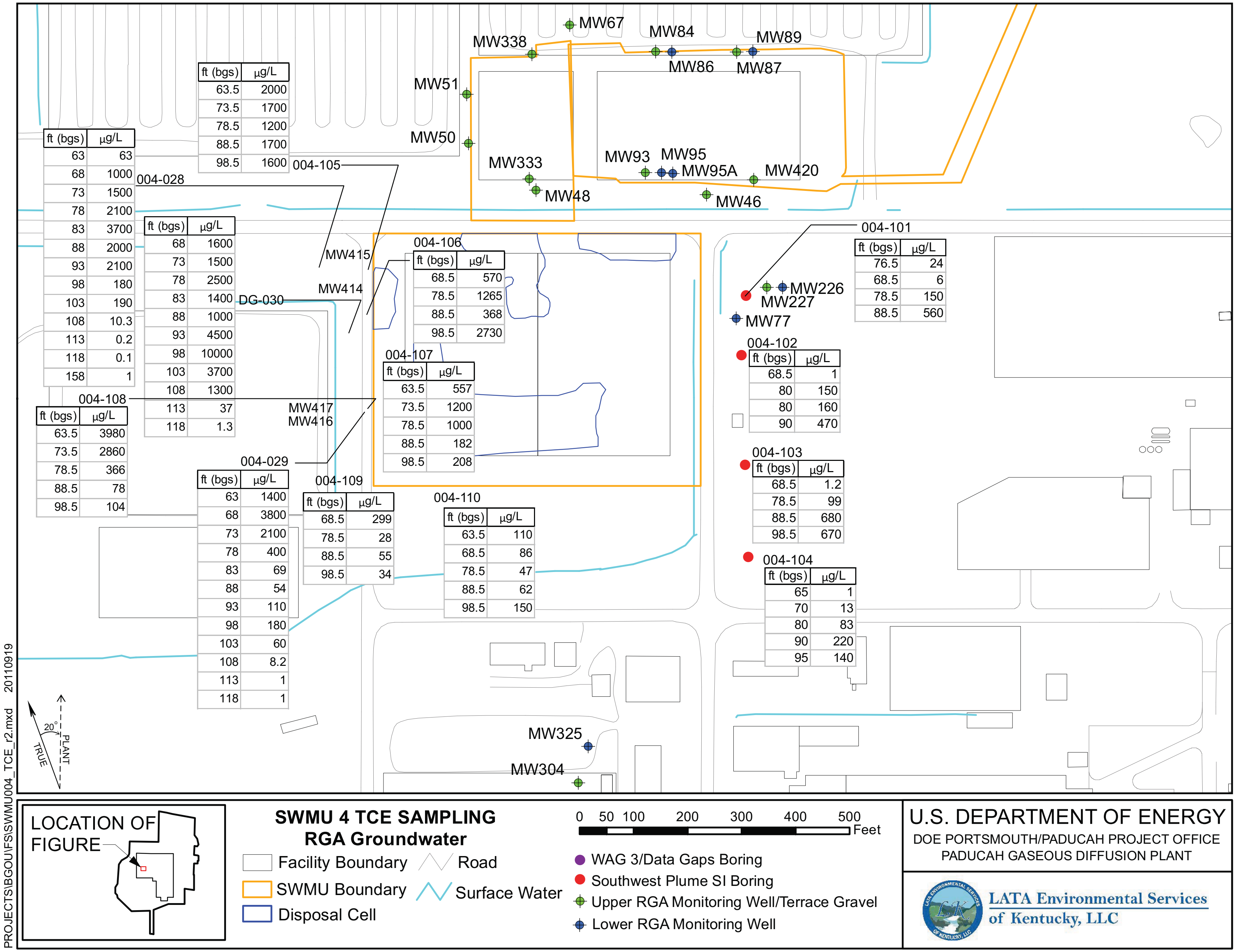

Figure 8. TCE Distribution in Temporary Borings in the Vicinity of SWMU 4

The WAG 3 investigation also advanced a limited number of borings (four to five) into the disposal cells; only one of these detected TCE (location 004-033, 0.079 mg/kg). Of the 40 samples collected from the top 20 ft in SWMU 4, only one (outside a burial cell) had a TCE concentration above 0.080 mg/kg; however, the samples taken from the UCRS matrix below the disposal cells indicated TCE at depth. Most of the highest concentrations were found near the bottom of the UCRS unit, which is approximately 60 ft to 65 ft bgs at SWMU 4 (Figure 7).

The WAG 3 data are summarized on Figure 7, which presents the TCE concentrations found in groundwater from the boring program supplemented with the approximate locations of the groundwater samples with concentrations that indicate a TCE source/dense nonaqueous-phase liquid (DNAPL) (> 10,000 µg/L). The concentrations in soil greater than 1 mg/kg are highlighted.

2.2 WAG 27, DATA GAPS, AND SOUTHWEST PLUME SITE INVESTIGATIONS

The WAG 27 and Data Gaps investigations provided indications of the presence of a Southwest Plume. The Southwest Plume was investigated further in the Southwest Plume SI. The SI presented data from all three investigations. The SI collected additional groundwater samples from temporary wells located along the east and west sides of SWMU 4.

The SI and WAG 3 information on groundwater concentrations in the RGA temporary borings is summarized in Figure 8. In response to these findings, two clusters of wells were installed along the west side of SWMU 4 at the locations with the highest found concentrations. The wells were installed west of SWMU 4 because that was thought to be the groundwater flow direction at the time. One well in each cluster is located at the top of the RGA and one at the bottom of the RGA.

2.3 RGA GROUNDWATER DATA FROM WELLS 414/415 AND 416/417

The WAG 27 and Data Gaps investigations provided indications of the presence of a Southwest Plume and resulted in the design and installation of two new RGA well clusters (co-located wells, one screened in the upper RGA and one screened in the lower RGA). From wells configured in this manner, one can determine the vertical profile of TCE concentration within the RGA. Once a vertical profile is established, inferences can be made about the location of the source of the TCE. Higher concentrations of TCE in the lower RGA are indicative of a DNAPL TCE source at the base of the RGA; higher concentrations of TCE in the upper RGA are indicative of a TCE source in the UCRS leaching downward into the RGA. The two well clusters (Wells 414/415 and 416/417) installed after the WAG 27 and Data Gaps investigations are located along the western edge of SWMU 4. The vertical profile of TCE in these wells is suggestive of a SWMU 4 UCRS source (i.e., the greatest TCE concentrations are in the upper RGA) (Figure 9). In addition, the maximum concentration of TCE identified in these wells is below the 1% effective water solubility limit (11,000 µg/L); the lower concentrations serve as an indication there is no RGA DNAPL in the area immediately upgradient.

2.4 RGA GROUNDWATER DATA/POTENTIOMETRIC SURFACE FROM ALL WELLS IN THE VICINITY OF SWMU 4

Recently, groundwater data from all wells in the vicinity of SWMU 4 have been combined with potentiometric surface information to support a review of the source(s) of TCE in the vicinity of SWMU 4. As discussed in Section 2.3, the vertical profile of TCE in the RGA suggests a high

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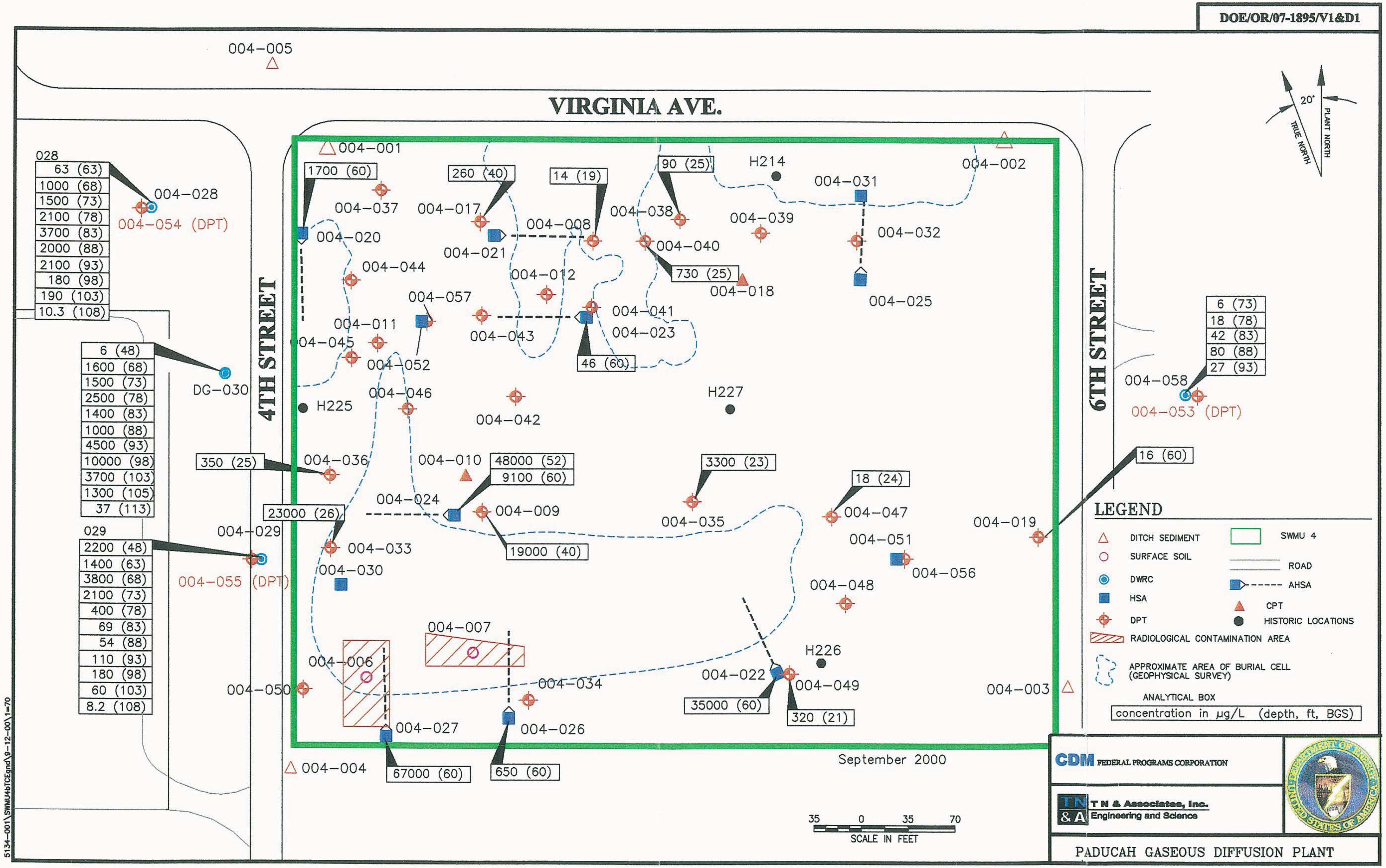

Figure 9. Groundwater TCE Concentrations

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concentration source in the UCRS rather than a DNAPL source at the base of the RGA. It appears that TCE from the UCRS at SWMU 4 migrates to the RGA and then moves downgradient in a north-northeast direction as shown in Figures 10 and 11. The potentiometric surface of the RGA beneath SWMU 4 is relatively flat, and precise flow direction is difficult to determine. Flow direction has been mapped in a range from west-northwest to north-northeast. The interpretation of flow direction depicted in Figure 11 is based on data collected as part of PGDP's Environmental Monitoring program, which is not conducted under CERCLA.

2.5 BASELINE RISK ASSESSMENT AND COCs

During the BGOU RI, the following COCs were identified for SWMU 4 based on quantitative risk and hazard results over all pathways relative to hazard benchmarks for land use scenarios of concern.[1] The benchmarks used for this comparison were (a) 0.1 for hazard index (HI) and (b) 1×10^{-6} for excess lifetime cancer risk (ELCR). Contaminants within a land use scenario of concern that exceeded these benchmarks were deemed COCs. The groundwater COCs are vinyl chloride, TCE, Tc-99 and *cis*-1,2-dichloroethene (DCE). The soil/waste COCs are listed below.

Barium	Uranium-234	Total PCBs	*cis*-1,2-DCE
Cadmium	Beryllium	Uranium-238	Manganese
Iron	Chromium	Vinyl chloride	Cesium-137
Uranium (metal)	Nickel	TCE	Uranium-235
Total dioxins/furans	Vanadium	Tc-99	

Although not a COC, uranium-235 was included based on information about isotopic ratios found in samples at PGDP. Potentially completed pathways resulting in the greatest threats are associated with ingestion of groundwater under unrestricted residential future use scenarios. In the absence of future residential use, there are but a few potential direct contact issues. Historical analysis has not indicated other constituents migrating from SWMU 4 at levels that cause an exceedance of maximum contaminant levels (MCLs) in the RGA.

[1] Land use scenarios of concern evaluated in the BGOU RI included current and future industrial workers; future outdoor workers; future residents within the SWMU 4 boundary; and future residents using groundwater drawn from the RGA at the boundary to the industrialized area and the DOE property boundary.

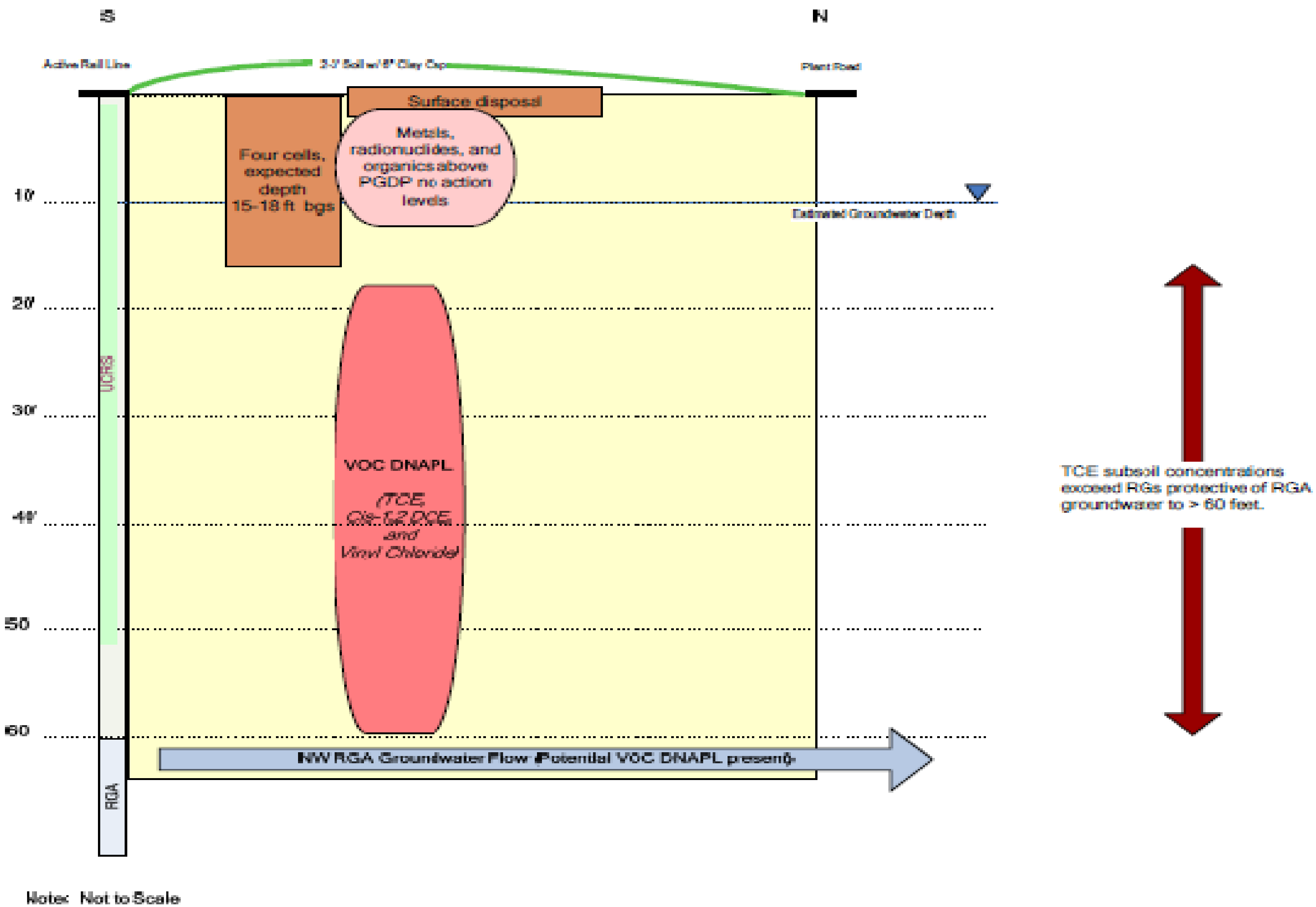

Figure 10. Conceptual Site Model for SWMU 4

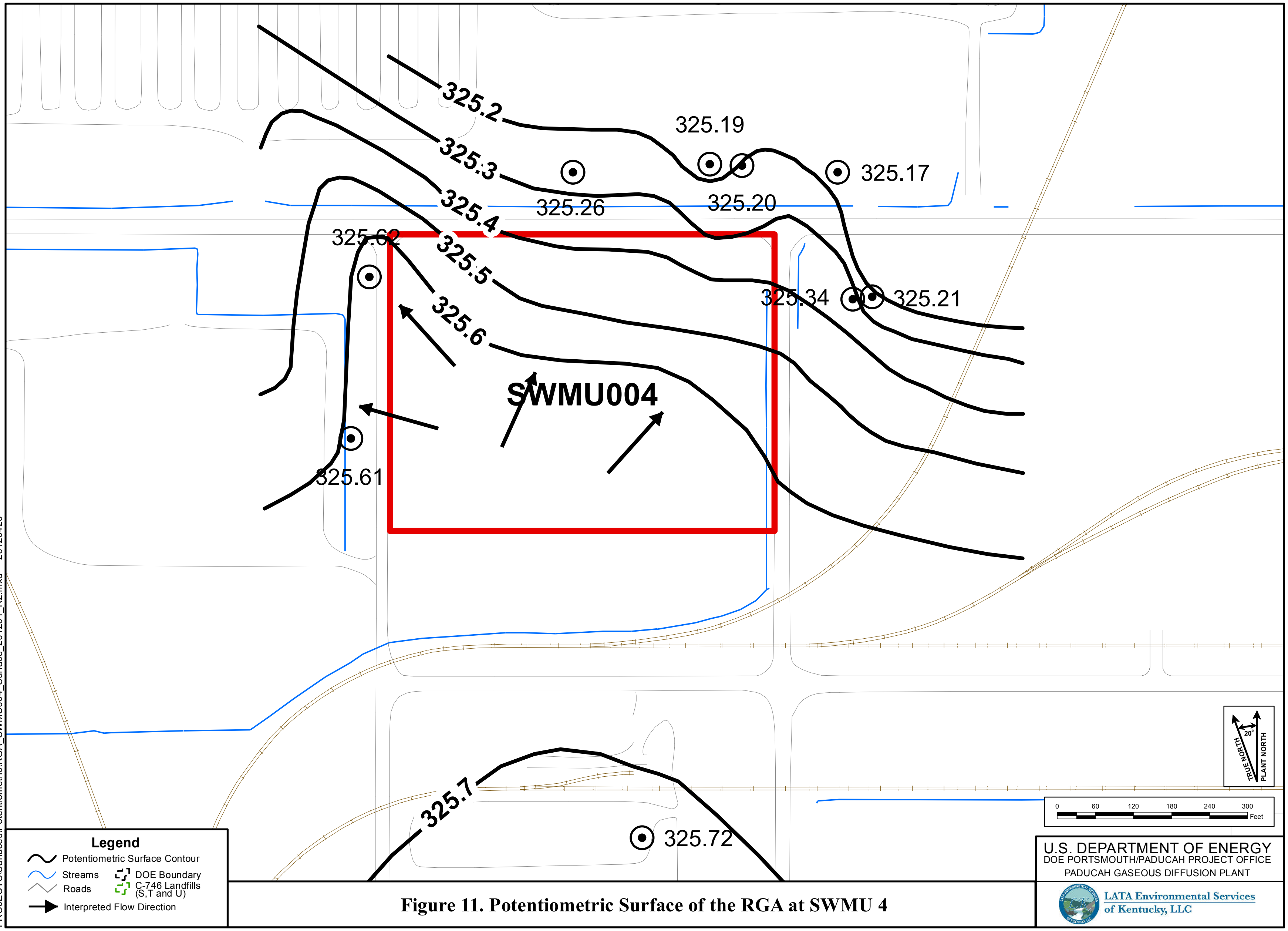

Figure 11. Potentiometric Surface of the RGA at SWMU 4

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3. CONCEPTUAL SITE MODEL

SWMU 4 consists of below ground burial cells in which various PGDP wastes have been placed and covered with soil. Incomplete soil coverage or cross-contamination between the waste and cover soil could result in contaminants from the waste being exposed at the ground surface. Once at the surface, the most likely pathway of contaminant migration would be surface water runoff (i.e., precipitation). Infiltration of water (i.e., precipitation) descending through the buried waste has mobilized contaminants within the waste resulting in contaminated subsurface soil. Additionally, TCE, a dense nonaqueous liquid, could migrate independently of infiltrating water and, like buried waste and contaminated soil, could serve as a source of contamination. Once mobilized by infiltrating water, the most likely pathway of contaminant migration would be downward through the UCRS soils, ultimately reaching the RGA (Figure 10). The potentiometric surface of the RGA beneath SWMU 4 is relatively flat, precise flow direction is difficult to determine. Flow direction has been mapped in a range from west northwest to north northeast. The interpretation of flow direction for this SAP and conceptual site model is seen in Figure 11. Some lateral movement of contaminants could occur in the UCRS, but these pathways are known to be limited. Based on this conceptual model, any contamination resulting from buried waste found at SWMU 4 would be expected to be found concentrated in the soils and groundwater of the UCRS immediately within and under the burial cells and landfills, with little lateral dispersion of contamination in the UCRS from the cells and immediately adjacent soils. The RI Report provides an assessment of analytical data that have been collected in and adjacent to SWMU 4 to evaluate the nature and extent of contamination (vertical and lateral) associated with the BGOU SWMUs.

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4. DATA GAPS

The existing collective data set is sufficient to support an excavation alternative for all the buried materials and associated contaminated soils at SWMU 4, but is not sufficient to optimize remedy selection or adequately support remedial design. Given the limited density of sampling locations in the disposal cells and the findings of TCE at depth in the UCRS underlying SWMU 4, additional investigation is needed to address uncertainties in the residual TCE present in the disposal cells or the underlying soils that may act as a continuing source to groundwater contamination.

In January 2011, DOE, LATA Kentucky, EPA, and the Commonwealth of Kentucky convened a meeting to discuss SWMU 4 project-related data gaps and associated DQOs for the sampling and analysis program to be conducted via this FSP. Table 1 presents these data gaps and DQOs, as well as a brief discussion of how fulfilling the DQOs may impact the evaluation of potential remediation alternatives at the SWMU. While the jointly identified data gaps specified TCE as the VOC of interest, this SAP includes sampling and analysis for a broader range of VOCs. Similarly, while the jointly identified data gaps and DQOs focus on burial cells and surrounding area within SWMU 4, the scope of this SAP is not arbitrarily confined to the administrative boundary of the SWMU.

The investigation approach to address these DQOs is further discussed in Section 5.

Table 1. SWMU 4 Additional Characterization Data Gaps and DQOs

	Data Gap/Problem Statement	Data Quality Objective
1.	There are insufficient data at SWMU 4 to determine whether TCE is present in each of the burial cells, and the extent and mass of TCE contamination with sufficient accuracy to effectively and efficiently complete a remedial design for a TCE remedy in the burial cells.	Collect sufficient quantity and quality of VOC sampling data from waste, soil, and water (depending on the depth of the water table) within the SWMU 4 identified burial cells to define the nature and extent of TCE source term in each burial cell. Data should be of sufficient quantity and quality to complete a remedial design for a TCE remedy in the burial cells.
2.	There are insufficient data at SWMU 4 to determine the extent and mass of TCE contamination with sufficient accuracy to effectively and efficiently complete a remedial design for TCE in the UCRS (i.e., soils from ground surface to the top of the RGA not identified as burial cells).	Collect sufficient quantity and quality of VOC sampling data from within the UCRS soil (and water where found) to define the nature and extent of TCE source term to complete a remedial design for a TCE remedy in the UCRS.

Table 1. SWMU 4 Additional Characterization Data Gaps and DQOs (Continued)

	Data Gap/Problem Statement	Data Quality Objective
3.	There are insufficient data at SWMU 4 to determine the extent and mass of TCE source term with sufficient accuracy to effectively and efficiently complete a remedial design for source term in the RGA.	Collect sufficient quantity and quality of VOC sampling data from RGA water to define the nature and extent of TCE source term to complete a remedial design for a TCE remedy in the RGA. Collect sufficient quantity and quality of VOC data from soil and water (where encountered) at the base of the UCRS to identify where VOC source term may have penetrated to the RGA. If a free-phase TCE source is determined to extend to the base of the RGA, collect sufficient quantity and quality of VOC data from soil at the interface with the McNairy to complete a remedial design for a TCE remedy in the RGA.
4.	There are insufficient data at SWMU 4 to determine with sufficient certainty whether COCs other than TCE in the five primary burial cells represent a migration risk to the RGA or principal threat waste (PTW).	Collect sufficient quantity and quality of sampling data to determine whether non-TCE COCs in the five identified primary burial cells represent PTW. Collect sufficient quantity and quality of sampling data to develop a waste acceptance criteria profile and sufficiently accurate cost estimate for excavation of burial cells and contaminated soils within the SWMU administrative boundary. Collect sufficient quantity and quality of sampling data for COCs other than TCE from waste, soil, and water within the burial cells to define the nature and extent of COCs above preliminary remediation goals (PRGs) protective of RGA groundwater and direct contact.
5.	There are insufficient data at SWMU 4 to determine the extent and mass of COCs other than TCE with sufficient accuracy to effectively and efficiently select and design a remedy for the UCRS (i.e., not burial cells or geophysical anomalies).	Collect sufficient quantity and quality of non-TCE COC sampling data from within the UCRS soil to define the nature and extent of COCs above PRGs protective of RGA groundwater and direct contact.

Table 1. SWMU 4 Additional Characterization Data Gaps and DQOs (Continued)

	Data Gap/Problem Statement	Data Quality Objective
6.	There are insufficient data at SWMU 4 to determine the extent and mass of COCs with sufficient accuracy to select and design a remedy for the geophysical anomalies identified in 1999 and 2010 geophysical surveys. Data should be of sufficient quantity and quality to determine whether COCs represent a migration risk to the RGA or PTW.	Collect sampling data for COCs from soil (and water, where found) within the geophysical anomalies identified in 1999 and 2010. Data should be of sufficient quantity and quality to define the nature and extent of COCs above PRGs protective of RGA groundwater and direct contact.
7.	The depth of the water table at SWMU 4 is uncertain. Specifically, is the buried material at SWMU 4 submerged in water?	Collect sufficient data to determine the depth of the water table at SWMU 4.
8.	It is uncertain whether the bedding materials surrounding the raw water pipe in the southeastern portion of the SWMU have been impacted by site constituents and act as a preferential pathway for migration outside of the SWMU.	Determine whether the bedding materials around the raw water pipe act as a preferential pathway for COCs at the SWMU.
9.	Hydraulic conductivity of the RGA under SWMU 4, as a measure of groundwater velocity and flow direction, is uncertain.	Collect sufficient quality and quantity of data to determine the RGA groundwater velocity and flow direction.
An additional data gap/problem statement was added during a September 2011 meeting held with parties from DOE, LATA Kentucky, EPA, and the Commonwealth of Kentucky.		
10.	There are insufficient data at SWMU 4 to determine the extent and mass of COCs in the surface soil within the SWMU 4 boundaries.	Collect sufficient quantity and quality of COC sampling data from within the surface soil to define the nature and extent of COCs above PRGs protective of direct contact.

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5. FIELD SAMPLING PLAN

This FSP describes how samples will be collected from the surface and subsurface at SWMU 4 and subsequently analyzed in order to help optimize the remedy selection. An understanding of the distribution of contaminants will support the development and evaluation of remediation alternatives.

5.1 SAMPLING MEDIA AND METHODS

Sampling of SWMU 4 will be conducted in a manner that addresses the ten data gaps and DQOs identified in Section 4 of this document. Five phases of investigation are identified in this FSP. Sections 5.1.1 through 5.1.5 each describes an investigation phase and links the phases to one or more data gaps.

5.1.1 Phase I—Passive Soil Gas and Surface Soil Sampling (0–1 ft)

Associated Data Gaps:

The desired outcome of this phase is to support closure of the following data gaps:

- #1—There are insufficient data at SWMU 4 to determine whether TCE is present in each of the burial cells, and the extent and mass of TCE contamination with sufficient accuracy to effectively and efficiently complete a remedial design for a TCE remedy in the burial cells.

- #8—It is uncertain whether the bedding materials surrounding the raw water pipe in the southeastern portion of the SWMU have been impacted by site constituents and act as a preferential pathway for migration outside of the SWMU.

Phase I sampling locations will close data gap #10:

- #10—There are insufficient data at SWMU 4 to determine the extent and mass of COCs in the surface soil within the SWMU 4 boundaries.

Investigative Approach:

Surface soil sampling

Surface soil samples will be collected at depths between 0 and 1 ft bgs with the use of a stainless-steel sampler, hand auger, spoon, trowel, spade, or scoop. Samples will be collected as five-point composites from 45-ft grids, as shown on Figure 12, resulting in 154 composite samples. Collection of the five points for each composite is shown in Figure 13. Unless otherwise noted, one grab sample will be collected from the center of the grid. Four additional grab samples will be collected 15 ft from the center point in each cardinal direction (north, south, east, and west). On alternating grids, grab samples will be collected from the center of the grid, and four additional grab samples will be collected 15 ft from the center point in each secondary direction (northeast, northwest, southeast, southwest).

Though not fully encompassing the entire SWMU, each sample point represents a 15 by 15 ft area (225 ft^2 or 25 yd^2). Should any individual sample point within the grid be obstructed, then the nearest possible location will be substituted. Grids will be positioned so that as much of the SWMU boundary is covered as possible or necessary.

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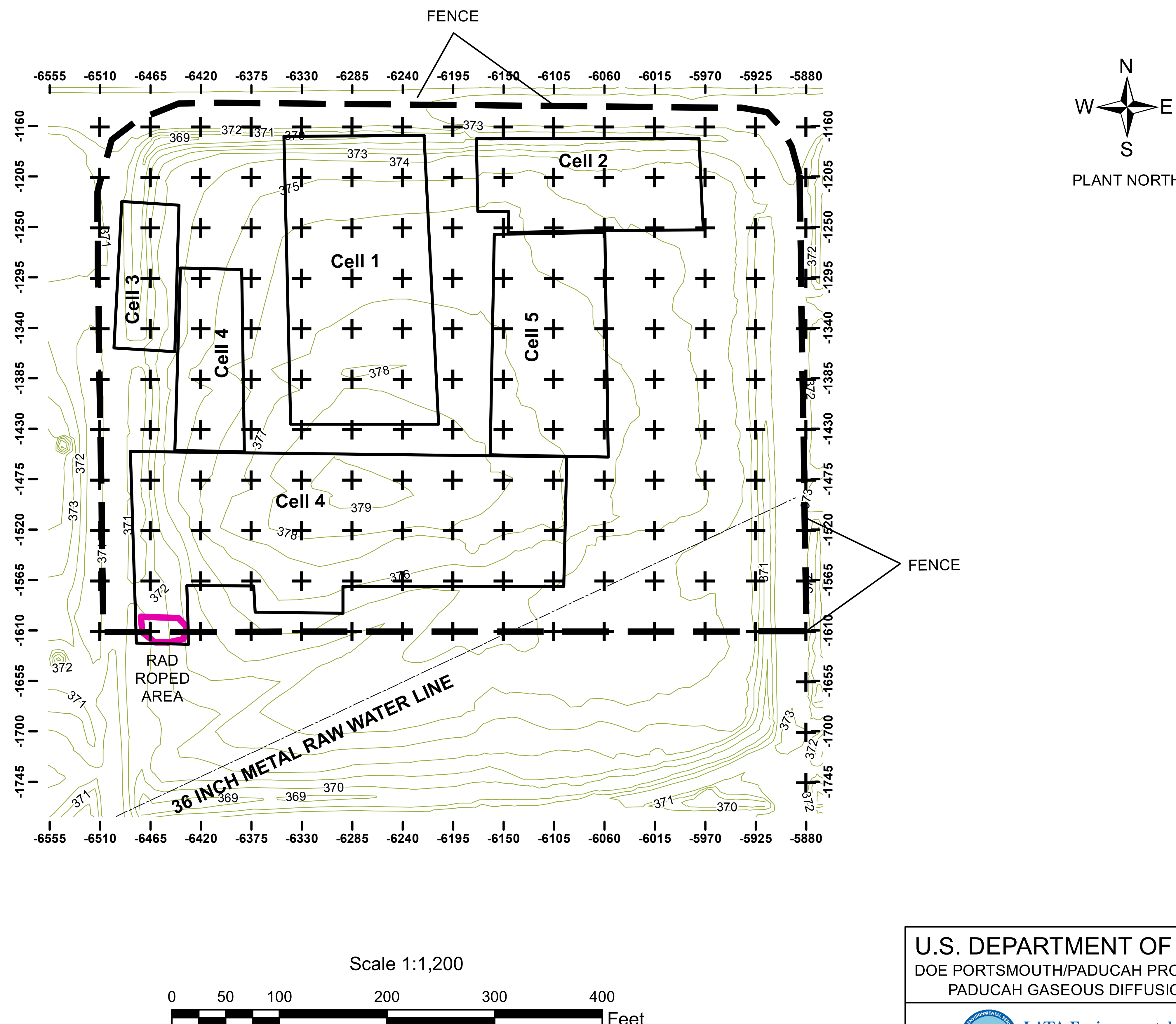

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

LATA Environmental Services of Kentucky, LLC

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Figure 12. Surface Soil Sampling Grid

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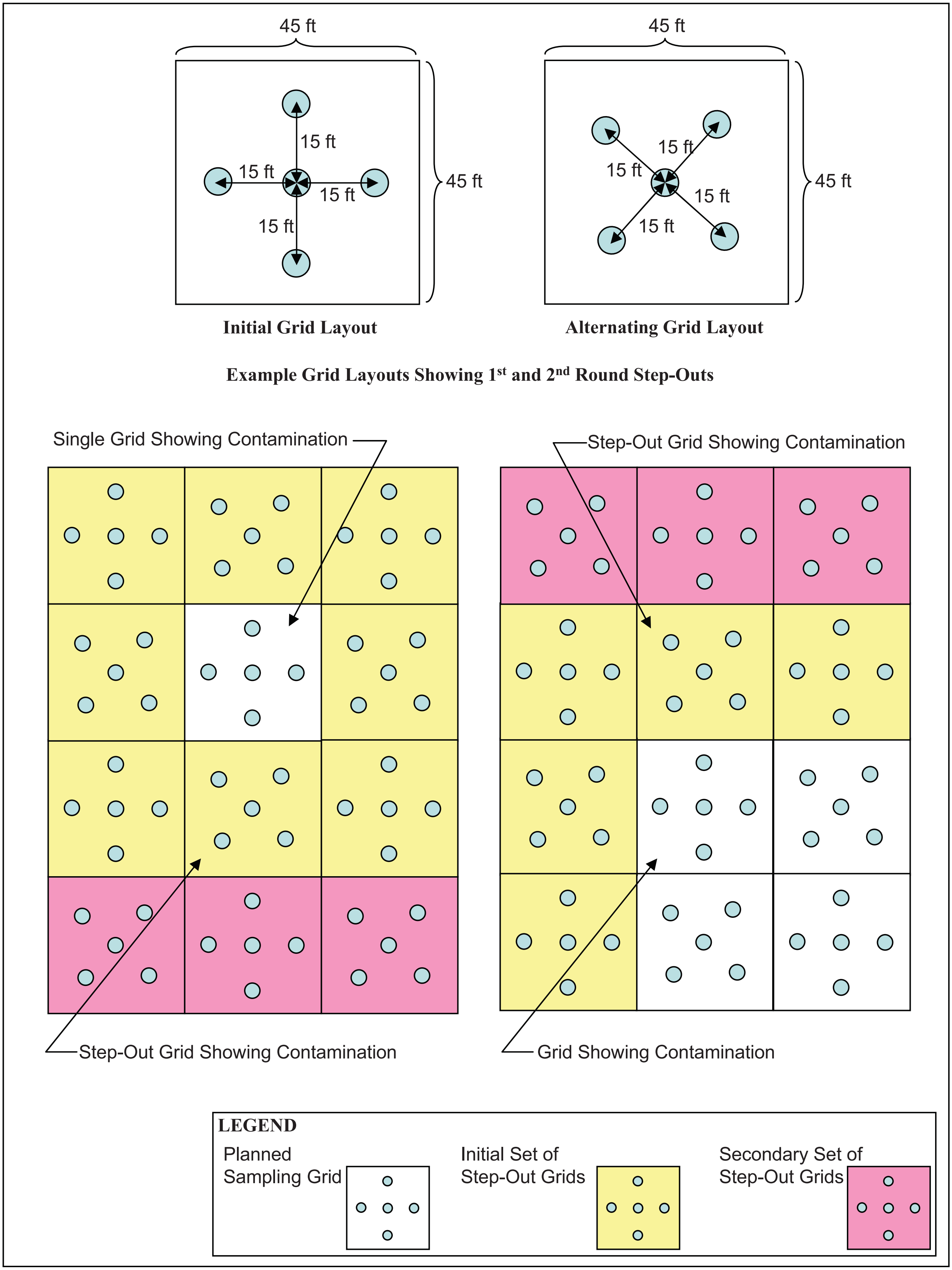

Figure 13. Grab Sample Locations within Each Composite Grid

Composite sampling provides an average of the contamination over the grid. Although individual hot spots within the grid may not be evident, the overall benefit of the grid coverage is to decrease the uncertainty of contaminant concentrations in the area.

The averaging of the soil concentrations potentially may lead to omitting chemicals of potential concern (COPCs) incorrectly from the unit because chemicals or radionuclides elevated only slightly above background at one or two spots may not have a concentration in the composite sample that exceeds background. This is unlikely to affect the list of COCs that requires remedial action because selection of COCs is based on a significant contribution to risk and/or hazard at the site from the exposure concentration (which is generally a 95% upper confidence limit of the mean concentration).

For compositing, equal volumes from each of the specified sampling location are obtained. The volume of each sample typically is at least the amount required for a single sample. Samples are thoroughly homogenized and a subsample is collected for analysis.

Due to the large number of samples required for the gridded sampling approach, the majority of the samples will be analyzed using field analytical instruments. Though the quantitation limits are higher for these instruments, the increased coverage of each unit decreases the uncertainty of the analytical precision. Trace constituents may not be determined throughout the unit, but major constituents are less likely to be missed. The industrial worker risk limits are used as the project action limit for SWMU 4.

Split samples and duplicates will be obtained from the composite, as necessary. Analyses for each composite sample will consist of field analysis of Resource Conservation and Recovery Act (RCRA) metals, plus uranium, by X-ray fluorescence (XRF) and Total PCB by PCB test kits. Ten percent of the samples will have fixed-base laboratory confirmation splits. These fixed-base laboratory samples will be selected randomly over all sample locations within the SWMU and be analyzed for all COCs, less VOCs.

For the purposes of this investigation, field duplicate and split samples are defined as follows:

- **Field Duplicate**—SW-846 defines a field duplicate sample as "independent samples which are collected as close as possible to the same point in space and time. They are two separate samples taken from the same source, stored in separate containers, and analyzed independently. These duplicates are useful in documenting the precision of the sampling process" (EPA 1994).

- **Split Sample**—Aliquots of sample taken from the same container and analyzed independently. These are usually taken after mixing or compositing and are used to document intra- or inter-laboratory precision (EPA 1994).

Field methods will include RCRA metals and uranium analysis by *ex situ* XRF using a Niton analyzer (or equivalent) at the SWMU and PCBs by Hach (or equivalent) immunoassay/colorimetric test kits at the SWMU. All samples will be field scanned for alpha, beta, and gamma activity using hand held instruments as part of preparations for transport and/or shipment.

To support field XRF analysis, three types of QC samples will be analyzed with each batch of 20 samples. These will include (1) blank, (2) duplicates, and (3) standard reference materials (SRMs). The XRF blanks will be vendor-provided. Three SRMs will be analyzed daily before use and at four-hour intervals to calibrate and to monitor XRF accuracy. The SRMs represent low [National Institute of Standards and Technology (NIST) 2709], moderate (NIST 2711), and high (NIST 2710) level standards for soil analysis for metals. In the event that readings of standards exceed +/- 20 % of the true value, the detector will be recalibrated, and standards will be reanalyzed according to manufacturer's instructions.

The PCB measurements are colorimetric in nature and result in semiquantitative results by employing a field grade photometer. As a result, calibration standards and calibration verification standards and blanks will be prepared weekly and stored in accordance with the procedure. To ensure PCB data can be evaluated fully, the system will be calibrated daily. Calibration standards and blanks will be analyzed daily or at the end of a sample group, whichever is more frequent, to monitor instrument drift during analysis. The calibration standards will be analyzed first, followed by the blank, and will follow the 20th natural sample analyzed or at the end of a group of samples, whichever is more frequent.

If other models, vendors, or contractor procedures are employed for field methods, the procedure for those operations will be added to the required reading for this FSP and the associated work package. All field methods shall be completed by a properly trained/qualified technician and those quantifiable (i.e., PCB test kits and XRF) will meet detection limits detailed in Section 6, QAPP Worksheets 15-E and 15-F.

Passive soil gas sampling

This first phase will utilize 65 passive soil gas samplers (modules) to identify areas within the SWMU that feature elevated VOC soil vapor readings. Passive gas soil samplers are being employed to obtain screening-level results. The passive gas samplers are quicker, easier, and less expensive to install than soil borings and are known, from past experience, to provide results of adequate quality for the data needs for this phase of the SWMU 4 effort. These elevated readings will indicate the presence of VOCs in soil, burial cells, or groundwater.

Forty-eight modules will be placed at the center of a 75 ft x 75 ft grid (except as noted below) in an impartial sampling program. A small roped-off area outside of SWMU 4 on the southwest corner potentially may be linked to SWMU 4; consequently, an additional grid and module will be placed over that area. Fourteen additional modules will be deployed above the burial cells: 10 above cell 4; 2 above cell 2; 1 above cell 1; and 1 above cell 5 (Figure 14). Historical data does not indicate a need for a biased location in Cell 3 or the vertical “leg” of Cell 4. The modules will be left in place for a period of time according to the manufacturer’s direction, after which they will be collected, placed in sample containers provided by the manufacturer, and shipped to the manufacturer’s laboratory for VOC analysis. The modules will be analyzed and a concentration map generated.

Two additional passive gas samplers will be installed to determine any effect the raw water line may be having on potential contaminant migration in the area. Placement of the gas samplers will be discussed with United States Enrichment Corporation (USEC) prior to installing them to ensure that enrichment operations are not jeopardized by placing them very near or above the line. Based on the discussion with USEC, the gas samplers will be placed as shown on Figure 14.

The modules will be installed using hand drilling tools to a depth below ground surface according to the manufacturer’s direction.

5.1.2 Phase II—Characterization of the Shallow Subsurface (1 to 20 ft)

<u>Associated Data Gaps:</u>

The desired outcome of this phase is to close the following data gaps:

- #1—There are insufficient data at SWMU 4 to determine whether TCE is present in each of the burial cells, and the extent and mass of TCE contamination with sufficient accuracy to effectively and efficiently complete a remedial design for a TCE remedy in the burial cells.

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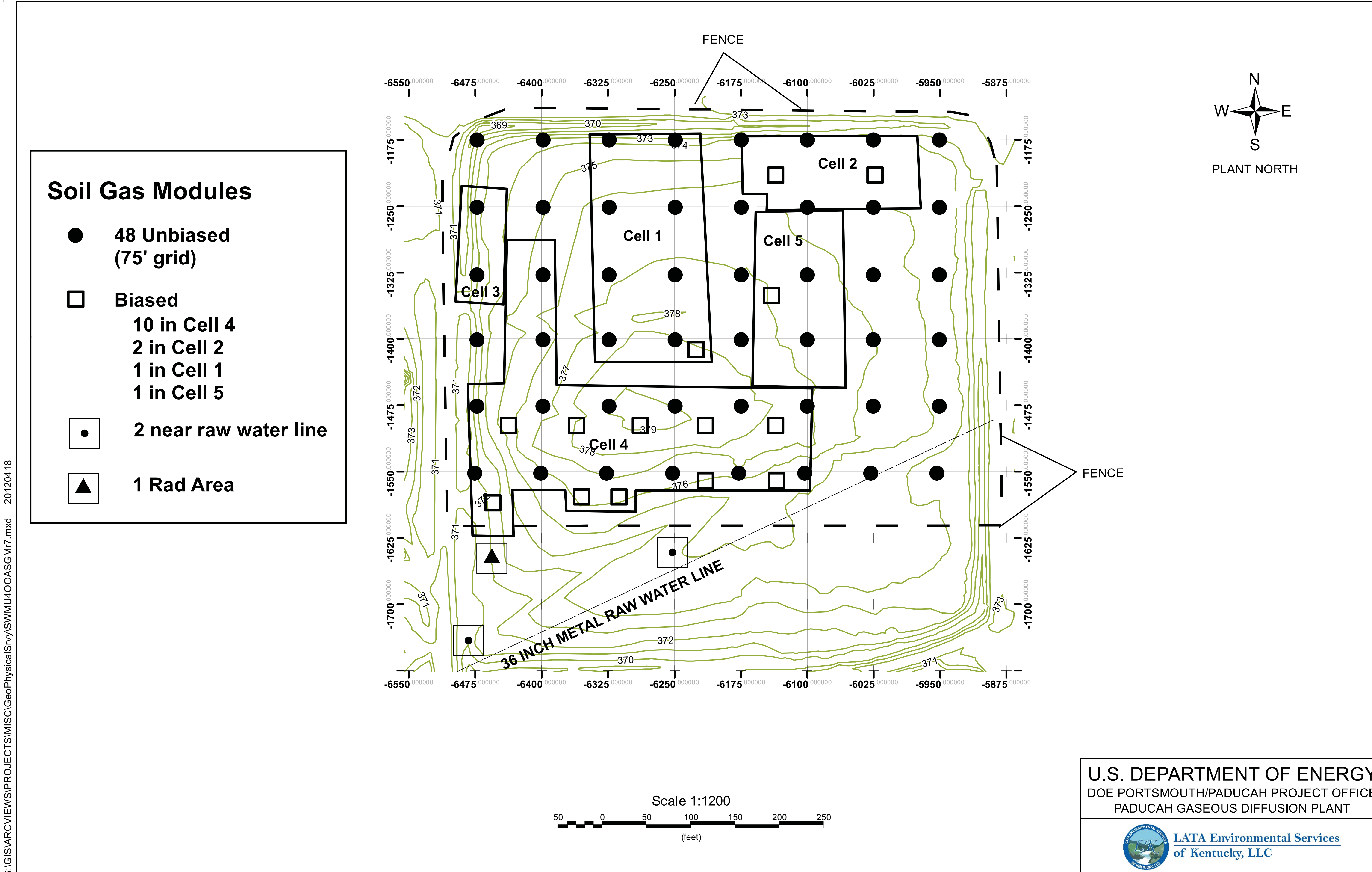

Figure 14. Passive Soil Gas Analyzer Locations

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- #4—There are insufficient data at SWMU 4 to determine with sufficient certainty whether COCs other than TCE in the five primary burial cells represent a migration risk to the RGA or PTW.

- #6—There are insufficient data at SWMU 4 to determine the extent and mass of COCs with sufficient accuracy to select and design a remedy for the geophysical anomalies identified in 1999 and 2010 geophysical surveys. Data should be of sufficient quantity and quality to determine whether COCs represent a migration risk to the RGA or PTW.

- #7—The depth of the water table at SWMU 4 is uncertain. Specifically, is the buried material at SWMU 4 submerged in water?

Another desired outcome of this phase is to support closure of data gap #8—It is uncertain whether the bedding materials surrounding the raw water pipe in the southeastern portion of the SWMU have been impacted by site constituents and act as a preferential pathway for migration outside of the SWMU.

Investigative Approach:

Twenty-two borings are anticipated to be advanced to a depth of 20 ft bgs, and they will be installed via direct push technology (DPT) under Phase II of the investigation. These borings will be sampled to identify VOCs and other COCs in burial cells and in the UCRS inter-burial cell areas of SWMU 4. Additionally, these borings will be utilized to observe UCRS water levels.

The location of the 22 soil borings will be selected as follows:

— Ten borings will be determined based on the results of the passive gas analyzer results (Figure 15). Borings will be located so that at least one boring is advanced through each of the burial cells;

— One boring will be located at 004-022, which was the highest historical sampling result at 41,000 µg/L;

— One boring will be located near the raw water line;

— An additional ten borings will be used for delineation of hot spots (TCE greater than 75 ppb). The location of the ten additional borings will be selected after consulting with the DOE Project Manager, who will consult with the regulatory agencies;

— If the extent of elevated TCE (> 75 ppb) is not bounded by these ten borings, then an additional eight will be placed at locations needed to make that determination after consultation with EPA and KDEP;

— If a total of 30 borings is exceeded, the FFA parties will convene to discuss the validity of the Conceptual Site Model.

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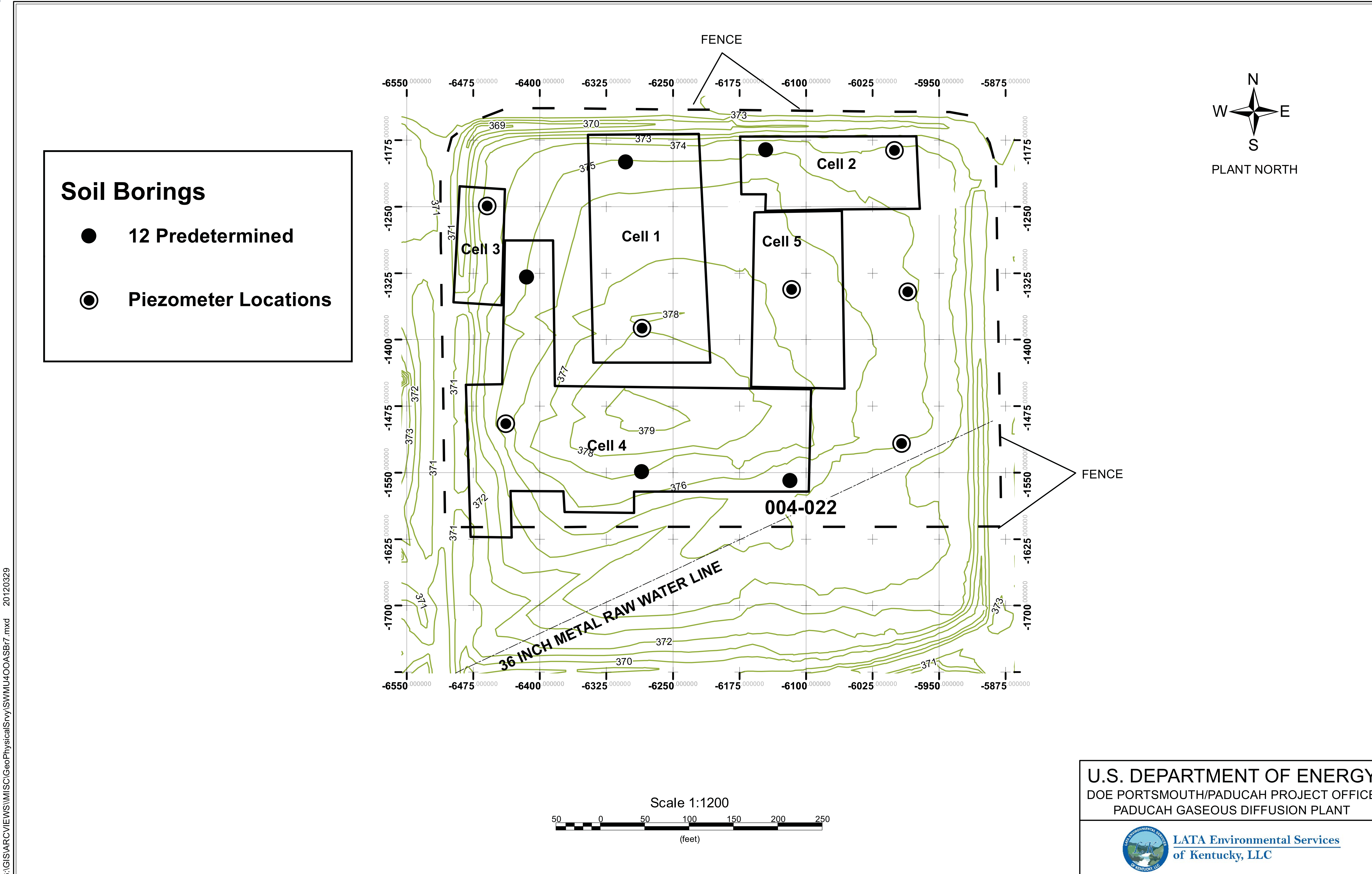

Figure 15. Soil Boring and Piezometer Locations

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Due to USEC operational concerns, it is not feasible to advance DPT borings within 15 ft of the raw water pipe. As described, the 150 ft by 150 ft sampling grid is oriented so that one of the systematic borings will be located between the raw water pipe and the nearest boundary of the southern burial cell.

Soil samples will be collected from every 5-ft interval below grade and sent to a fixed-base laboratory for analysis of VOCs and other COCs. One water sample will be collected from each boring that yields sufficiently. If sufficient water is available, samples will be collected for VOCs, PCBs, and SVOAs (in that order), but not for metals or radiological constituents. Soil samples from the same borehole will be available for metals and radiological constituent analysis.

Seven borings will be converted to piezometers to assist in determining the water table depth. The planned location of the piezometers is shown in Figure 15 and includes one in each of the five burial cells and two in undisturbed UCRS soils. Locations may require modification if it is determined that location will yield insufficient water. Water levels in the piezometers will be measured monthly for 12 months.

At least one test pit will be excavated in each of the five burial cells. There will be a minimum of one test pit in cells 1, 2, 3, and 5, and at least 2 in cell 4, due to its size, and the fact that cell 4 is known to have the highest VOC concentrations. Test pit locations will based on DPT refusals. The DPT refusal will be based on “final” refusal, after all “step outs.” If no DPT refusal is encountered in one or more of the cells, then the pit location will be selected after consulting with the DOE Project Manager, who will consult with the regulatory agencies. The test pits will be excavated using a hydraulic excavator or tractor backhoe at the first point of refusal. If there is no DPT refusal in a cell, then a location for the test pit will be determined based upon data obtained from the boring. Pit size will be approximately 5 ft wide by 10 ft long and as deep as 20 ft bgs. Depth adjustment may be required due to site conditions. Additional test pits may be excavated based on early results; see contingency investigations/decision rules below.

The pits will be backfilled as soon as possible, ideally within the same shift as they are opened. The spoil material will be replaced in the pits. Water will not be pumped from the pit. A maximum of six test pits will be excavated. Spoil piles not returned to the test pits during the same shift they are excavated (for example – due to quick onset of bad weather) will be covered and temporary silt fencing will be used around the perimeter of the piles to prevent releases of potentially contaminated materials prior to returning materials to the pit or transport to a treatment, storage, and disposal facility. Before returning spoils to test pits, a teleconference will be held with the FFA parties. The types of materials found and the appropriate path forward will be discussed, including disposition of the excavated materials.

Excavation of test pits is classified as a Phase II activity because of the depth interval in question; however, chronologically, the pits will be excavated at the end of the scheduled field activities (see Worksheet 16 of the QAPP). The excavations will present logistical complexities, including safety and security concerns and the necessity of mobilizing a separate field crew. These complexities could delay subsequent activities; therefore, the excavations have been scheduled so that there are no subsequent sampling activities.

It is recognized that excavating the test pits at the end of the fieldwork introduces an element of risk that data collected from the pit would have influenced where Phase II boring were installed. This scenario is addressed below in Contingency Investigations/Decision Rules.

<u>Contingency Investigations/Decision Rules</u>:

- Should the passive soil gas survey fail to identify any locations for judgmental sampling, the FFA parties will convene and discuss the appropriate path forward.

— One option to be considered in the event that the passive soil gas samplers do not identify locations for judgmental sampling is that borings will be placed at the locations of historic WAG 3 samples that indicated elevated levels of TCE. Those sample locations are 004-020, 004-021, 004-024, 004-026, 004-027, 004-030, 004-034, 004-035, 004-043, and 004-051. If the soil gas survey identifies between one and ten locations for judgmental sampling, then borings will be placed in those locations, with the balance coming from the historic WAG 3 locations to make up a total of 10 locations. The borings of interest and the order in which the co-located borings will be placed are as follows: 004-030, 004-024, 004-027, 004-035, 004-051, 004-043, 004-020, 004-026, 004-021, and 004-034.

- If water is encountered from borings, field personnel will record the elevation where encountered and collect 1 grab water sample from the base of each boring and send it to a fixed-base laboratory for VOC analysis. Borings that fail to yield sufficient water volume for VOC analysis within 60 minutes after reaching total depth will be not be sampled or converted to piezometers.

- Boring refusals and test pits:

— At least one test pit will be excavated in each of the 5 burial cells. There will be a minimum of one test pit in cells 1, 2, 3, and 5, and at least 2 in cell 4, due to its size and the fact that cell 4 is known to have the highest VOC concentrations.

Test pit locations will be based on DPT refusals. If no DPT refusal is encountered, then the location of the test pits will be selected after consulting with the DOE Project Manager, who will consult with the regulatory agencies.

— If DPT refusal is encountered, then relocate up to three times in any direction within a 5 ft radius of the original attempt. If a successful penetration is not made with a 5 ft radius, then make up to three additional attempts in the 5 to 10 ft radius. Continue in this manner (i.e., stepping out in 5 ft increments and making 3 attempts) until a successful penetration is achieved or until there are no additional untested locations remaining within the boundary of the cell.

— The depth of pits associated with DPT refusals will be to the base of visible debris or to a maximum of 20 ft bgs, whichever is less.

— The depth of pits not associated with DPT refusals will be 15 ft bgs unless debris is present, in which case, the excavation depth will be to the base of visible debris or to a maximum of 20 ft bgs.

— One soil sample will be collected from the base of each test pit. If the TCE concentration in the sample is greater than the tenth highest concentration in samples from the DPT borings (bottom samples), DOE will consult with the regulatory agencies to ascertain if additional borings are warranted or if the uncertainty can be managed.

— One water sample will be collected from the base of each test pit, if water is present.

— If an intact drum is encountered, the material inside the drum will be sampled; it will be removed only if it contains a mobile contaminant.

- If more than one intact drum is encountered in an excavation, these drums may be sampled at direction of the Prime Contractor Task Lead after consulting with the DOE Project Manager, who will consult with the regulatory agencies.

- Excavation of a test pit will be suspended if significant water inflow is detected (i.e., if water prevents observation of the base of the excavation).

5.1.3 Phase III—UCRS Sampling (20 to 58 ft)

Associated Data Gaps:

The desired outcome of this phase is to close the following data gaps:

- #2—There are insufficient data at SWMU 4 to determine the extent and mass of TCE contamination with sufficient accuracy to effectively and efficiently complete a remedial design for TCE in the UCRS (i.e., soils from ground surface to the top of the RGA not identified as burial cells).

- #5—There are insufficient data at SWMU 4 to determine the extent and mass of COCs other than TCE with sufficient accuracy to effectively and efficiently select and design a remedy for the UCRS (i.e., not burial cells or geophysical anomalies).

Investigative Approach:

Phase III of the investigation will focus on the UCRS at depths ranging from 20 ft bgs to the top of the RGA, expected to be approximately 58 ft bgs. Ten borings will be installed via DPT at the locations of the highest TCE results from Phase II borings (bottom samples). Soil samples will be collected from the borings at 10-ft depth intervals and sent to a fixed-base laboratory analysis. All samples will be analyzed for VOCs; additionally, the shallowest and the deepest sample from each borehole will be analyzed for other COCs.

Contingency Investigations/Decision Rules:

- If all 10 borings fall within the cells, two additional borings will be located outside the cells in order to close data gap #5. The two additional borings will be placed using results of earlier phases of the investigation and the geophysical survey so that the probability of not being in a burial cell is maximized. The location of the two additional borings will be selected after consulting with the DOE Project Manager, who will consult with the regulatory agencies.

- As a contingency measure, an additional four borings will be used for delineation of hot spots (TCE greater than 75 ppb). The location of the four additional borings will be selected after consulting with the DOE Project Manager, who will consult with the regulatory agencies. If the extent of elevated TCE (> 75 ppb) is not bounded by these four borings, then the FFA parties will convene to discuss the validity of the Conceptual Site Model.

5.1.4 Phase IV—RGA Sampling (59 to 105 ft)

Associated Data Gaps:

The desired outcome of this phase is to close data gap #3—There are insufficient data at SWMU 4 to determine the extent and mass of TCE source term with sufficient accuracy to effectively and efficiently complete a remedial design for source term in the RGA.

Investigation Approach:

Ten borings will be installed via HSA or rotosonic to the top of the McNairy formation, approximately 105 ft (Figure 16). The FFA parties will be consulted prior to finalizing the exact locations of these borings.

- One possibility for locating the borings is that five of these borings will be downgradient of SWMU 4, one will be located upgradient of SWMU 4, and four will be located inside the SWMU 4 boundary (Figure 16). The four borings inside SWMU 4 will be located to sample below the highest elevated TCE results from Phase III (bottom samples).

- Another possibility is that the five downgradient borings could be spread out to define more accurately the extent of the high concentration TCE plume to the west.

- Yet another possibility is to locate two of the five boring that were planned to be located downgradient of SWMU 4 to locations within the SWMU boundary. This would enable focusing on releases of PTW below the SWMU.

Borings will be installed at a sufficient angle, if necessary, to avoid penetration of the burial cell and obtain sample results from under the burial cells, as penetration of the burial cells would provide a migratory conduit into the RGA for potential COCs. Water samples will be collected every 5 ft within the RGA and analyzed for VOCs and Tc-99. Soil samples will be collected at the top of the RGA and the top of the McNairy and analyzed for VOCs and Tc-99 from borings inside the SWMU boundary.

Contingency Investigations/Decision Rules:

- If attempts to collect soil samples from the top of the RGA fail, then a second attempt will be made over the next 5-ft interval.

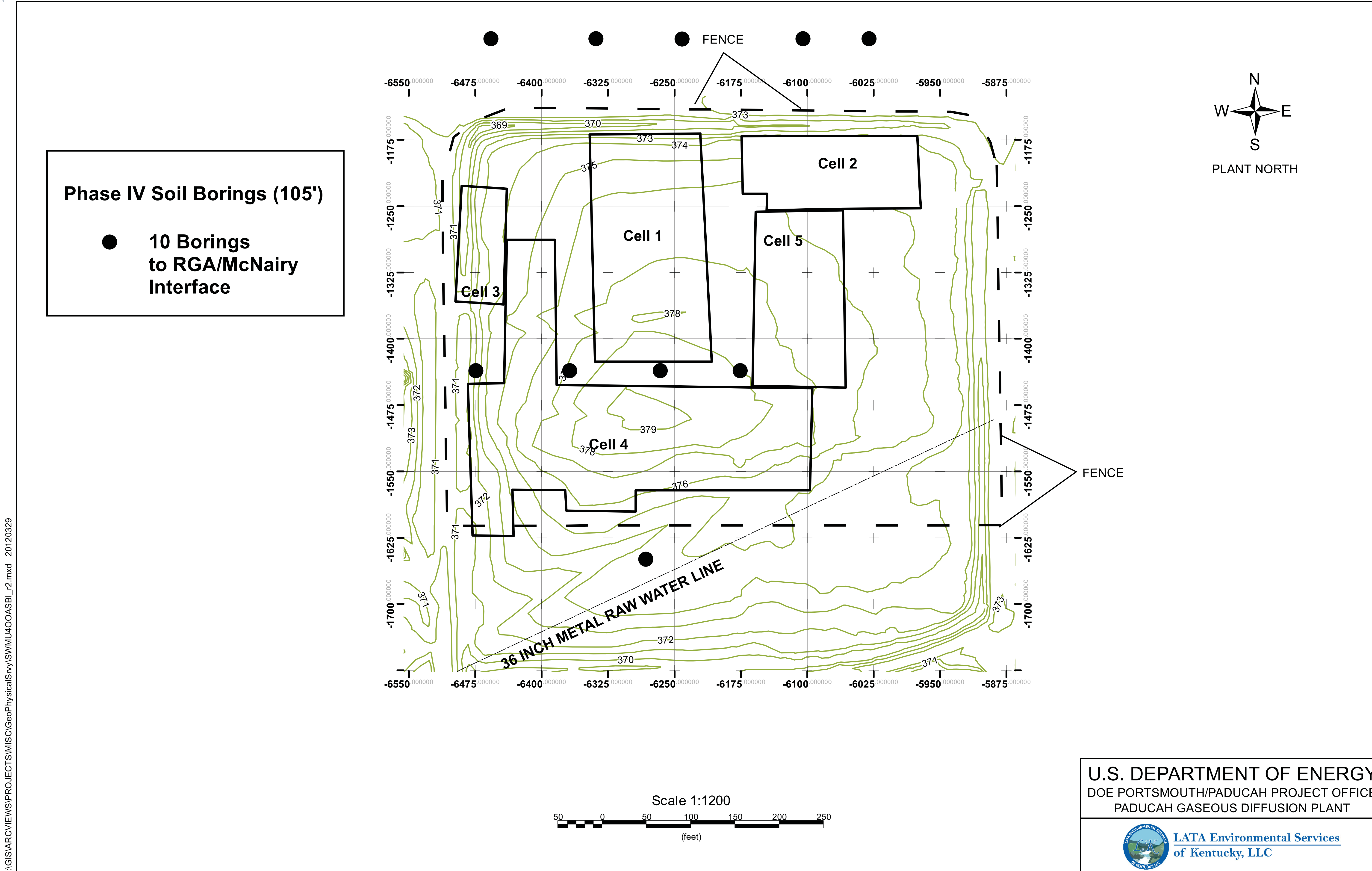

Figure 16. Phase IV Soil Boring Locations

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5.1.5 Phase V—Installation of Additional RGA Monitoring Wells

Associated Data Gaps:

The desired outcome of this phase is to support closure of the following data gaps:

- #3—There are insufficient data at SWMU 4 to determine the extent and mass of TCE source term with sufficient accuracy to effectively and efficiently complete a remedial design for source term in the RGA.

- #9—Hydraulic conductivity of the RGA under SWMU 4, as a measure of groundwater velocity and flow direction, is uncertain.

Investigation Approach:

Install and sample five additional RGA monitor wells (Figure 17) as follows:

- Install one middle RGA well upgradient of SWMU 4 to the south-southeast of the SWMU.

- Install a three-well RGA well cluster (i.e., lower, middle, and upper RGA wells closely spaced) based on data collected during previous phases of this sampling effort, after consultation among the FFA parties. The RGA is estimated to be approximately 30-ft thick at SWMU 4. Three wells with 10-ft well screens will allow for monitoring of the vertical distribution of TCE within the RGA. Samples collected at, or immediately downgradient, of the suspected source area, should have greater utility than if collected further downgradient where vertical dispersion of the TCE plume may mask the depth of the source.

- Install one lower RGA well downgradient of SWMU 4, adjacent to MW333 (an existing upper RGA well). Well logs from MW333 show the RGA to be approximately 20-ft thick and the upper 10 ft to be screened. The proposed well will be screened in the lower 10 ft of the RGA.

- Conduct a slug test on newly installed monitor wells to determine the hydraulic conductivity of the aquifer in the vicinity of SWMU 4.

Contingency Investigations/Decision Rules:

- If the RGA is less than 25-ft thick at the location of the above proposed three-well cluster, then a two-well cluster (upper-most and lower-most RGA) will be installed to avoid excessive overlap (redundancy) in the screened interval.

5.2 SAMPLE ANALYSIS

The analyses of samples taken under this FSP will provide data to refine the alternative development and remedy selection for TCE and other COCs in the soils and groundwater at SWMU 4 (Table 2) and to design and implement the selected remedy. The analytical data will support characterization of investigation-derived waste and material that may be excavated from the burial cells. Detailed sample analysis information is presented in Section 6, QAPP.

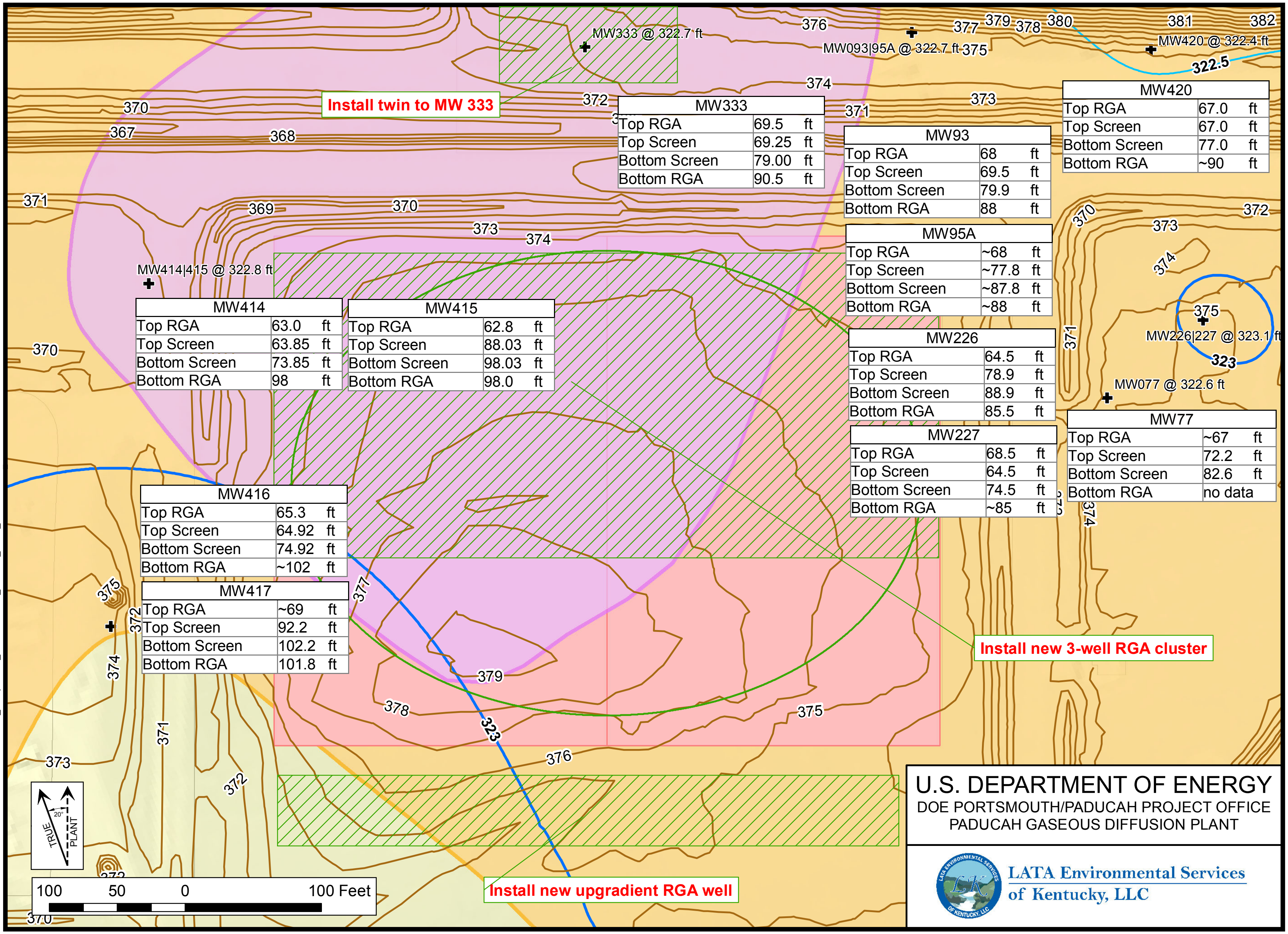

Figure 17. Phase V Monitoring Well Locations

5.3 SAMPLING PROCEDURES

Fieldwork and sampling at PGDP will be conducted in accordance with DOE Prime Contractor-approved medium-specific work instructions or procedures (Table 3). Subcontractor drilling and sampling will comply with the subcontractor's operating procedures and will comply with applicable or relevant and appropriate requirements (ARARs), as required in the Scope of Work. DOE or its 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 (Section 6).

Drilling and sampling will be conducted in accordance with approved procedures. These procedures either will be DOE contractor procedures or subcontractor procedures that have been reviewed and approved by the DOE contractor as being complete and in compliance with ARARs. The procedures used during the sampling and data analysis effort are available at the following address: http://www.latakentucky.com/public_documents_dynamic.asp. The procedures have been added to the Administrative Record, as well. All quality assurance (QA) activities (trip blanks, duplicates, matrix spikes and matrix spike duplicates) will be collected and handled in accordance with approved procedures. Data validation and review will also be in accordance with approved procedures.

5.3.1 Soil Sampling

Surface soil samples will be obtained from a 45 ft grid place over the 675 ft x 525 ft area of SWMU 4, resulting in 154 5-point composite samples. The composite samples will follow the requirements set forth in *Composite Sampling*, PAD-ENM-0023. Once the samplers recover the soil sample, the soil will be placed in the sample preparation area. A health and safety officer (HSO) and radiation control technician will scan the soil sample for VOCs and radiation before releasing the sample to the sample crew. The HSO will use a photoionization detector (PID) with ultraviolet (UV) light source with an ionization potential (eV) of 10.6 to scan for the presence of VOCs. If contamination is found above project exposure limits, the HSO and radiation control technician will direct the field crew in any additional PPE requirements and appropriate handling precautions, in accordance with the project-specific Health and Safety Plan and the procedure, PAD-RAD-1110, *Radiation Surveys*. At that time, the Derivative Classifier will review the soil sample for any security items of concern. Any items found will be handled in accordance with the security protocols in place. Immediately upon approval from the HSO, radiation control technician, and Derivative Classifier to proceed with sampling, the field crew will collect the samples for analysis, the 5-point composite soil samples will be placed in a clean bowl and mixed thoroughly using the quartering procedure to composite the sample. Samplers will place the resulting soil mixture in the appropriate sample jars for analysis. This process will be repeated until all 154 composite samples are produced. Any excess sample material will be placed in the waste disposal containers specific to the sample location.

Table 2. Summary of SWMU 4 Sampling and Analysis[1]

	Method	Depth (ft)	Sampling Interval (ft/sample)	Soil Samples	Water Samples	Analysis	Comments
Phase I	Soil gas samplers	*	n/a	0	0	VOC	75 ft x 75 ft grid over the SWMU 4 area, resulting in 48 impartially placed samplers plus 17 additional samplers placed based on process knowledge (See Section 5.1.1)
	5-point Surface soil samples (field	0 to 1	0-1	154	0	Metals by XRF, and PCBs by	5-point composite samples from 154, 45-ft grids over the SWMU 4 area.

Table 2. Summary of SWMU 4 Sampling and Analysis (Continued)

	Method	Depth (ft)	Sampling Interval (ft/sample)	Soil Samples	Water Samples	Analysis	Comments
	screen)					field test kits	
	5-point composite surface soil samples	0 to 1	0-1	16	0	Fixed-base lab for full suite of analyses (less VOCs)	10% of the samples described on the previous line
Phase II	20 ft borings	20	0–5, 5–10, 10–15, 15–20	48	12	full suite	150 ft x 150 ft grid, 12 locations, take a water sample if present, analyze for TCE, record water level
Phase II	20 ft borings	20	0–5, 5–10, 10–15, 15–20	40	10	full suite	10 locations biased per highest concentrations from soil gas analysis of soil gas modules (includes mercury and lead for waste cell samples)
Phase III	58 ft borings	58	20–30, 30–40, 40–50, 50–58	40	10	20 VOC, 20 full suite	Extend the 10 biased boring locations from Phase II to 58 ft (top of RGA), sample every 10 ft beyond 20 ft bgs; 20 ft–30 ft and 50 ft–58 ft samples will be analyzed for the full suite of analytes; 30 ft–40 ft and 40 ft–50 ft samples will be analyzed for VOCs only; collect a water sample, if water is present and analyze for VOCs, record water level.
Phase IV	105 ft borings	105	every 5 in RGA	20	90	VOCs, Tc-99	Borings will be located upon consultation with EPA and KDEP.
Phase V	RGA monitoring wells				5		Install one well upgradient screened to middle of the RGA. Install one well down- gradient, twin of MW333, screened to bottom of the RGA. Install a three well cluster within the SWMU screened top, middle, and bottom of the RGA.
Test Pits	One in burial cells1, 2, 3, 5; two in burial cell 4.	20	NA	6	6 (if present)	VOC, PCBs, and SVOAs (in that order)	5 ft wide x 10 ft long x 20 ft deep one test pit in each cell and one more in cell 4

*Manufacturer's direction

[1] The values in this table are estimates and are subject to change based on results and a coordination among the FFA parties.

Table 3. Example Fieldwork and Sampling Activities Procedures*

Procedure Number	Procedure Title
PAD-DD-2701	Large Equipment Decontamination
PAD-ENM-0018	Sampling of Containerized Wastes
PAD-ENM-0021	Temperature Control for Sample Storage
PAD-ENM-0023	Composite Sampling
PAD-ENM-1003	Developing, Implementing and Maintaining Data Management Implementation Plans
PAD-ENM-2101	Groundwater Sampling
PAD-ENM-2300	Collection of Soil Samples
PAD-ENM-2303	Borehole Logging
PAD-ENM-2700	Logbooks and Data Forms
PAD-ENM-2702	Decontamination of Sampling Equipment and Devices
PAD-ENM-2704	Trip, Equipment and Field Blank Preparation
PAD-ENM-2708	Chain of Custody Forms, Field Sampling Logs, Sample Labels, and Custody Seals
PAD-ENM-5003	Quality Assured Data
PAD-ENM-5007	Data Management Coordination
PAD-ENM-5102	Radiochemical Data Verification and Validation
PAD-ENR-0020	Collection of Soil Samples with Direct Push Technology Sampling
PAD-ENR-0034	XRF Field Analysis of Soils
PAD-ENR-0035	Vapor Sampling
PAD-PLA-ENV-001	Waste Management Plan for the Paducah Environmental Remediation Project
PAD-PROJ-0025	Well and Temporary Boring Abandonment
PAD-QA-1020	Control and Calibration of Measuring and Test Equipment
PAD-RAD-1110	Radiation Surveys
PAD-WD-0016	Waste Handling and Storage in DOE Waste Storage Facilities
PAD-WD-0022	Waste Water Accumulation, Storage, Treatment and Disposal
PAD-WD-0621	Standard Operating Procedure Recessed Chamber Filter Press at the C-752-C Off-Site Decontamination Pad
PAD-WD-1017	Safe Handling and Opening of Sealed Containers
PAD-WD-3015	Waste Packaging
PAD-WD-3028	Off Site Shipping

*SOPs are posted to the LATA Kentucky external Web site at http://www.latakentucky.com/public_documents_dynamic.asp under Paducah Procedures.

Soil borings will be sampled with a DPT rig following the requirements of *Collection of Soil Samples with Direct Push Technology Sampling*, PAD-ENR-0020. A GeoProbe® Dual Tube 22 system (or equal) will be used to minimize contaminants migrating down into the UCRS from the disposal cells. The Dual Tube 22 uses a 2.25 inch outer diameter casing with an inner rod string. When driven into the subsurface, a 1.125 inch soil core is collected inside the inner rod string in a clear Teflon liner. Grab groundwater samples and temporary monitoring wells can be installed through the Dual Tube 22 system. As soon as the DPT crew recovers the Teflon liner containing the soil sample, the soil core will be placed in the sample preparation area. In order to protect the health and safety of response actions workers and ensure that no security concerns arise during sample collection and bottling, the following steps will be taken before the sample is put in the appropriate sample bottles:

- An HSO and radiation control technician will scan the Teflon liner and the ends of the soil core for VOCs and radiation before releasing the core to the sample crew. The HSO will use a PID with UV light source with an eV of 10.6 to scan for the presence of VOCs (1 minute).

- Once the soil core in the Teflon liner has been cleared initially, the sample crew will open the Teflon liner with a sample liner cutter and utility knife and an HSO and radiation control technician will scan the sample for contamination; then a derivative classifier will review the exposed surface for classified matter.

- If contamination is found above project exposure limits, the HSO and radiation control technician will direct the field crew in any additional PPE requirements and appropriate handling precautions (doffing time dependant on extra PPE required).

- The sample core will be split in half, at which time the derivative classifier will review the exposed surface for classified matter (1 minute).

- Immediately upon approval from the HSO, the radiation control technician, and the derivative classifier to proceed with sampling, the field crew will collect the samples for VOC analysis by filling three EnCore® samplers, consistent with Collection of Soil Samples, PAD-ENR-2300. The VOC sample will be collected first from the area of the core that indicates highest contamination based on field screening instrument. The time between retrieval of the Teflon liner to sealing the EnCore® sampler is expected to be approximately 5 minutes.

- The derivative classifier will review the soil core for any security items of concern while the sample material is being bottled. Any items found will be handled in accordance with the security protocols in place. At the same time, the project geologist will examine the soil core sample for lithologic description, consistent with Section 3.5 of *Borehole Logging*, PAD-ENM-2303.

The lithologic descriptions (and notes of the presence and general type of any buried materials that may be recovered) will be recorded in a project log book. As directed by *Collection of Soil Samples*, PAD-ENR-2300, after the collection of the VOC samples and the description of the lithology are completed, the remaining soil will be placed in a clean bowl and mixed thoroughly using the quartering procedure to composite the sample. Samplers will place the resulting soil mixture in the appropriate sample jars for analysis. (The analyses can be found in Section 6, QAPP).

Soil samples collected under Phases II through V will be screened using an *OilScreenSoil (Sudan IV* or *Scarlet Red)*® (or equivalent) field test kit capable of indicating the presence of DNAPL and the results will be appropriately documented.

Duplicate soil samples will be collected at a frequency of one duplicate for each 20 scheduled soil samples. Additional QA/Quality Control (QC) samples will be required for matrix spike samples and trip blanks. Any excess sample material will be placed in the waste disposal containers specific to the sample boring.

Any nondisposable sampling equipment that will come in contact with the soil samples must be decontaminated between samples, as directed by *Decontamination of Sampling Equipment and Devices*, PAD-ENM-2702. The DPT rig and other large field equipment will be decontaminated in accordance with *Large Equipment Decontamination*, PAD-DD-2701, before use on-site, before sampling outside the disposal cells, between moving among disposal cells, at any other time when the DPT rig becomes splattered with potentially contaminated mud, and after sampling has been completed. The DPT rigs will be maintained in relatively clean condition. The only decontamination activity that will be required between boreholes will be cleaning of the down-hole tool string. This tooling will be cleaned at the drill site and the decontamination water will be contained, collected, and transferred to the C-752-C facility for treatment and disposal. The decontamination water will be field screened for PCB contamination prior to transfer. The final decontamination of the rigs for off-site transportation also will take place at the C-752-C facility.

All logbook entries that document the project activities will be made in accordance with *Logbooks and Data Forms*, PAD-ENM-2700. Reviews of the logbooks and any project data forms will be completed at least monthly.

5.3.2 Groundwater Sampling

Groundwater samples will be collected from the UCRS and RGA using temporary borings at various locations as directed in Section 5 of this FSP. Water sampling in the UCRS is dictated by the presence of water-bearing zones. Where groundwater is encountered, 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 stabilizes, as is consistent with applicable steps of Section 7.2 of *Groundwater Level Measurement*, PAD-ENM-2100. 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.

Groundwater sampling would begin after the groundwater level stabilizes (or 15 minutes, whichever comes first). The sample system will be lowered into the boring and the sample collection process will begin. Where 1 ft of water column or less is present in the soil boring, a disposable bailer initially will be used to collect the groundwater sample. In shallow soil borings (down to approximately 18 ft deep) where greater than 1 ft of water column is present or bailing demonstrates that the soil boring produces sufficient water for sustained pumping, it is anticipated that the sample crew will use a bladder pump to collect the groundwater sample. In deeper soil borings (deeper than approximately 18 ft), where greater than 1 ft of water column is present or bailing demonstrates that the soil boring produces sufficient water for sustained pumping, the field crew most likely will use an air- or inert gas-driven bladder pump to collect the groundwater sample. The small inner diameter of the soil sampling system and the anticipated suspended sand content in the purge water limit the types of pumps that can be used. Once a particular sample collection devise is selected, it will be used for the duration of the project.

Where greater than 1 ft of water column is initially present in the soil boring and pumping is initiated, a small amount of water, typically less than a gal, will be purged to reduce the initial turbidity of the water sample. Because 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 the geochemical parameters pH, conductivity, and temperature to stabilize within the boring. The field crew will use a water quality meter, such as a Hach™, Horiba™, or YSI™ multimeter, mounted in a flow cell to measure the geochemical parameters. Stabilization will be considered to be reached when at least three measurements taken three minutes apart have consistent readings, as follows:

- Temperature measurements agree within 1°C
- Conductivity measurements agree within 10%
- pH measurements agree within 0.5 units

Measurements also will be made for oxidation reduction potential and dissolved oxygen. When the geochemical parameters have stabilized, the flow rate of the sampling pump will be adjusted to 200 mL/minute or less for sampling.

Where 1 ft or less of water is present initially in the soil boring and the groundwater is sampled with a disposable bailer, the groundwater sample will be collected without purging and without initial measurement of pH, conductivity, or temperature. If sufficient water is present for the collection of all scheduled laboratory analyses and available water remains, a cup sample will be collected for measurement of pH, conductivity, and temperature (without purging for stabilization) and dissolved oxygen.

The required analyses for collected water samples are documented in Section 6, the QAPP. Duplicate water samples will be collected at a frequency of one duplicate for each 20 scheduled water samples. Additional samples will be required for matrix spike samples and trip blanks. Trip blanks will be submitted for VOC analyses only.

After sampling is completed, the sample system will be removed from the boring. Any bailer, sample pump, or nondisposable tubing that comes into contact with groundwater will be decontaminated in accordance with *Decontamination of Sampling Equipment and Devices*, PAD-ENM-2702, prior to its next use. Purge water will be collected on-site and staged in a drum or waste water tank until treatment and disposal in accordance with *LATA Environmental Services of Kentucky, LLC, Waste Management Plan for the Paducah Environmental Remediation Project*, PAD-PLA-ENV-001.

The sampling effort, including groundwater purge volumes and all measurements of geochemical parameters, will be documented in a project logbook. All logbook entries will be made in accordance with *Logbooks and Data Forms*, PAD-ENM-2700. Reviews of the logbooks and any project data forms will be completed at least monthly.

5.4 DOCUMENTATION

Field documentation will be maintained throughout the SWMU 4 sampling activity 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 consistent with *Logbooks and Data Forms*, PAD-ENM-2700, and *Chain-of-Custody Forms, Field Sample Logs, Sample Labels, and Custody Seals*, PAD-ENM-2708. 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.

5.4.1 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 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.

5.4.2 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 Project Environmental Measurements System (PEMS) 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
- Preservative

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

- Analysis/method
- Container type
- Number of containers
- Container volume

- Preservative (type/volume)
- 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 Remedial Action 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, air bill number, and container lot number
- 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 field team manager as part of his/her review of the logbook.

5.4.3 Field Data Sheets

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

- Sample log sheets
- Chain-of-custody forms
- Instrument calibration logs
- Temperature monitoring sheets
- 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.

5.4.4 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 Teflon 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)
- 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.

5.4.5 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 any of the following:

- In the possession of the sampling team;
- In view of the sampling team; or
- 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 Sample Management Office 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)
- Analyses required for each sample
- Blocks to be signed as custody is transferred from one individual to another

The air bill 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; or

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

5.4.6 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 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 regulations pursuant to 49 *CFR* § 173. All samples will be prepared and shipped in accordance with current procedures and pursuant to applicable requirements of 49 *CFR* § 100–177 and International Air Transportation Association Dangerous Goods Regulations.

5.4.7 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
- Documents covering on-site fieldwork

5.4.8 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
- Health and safety equipment

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

The documentation for the investigation of TCE and other COC contamination at SWMU 4 will be reported as an addendum to the RI for the BGOU.

5.5 SAMPLE LOCATION SURVEY

Surveying of sampling locations associated with judgmental borings or boring locations moved from their original location will be conducted upon completion of sampling activities. Where possible, temporary markers consisting of flagging or wooden or metal stakes will be used to mark sample locations. A member of the field sampling crew will accompany the survey crew to provide information regarding the location of sampling points.

Coordinates for sample locations from the disposal cell samples will be obtained using a global positioning system (GPS) or standard survey techniques. 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 file to Paducah Oak Ridge Environmental Information System (OREIS).

6. QUALITY ASSURANCE PROJECT PLAN

Worksheet #1
Title Page

Document Title: *Addendum to the Work Plan for the Burial Grounds Operable Unit Remedial Investigation/Feasibility Study at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky Solid Waste Management Unit 4 Sampling and Analysis Plan*

Lead Organization: U.S. Department of Energy

Preparer's Name and Organizational Affiliation:, Fraser Johnstone, LATA Environmental Services of Kentucky, LLC (LATA Kentucky)

Preparer's Address, Telephone Number, and E-mail Address: 761 Veterans Avenue, Kevil, KY, 42053, Phone (270) 441-5000, edward.johnstone@lataky.com

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Preparation Date (Month/Year): April 2012

Document Control Number: DOE/OR/07-2179&D2/A2/R1

LATA Kentucky Environmental Remediation Project Manager	Signature Mark J. Duff	4-24-12 Date
LATA Kentucky Regulatory Manager	Signature Myrna Espinosa Redfield	4/24/12 Date
LATA Kentucky Sample/Data Management Manager	Signature Lisa Crabtree	4/24/12 Date

Worksheet #2
QAPP Identifying Information

Site Name/Project Name: Paducah Gaseous Diffusion Plant
Site Location: Paducah, Kentucky
Site Number/Code: KY8890008982
Contractor Name: LATA Environmental Services of Kentucky, LLC
Contractor Number: DE-AC30-10CC40020
Contract Title: Paducah Gaseous Diffusion Plant Paducah Environmental Remediation Project
Work Assignment Number: NA

1. Identify guidance used to prepare QAPP:

   Intergovernmental Data Quality Task Force, March 2005. The Uniform Federal Policy for Implementing Environmental Quality Systems, Version 2.0, 126 pages.

   Intergovernmental Data Quality Task Force, March 2005. The Uniform Federal Policy for Quality Assurance Project Plans: Part 1 UFP QAPP Manual, Version 1.0, 177 pages (DTIC ADA 427785 or EPA-505-B-04-900A).

   Intergovernmental Data Quality Task Force, March 2005. The Uniform Federal Policy for Quality Assurance Project Plans: Part 2A UFP QAPP Worksheets, Version 1.0, 44 pages.

   Intergovernmental Data Quality Task Force, March 2005. The Uniform Federal Policy for Quality Assurance Project Plans: Part 2B Quality Assurance/Quality Control Compendium: Minimum QA/QC activities, Version 1.0, 76 pages.

2. Identify regulatory program: Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and *Federal Facility Agreement for the Paducah Gaseous Diffusion Plant*, DOE/OR/07-1707 (FFA)

3. Identify approval entity: DOE, EPA Region 4, and Kentucky Department for Environmental Protection (KDEP)

4. Indicate whether the QAPP is a generic or a project-specific QAPP (circle one).

5. List dates of scoping sessions that were held: December 2010 and January 2010

Worksheet #2 (Continued)
QAPP Identifying Information

6. List dates and titles of QAPP documents written for previous site work, if applicable:

Title:	Approval Date:
Data and Documents Management and Quality Assurance Plan for Paducah Environmental Management and Enrichment Facilities, DOE/OR/07-1595&D2 (DOE 1998b)	10/5/1998

7. List organizational partners (stakeholders) and connection with lead organization:
DOE, EPA Region 4, KDEP

8. List data users: DOE, LATA Kentucky, subcontractors, EPA Region 4, KDEP

9. If any required QAPP elements and required information are not applicable to the project, then indicate the omitted QAPP elements and required information on the attached table. Provide an explanation for their exclusion here.

No elements specifically are omitted from this QAPP.

Worksheet #2 (Continued)
QAPP Identifying Information

Required QAPP Element(s) and Corresponding QAPP Section(s) from the IDQTF UFP-QAPP Manual	Required Information	Applicable Worksheet Numbers in this Project Specific QAPP
Project Management and Objectives		
2.1 Title and Approval Page	· Title and Approval Page	1
2.2 Document Format and Table of Contents 2.2.1 Document Control Format 2.2.2 Document Control Numbering System 2.2.3 Table of Contents 2.2.4 QAPP Identifying Information	· Table of Contents · QAPP Identifying Information	2
2.3 Distribution List and Project Personnel Sign-Off Sheet 2.3.1 Distribution List 2.3.2 Project Personnel Sign-Off Sheet	· Distribution List · Project Personnel Sign-Off Sheet	3, 4
2.4 Project Organization 2.4.1 Project Organizational Chart 2.4.2 Communication Pathways 2.4.3 Personnel Responsibilities and Qualifications 2.4.4 Special Training Requirements and Certification	· Project Organizational Chart · Communication Pathways · Personnel Responsibilities and Qualifications Table · Special Personnel Training Requirements Table	5, 6, 7, 8
2.5 Project Planning/Problem Definition 2.5.1 Project Planning (Scoping) 2.5.2 Problem Definition, Site History, and Background	· Project Planning Session Documentation (including Data Needs tables) · Project Scoping Session Participants Sheet · Problem Definition, Site History, and Background · Site Maps (historical and present)*	9, 10
2.6 Project Quality Objectives and Measurement Performance Criteria 2.6.1 Development of Project Quality Objectives Using the Systematic Planning Process 2.6.2 Measurement Performance Criteria	· Site-Specific Project Quality Objectives · Measurement Performance Criteria Table	11, 12
2.7 Secondary Data Evaluation	· Sources of Secondary Data and Information · Secondary Data Criteria and Limitations Table	13
2.8 Project Overview and Schedule 2.8.1 Project Overview 2.8.2 Project Schedule	· Summary of Project Tasks · Reference Limits and Evaluation Table · Project Schedule/Timeline Table	14, 15, 16

* Found in Sections 1 and 2

Worksheet #2 (Continued)
QAPP Identifying Information

Required QAPP Element(s) and Corresponding QAPP Section(s) from the IDQTF UFP-QAPP Manual	Required Information	Applicable Worksheet Numbers in this Project Specific QAPP
Measurement/Data Acquisition		
3.1 Sampling Tasks 3.1.1 Sampling Process Design and Rationale 3.1.2 Sampling Procedures and Requirements 3.1.2.1 Sampling Collection Procedures 3.1.2.2 Sample Containers, Volume, and Preservation 3.1.2.3 Equipment/Sample Containers Cleaning and Decontamination Procedures 3.1.2.4 Field Equipment Calibration, Maintenance, Testing, and Inspection Procedures 3.1.2.5 Supply Inspection and Acceptance Procedures 3.1.2.6 Field Documentation Procedures	· Sampling Design and Rationale · Sample Location Map* · Sampling Locations and Methods/SOP Requirements Table · Analytical Methods/SOP Requirements Table · Field Quality Control Sample Summary Table · Sampling SOPs · Project Sampling SOP References Table · Field Equipment Calibration, Maintenance, Testing, and Inspection Table	17, 18, 19, 20, 21, 22
3.2 Analytical Tasks 3.2.1 Analytical SOPs 3.2.2 Analytical Instrument Calibration Procedures 3.2.3 Analytical Instrument and Equipment Maintenance, Testing, and Inspection Procedures 3.2.4 Analytical Supply Inspection and Acceptance Procedures	· Analytical SOPs · Analytical SOP References Table · Analytical Instrument Calibration Table · Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table	23, 24, 25
3.3 Sample Collection Documentation, Handling, Tracking, and Custody Procedures 3.3.1 Sample Collection Documentation 3.3.2 Sample Handling and Tracking System 3.3.3 Sample Custody	· Sample Collection Documentation Handling, Tracking, and Custody SOPs · Sample Container Identification · Sample Handling Flow Diagram · Example Chain-of-Custody Form and Seal	26, 27
3.4 Quality Control Samples 3.4.1 Sampling Quality Control Samples 3.4.2 Analytical Quality Control Samples	· QC Samples Table · Screening/Confirmatory Analysis Decision Tree	28
3.5 Data Management Tasks 3.5.1 Project Documentation and Records 3.5.2 Data Package Deliverables 3.5.3 Data Reporting Formats 3.5.4 Data Handling and Management 3.5.5 Data Tracking and Control	· Project Documents and Records Table · Analytical Services Table · Data Management SOPs	29, 30

* Found in Section 5

Worksheet #2 (Continued)
QAPP Identifying Information

Required QAPP Element(s) and Corresponding QAPP Section(s) from the IDQTF UFP-QAPP Manual	Required Information	Applicable Worksheet Numbers in this Project Specific QAPP
Assessment/Oversight		
4.1 Assessments and Response Actions 4.1.1 Planned Assessments 4.1.2 Assessment Findings and Corrective Action Responses	· Assessments and Response Actions · Planned Project Assessments Table · Audit Checklists · Assessment Findings and Corrective Action Responses Table	31, 32
4.2 QA Management Reports	· QA Management Reports Table	33
4.3 Final Project Report		
Data Review		
5.1 Overview		
5.2 Data Review Steps 5.2.1 Step I: Verification 5.2.2 Step II: Validation 5.2.2.1 Step IIa Validation Activities 5.2.2.2 Step IIb Validation Activities 5.2.3 Step III: Usability Assessment 5.2.3.1 Data Limitations and Actions from Usability Assessment 5.2.3.2 Activities	· Verification (Step I) Process Table · Validation (Steps IIa and IIb) Process Table · Validation (Steps IIa and IIb) Summary Table · Usability Assessment	34, 35, 36, 37
5.3 Streamlining Data Review 5.3.1 Data Review Steps To Be Streamlined 5.3.2 Criteria for Streamlining Data Review 5.3.3 Amounts and Types of Data Appropriate for Streamlining		

Worksheet #3
Minimum Distribution List

The distribution for this project-specific QAPP will be the same as that used for other FFA documents. The current version of this list is shown below.

Standard Distribution List—FFA Documents

REGULATORY DISTRIBUTION				
	D1 and D2 Documents			
	Document	Redline[a]	E-copy[b]	CD
Environmental Protection Agency (EPA)				
Turpin Ballard/Jennifer Tufts (original letter)	2	1	P	P
Jana Dawson, TLI (copy of letter)	1	-	P	P
State of Kentucky (KY)				
Todd Mullins (original letter)	3	1	P	3
Gaye Brewer (copy of letter)	1	-	P	1
U.S. Department of Energy (DOE)				
DOE[c]	1	1	P	1
Citizens Advisory Board (CAB)[d]	-	-	-	2
LATA Environmental Services of Kentucky, LLC (LATA Kentucky)[e]				
Document Management Center (DMC)				
DMC-RC (unbound)	1	1	P	-
Administrative Record (unbound)	1	1	P	1
National Resource Damage Assessment (NRDA) Trustees				
Kentucky Department of Fish & Wildlife				
Tim Kreher	-	-	-	1
Kentucky Energy and Environment Cabinet				
Dr. Len Peters, Cabinet Secretary	-	-	-	1
Tennessee Valley Authority				
Cynthia Anderson	-	-	-	1
Robert Casey	-	-	P	-
A. Stephens	-	-	P	-
U.S. Fish & Wildlife				
Tony Velasco	-	-	-	1
TOTAL DISTRIBUTION	10	5	-	15

[a] For KY, one redlined hard copy is sufficient if the document is less than 100 pages. If the document is greater than 100 pages, KY would like an additional redlined hard copy. For D2 documents, DOE has requested 3 redlined copies and 8 comment response summaries (CRS). Two additional redlined copies will be generated for the AR file and for the DMC file if the DOE letter cites that a redlined copy is enclosed. CRSs in response to DOE comments are provided to DOE only.
[b] Electronic distribution will be made via e-mail for documents less than 10 MB, otherwise the link to the Public Documents Web site will be provided. DOE will be responsible for sending the e-copy e-mail. LATA Kentucky is responsible for posting to the Public Documents Web site.
[c] CDs are provided to Kim Crenshaw.
[d] Environmental Reporting and Deliverables Quality (ERDQ)/Document Production (within the Regulatory Management group) will provide CDs to Eddie Spraggs who will make distribution of the CDs.
[e] Additional copies needed for LATA Kentucky personnel are not included in the above totals. ERDQ will provide copies to the appropriate administrative staff to complete distribution of these documents.

Worksheet #4
Project Personnel Sign-Off Sheet

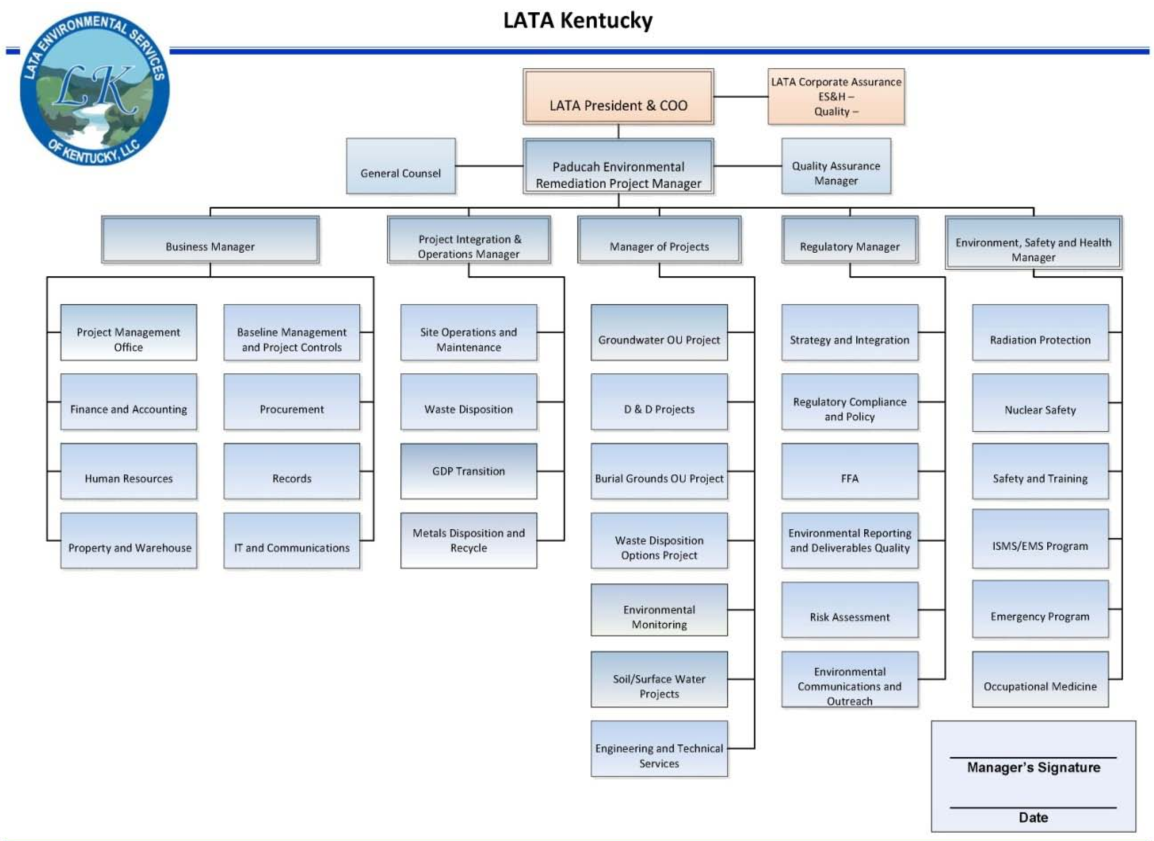
Personnel actively engaged in sample collection, data analysis, and data validation for the projects are required to read applicable sections of this project-specific QAPP upon approval of its contents by all FFA parties. The master list of signatures will be kept with the project work control documentation.

Project Position Title	Organization	Signature	Date

Title: SWMU 4 RI Addendum Work Plan QAPP
Revision Number: 2
Revision Date: 04/2012

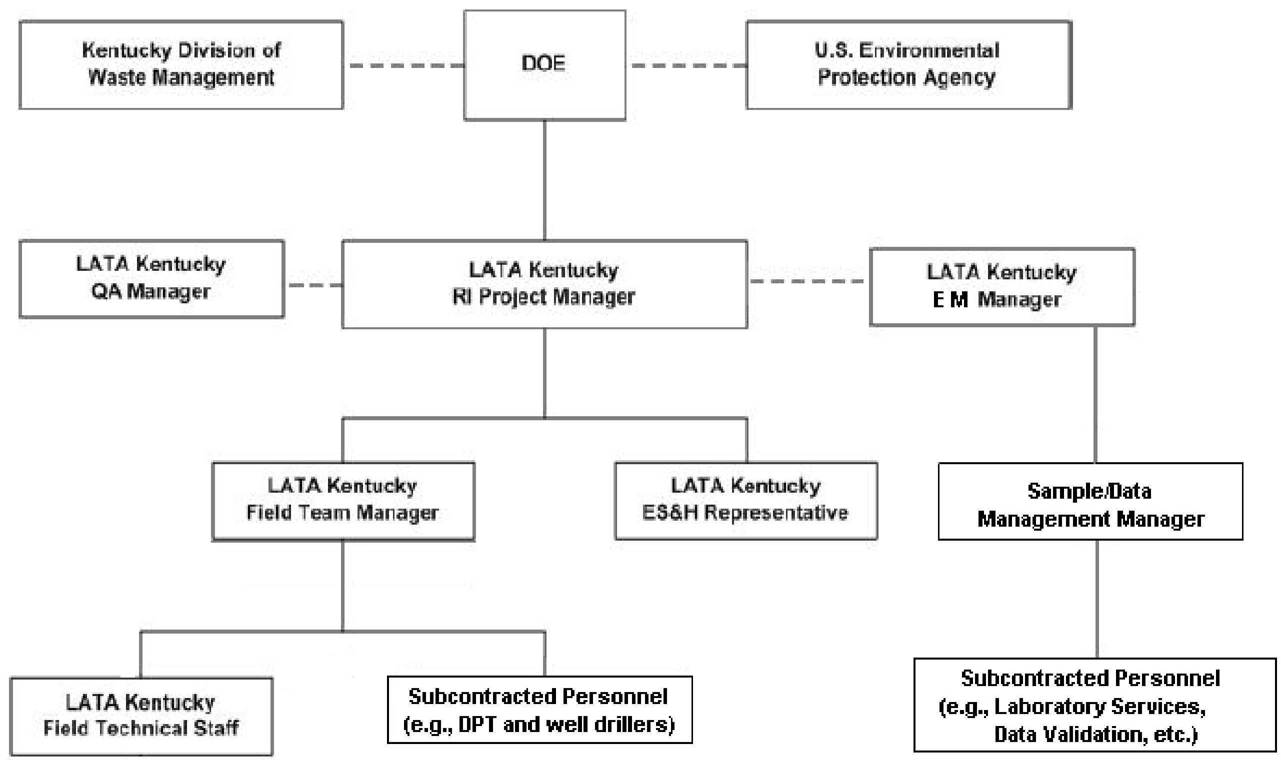
Worksheet #5-A
Project Contractor Organizational Chart*

This portion of the QAPP addresses the project organization as it provides for QA/QC coordination and responsibilities. This QAPP includes the overall project organization at the Remediation Project Manager level and its principal lines of communication and authority.



* A copy of the current organizational chart will be maintained at the LATA Kentucky Web site.

Worksheet #5-B
Project Level Organizational Chart



Worksheet #6
Communication Pathways

NOTE: Formal communication across company or regulatory boundaries occurs via letter. Other forms of communication, such as e-mail, meetings, etc., will occur throughout the project.

Communication Drivers	Organizational Affiliation	Position Title Responsible	Procedure
Federal Facility Agreement DOE/OR/07-1707	DOE Paducah Site Lead	Paducah Site Lead	All formal communication among DOE, EPA, and KDEP
Federal Facility Agreement DOE/OR/07-1707	DOE Paducah	Environmental Remediation Project Manager	All formal communication between DOE and contractor for Environmental Remediation Projects
All project requirements	LATA Kentucky	Environmental Remediation Project Manager	All formal communication between the project and the Site Lead
All project requirements	LATA Kentucky	Project Manager	All communication between the project and the LATA Kentucky Environmental Remediation Project Manager
Project QA requirements	LATA Kentucky	Quality Assurance Manager	All project quality related communication between the QA department and LATA Kentucky project personnel
FFA Compliance	LATA Kentucky	Regulatory Manager	All internal communication regarding FFA compliance with the LATA Kentucky Project Manager

Roles presented above are at the program level.

Worksheet #6 (Continued)
Communication Pathways

Communication Drivers	Organizational Affiliation	Position Title Responsible	Organizational Department Manager	Procedure
Sampling Requirements	LATA Kentucky	Sampling Lead	Project and Operations Manager	All internal communication regarding field sampling with the LATA Kentucky Project Manager
Analytical Laboratory Interface	LATA Kentucky	Laboratory Coordinator	Project and Operations Manager	All communication between LATA Kentucky and analytical laboratory
Waste Management Requirements	LATA Kentucky	Waste Coordinator	Project and Operations Manager	All internal communication regarding project waste management with LATA Kentucky Project Manager
Environmental Compliance Requirements	LATA Kentucky	Compliance Manager	Regulatory Manager	All internal correspondence regarding environmental requirements and compliance with the LATA Kentucky Project Manager
Subcontractor Requirements (if applicable)	LATA Kentucky	Subcontract Administrator	Business Manager	All correspondence between the project and subcontractors, if applicable
Health and Safety Requirements	LATA Kentucky	Environment, Safety, and Health Manager	Environment, Safety, and Health Manager	All internal communication regarding safety and health requirements with the LATA Kentucky Project Manager

NOTE:. In the event the contractor changes, DOE will notify EPA and KDEP of the change, but not request approval of the report.

Title: SWMU 4 RI Addendum Work Plan QAPP
Revision Number: 2
Revision Date: 04/2012

Worksheet #7
Personnel Responsibility and Qualifications Table

Position Title Responsible	Organization Affiliation	Responsibilities	Education and Experience Qualifications
Project Manager	LATA Kentucky	Overall project responsibility	> 4 years relevant work experience
Environmental Engineer	LATA Kentucky	Project sampling and analysis plan	Bachelor of Science plus > 1 year relevant work experience
Environmental Compliance Manager	LATA Kentucky	Project environmental compliance responsibility	Bachelor of Science plus > 4 years work experience
FFA Manager	LATA Kentucky	Project compliance with the FFA	> 4 years work relevant experience
Environmental Monitoring and Reporting Program Manager	LATA Kentucky	Support project on sampling and reporting activities	> 4 years relevant work experience
Sample/Data Management Manager	LATA Kentucky	Project sample and data management	> 1 year relevant work experience
Health and Safety Representative	LATA Kentucky	Project safety and health responsibility	Bachelor degree plus > 1 year relevant experience
Waste Coordinator	LATA Kentucky	Overall project waste management responsibility	> 4 years relevant experience
Data Validator	Independent third party contractor	Performing data validation according to specified procedures	Bachelor degree plus relevant experience
Analytical Laboratory Project Manager	Analytical Laboratory	Sample analysis and data reporting	Bachelor degree plus relevant experience

Worksheet #8
Special Personnel Training Requirements Table

Personnel are trained in the safe and appropriate performance of their assigned duties in accordance with requirements of work to be performed. There are no special training requirements other than what normally is required for work at the PGDP site. QAPP development uses a graded approach. A work control package will be generated prior to implementation of the FSP; the package will list specific project-level training requirements.

Project Function	Specialized Training¾ Title or Description of Course	Training Provider	Training Date	Personnel/Groups Receiving Training	Personnel Titles/ Organizational Affiliation	Location of Training Records/Certificates*
Project Tasks	There will be no specialized training required for this program other than what normally is required for site work at PGDP. The contractor will evaluate specific tasks and personnel will be assigned training as necessary to perform those tasks. Training may address health and safety aspects of specific tasks as well as contractor-specific, site-specific, and task-specific requirements.	TBD	TBD	TBD	LATA Kentucky staff, subcontractors	Training files are maintained by the LATA Kentucky training organization. A training database is utilized to manage and track training.

* Training records are maintained by the LATA Kentucky training department. If training records and/or certificates do not exist or are not available, this should be noted.
TBD = to be determined

Worksheet #9
Project Scoping Session Participant Sheet

Two scoping meetings were held prior to developing the SAP and QAPP. The following tables include details about these meetings.

Name of Project: SWMU 4 Sampling
Date of Session: December 9, 2010
Scoping Session Purpose: DOE contractor internal scoping held to identify physical, hazard, and security constraints at SWMU 4 that might impact data collection.

Position Title	Affiliation	Name	Phone #	E-mail Address	Project Role
Project Manager	LATA Kentucky	John Samples	270-441-5080	john.samples@lataky.com	PM
BGOU Manager	LATA Kentucky	Jim Erickson	270-441-5083	jim.erickson@lataky.com	Program management
Engineering Manager	LATA Kentucky	Randy Scott	270-441-5162	randy.scott@lataky.com	Engineering support
Sample/Data Management Manager	LATA Kentucky	Lisa Crabtree	270-441-5315	lisa.crabtree@lataky.com	Laboratory requirements
Risk Manager	LATA Kentucky	Joe Towarnicky	270-441-5134	joe.towarnicky@lataky.com	Technical support
QA specialist	LATA Kentucky	Ryan Nall	270-331-0852	ryan.nall@lataky.com	QA
Waste Engineer	LATA Kentucky	Robert Owens	270-441-5356	robert.owens@lataky.com	Waste disposition
Rad Con Supervisor	LATA Kentucky	Matt Morin	270-441-5330	matt.morin@lataky.com	Rad control
Rad Con Tech	LATA Kentucky	Jim Mullins	240-441-5395	jim.mullins@lataky.com	Rad control
Security	SST Security	Chuck Moreland	270-441-5078	chuck.moreland@swiftstaley.com	Physical security
Engineer	GEO Consultants	Chris Marshall	270-462-3882	chris.marshall@lataky.com	Estimator

Worksheet #9 (Continued)
Project Scoping Session Participant Sheet

Name of Project: SWMU 4 Sampling
Date of Session: December 9, 2010
Scoping Session Purpose: Kickoff meeting

Position Title	Affiliation	Name	Phone #	E-mail Address	Project Role
Health and Safety	LATA Kentucky	Mark Mitchell	270-519-2292	mark.mitchell@lataky.com	Safety rep
Industrial Hygiene	LATA Kentucky	J. Scott McIntyre	270-441-5789	scott.mcintyre@lataky.com	IH
Security	SST Security	Charlie Cobb	270-441-5248	charlie.cobb@swiftstaley.com	Physical security
Facility Manager	LATA Kentucky	Eddie Windhorst	270-441-5170	edward.windhorst@lataky.com	Facility manager
Nuclear Safety	LATA Kentucky	John Justice	270-441-5207	john.justice@lataky.com	Nuclear safety

Worksheet #9 (Continued)
Project Scoping Session Participant Sheet

Name of Project: SWMU 4 Sampling
Date of Session: January 18–19, 2011
Scoping Session Purpose: Reach agreement on the objectives of data collection with FFA managers

Name	Organization	Phone	E-mail
Ballard, Turpin	EPA	404-562-8553	ballard.turpin@epa.gov
Bonczek, Richard	DOE	859-219-4051	rich.bonczek@lex.doe.gov
Brewer, Gaye	KDWM	270-898-8468	gaye.brewer@ky.gov
Brock, Stephanie	KY RHB	502-564-8390	stephaniec.brock@ky.gov
Burright, Jeff	Sapere Consulting	541-368-5390	jburright@sapereconsulting.com
Dawson, Jana	TechLaw	703-818-3254	jdawson@techlawinccom
Duncan, Tracey	PRC	270-441-6803	tracey.duncan@lex.doe.gov
Erickson, Jim	LATA Kentucky	270-441-5083	jim.erickson@lataky.com
Garner, Nathan	KY RHB	502-564-8390	nathan.garner@ky.gov
Gibson, Jeff	KDWM	502-564-6716	jeffrey.gibson@ky.gov
Macdonald, Emily	Sapere Consulting	509-524-2344	emacdonald@sapereconsulting.com
Richards, Walt	PRC	270-444-6839	walt.richards@lex.doe.gov
Samples, John	LATA Kentucky	270-441-5080	john.samples@lataky.com
Struttmann, Todd	LATA Kentucky	270-816-8852	todd.struttmann@lataky.com
Towarnicky, Joe	LATA Kentucky	270-217-6789	joseph.towarnicky@lataky.com
Winner, Edward	KDWM	502-564-6716	edward.winner@ky.gov
Woodard, Jennifer	DOE	270-441-6820	jennifer.woodard@lex.doe.gov

Worksheet #10
Problem Definition

The problem to be addressed by the project: The following data gaps* have been identified:

1. There is insufficient data at SWMU 4 to determine whether TCE is present in each of the burial cells, as well as the extent and mass of TCE contamination with sufficient accuracy to effectively and efficiently complete a remedial design for a TCE remedy in the burial cells.

2. There is insufficient data at SWMU 4 to determine the extent and mass of TCE contamination with sufficient accuracy to effectively and efficiently complete a remedial design of TCE in the UCRS (i.e., soils from ground surface to the top of the RGA not identified as burial cells).

3. There is insufficient data at SWMU 4 to determine the extent and mass of TCE source term with sufficient accuracy to effectively and efficiently complete a remedial design for source term in the RGA.

4. There is insufficient data at SWMU 4 to determine with sufficient certainty whether COCs other than TCE in the five primary burial cells represent a migration risk to the RGA or principal threat waste.

5. There is insufficient data at SWMU 4 to determine the extent and mass of COCs other than TCE with sufficient accuracy to effectively and efficiently select and design a remedy for the UCRS (i.e., not burial cells or geophysical anomalies).

6. There is insufficient data at SWMU 4 to determine the extent and mass of COCs with sufficient accuracy to select and design a remedy for the geophysical anomalies identified in 1999 and 2010 geophysical surveys. Data should be of sufficient quantity and quality to determine whether COCs represent a migration risk to the RGA or Principal Threat Waste.

7. The depth of the water table at SWMU 4 is uncertain. Specifically, is the buried material at SWMU 4 submerged in water?

8. It is uncertain whether the bedding materials surrounding the raw water pipe in the southeastern portion of SWMU 4 have been impacted by site constituents and act as a preferential pathway for migration outside of the SWMU.

9. Hydraulic conductivity of the RGA under SWMU 4, as a measure of groundwater velocity and flow direction, is uncertain.

10. There are insufficient data at SWMU 4 to determine the extent and mass of COCs in the surface soil within the SWMU 4 boundaries.

*Data gaps were jointly identified by DOE, EPA, and KDEP; they specify TCE as the VOC of interest, however, this SAP includes sampling and analysis for a broader range of VOCs.

Worksheet #10 (Continued)
Problem Definition

The environmental questions being asked: What is the volume of TCE present in the disposal cells, UCRS, and RGA at SWMU 4? What other potential COCs are present?

Observations from any site reconnaissance reports: WAG 3 sampling indicated TCE contamination along with metals, PCBs, and radiological contaminants; however, the samples from WAG 3 were not taken from within the primary disposal cells. WAG 3 and other existing SWMU 4 data are summarized in the BGOU RI Report.

A synopsis of secondary data or information from site reports: Section 3 of the work plan describes the secondary data used to develop DQOs.

The possible classes of contaminants and the affected matrices: The primary contaminant of concern is TCE. Other potential contaminants include Tc-99, uranium, vinyl chloride, *cis*-1,2-DCE, and PCBs.

Affected matrices are expected to be as follows (if present)

1. Soil
2. Water

The rationale for inclusion of chemical and nonchemical analyses: Worksheet #11 presents rationale for inclusion of chemical and nonchemical analyses.

Information concerning various environmental indicators: Groundwater investigations have indicated SWMU 4 as contributor to the TCE contamination plume.

Project decision conditions ("If..., then..." statements): If there is an insufficient sample volume of soil or water for any particular sample point to conduct all planned analysis, then the following priority shall be given to filling sample containers: first, VOCs; second, RADs; third, metals; fourth, PCBs; and fifth, geotechnical and other remedial design parameters listed in Worksheet #17B.

Additional contingency investigations and decision rules are listed in Section 5.1 of this document.

Worksheet #11
Project Quality Objectives/Systematic Planning Process Statements

Who will use the data? DOE, KDEP, EPA, and their contractors (e.g., PRC, LATA Kentucky).

What will the data be used for? To eliminate the data gaps identified in Worksheet #10.

What type of data are needed? (target analytes, analytical groups, field screening, on-site analytical or off-site laboratory techniques, sampling techniques) Soil gas data, concentrating on VOCs, from passive soil gas investigation monitors analyzed by fixed-based analytical laboratory techniques. Field screening samples from XRF analysis of soil samples and PCB test kits also will be used to determine subsequent sample locations. VOCs and Tc-99 data from both soil and water samples using fixed-based analytical laboratory techniques. Selected samples (see Worksheet #18) will be analyzed for the full radiological, VOC, and PCB suites and for COC metals from the BGOU RI. Geotechnical and other related samples that may be needed for remedy selection and implementation will be collected (see Worksheet #17-B).

How "good" do the data need to be in order to support the environmental decision? Data needs to meet the measurement quality objective and data quality indicators established by the systematic planning process. All fixed-laboratory data will be verified and assessed with 10% validated at Level IV.

How much data are needed? (number of samples for each analytical group, matrix, and concentration) Worksheet #18.

Where, when, and how should the data be collected/generated? See Work Plan and Field Sampling Plan.

Who will collect and generate the data? DOE's remediation contractor will assemble a sampling team of individuals who are properly trained and skilled in the execution of screening and sampling procedures will collect samples and perform the field screening measurements.

How will the data be reported? Field data will be recorded on chain-of-custody forms, in field logbooks, and field data sheets. The fixed-base laboratory will provide data in an electronic data deliverable (EDD). Project data following verification, assessment and validation will be placed into and reported from the Paducah OREIS.

How will the data be archived? Electronic data will be archived in OREIS. Hard-copy data will be submitted to the Document Management Center.

Worksheet #12-A
Measurement Performance Criteria Table

UFP-QAPP Manual Section 2.6.2:

Matrix	Soil/Sediment
Analytical Group[1]	Volatile Organic Compounds
Concentration Level	Low

Sampling Procedure[2]	Analytical Method/SOP[3, 4]	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
	SW846-8260	Precision–Lab	RPD–< 22%	Laboratory Duplicates	A
		Precision	RPD–< 50%	Field Duplicates	S
		Accuracy/Bias	% recovery[6]	Laboratory Sample Spikes	A
		Accuracy/Bias-Contamination	No target compounds > PQL	Method Blanks/Instrument Blanks	A
		Accuracy/Bias Contamination	No target compounds > PQL	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > PQL	Trip Blanks	S
		Accuracy/Bias Contamination	No target compounds > PQL	Equipment Rinseates	S
		Completeness[5]	90%	Data completeness check	S&A

PQL = practical quantitation limit
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] The most current version of the method will be used.
[5] Completeness is calculated as the number of samples planned to be collected divided by the number of sample results that were rejected.
[6] Percent recovery is laboratory-specific, calculated from studies performed every six months. Percent recovery ranges will be provided in the laboratory data packages based on the most current study.

Worksheet #12-B
Measurement Performance Criteria Table

Matrix	Soil/Sediment
Analytical Group[1]	Metals (Arsenic, barium, beryllium, cadmium, chromium, iron, lead, manganese, nickel, uranium and, vanadium)
Concentration Level	Low

Sampling Procedure[2]	Analytical Method/SOP[3, 4]	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
	SW846-6010/6020	Precision–Lab	RPD–≤ 35%	Laboratory Duplicates	A
		Precision	RPD–≤ 35%	Field Duplicates	S
		Accuracy/Bias	% recovery[6]	Laboratory Sample Spikes	A
		Accuracy/Bias-Contamination	No target compounds > PQL	Method Blanks/Instrument Blanks	A
		Accuracy/Bias-Contamination	No target compounds > PQL	Field Blanks	S
		Accuracy/Bias-Contamination	No target compounds > PQL	Equipment Rinseates	S
		Completeness[5]	90%	Data completeness check	S&A

PQL = practical quantitation limit
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] The most current version of the method will be used.
[5] Completeness is calculated as the number of samples planned to be collected divided by the number of sample results that were rejected.
[6] Percent recovery is laboratory-specific, calculated from studies performed every six months. Percent recovery ranges will be provided in the laboratory data packages based on the most current study.

Worksheet #12-C
Measurement Performance Criteria Table

Matrix	Soil/Sediment
Analytical Group[1]	Metals (Mercury)
Concentration Level	Low

Sampling Procedure[2]	Analytical Method/SOP[3, 4]	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
	SW846-7471	Precision–Lab	RPD–≤ 35%	Laboratory Duplicates	A
		Precision	RPD–≤ 35%	Field Duplicates	S
		Accuracy/Bias	% recovery[6]	Laboratory Sample Spikes	A
		Accuracy/Bias-Contamination	No target compounds > PQL	Method Blanks/Instrument Blanks	A
		Accuracy/Bias-Contamination	No target compounds > PQL	Field Blanks	S
		Accuracy/Bias-Contamination	No target compounds > PQL	Equipment Rinseates	S
		Completeness[5]	90%	Data completeness check	S&A

PQL = practical quantitation limit
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] The most current version of the method will be used.
[5] Completeness is calculated as the number of samples planned to be collected divided by the number of sample results that were rejected.
[6] Percent recovery is laboratory-specific, calculated from studies performed every six months. Percent recovery ranges will be provided in the laboratory data packages based on the most current study.

Worksheet #12-D
Measurement Performance Criteria Table

Matrix	Soil/Sediment
Analytical Group[1]	PCBs
Concentration Level	Low

Sampling Procedure[2]	Analytical Method/SOP[3, 4]	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
	SW846-8082	Precision–Lab	RPD–≤ 43%	Laboratory Duplicates	A
		Precision	RPD–≤ 43%	Field Duplicates	S
		Accuracy/Bias	% recovery[6]	Laboratory Sample Spikes	A
		Accuracy/Bias-Contamination	No target compounds > PQL	Method Blanks/Instrument Blanks	A
		Accuracy/Bias-Contamination	No target compounds > PQL	Field Blanks	S
		Accuracy/Bias-Contamination	No target compounds > PQL	Equipment Rinseates	S
		Completeness[5]	90%	Data completeness check	S&A

PQL = practical quantitation limit
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] The most current version of the method will be used.
[5] Completeness is calculated as the number of samples planned to be collected divided by the number of sample results that were rejected.
[6] Percent recovery is laboratory-specific, calculated from studies performed every six months. Percent recovery ranges will be provided in the laboratory data packages based on the most current study.

Worksheet #12-E
Measurement Performance Criteria Table

Matrix	Soil/Sediment
Analytical Group[1]	Radionuclides (uranium-234, uranium-235, uranium-238)
Concentration Level	Low

Sampling Procedure[2]	Analytical Method/SOP[3, 4]	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
	Alpha spectroscopy	Precision–Lab	RPD–≤ 25%	Laboratory Duplicates	A
		Precision	RPD–≤ 50%	Field Duplicates	S
		Accuracy/Bias	% recovery[6]	Laboratory Sample Spikes	A
		Accuracy/Bias-Contamination	No target compounds > MDA	Method Blanks/Instrument Blanks	A
		Accuracy/Bias Contamination	No target compounds > MDA	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > MDA	Equipment Rinseates	S
		Completeness[5]	90%	Data completeness check	S&A

MDA = minimum detectable activity
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] The most current version of the method will be used.
[5] Completeness is calculated as the number of samples planned to be collected divided by the number of sample results that were rejected.
[6] Percent recovery is laboratory-specific, calculated from studies performed every six months. Percent recovery ranges will be provided in the laboratory data packages based on the most current study.

Worksheet #12-F
Measurement Performance Criteria Table

Matrix	Soil/Sediment
Analytical Group[1]	Radionuclides (americium-241, neptunium-237, plutonium-238, plutonium-239/240, thorium-230)
Concentration Level	Low

Sampling Procedure[2]	**Analytical Method/SOP**[3, 4]	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
	Alpha spectroscopy	Precision–Lab	RPD–≤ 50%	Laboratory Duplicates	A
		Precision	RPD–≤ 50%	Field Duplicates	S
		Accuracy/Bias	% recovery[6]	Laboratory Sample Spikes	A
		Accuracy/Bias-Contamination	No target compounds > MDA	Method Blanks/Instrument Blanks	A
		Accuracy/Bias Contamination	No target compounds > MDA	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > MDA	Equipment Rinseates	S
		Completeness[5]	90%	Data completeness check	S&A

MDA = minimum detectable activity
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] The most current version of the method will be used.
[5] Completeness is calculated as the number of samples planned to be collected divided by the number of sample results that were rejected.
[6] Percent recovery is laboratory-specific, calculated from studies performed every six months. Percent recovery ranges will be provided in the laboratory data packages based on the most current study.

Worksheet #12-G
Measurement Performance Criteria Table

Matrix	Soil/Sediment
Analytical Group[1]	Radionuclides (cesium-137, cobalt-60)
Concentration Level	Low

Sampling Procedure[2]	**Analytical Method/SOP**[3, 4]	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
	Gamma spectroscopy	Precision–Lab	RPD–≤ 50%	Laboratory Duplicates	A
		Precision	RPD–≤ 50%	Field Duplicates	S
		Accuracy/Bias Contamination	No target compounds > MDA	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > MDA	Equipment Rinseates	S
		Completeness[5]	90%	Data completeness check	S&A

MDA = minimum detectable activity
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] The most current version of the method will be used.
[5] Completeness is calculated as the number of samples planned to be collected divided by the number of sample results that were rejected.

Worksheet #12-H
Measurement Performance Criteria Table

Matrix	Soil/Sediment
Analytical Group[1]	Radionuclides (technetium-99)
Concentration Level	Low

Sampling Procedure[2]	**Analytical Method/SOP**[3, 4]	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
	Liquid scintillation	Precision–Lab	RPD–≤ 50%	Laboratory Duplicates	A
		Precision	RPD–≤ 50%	Field Duplicates	S
		Accuracy/Bias	% recovery[6]	Laboratory Sample Spikes	A
		Accuracy/Bias-Contamination	No target compounds > MDA	Method Blanks/Instrument Blanks	A
		Accuracy/Bias Contamination	No target compounds > MDA	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > MDA	Equipment Rinseates	S
		Completeness[5]	90%	Data completeness check	S&A

MDA = minimum detectable activity
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] The most current version of the method will be used.
[5] Completeness is calculated as the number of samples planned to be collected divided by the number of sample results that were rejected.
[6] Percent recovery is laboratory-specific, calculated from studies performed every six months. Percent recovery ranges will be provided in the laboratory data packages based on the most current study.

Worksheet #12-I
Measurement Performance Criteria Table

Matrix	Soil/Sediment
Analytical Group[1]	Metals (arsenic, barium, beryllium, cadmium, chromium, iron, lead, manganese, mercury, nickel, uranium, and vanadium)
Concentration Level	Low

Sampling Procedure[2]	**Analytical Method/SOP**[3, 4]	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
	SW846-6200 (XRF)	Precision–Lab	RPD–≤ 20%	Laboratory Duplicates	A
		Precision	RPD–≤ 50%	Field Duplicates	S
		Accuracy/Bias	% recovery[6]	Laboratory Sample Spikes	A
		Accuracy/Bias-Contamination	No target compounds > PQL	Method Blanks/Instrument Blanks	A
		Accuracy/Bias Contamination	No target compounds > PQL	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > PQL	Equipment Rinseates	S
		Completeness[5]	90%	Data completeness check	S&A

PQL = practical quantitation limit
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] The most current version of the method will be used.
[5] Completeness is calculated as the number of samples planned to be collected divided by the number of sample results that were rejected.
[6] Percent recovery is laboratory-specific, calculated from studies performed as required. Percent recovery ranges will be provided in the laboratory data packages based on the most current study.

Worksheet #12-J
Measurement Performance Criteria Table

Matrix	Soil/Sediment
Analytical Group[1]	PCBs (test kits)
Concentration Level	Low

Sampling Procedure[2]	Analytical Method/SOP[3, 4]	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
	Manufacturer's instructions	Precision–Lab	n/a	n/a	n/a
		Precision	RPD–≤ 50%	Field Duplicates	S
		Accuracy/Bias	n/a	n/a	n/a
		Accuracy/Bias-Contamination	No target compounds > PQL	Method Blanks/Instrument Blanks	A
		Accuracy/Bias Contamination	No target compounds > PQL	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > PQL	Equipment Rinseates	S
		Completeness[5]	90%	Data completeness check	S&A

PQL = practical quantitation limit
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] The most current version of the method will be used.
[5] Completeness is calculated as the number of samples planned to be collected divided by the number of sample results that were rejected.
N/A = not applicable

Worksheet #12-K
Measurement Performance Criteria Table

Matrix	Water/Groundwater
Analytical Group[1]	Volatile Organic Compounds
Concentration Level	Low

Sampling Procedure[2]	**Analytical Method/SOP**[3, 4]	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
	SW846-8260	Precision–Lab	RPD–≤ 25%	Laboratory Duplicates	A
		Precision	RPD–≤ 25%	Field Duplicates	S
		Accuracy/Bias	% recovery[6]	Laboratory Sample Spikes	A
		Accuracy/Bias-Contamination	No target compounds > PQL	Method Blanks/Instrument Blanks	A
		Accuracy/Bias Contamination	No target compounds > PQL	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > PQL	Trip Blanks	S
		Accuracy/Bias Contamination	No target compounds > PQL	Equipment Rinseates	S
		Completeness[5]	90%	Data completeness check	S&A

PQL = practical quantitation limit
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] The most current version of the method will be used.
[5] Completeness is calculated as the number of samples planned to be collected divided by the number of sample results that were rejected.
[6] Percent recovery is laboratory-specific, calculated from studies performed every six months. Percent recovery ranges will be provided in the laboratory data packages based on the most current study.

Worksheet #12-L
Measurement Performance Criteria Table

Matrix	Water/Groundwater
Analytical Group[1]	Metals (arsenic, barium, beryllium, cadmium, chromium, iron, lead, manganese, nickel, uranium, and vanadium)
Concentration Level	Low

Sampling Procedure[2]	**Analytical Method/SOP**[3, 4]	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
	SW846-6010/6020	Precision–Lab	RPD–≤ 25%	Laboratory Duplicates	A
		Precision	RPD–≤ 25%	Field Duplicates	S
		Accuracy/Bias	% recovery[6]	Laboratory Sample Spikes	A
		Accuracy/Bias-Contamination	No target compounds > PQL	Method Blanks/Instrument Blanks	A
		Accuracy/Bias-Contamination	No target compounds > PQL	Field Blanks	S
		Accuracy/Bias-Contamination	No target compounds > PQL	Equipment Rinseates	S
		Completeness[5]	90%	Data completeness check	S&A

PQL = practical quantitation limit
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] The most current version of the method will be used.
[5] Completeness is calculated as the number of samples planned to be collected divided by the number of sample results that were rejected.
[6] Percent recovery is laboratory-specific, calculated from studies performed every six months. Percent recovery ranges will be provided in the laboratory data packages based on the most current study.

Worksheet #12-M
Measurement Performance Criteria Table

Matrix	Water/groundwater
Analytical Group[1]	Metals (Mercury)
Concentration Level	Low

Sampling Procedure[2]	Analytical Method/SOP[3, 4]	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
	SW846-7470	Precision–Lab	RPD–≤ 25%	Laboratory Duplicates	A
		Precision	RPD–≤ 25%	Field Duplicates	S
		Accuracy/Bias	% recovery[6]	Laboratory Sample Spikes	A
		Accuracy/Bias-Contamination	No target compounds > PQL	Method Blanks/Instrument Blanks	A
		Accuracy/Bias-Contamination	No target compounds > PQL	Field Blanks	S
		Accuracy/Bias-Contamination	No target compounds > PQL	Equipment Rinseates	S
		Completeness[5]	90%	Data completeness check	S&A

PQL = practical quantitation limit
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] The most current version of the method will be used.
[5] Completeness is calculated as the number of samples planned to be collected divided by the number of sample results that were rejected.
[6] Percent recovery is laboratory-specific, calculated from studies performed every six months. Percent recovery ranges will be provided in the laboratory data packages based on the most current study.

Worksheet #12-N
Measurement Performance Criteria Table

Matrix	Water/groundwater
Analytical Group[1]	PCBs
Concentration Level	Low

Sampling Procedure[2]	Analytical Method/SOP[3, 4]	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
	SW846-8082	Precision–Lab	RPD–≤ 25%	Laboratory Duplicates	A
		Precision	RPD–≤ 25%	Field Duplicates	S
		Accuracy/Bias	% recovery[6]	Laboratory Sample Spikes	A
		Accuracy/Bias-Contamination	No target compounds > PQL	Method Blanks/Instrument Blanks	A
		Accuracy/Bias-Contamination	No target compounds > PQL	Field Blanks	S
		Accuracy/Bias-Contamination	No target compounds > PQL	Equipment Rinseates	S
		Completeness[5]	90%	Data completeness check	S&A

PQL = practical quantitation limit
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] The most current version of the method will be used.
[5] Completeness is calculated as the number of samples planned to be collected divided by the number of sample results that were rejected.
[6] Percent recovery is laboratory-specific, calculated from studies performed every six months. Percent recovery ranges will be provided in the laboratory data packages based on the most current study.

Worksheet #12-O
Measurement Performance Criteria Table

Matrix	Water/groundwater
Analytical Group[1]	Radionuclides (americium-241, neptunium-237, plutonium-238, plutonium-239/240, thorium-230, uranium-234, uranium-235, uranium-238)
Concentration Level	Low

Sampling Procedure[2]	Analytical Method/SOP[3, 4]	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
	Alpha spectroscopy	Precision–Lab	RPD–≤ 25%	Laboratory Duplicates	A
		Precision	RPD–≤ 25%	Field Duplicates	S
		Accuracy/Bias	% recovery[6]	Laboratory Sample Spikes	A
		Accuracy/Bias-Contamination	No target compounds > MDA	Method Blanks/Instrument Blanks	A
		Accuracy/Bias Contamination	No target compounds > MDA	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > MDA	Equipment Rinseates	S
		Completeness[5]	90%	Data completeness check	S&A

MDA = minimum detectable activity
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] The most current version of the method will be used.
[5] Completeness is calculated as the number of samples planned to be collected divided by the number of sample results that were rejected.
[6] Percent recovery is laboratory-specific, calculated from studies performed every six months. Percent recovery ranges will be provided in the laboratory data packages based on the most current study.

Worksheet #12-P
Measurement Performance Criteria Table

Matrix	Water/groundwater
Analytical Group[1]	Radionuclides (cesium-137, cobalt-60)
Concentration Level	Low

Sampling Procedure[2]	Analytical Method/SOP[3, 4]	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
	Gamma spectroscopy	Precision–Lab	RPD–≤ 25%	Laboratory Duplicates	A
		Precision	RPD–≤ 25%	Field Duplicates	S
		Accuracy/Bias Contamination	No target compounds > MDA	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > MDA	Equipment Rinseates	S
		Completeness[5]	90%	Data completeness check	S&A

MDA = minimum detectable activity
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] The most current version of the method will be used.
[5] Completeness is calculated as the number of samples planned to be collected divided by the number of sample results that were rejected.

Worksheet #12-Q
Measurement Performance Criteria Table

Matrix	Water/groundwater
Analytical Group[1]	Radionuclides (technetium-99)
Concentration Level	Low

Sampling Procedure[2]	Analytical Method/SOP[3, 4]	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
	Liquid scintillation	Precision–Lab	RPD–≤ 25%	Laboratory Duplicates	A
		Precision	RPD–≤ 25%	Field Duplicates	S
		Accuracy/Bias	% recovery[6]	Laboratory Sample Spikes	A
		Accuracy/Bias-Contamination	No target compounds > MDA	Method Blanks/Instrument Blanks	A
		Accuracy/Bias Contamination	No target compounds > MDA	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > MDA	Equipment Rinseates	S
		Completeness[5]	90%	Data completeness check	S&A

MDA = minimum detectable activity
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] The most current version of the method will be used.
[5] Completeness is calculated as the number of samples planned to be collected divided by the number of sample results that were rejected.
[6] Percent recovery is laboratory-specific, calculated from studies performed every six months. Percent recovery ranges will be provided in the laboratory data packages based on the most current study.

Worksheet #13
Secondary Data Criteria and Limitations Table

Secondary Data	Data Source (Originating Organization, Report Title, and Date)	Data Generator(s) (Originating Org., Data Types, Data Generation/Collection Dates)	How Data Will Be Used	Limitations on Data Use
OREIS Database	Various	Various	The data in the OREIS database will be used in conjunction with newly acquired data to fill data gaps, as described in Worksheet #10 (e.g., COC data in the OREIS database will be used in conjunction with newly acquired data, using professional judgment considering the uncertainties of the historic data, to determine whether COCs are present in the burial cells, as well as the extent and mass of TCE contamination with sufficient accuracy to complete a remedial design for a remedy in the burial cells).	The changes that may have taken place in the *in situ* environmental media since collecting older data must be considered.

Worksheet #13
Secondary Data Criteria and Limitations Table (Continued)

Secondary Data	Data Source (Originating Organization, Report Title, and Date)	Data Generator(s) (Originating Org., Data Types, Data Generation/Collection Dates)	How Data Will Be Used	Limitations on Data Use
Historical Documentation	CH2M Hill 1992. *Results of the Site Investigation, Phase II, Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, KY/Sub/13B-97777C P03/1991/1. Clausen, J. L., K. R. Davis, J. W. Douthitt, and B. E. Phillips 1992. *Report of the Paducah Gaseous Diffusion Plant Groundwater Investigation Phase III*, KY/E-150, Paducah, KY. DOE 2000a. *Remedial Investigation Report for Waste Area Grouping 3 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1895/V1-V4&D1, U.S. Department of Energy, Paducah, KY, September. DOE 2000b. *Data Report for the Sitewide Remedial Evaluation for Source Areas Contributing to Off-site Groundwater Contamination at the Paducah Gaseous Diffusion Plant, Paducah Kentucky*, DOE/OR/07-1845&D1).	DOE contractors, soil and water, 1998–2008	Information will be used in conjunction with newly collected data to determine whether COCs are present in the burial cells, as well as the extent and mass of TCE contamination with sufficient accuracy to complete a remedial design for a remedy in the burial cells.	Data have been verified, assessed, and validated (if validation required). Rejected data will not be used.

Worksheet #14
Summary of Project Tasks*

Sampling Tasks: Collect samples, prepare blanks, preserve samples, document field notes, complete chain-of-custody, label samples, package/ship samples per standard operating procedures Worksheet #21.

Analysis Tasks: Receive samples, complete chain-of-custody, extract samples, analyze extract, review data, report data per standard methods Worksheet #21.

Quality Control Tasks: QC will be per QAPP worksheets as follows:

- QC samples¾ Worksheets #20 and #28
- Equipment calibration¾ Worksheets #22 and #24
- Data review/validation¾ Worksheets #34, #35, #36, and #37

Secondary Data: See Worksheet #13.

Data Management Tasks: Data management will be per procedure PAD-ENM-5007, *Data Management Coordination*, and the data management implementation plan found in the BGOU RI Work Plan (DOE/OR/07-2179&D2/R1).

Documentation and Records: Documentation and records will be per procedure PAD-RM-1009, *Records Management, Administrative Records, and Document Control.*

Assessment/Audit Tasks: Assessments and audits will be per procedure PAD-QAP-1420, *Conduct of Assessments.*

Prior to mobilization to perform fieldwork, an independent assessment (Internal Field Readiness Review) will be conducted to determine if the project is prepared to proceed (e.g., scope has been defined and is understood by workforce, scope has regulatory approval, scope properly contracts, personnel properly training to complete).

One management assessment will be performed during each phase (Phase I, II, III, IV) of field implementation to verify work is being performed consistent with the SAP. See project schedule on Worksheet #16.

Data Review Tasks: Data review tasks will be per procedure PAD-ENM-5003, *Quality Assured Data.*

* It is understood that SOPs are contractor specific.

Worksheet #15-A
Reference Limits and Evaluation Table

Matrix:Water
Analyte Group: VOCs

VOCs	CAS Number	Project Action Limit/NAL (µg/L)[a]	Project Action Limit Reference[b]	Site COPC[c]	Laboratory-Specific*	
					PQLs (µg/L)	MDLs (µg/L)
Acrylonitrile	107-13-1	4.77 E-05	NAL	Yes	10	TBD
Benzene	71-43-2	4.27 E-04	NAL	Yes	5	TBD
Carbon tetrachloride	56-23-5	1.97 E-04	NAL	Yes	5	TBD
Chloroform	67-66-3	2.27 E-04	NAL	Yes	5	TBD
1,1-Dichloroethene	75-35-4	5.11 E-05	NAL	Yes	5	TBD
cis-1,2-Dichloroethene	156-59-2	2.49 E-03	NAL	Yes	1	TBD
Dichlorodifluoromethane	75-71-8	Not Calculated	Not Calculated	Unknown	5	TBD
Ethylbenzene	100-41-4	1.51 E-03	NAL	Yes	5	TBD
Tetrachloroethene	127-18-4	7.81 E-05	NAL	Yes	5	TBD
Trichloroethene	79-01-6	4.65 E-05	NAL	Yes	1	TBD
Vinyl Chloride	75-01-4	7.25 E-05	NAL	Yes	2	TBD
Total Xylenes	1330-20-7	9.01 E-03	NAL	Yes	15	TBD
Xylene o	95-47-6	4.85 E-02	NAL	Yes	15	TBD
Xylene m	108-38-3	4.83 E-02	NAL	Yes	15	TBD
Xylene p	106-42-3	4.84 E-02	NAL	Yes	15	TBD

* The quantitation limits achievable by the contracted laboratory will be reported to the FFA parties in a letter after the laboratory contract has been finalized.
[a] These values are taken from Table A.6 of the Risk Methods Document using the child resident NAL(DOE 2011b).
[b] NAL is for child resident scenario from the Risk Methods Document (DOE 2011b).
[c] Analytes marked with COPC are from Table 2.1 of the Risk Methods Document (DOE 2011b) and represent the list of chemicals, compounds, and radionuclides compiled from chemicals of potential concern retained as contaminants of concern in risk assessments performed at PGDP between 1990 and 2008.

Worksheet #15-B
Reference Limits and Evaluation Table

Matrix: Water
Analytical Group: Metals

Metals	CAS Number	Project Action Limit/NAL (mg/L)[a]	Project Action Limit Reference[b]	RGA Background (mg/L)[c]	Site COPC?[d]	Laboratory-Specific*	
						PQLs (mg/L)	MDLs (mg/L)
Arsenic	7440-38-2	3.80 E-05	NAL	0.005	Yes	0.001	TBD
Barium	7440-39-3	2.06 E-01	NAL	0.202	Yes	0.005	TBD
Beryllium	7440-41-7	1.12 E-05	NAL	0.004	Yes	0.001	TBD
Cadmium	7440-43-9	1.46 E-04	NAL	0.010	Yes	0.001	TBD
Chromium (total)	7440-47-3	1.47 E+00	NAL	0.134	Yes	0.010	TBD
Iron	7439-89-6	7.29 E-01	NAL	3.72	Yes	0.200	TBD
Lead	7439-92-1	1.50 E-02	NAL	0.25	Yes	0.0013	TBD
Manganese	7439-96-5	2.45 E-02	NAL	0.082	Yes	0.005	TBD
Mercury	7439-97-6	3.09 E-04	NAL	0.0002	Yes	0.0002	TBD
Nickel	7440-02-0	2.08 E-02	NAL	0.682	Yes	0.005	TBD
Uranium	7440-61-1	3.13 E-03	NAL	0.002	Yes	0.001	TBD
Vanadium	7440-62-2	7.06 E-05	NAL	0.139	Yes	0.020	TBD

* The quantitation limits achievable by the contracted laboratory will be reported to the FFA parties in a letter after the laboratory contract has been finalized.
[a] These values are taken from Table A.6 of the Risk Methods Document using the child resident NAL(DOE 2011b).
[b] NAL is for child resident scenario from the Risk Methods Document (DOE 2011b).
[c] These values are taken from Table A.13 of the Risk Methods Document (DOE 2011b) and represent background concentrations for groundwater drawn from the RGA and McNairy formation at PGDP, using observations wells and unfiltered samples. The contracted laboratory will be required to meet the higher of either background or the PAL.
[d] Analytes marked with COPC are from Table 2.1 of the Risk Methods Document (DOE 2011b) and represent the list of chemicals, compounds, and radionuclides compiled from chemicals of potential concern retained as contaminants of concern in risk assessments performed at PGDP between 1990 and 2008.

Worksheet #15-C
Reference Limits and Evaluation Table

Matrix: Water
Analytical Group: PCBs

PCBs	CAS Number	Project Action Limit (µg/L)[a]	Project Action Limit Reference[b]	Site COPC?[c]	Laboratory-Specific*	
					PQLs (µg/L)	MDLs (µg/L)
Aroclor-1016	12674-11-2	1.99 E-02	NAL	Yes	0.17	TBD
Aroclor-1221	11104-28-2	6.73 E-02	NAL	Yes	0.18	TBD
Aroclor-1232	11141-16-5	6.73 E-02	NAL	Yes	0.14	TBD
Aroclor-1242	53469-21-9	1.59 E-02	NAL	Yes	0.1	TBD
Aroclor-1248	12672-29-6	1.49 E-02	NAL	Yes	0.12	TBD
Aroclor-1254	11097-69-1	1.87 E-03	NAL	Yes	0.07	TBD
Aroclor-1260	11096-82-5	1.72 E-03	NAL	Yes	0.05	TBD
Aroclor-1268	11100-14-4	Not Calculated	None	Unknown	0.09	TBD

* The quantitation limits achievable by the contracted laboratory will be reported to the FFA parties in a letter after the laboratory contract has been finalized.
[a] NAL is for child resident scenario from the Risk Methods Document (DOE 2011b).
[b] NAL is for child resident scenario from the Risk Methods Document (DOE 2011b).
[c] Analytes marked with COPC are from Table 2.1 of the Risk Methods Document (DOE 2011b) and represent the list of chemicals, compounds, and radionuclides compiled from chemicals of potential concern retained as contaminants of concern in risk assessments performed at PGDP between 1990 and 2008.

Worksheet #15-D
Reference Limits and Evaluation Table

Matrix: Water Analytical Group: Radionuclides

Radionuclides	CAS Number	Project Action Limit (pCi/L)[a]	Project Action Limit Reference[b]	RGA Background (pCi/L)[c]	Site COPC?[d]	Laboratory-Specific* MDAs (pCi//L)
Americium-241	14596-10-2	9.06 E-01	NAL	NA	Yes	TBD
Cesium-137	10045-97-3	3.10 E+00	NAL	NA	Yes	TBD
Cobalt-60	10198-40-0	6.00 E+00	NAL	NA	Yes	TBD
Neptunium-237	13994-20-2	1.40 E+00	NAL	0.21	Yes	TBD
Plutonium-238	13981-16-3	7.19 E-01	NAL	NA	Yes	TBD
Plutonium-239/240	15117-48-3/ 14119-33-6	6.98 E-01	NAL	0.03	Yes	TBD
Technetium-99	14133-76-7	3.43 E+01	NAL	10.8	Yes	TBD
Thorium-230	14269-63-7	1.04 E+00	NAL	0.54	Yes	TBD
Uranium-234	13966-29-5	1.33 E+00	NAL	0.7	Yes	TBD
Uranium-235	15117-96-1	1.31 E+00	NAL	0.3	Yes	TBD
Uranium-238	24678-82-8	1.08 E+00	NAL	0.7	Yes	TBD

* The quantitation limits achievable by the contracted laboratory will be reported to the FFA parties in a letter after the laboratory contract has been finalized.
[a] PAL and NAL are for the child resident scenario from the Risk Methods Document (DOE 2011b).
[b] NAL is for child resident scenario from the Risk Methods Document (DOE 2011b).
[c] These values are taken from Table A.13 of the Risk Methods Document (DOE 2011b) and represent background concentrations for groundwater drawn from the RGA and McNairy formation at PGDP, using observations wells and unfiltered samples. The contracted laboratory will be required to meet the higher of either background or the PAL.
[d] Analytes marked with COPC are from Table 2.1 of the Risk Methods Document (DOE 2011b) and represent the list of chemicals, compounds, and radionuclides compiled from chemicals of potential concern retained as contaminants of concern in risk assessments performed at PGDP between 1990 and 2008.

Worksheet #15-E
Reference Limits and Evaluation Table

Matrix: Soils/Sediment
Analytical Group: Metals

Metals	CAS Number	Project Action Limit (mg/kg)[a]	Project Action Limit Reference[b]	Background (mg/kg) Surface/Subsurface[c]	Site COPC?[d]	Laboratory-Specific*	
						PQLs (mg/kg)	MDLs (mg/kg)
Arsenic	7440-38-2	9.97E-01	NAL	12/7.9	Yes	1	TBD
Barium	7440-39-3	5.92E+02	NAL	200/170	Yes	2.5	TBD
Beryllium	7440-41-7	1.40E-02	NAL	0.67/0.69	Yes	0.5	TBD
Cadmium	7440-43-9	3.16E+00	NAL	0.21/0.21	Yes	0.5	TBD
Chromium (total)	7440-47-3	3.02E+01	NAL	16/43	Yes	2.5	TBD
Iron	7439-89-6	2.51E+04	NAL	28,000/28,000	Yes	20	TBD
Lead	7439-92-1	4.00E+02	NAL	36/23	Yes	1	TBD
Manganese	7439-96-5	2.58E+03	NAL	1,500/820	Yes	2.5	TBD
Mercury	7439-97-6	9.00E-01	NAL	0.2/0.13	Yes	0.02	TBD
Nickel	7440-02-0	4.28E+01	NAL	21/22	Yes	5	TBD
Uranium	7440-61-1	1.07E+02	NAL	4.9/4.6	Yes	1	TBD
Vanadium	7440-62-2	1.51E-01	NAL	38/37	Yes	2.5	TBD

* The quantitation limits achievable by the contracted laboratory will be reported to the FFA parties in a letter after the laboratory contract has been finalized.
[a] PAL and NAL are taken from Table A.4 of the Risk Methods Document using the industrial worker NAL (DOE 2011b).
[b] NAL is for industrial worker scenario from the Risk Methods Document (DOE 2011b).
[c] These values are taken from Table A.12 of the Risk Methods Document (DOE 2011b).
[d] Analytes marked with COPC are from Table 2.1 of the Risk Methods Document (DOE 2011b) and represent the list of chemicals, compounds, and radionuclides compiled from chemicals of potential concern retained as contaminants of concern in risk assessments performed at PGDP between 1990 and 2008.

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Worksheet #15-F
Reference Limits and Evaluation Table

Matrix: Soils/Sediments
Analytical Group: PCBs

PCBs	CAS Number	Project Action Limit (mg/kg)[a]	Project Action Limit Reference[b]	Site COPC?[c]	Laboratory-Specific*	
					PQLs (mg/kg)	MDLs (mg/kg)
Aroclor-1016	12674-11-2	1.82E-01	NAL	Yes	0.13	TBD
Aroclor-1221	11104-28-2	1.10E-01	NAL	Yes	0.13	TBD
Aroclor-1232	11141-16-5	1.10E-01	NAL	Yes	0.13	TBD
Aroclor-1242	53469-21-9	1.86E-01	NAL	Yes	0.13	TBD
Aroclor-1248	12672-29-6	2.02E-01	NAL	Yes	0.13	TBD
Aroclor-1254	11097-69-1	1.89E-01	NAL	Yes	0.13	TBD
Aroclor-1260	11096-82-5	1.94E-01	NAL	Yes	0.13	TBD
Aroclor-1268	11100-14-4	Not Calculated	None	Unknown	0.13	TBD

* The quantitation limits achievable by the contracted laboratory will be reported to the FFA parties in a letter after the laboratory contract has been finalized.
[a] PAL and NAL are taken from Table A.4 of the Risk Methods Document using the industrial worker NAL (DOE 2011b).
[b] NAL is for industrial worker scenario from the Risk Methods Document (DOE 2011b).
[c] Analytes marked with COPC are from Table 2.1 of the Risk Methods Document (DOE 2011b) and represent the list of chemicals, compounds, and radionuclides compiled from chemicals of potential concern retained as contaminants of concern in risk assessments performed at PGDP between 1990 and 2008.

Worksheet #15-G
Reference Limits and Evaluation Table

Matrix:
Soils/Sediments
Analytical Group: Radionuclides

Radionuclides	CAS Number	Project Action Limit (pCi/g)[a]	Project Action Limit Reference[b]	Background (pCi/g) Surface/subsurface[c]	Site COPC?[d]	Laboratory-Specific* MDAs (pCi/g)
Americium-241	14596-10-2	5.01E+00	NAL	NA	Yes	TBD
Cesium-137	10045-97-3	8.61E-02	NAL	0.49/0.28	Yes	TBD
Cobalt-60	7440-48-4	1.77E-02	NAL	NA	Yes	TBD
Neptunium-237	13994-20-2	2.71E-01	NAL	0.1/NA	Yes	TBD
Plutonium-238	13981-16-3	1.09E+01	NAL	0.073/NA	Yes	TBD
Plutonium-239/240	15117-48-3/ 14119-33-6	1.07E+01	NAL	0.025/NA	Yes	TBD
Technetium-99	14133-76-7	3.61E+02	NAL	2.5/2.8	Yes	TBD
Thorium-230	14269-63-7	1.38E+01	NAL	1.5/1.4	Yes	TBD
Uranium-234	13966-29-5	1.89E+01	NAL	1.2/1.2	Yes	TBD
Uranium-235	15117-96-1	3.95E-01	NAL	0.06/0.06	Yes	TBD
Uranium-238	24678-82-8	1.70E+00	NAL	1.2/1.2	Yes	TBD

* The quantitation limits achievable by the contracted laboratory will be reported to the FFA parties in a letter after the laboratory contract has been finalized.
[a] PAL and NAL are taken from Table A.4 of the Risk Methods Document using the industrial worker NAL (DOE 2011b).
[b] NAL is for industrial worker scenario from the Risk Methods Document (DOE 2011b).
[c] These values are taken from Table A.12 of the Risk Methods Document (DOE 2011b).
[d] Analytes marked with COPC are from Table 2.1 of the Risk Methods Document (DOE 2011b) and represent the list of chemicals, compounds, and radionuclides compiled from chemicals of potential concern retained as contaminants of concern in risk assessments performed at PGDP between 1990 and 2008. The contracted laboratory will be required to meet the higher of either background or the PAL.

Worksheet #15-H
Reference Limits and Evaluation Table

Matrix: Soils/Sediments
Analytical Group: VOCs

VOCs	CAS Number	Project Action Limit (µg/kg)[a]	Project Action Limit Reference[b]	Site COPC?[c]	Laboratory-Specific*	
					PQLs (µg/kg)	MDLs (µg/kg)
Acrylonitrile	107-13-1	1.70E-01	NAL	Yes	10	TBD
Benzene	71-43-2	6.98E-01	NAL	Yes	10	TBD
Carbon Tetrachloride	56-23-5	2.07E-01	NAL	Yes	10	TBD
Chloroform	67-66-3	2.42E-01	NAL	Yes	10	TBD
1,1-Dichloroethene	75-35-4	4.89E-02	NAL	Yes	10	TBD
cis-1,2-Dichloroethene	156-59-2	6.14E+00	NAL	Yes	10	TBD
Dichlorodifluoromethane	75-71-8	Not Calculated	None	Unknown	5	TBD
Ethylbenzene	100-41-4	3.29E+00	NAL	Yes	10	TBD
Tetrachloroethene	127-18-4	2.82E-01	NAL	Yes	10	TBD
Trichloroethene	79-01-62	4.69E-02	NAL	Yes	10	TBD
Vinyl chloride	75-01-4	2.04E-01	NAL	Yes	10	TBD
Total xylenes	1330-20-7	3.50E+01	NA	Yes	15	TBD
Xylene p	106-42-3	2.11E+02	NAL	Yes	10	TBD
Xylene m	108-38-3	2.07E+02	NAL	Yes	10	TBD

Worksheet #15-H (Continued)
Reference Limits and Evaluation Table

VOCs	CAS Number	Project Action Limit (µg/Kg)[a]	Project Action Limit Reference[b]	Site COPC?[c]	Laboratory-Specific*	
					PQLs (µg/kg)	MDLs (µg/kg)
Xylene o	95-47-6	2.38E+02	NAL	Yes	10	TBD

* The quantitation limits achievable by the contracted laboratory will be reported to the FFA parties in a letter after the laboratory contract has been finalized.
[a] PAL and NAL are taken from Table A.4 of the Risk Methods Document using the industrial worker NAL (DOE 2011b).
[b] NAL is for industrial worker scenario from the Risk Methods Document (DOE 2011b).
[c] Analytes marked with COPC are from Table 2.1 of the Risk Methods Document (DOE 2011b) and represent the list of chemicals, compounds, and radionuclides compiled from chemicals of potential concern retained as contaminants of concern in risk assessments performed at PGDP between 1990 and 2008.

Worksheet #16
Project Schedule/Timeline Table

Activities	Organization	Dates*		Deliverable	Deliverable Due Date
		Anticipated Date(s) of Initiation	Anticipated Date of Completion		
SWMU 4 Sampling	BGOU	05-Apr-12	31-Aug-13	N/A	N/A
Procurement/Work Package Development and Management Readiness Review	BGOU	05-Apr-12	31-Aug-12	Work Package	31-Aug-12
Phase 1					
Collection of Soil & Gas Samples****	BGOU	27-Aug-12	01-Nov-12	Samples	01-Nov-12
Sample Analysis	BGOU	04-Sep-12	31-Nov-12	Data	31-Nov-12
Determine 20 ft boring locations based on soil gas analysis**	BGOU	01-Dec-12	04-Jan-13	Locations of 20 ft borings	04-Jan-13
Phase 2					
Collection of Samples****	BGOU	15-Dec-12	18-Jan-13	Samples	18-Jan-13
Sample Analysis	BGOU	20-Dec-12	18-Feb-13	Data	18-Feb-13
Determine locations for 58 ft borings**	BGOU	26-Jan-13	18-Feb-13	Locations for 58 ft borings	18-Feb-13
Phase 3					
Collection of Samples****	BGOU	22-Jan-13	14-Mar-13	Samples	14-Mar-13
Sample Analysis	BGOU	25-Feb-13	14-Apr-13	Data	14-Apr-13
Determine RGA boring locations**	BGOU	21-Mar-13	30-Mar-13	RGA boring locations	30-Mar-13
Phase 4					
Collection of Samples****	BGOU	07-Apr-13	22-May-13	Samples	22-May-13
Sample Analysis	BGOU	10-Apr-13	22-Jun-13	Data	22-Jun-13
Determine RGA boring locations**	BGOU	29-May-13	12-Jun-13	RGA boring locations	12-Jun-13
Phase 5					
Install/Develop Monitoring Wells**	BGOU	18-Jun-13	01-Aug-13	Monitoring Wells	01-Aug-13
Water Sample and Analysis	BGOU	23-Jun-13	31-Aug-13	Data package for inclusion in OREIS	31-Aug-13
Slug test	BGOU	23-Jun-13	31-Aug-13	Field report for inclusion in the RI Report	31-Aug-13
Phase 2					
Test Pits***	BGOU	03-Aug-13	13-Aug-13	Test Pits	13-Aug-13

* These dates are for project planning purposes only, not enforceable milestones. Enforceable milestones are found in the Site Management Plan.
** This activity includes a “hold point” at which consultation with the FFA parties will occur prior to executing the subsequent Phase or for final selection of testing and sampling locations.
*** Consult regulators prior to returning waste or waste like materials to the pit.
**** A management assessment will occur as part of this activity.

Worksheet #17-A
Sampling Design and Rationale

Describe and provide a rationale for choosing the sampling approach (e.g., grid system, judgmental statistical approach):
The investigation will be implemented in five phases. The first phase will utilize passive soil gas technology to identify areas within the SWMU that feature elevated VOC soil vapor readings. The rationale for this phase is to provide screening level data to determine the best location of subsequent data collection efforts. These are employed because they are fast, easy, and inexpensive and provide data adequate for this screening-level phase of the project. Though the sphere, or radius, of effectiveness is influence by many factors (e.g., depth and concentration of the source, soil porosity, etc.) and difficult to determine, the method will detect VOCs over a larger area than a conventional soil sample. The first phase also will consist of collecting surface soil samples to determine contaminant distribution and concentration in surface soils. This will be accomplished using 5-point composite sampling that will be analyzed using field techniques, and sending 10% of the total to a fixed-based laboratory. The rationale for this is to get the maximum coverage of the area while minimizing analytical costs. The second phase will collect shallow (< 20 ft bgs) samples. These samples will be used to identify VOC concentrations, along with other COCs, in the disposal cells and adjacent shallow soils. The results from the passive soil gas sampling and historical soil and water sample result will be used to select locations most likely to contain elevated COCs. The third phase of the investigation will include DPT at the locations agreed to by the FFA parties. The rationale for this phase is to determine the contaminant gradient with depth and the lateral extent of contamination. Phase Four will install 10 borings to the top of the McNairy formation, approximately 105 ft. The rational for these borings is to determine the concentrations in RGA groundwater up and downgradient of SWMU 4, the concentrations of COCs, as well as the contaminant gradient with depth. Phase Five will include installation of five additional RGA monitoring wells. The rationale for this sampling is to define the nature and extent of VOC source term so that a remedial design for VOCs can be completed. Samples will be collected from soil and water (where encountered) at the base of the UCRS (HU 4) to identify where VOC source term may have penetrated to the RGA. Additional samples will be collected from soil at the interface with the McNairy to complete a remedial design for a VOC remedy in the RGA, if a free-phase TCE source is found at the base of the RGA. A second objective of Phase Five is to collect sufficient quality and quantity of data to determine the RGA groundwater velocity and flow direction.

Worksheet #17-A (Continued)
Sampling Design and Rationale

Describe the sampling design and rationale in terms of which matrices will be sampled: Passive soil gas sampling will be used to determine the locations of highest VOC concentrations. Soil borings will collect soil samples, both judgmental (based on the passive soil gas sampling results) and impartial, and water samples where water is encountered. Soil samples will be analyzed for VOCs as well as other COCs. Water samples will be analyzed for VOCs. Twenty-two soil borings will be sampled down to 20 ft bgs, with 10 selected locations extended to 58 ft bgs. Ten additional borings will be advanced 105 ft to the bottom of the RGA/top of the McNairy formation and water samples taken every 5 ft after water is encountered.

- What analyses will be performed and at what method detection limits?

  Standard Environmental Sampling: Total volatile organic analyte (VOA) analysis by SW846, 8260; PCB extraction by SW846-3150C for water, PCB extraction for soil by SW846-3540C or SW846-3546, analysis by 8082, metal analysis by SW846, 200.8/6010B/6020; radiological analysis by alpha spec, gamma spec, and liquid scintillation. See Worksheet #12 for method detection limit.

  Engineering and Design Sampling: Natural oxidant demand by ASTM D7262-10; chemical oxygen demand by EPA 410.4; total and dissolved organic carbon by SW846, 9060. See worksheet 17B for additional details.

- Where the sampling locations (including QC, critical, and background samples)? See Worksheet #18.

- How many samples to be taken? 161 soil samples, up to 132 water samples (dependant on water yield). See Worksheet #18.

- What is the sampling frequency (including seasonal considerations)? This is a one-time sampling event except for the piezometer, which will be measured monthly for 12 months in order to determine the effects of various seasonal conditions on groundwater level. Installed wells will be sampled once upon completion; subsequent sampling will be based on the Environmental Monitoring Plan for the PGDP, which is updated annually. Thus seasonal conditions at the time of sampling are unknown. Passive soil gas sampling is the only other sampling that may be affected by seasonal conditions; it is assumed that unsaturated soil conditions are optimal for this data gathering; the manufacturer will be consulted and the deployment schedule may be altered to avoid seasonal saturation.

Worksheet #17-B
Sampling Design and Rationale (Engineering and Design Sampling)

	Media Type	# of Samples	Test/Analytical Method	Project Action Limit	PQL
Grain Size Data	Soil	4 UCRS, 3 RGA	ASTM D6913-04	NA	NA
Air Permeability	Soil	1	ASTM D6539	10^{-10} cm^2	NA
Percolation Test	Soil	4 UCRS	ASTM D7242-06	10^{-5} cm/s	NA
Electrical Resistance	Soil	2	ASTM D6431-99 (2010)	NA	NA
Electron Donor Parameters					
Chemical Oxygen Demand	Water	2	EPA 410.4	NA	27 mg/L
Total Organic Carbon	Water	2	EPA 415.1/ SW846-9060	20 mg/L	1 mg/L
Dissolved Organic Carbon	Water	2	EPA 415.1/ SW856-9060	20 mg/L	1 mg/L
Field Parameters					
DO	Water	All Water	Hach Quanta Hydrolab	0.5 mg/L	0.2 mg/L
pH	Water	All Water	Hach Quanta Hydrolab	5 to 9 Std Units	02. Std Units
Redox	Water	All Water	Hach Quanta Hydrolab	50 mV against Ag/AgCl	20 mV
Temperature	Water	All Water	Hach Quanta Hydrolab	20°C	0.1°C
Specific Conductance		All Water	Hach Quanta Hydrolab	NA	0.001 mS/cm
Metals	Soil		XRF	See WS 12	WS 12
PCBs	Soil		PCB test kits	See WS 12	WS 12
Soil gas	gas		Passive gas samplers	See WS 12	WS 12
Microbial Parameters					
Microbial Community	Soil	2	Laboratory SOP	1,000 cells/mL of sample	
Molecular Parameter	Soil	2	Laboratory SOP		NA
Water Quality Parameters[1]					
Sulfate	Water	1	EPA 300.0/SW846-9056	20 mg/L	2 mg/L
Chloride	Water	1	EPA 300.0/SW846-9056	NA	2 mg/L
Calcium	Water	1	SW846-6010B	NA	1 mg/L
Nitrate	Water	1	EPA 300.0/SW846-9056	1 mg/L	4 mg/L
Ferrous Iron	Water	1	SM 3500-Fe B	1 mg/L	0.3 mg/L
Natural Oxidant Demand	Soil	2	ASTM D7262-10	NA	1 g $KMnO_4$/kg

[1] Water can be collected during remedial design from wells in or adjacent to SWMU 4.

Worksheet #18
Sampling Locations and Methods/Standard Operating Procedure Requirements Table for Screening Samples

Sampling Location/ID Number	Matrix	Depth (units)	Analytical Group	Concentration Level	Number of Samples (Identify Field Duplicates)[a]	Sampling SOP Reference[b]	Rationale for Sampling Location
TBD	Soil	0-3 ft, 3-8 ft, 8-13 ft, 13-18 ft, 18-28 ft, 28-38 ft, 38-48 ft, 48-58 ft	VOC	Low	141 (minimum of 5%)	See Worksheet #21	See Worksheet #17
TBD	Soil	0-3 ft, 3-8 ft, 8-13 ft, 13-18 ft, 18-28 ft, 48-58 ft	PCBs	Low	121 (minimum of 5%)	See Worksheet #21	See Worksheet #17
TBD	Soil	0-3 ft, 3-8 ft, 8-13 ft, 13-18 ft, 18-28 ft, 48-58 ft	Radiological	Low	121 (minimum of 5%)	See Worksheet #21	See Worksheet #17
TBD	Soil	0-3 ft, 3-8 ft, 8-13 ft, 13-18 ft, 18-28 ft, 48-58 ft	Metals (includes mercury and lead only for waste cell samples)	Low	121 (minimum of 5%)	See Worksheet #21	See Worksheet #17
TBD	Soil	0-1 ft	PCBs, SVOAs	Low	154 (field lab) 16 (fixed-base lab) (minimum of 5%)	See Worksheet #21	See Worksheet #17
TBD	Soil	From RGA Wells approximately 105 ft	VOCs, Metals, PCBs, Radiological	Low	8 (minimum of 5%)	See Worksheet #21	See Worksheet #17
TBD	Water	From open test pit in each cell, appx. 20 ft	VOCs, Metals, PCBs, Radiological	Low	1 to 5 (minimum of 5%)	See Worksheet #21	See Worksheet #17
TBD	Water	0-20 ft	VOCs and Tc-99	Low	22 (minimum of 5%)	See Worksheet #21	See Worksheet #17
TBD	Water	20-58 ft	VOCs and Tc-99	Low	10 (minimum of 5%)	See Worksheet #21	See Worksheet #17

Worksheet #18 (Continued)
Sampling Locations and Methods/Standard Operating Procedure Requirements Table for Screening Samples

Sampling Location/ID Number	Matrix	Depth (units)	Analytical Group	Concentration Level	Number of Samples (Identify Field Duplicates)[a]	Sampling SOP Reference[b]	Rationale for Sampling Location
TBD	Water	60-65 ft, 65-70 ft, 70-75 ft, 75-80 ft, 80-85 ft, 85-90 ft, 90-95 ft, 95-100 ft, 100-105 ft	VOCs and Tc-99	Low	90 (minimum of 5%)	See Worksheet #21	See Worksheet #17
TBD	Water	From RGA Wells approximately 60 to 100 ft	VOCs and Tc-99	Low	5 (minimum of 5%)	See Worksheet #21	See Worksheet #17
TBD	Soil gas	0-1 ft	VOCs	Low	48	See Worksheet #21	See Worksheet #17

[a] Enough material will be taken from each sample location to perform all five analytical group analysis. One hundred twenty-eight total soils samples will be collected.
[b] See Analytical SOP References Table (Worksheet #23).

Worksheet #19
Analytical SOP Requirements Table

Matrix	Analytical Group	Concentration Level	Analytical and Preparation Method/SOP Reference*	Sample Volume	Containers (number, size, and type)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (preparation/ analysis)
Water	VOC	Low	See Worksheet #12	120mL	3 x 40 mL Glass VOA vial	HCl; cool to < 4°C	14 days for preserved
Water	PCBs	Low	See Worksheet #12	1L	1L Amber Glass	Cool to < 4°C	NA
Water	RADs	Low	See Worksheet #12	3L	Plastic	Cool to < 4°C	6 months
Water	Metals	Low	See Worksheet #12	1L	Plastic	HNO_3 ph < 2 Cool to < 4°C	6 months
Soil/sediment	Metals	Low	See Worksheet #12	100 g	4 oz. Glass	Cool to < 4°C	6 months
Soil/sediment	PCBs	Low	See Worksheet #12	250 g	9 oz. Glass	Cool to < 4°C	NA
Soil/sediment	RADs	Low	See Worksheet #12	250 g	9 oz. Glass	Cool to < 4°C	6 months
Soil/sediment	VOCs	Low	See Worksheet #12	250 g	9 oz. Glass	Cool to < 4°C	14 days
Soil gas	VOCs	Low	See Worksheet #12	Per manufacturer's instructions			

NOTE: Sample volume and container requirements may change to meet the requirements of a specific laboratory.
* See Analytical SOP References table (Worksheet #23).

Worksheet #20
Field Quality Control Sample Summary Table

Matrix	Analytical Group	Concentration Level	Analytical and Preparation SOP Reference	No. of Sampling Locations*	No. of Field Duplicate Pairs	Inorganic No. of MS	No. of Field Blanks	No. of Equip. Blanks	No. of PT Samples	Total No. of Samples to Lab*
Soil/Sediments	VOCs	Low	See Worksheet #12	See Worksheet #17	5%	5%	5%	5%	A	See Worksheet #17
Soil/Sediments	PCBs	Low	See Worksheet #12	See Worksheet #17	5%	5%	5%	5%	A	See Worksheet #17
Soil/Sediment	Metals	Low	See Worksheet #12	See Worksheet #17	5%	5%	5%	5%	A	See Worksheet #17
Soil/Sediment	Radionuclides	Low	See Worksheet #12	See Worksheet #17	5%	5%	5%	5%	A	See Worksheet #17
Water	VOCs	Low	See Worksheet #12	See Worksheet #17	5%	5%	5%	5%	A	See Worksheet #17
Water	Metals	Low	See Worksheet #12	See Worksheet #17	5%	5%	5%	5%	A	See Worksheet #17
Water	PCBs	Low	See Worksheet #12	See Worksheet #17	5%	5%	5%	5%	A	See Worksheet #17
Water	Radionuclides	Low	See Worksheet #12	See Worksheet #17	5%	5%	5%	5%	A	See Worksheet #17

*Work package documents will identify the sampling locations, matrices, number of samples, and sample identification numbers for samples to be submitted to DOE Consolidated Audit Program (CAP)-audited laboratory. This is not applicable for samples analyzed by field methods.
A = PT sample will only be collected when required by a specific project.

Worksheet #21
Project Sampling SOP References Table

Site-specific standard operating procedures (SOPs) have been developed for site sampling activities. Below is a list of site sampling procedures that projects will select from for implementing sampling activities.

Reference Number	Title, Revision Date, and/or Number[a]	Originating Organization[b]	Equipment Type	Modified for Project Work? (Y/N)	Comments
1	PAD-ENM-0023, *Composite Sampling*	Contractor	Sampling	N	
2	PAD-ENM-2300, *Collection of Soil Samples*	Contractor	Sampling	N	
3	PAD-ENM-0017, *Paint Chip Sampling*	Contractor	Sampling	N	
4	PAD-ENM-0026, *Wet Chemistry and Miscellaneous Analyses Data Verification and Validation*	Contractor	NA	N	
5	PAD-ENM-0811, *ROAC1 Pesticide and PCB Data Verification and Validation*	Contractor	NA	N	
6	PAD-ENM-1001, *Transmitting Data to the Paducah Oak Ridge Environmental Information System (OREIS)*	Contractor	NA	N	
7	PAD-ENM-1003, *Developing, Implementing, and Maintaining Data Management Implementation Plans*	Contractor	NA	N	
8	PAD-ENM-2002, *Sampling of Structural Elements and Miscellaneous Surfaces*	Contractor	Sampling	N	
9	PAD-ENM-2100, *Groundwater Level Measurement*	Contractor	Sampling	N	
10	PAD-ENM-2101, *Groundwater Sampling*	Contractor	Sampling		
11	PAD-ENM-2203, *Surface Water Sampling*	Contractor	Sampling	N	
12	PAD-ENM-2300 *Collection of Soil Samples*		Sampling	N	
13	PAD-ENM-2302, *Collection of Sediment Samples Associated with Surface Water*	Contractor	Sampling	N	
14	PAD-ENM-2303, *Borehole Logging*	Contractor	Sampling	N	
15	PAD-ENM-2700, *Logbooks and Data Forms*	Contractor	NA	N	
16	PAD-ENM-2702, *Decontamination of Sampling Equipment*	Contractor	Sampling	N	
17	PAD-ENM-2704, *Trip, Equipment, and Field Blank*	Contractor	NA	N	

Worksheet #21
Project Sampling SOP References Table (Continued)

Reference Number	Title, Revision Date, and/or Number[a]	Originating Organization[b]	Equipment Type	Modified for Project Work? (Y/N)	Comments
18	PAD-ENM-2708, *Chain-of-Custody Forms, Field Sample Logs, Sample Labels, and Custody Seals*	Contractor	NA	N	
19	PAD-ENM-5003, *Quality Assured Data*	Contractor	NA	N	
20	PAD-ENM-5004, *Sample Tracking, Lab Coordination, and Sample Handling Guidance*	Contractor	NA	N	
21	PAD-ENM-5007, *Data Management Coordination*	Contractor	NA	N	
22	PAD-ENM-5102, *Radiochemical Data Verification and Validation*	Contractor	NA	N	
23	PAD-ENM-5103, Polychlorinated Dibenzodioxins-Polychlorinated Dibenzofurans Verification and Validation	Contractor	NA	N	
24	PAD-ENM-5105, *ROAC1 Volatile and Semivolatile Data Verification and Validation*	Contractor	NA	N	
25	PAD-ENM-5107, *Inorganic Data Validation and Verification*	Contractor	NA	N	
26	PAD-ENR-0020, *Collection of Soil Samples with Direct Push Technology Sampling*	Contractor	Sampling	N	
27	PAD-ENR-0023, *Downhole Video Camera Inspection*	Contractor	Sampling	N	
28	PAD-ENR-0032, *PCB Wipe Sample Procedure*	Contractor	Sampling	N	
29	PAD-SO-0034, *PCB Spill Management*	Contractor	Sampling	N	

[a] SOPs are posted to the LATA Kentucky external Web site at http://www.latakentucky.com/public_documents_dynamic.asp under Paducah Procedures.
[b] The work will be conducted by LATA Kentucky staff or a subcontractor. In either case, SOPs listed will be followed.

Worksheet #22
Field Equipment Calibration, Maintenance, Testing, and Inspection Table

Field Equipment*	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
Mini RAE Photoionization Detector (PID) Toxic Gas Monitor with 10.5 eV Lamp or Similar Meter	Calibration checked at the beginning and end of the day	As needed in the field; semi-annually by the supplier	Measure known concentration of isobutylene 100 ppm (calibration gas)	Upon receipt, successful operation	Calibrate am, check pm	± 10% of the calibrated value	Manually zero meter or service as necessary and recalibrate	Field Team Leader	Manufacturer's specifications
Water Quality Meter	Calibrate at the beginning of the day	Performed monthly and as needed	Measure solutions with known values [National Institute of Standards and Technology (NIST) traceable buffers and conductivity calibration solutions]	Upon receipt, successful operation	Daily before each use	pH: ± 0.1 s.u. Specific Conductivity: ± 3% ORP: ± 10 mV DO: ± 0.3 mg/L Temp.: ± 0.3ºC	Recalibrate or service as necessary	Field Team Leader	Manufacturer's specifications

Worksheet #22 (Continued)
Field Equipment Calibration, Maintenance, Testing, and Inspection Table

Field Equipment	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference*
Turbidity Meter (Nephthelometer)	Calibrate daily before each use	As needed	Measure solutions with known turbidity standards	Upon receipt, successful operation	Daily before each use	NA (instrument zeroed)	Manually zero meter or service as necessary and recalibrate	Field Team Leader	Manufacturer's specifications
Ferrous Iron Colorimeter	Accuracy check at the beginning and end of the day	Return to instrument rental for replacement	Measure with standard solution	Upon receipt, successful operation	Check daily before each use	Pass/Fail	Return to rental company for replacement	Field Team Leader	Manufacturer's specifications
PCB Colorimeter	Accuracy check at the beginning of each day	As needed	Measure with standards	Upon receipt, successful operation	Check daily before each use	Within range of manufacturer's standard	Service by manufacturer	Field Team Leader	Manufacturer's specifications
Titrator (for total residual chlorine)	Calibrate to manufacturer's solution weekly	As needed	Measure with standard solution	Upon receipt, successful operation	Daily before each use	With range of manufacturer's standard	Service by manufacturer	Field Team Leader	Manufacturer's specifications
Global Flow Meter	Calibrate when replace battery	Check daily as needed prior to use	Spin prop to verify instrument reading	Upon receipt, successful operation	Check daily before each use	Pass/Fail	Service by manufacturer	Field Team Leader	Manufacturer's specifications
Electron Water Level Meter	Annually calibrate depth scale to standard	None	Check daily before each use	Upon receipt, successful operation	Check daily before each use	Pass/Fail	Return to rental company for replacement	Field Team Leader	Manufacturer's specifications

Worksheet #22 (Continued)
Field Equipment Calibration, Maintenance, Testing, and Inspection Table

Field Equipment	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference*
Alpha Scintillator	Annually or as specified by manufacturer	Annually or as needed	Daily prior to use	Upon receipt, successful operation	Daily prior to use	Pass/Fail	Return to rental company for replacement	RCT Supervisor	Manufacturer's specifications
Geiger Müeller	Annually or as specified by manufacturer	Annually or as needed	Daily prior to use	Upon receipt, successful operation	Daily prior to use	Pass/Fail	Return to rental company for replacement	RCT Supervisor	Manufacturer's specifications
Gamma Scintillator or FIDLER	Annually or as specified by manufacturer	Annually or as needed	Daily prior to use	Upon receipt, successful operation	Daily prior to use	Pass/Fail	Service by manufacturer	RCT Supervisor	Manufacturer's specifications
Field Equipment Global Positioning System (GPS)	Daily check of known point beginning and end of each field day	Per manufacturers specifications	Measure known control points and compare values	Upon receipt, successful operation	Daily prior to use	Pass/Fail	Service by manufacturer	Field Team Leader	Manufacturer's specifications
Passive Soil Gas Analyzer	Manufacturer's specifications	Manufacturer's specifications	Manufacturer's specifications	Manufacturer's specifications	Manufacturer's specifications	Manufacturer's specifications	Manufacturer's specifications	Manufacturer's specifications	Manufacturer's specifications

* Additional equipment may be needed: additional equipment will follow manufacturer's specifications for calibration, maintenance, inspection, and testing.
Calibration data will be documented in logbooks consistent with PAD-ENM-2700, *Logbooks and Data Forms*.

Worksheet #23
Analytical SOP References Table

Reference Number*	Title, Revision Date, and/or Number	Definitive or Screening Data	Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
8260	Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS)	Definitive	VOAs	GC/MS	TBD	TBD
8082	Polychlorinated Biphenyls (PCBs) by Gas Chromatography	Definitive	PCBs	GC	TBD	TBD
6010	Inductively Coupled Plasma-Atomic Emission Spectrometry	Definitive	Metals	ICP	TBD	TBD
6020	Inductively Coupled Plasma-Mass Spectrometry	Definitive	Metals	ICP-MS	TBD	TBD
Gas Flow Proportional**	Gas Flow Proportional	Definitive	Rads	Gas flow proportional counter	TBD	TBD
Alpha Spec**	Alpha Spectrometry	Definitive	Rads	Alpha Spectrometry	TBD	TBD
Gamma Spec**	Gamma Spectrometry	Definitive	Rads	Gamma Spectrometry	TBD	TBD
Liquid Scintillation**	Tc-99 by Liquid Scintillation	Definitive	Rads	Liquid Scintillation	TBD	TBD

* Information will be based on laboratory used. Analysis will be by the most recent revision.
** Analytical methods for radiochemistry parameters are laboratory specific.
TBD = to be determined

Worksheet #24
Analytical Instrument Calibration Table

All laboratory equipment and instruments used for quantitative measurements are calibrated in accordance with the laboratory's formal calibration program. Whenever possible, the laboratory uses recognized procedures for calibration such as those published by EPA or American Society for Testing and Materials (ASTM). If established procedures are not available, the laboratory develops a calibration procedure based on the type of equipment, stability, characteristics of the equipment, required accuracy, and the effect of operation error on the quantities measured. Whenever possible, physical reference standards associated with periodic calibrations such as weights or certified thermometers with known relationships to nationally recognized standards, are used. Where national reference standards are not available, the basis for the reference standard is documented. Equipment or instruments that fail calibration or become inoperable during use are tagged to indicate they are out of calibration. Such instruments or equipment are repaired and successfully recalibrated prior to reuse. All high resolution mass spectrometer instruments undergo extensive tuning and calibration prior to running each sample set. The calibrations and ongoing instrument performance parameters are recorded and reported as part of the analytical data package.

Instrument*	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
NA						

* The laboratory is responsible for maintaining instrument calibration information per their QA Plan including control charts established for all instrumentation. This information is audited annually by DOE Consolidated Audit Program (DOECAP). Laboratory(s) contracted will be DOECAP audited. Additional certifications may be needed based on project-specific requirements [e.g., National Environmental Laboratory Accreditation Program (NELAP), KDEP Drinking Water Laboratory Program]. Field survey/sampling instrumentation will be calibrated according to manufacturer's instructions.

Worksheet #25
Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference*
GC-MS	Replace/clean ion source; clean injector, replace injector liner, replace/clip capillary column, flush/replace tubing on purge and trap; replace trap	QC standards	Ion source, injector liner, column, column flow, purge lines, purge flow, trap	As needed	Must meet initial and/or continuing calibration criteria	Repeat maintenance activity or remove from service	Laboratory Section Manager	See Worksheet #23
GC	ECD/FID maintenance; replace/clip capillary column	QC standards	ECD, FID, injector, injector liner, column, column flow	As needed	Must meet initial and/or continuing calibration criteria	Repeat maintenance activity or remove from service	Laboratory Section Manager	See Worksheet #23
ICP-AES	Clean plasma torch; clean filters; clean spray and nebulizer chambers; replace pump tubing	Metals	Torch, filters, nebulizer chamber, pump, pump tubing	Perform as needed	Initial and/or continuing calibration criteria must be met	Repeat maintenance activity or remove from service	Laboratory Area Supervisor	See Worksheet #23
ICP-MS	Clean plasma torch; clean filters; clean spray and nebulizer chambers; replace pump tubing	Metals	Torch, filters, nebulizer chamber, pump, pump tubing	As needed	Must meet initial and/or continuing calibration criteria	Repeat maintenance activity or remove from service	Laboratory Area Supervisor	See Worksheet #23

Worksheet #25 (Continued)
Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference*
pH meter	Clean probe	QC standards	Probe	As needed	The value for each of the certified buffer solutions must be within ± 0.05 pH units of the expected value	Repeat maintenance activity or remove from service	Laboratory Manager	See Worksheet #23
Spectrophotometer	Flush/replace tubing	QC standards	Tubing	As needed	Must meet initial and/or continuing calibration criteria	Repeat maintenance activity of remove from service	Laboratory Manager	See Worksheet #23
TOC Analyzer (NDIRD)	Replace sample tubing, clean sample boat, replace syringe	QC standards	Tubing, sample boat, syringe	As needed	Must meet initial and/or continuing calibration criteria	Repeat maintenance activity or remove from service	Laboratory Manager	See Worksheet #23

* The laboratory is responsible for maintaining instrument and equipment maintenance, testing, and inspection information per their QA Plan. This information is audited annually by DOECAP. Laboratory(s) contracted will be DOECAP audited. Field survey/sampling instrumentation will be maintained, tested, and inspected according to manufacturer's instructions.

Worksheet #26
Sample Handling System

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT	
Sample Collection (Personnel/Organization):	Sampling Teams/DOE Prime Contractor and Subcontractors
Sample Packaging (Personnel/Organization):	Sampling Teams/DOE Prime Contractor and Subcontractors
Coordination of Shipment (Personnel/Organization):	Lab Coordinator/DOE Prime Contractor
Type of Shipment/Carrier:	Direct Delivery or Overnight/Federal Express
SAMPLE RECEIPT AND ANALYSIS	
Sample Receipt (Personnel/Organization):	Sample Management/Contracted Laboratory
Sample Custody and Storage (Personnel/Organization):	Sample Management/Contracted Laboratory
Sample Preparation (Personnel/Organization):	Analysts/Contracted Laboratory
Sample Determinative Analysis (Personnel/Organization):	Analysts/Contracted Laboratory
SAMPLE ARCHIVING	
Field Sample Storage (No. of days from sample collection):	The fixed-base laboratory archives samples after six months.
Sample Extract/Digestate Storage (No. of days from extraction/digestion):	See Worksheet #19
Biological Sample Storage (No. of days from sample collection):	See Worksheet #19

Worksheet #26 (Continued)
Sample Handling System

SAMPLE DISPOSAL	
Personnel/Organization:	Waste Disposition/DOE Prime Contractor and Subcontractors
Number of Days from Analysis:	6 months

Worksheet #27
Sample Custody Requirements*

Chain-of-custody procedures are comprised of maintaining sample custody and documentation of samples for evidence. To document chain-of-custody, an accurate record of samples must be maintained in order to trace the possession of each sample from the time of collection to its introduction to the laboratory.

Field Sample Custody Procedures (sample collection, packaging, shipment, and delivery to laboratory):

Field sample custody requirements will be per DOE Prime Contractor procedures, PAD-ENM-2708, *Chain-of-Custody Forms, Field Sample Logs, Sample Labels, and Custody Seals*; and PAD-ENM-5004, *Sample Tracking, Lab Coordination, and Sample Handling Guidance.*

Laboratory Sample Custody Procedures (receipt of samples, archiving, disposal):

When the samples are delivered to the laboratory, signatures of the laboratory personnel receiving them and the courier personnel relinquishing them will be completed in the appropriate spaces on the chain-of-custody record, unless the courier is a commercial carrier. This will complete the sample transfer. It will be every laboratory's responsibility to maintain internal logbooks and records that provide custody throughout sample preparation and analysis process.

Sample Identification Procedures:

Sample identification requirements will be specified in work package documents and will comply with the Data Management Implementation Plan included in the BGOU Work Plan.

Chain-of-custody Procedures:

Chain-of-custody requirements will be per DOE Prime Contractor procedures, PAD-ENM-2708, *Chain-of-Custody Forms, Field Sample Logs, Sample Labels, and Custody Seals*; and PAD-ENM-5004, *Sample Tracking, Lab Coordination, and Sample Handling Guidance.*

* It is understood that SOPs are contractor specific.

Worksheet #28-A
QC Samples Table

Matrix: Aqueous Samples						
Analytical Group/Concentration Level: VOC, Metals, PCBs, Rads						
Sampling SOP: See Worksheet #21						
Analytical Method/SOP Reference: 8260, 200.8/6010/6020,8082, Alpha Spec, Gamma Spec, Liquid Scint						
Sampler's Name/Field Sampling Organization: TBD						
Analytical Organization: TBD						
No. of Sample Locations: TBD						
QC Sample	**Frequency/Number***	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
Field blank	Minimum 5%	≤ CRQL**	Verify results; reanalyze	Laboratory should alert project	Contamination¾ Accuracy/bias	See procedure PAD-ENM-5003, *Quality Assured Data*
Trip blank	1 per cooler containing VOC samples	≤ CRQL	Verify results; reanalyze		Contamination¾ Accuracy/bias	See procedure PAD-ENM-5003, *Quality Assured Data*
Equipment blank	Minimum 5%	≤ CRQL	Verify results; reanalyze		Contamination¾ Accuracy/bias	See procedure PAD-ENM-5003, *Quality Assured Data*
Internal standards, laboratory spiked blanks, or spiked field samples	All samples and standards	See data validation procedures PAD-ENM-5105, 5107, 5103, 5102	Check calculations and instrument; reanalyze affected samples		Accuracy	See procedure PAD-ENM-5003, *Quality Assured Data*

Worksheet #28-A (Continued)
QC Samples Table

QC Sample	Frequency/Number*	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Field duplicate	Minimum 5%	None	Data reviewer will place qualifiers on samples affected	Project	Homogeneity/ Precision	RPD ≤ 50% soils, RPD < 25% aqueous
Laboratory duplicate	Per laboratory procedure	See data validation procedures PAD-ENM-5105, 5107, 5103, 5102	Verify results re-prepare and reanalyze	Laboratory analyst	Precision	See procedure PAD-ENM-5003, *Quality Assured Data*

* The number of QC samples is listed on Worksheet #20.
** Unless dictated by project-specific parameters, ≤ contract required quantitation limit (CRQL).

Worksheet #28-B
QC Samples Table

Matrix: Soils
Analytical Group/Concentration Level: VOC, Metals, PCBs, Rads
Sampling SOP: See Worksheet #21
Analytical Method/SOP Reference: 8260, 200.8/6010/6020,8082, Alpha Spec, Gamma Spec, Liquid Scint
Sampler's Name/Field Sampling Organization: TBD
Analytical Organization: TBD
No. of Sample Locations: TBD

QC Sample	Frequency/Number*	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Field blank	Minimum 5%	≤ CRQL**	Verify results; reanalyze	Laboratory should alert project	Contamination¾ Accuracy/bias	See procedure PAD-ENM-5003, *Quality Assured Data*
Trip blank	1 per cooler containing VOC samples	≤ CRQL	Verify results; reanalyze		Contamination¾ Accuracy/bias	See procedure PAD-ENM-5003, *Quality Assured Data*
Equipment blank	Minimum 5%	≤ CRQL	Verify results; reanalyze		Contamination¾ Accuracy/bias	See procedure PAD-ENM-5003, *Quality Assured Data*
Internal standards, laboratory spiked blanks, or spiked field samples	All samples and standards	See data validation procedures PAD-ENM-5105, 5107, 5103, 5102	Check calculations and instrument; reanalyze affected samples		Accuracy	See procedure PAD-ENM-5003, *Quality Assured Data*

Worksheet #28-B (Continued)
QC Samples Table

QC Sample	Frequency/Number*	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Field duplicate	Minimum 5%	None	Data reviewer will place qualifiers on samples affected	Project	Homogeneity/ Precision	RPD ≤ 50% soils, RPD < 25% aqueous
Laboratory duplicate	Per laboratory procedure	See data validation procedures PAD-ENM-5105, 5107, 5103, 5102	Verify results re-prepare and reanalyze	Laboratory analyst	Precision	See procedure PAD-ENM-5003, *Quality Assured Data*

* The number of QC samples is listed on Worksheet #20.
** Unless dictated by project-specific parameters, ≤ CRQL.

Worksheet #29
Project Documents and Records Table

All project data and information must be documented in a format that is usable by project personnel. The QAPP describes how project data and information shall be documented, tracked, and managed from generation in the field to final use and storage in a manner that ensures data integrity, defensibility, and retrieval.

Sample Collection Documents and Records	On-site Analysis Documents and Records	Off-site Analysis Documents and Records	Data Assessment Documents and Records*	Other
Data logbooks and associated completed sampling forms; sample chains-of-custody	Laboratory data packages, OREIS database, and associated data packages	OREIS database and associated data packages	PAD-ENM-5003, Att. G, Data Assessment Review Checklist and Comment Form	Form QA-F-0004, Management/ Independent Assessment Report

* It is understood that SOPs are contractor specific.

Worksheet #30
Analytical Services Table

Matrix	Analytical Group	Concentration Level	Sample Locations/ID Numbers	Analytical SOP*	Data Package Turnaround Time	Laboratory/Organization (Name and Address, Contact Person and Telephone Number)	Backup Laboratory/Organization (Name and Address, Contact Person and Telephone Number)
Soil/Sediment	PCBs	Low	See Worksheet #18 For ID Numbers, see Worksheet #27	See Worksheet #23	28-day	TBD	TBD
Soil/Sediment	Metals	Low		See Worksheet #23	28-day	TBD	TBD
Soil/Sediment	Radionuclides	Low		See Worksheet #23	28-day	TBD	TBD
Soil/Sediment	VOCs	Low		See Worksheet #23	28-day	TBD	TBD
Water	PCBs	Low	See Worksheet #18 For ID Numbers, see Worksheet #27	See Worksheet #23	28-day	TBD	TBD
Water	Metals	Low		See Worksheet #23	28-day	TBD	TBD
Water	Radionuclides	Low		See Worksheet #23	28-day	TBD	TBD
Water	VOCs	Low		See Worksheet #23	28-day	TBD	TBD

* Analytical method SOPs for radiochemistry parameters are laboratory specific.

Worksheet #31
Planned Project Assessments Table

LATA Kentucky will ensure that protocol outlined in the QAPP is implemented adequately. Assessment activities help to ensure that the resultant data quality is adequate for its intended use and that appropriate responses are in place to address nonconformances and deviations from the QAPP. Below is a list of assessments project teams may use.

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment (Title and Organizational Affiliation)	Person(s) Responsible for Responding to Assessment Findings (Title and Organizational Affiliation)	Person(s) Responsible for Identifying and Implementing Corrective Actions (CA) (Title and Organizational Affiliation)	Person(s) Responsible for Monitoring Effectiveness of CA (Title and Organizational Affiliation)
Independent Assessment/ Surveillance	A	Internal	QA Manager or designee	QA Specialists,	Project Manager,	Project Manager	QA Manager
Laboratory Audit	Annual	External	DOE Consolidated Audit Program (DOECAP)	Laboratory Assessor	Laboratory	Laboratory	DOECAP
Management Assessments	Annual	Internal	Project Manager or designee	Project Manager,		Project Manager	QA Manager
Management by Walking Around (MBWA)*	B	Internal	Project Manager or designee	Project Manager	Project Manager	Project Manager	Project Manager
MBWA Follow-up surveillances	Quarterly	Internal	Project Manager or designee	Project Manager or designee	Project Manager	Project Manager	Project Manager

A = assessment frequency determined by QA Manager and conducted per PAD-QA-1420, *Conduct of Assessments*.
B = assessment frequency determined by regulatory manager and conducted per PAD-QA-1420.
* Reference: PAD-QA-1033, *Management by Walking Around (MBWA) Program*.

Worksheet #32
Assessment Findings and Corrective Action Responses*

All provisions shall be taken in the field and laboratory to ensure that any problems that may develop shall be dealt with as quickly as possible to ensure the continuity of the project/sampling events. Field modifications to procedures in the QAPP must be approved before the modifications are implemented and then documented. The process controlling procedure modification is PAD-PD-1107, *Development, Approval, and Change Control for LATA Kentucky Performance Documents*. Field modifications are documented through the work control process per PAD-WC-0021. Corrective action in the field may be necessary when the sampling design is changed. For example, a change in the field may include increasing the number or type of samples or analyses, changing sampling locations, and/or modifying sampling protocol. When this occurs, the project team shall identify any suspected technical or QA deficiencies and note them in the field logbook. Listed in Worksheet #32 is how project teams will address assessment findings.

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (Name, Title, Organization)	Time frame of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response (Name, Title, Org.)	Time Frame for Response
Management, Independent, and Surveillances	Form QA-F-004, Management/ Independent Assessment Report, and QA-F-0710, Issue Identification Form	Project manager, issue owner, contractor	Upon issuance of Form QA-F-004, Management/ Independent Assessment Report, form QA-F-0710, Issue Identification Form, will be completed and attached to the assessment report	QA-F-0710, Issue Identification Form, documents the issue response and/or corrective actions	Action owner as designated by issue owner, contractor	Fifteen days for initial issue response, corrective action schedule determined by issue owner, per PAD-QA-1210

* It is understood that SOPs are contractor specific.

Worksheet #33
QA Management Reports Table

Reports to management include project status reports, field and/or laboratory audits, and data quality assessments. These reports will be directed to the QA Manager and Project Manager who have ultimate responsibility for assuring that any corrective action response is completed, verified, and documented.

Type of Report	Frequency (daily, weekly monthly, quarterly, annually, etc.)	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation (Title and Organizational Affiliation)	Report Recipient(s) (Title and Organizational Affiliation)
Field Change Requests	As needed	Ongoing	Field staff	QAPP recipients
QAPP Addenda	As needed	Not Applicable	Project Manager	QAPP recipients
Field Audit Report	TBD as determined by QA Manager	30 days after completion of audit	QA Manager	LATA Kentucky Project Manager QA Manager
Corrective Action Plan	As needed	Within 3 weeks of request	Project Manager	QA Manager

Worksheet #34
Verification (Step I) Process Table

This section of the QAPP provides a description of the QA activities that will occur after the data collection phase of the project is completed. Implementation of this section will determine whether the data conforms to the specified criteria satisfying the project objectives.

Verification Input	Description*	Internal/ External	Responsible for Verification (Name, Organization)
Field Logbooks	Field logbooks are verified per DOE Prime Contractor procedure, PAD-ENM-2700, *Logbooks and Data Forms*, and PAD-ENM-5003, *Quality Assured Data*.	Internal	Project Management or designee, Contractor
Chains-of-custody	Chains-of-custody are controlled by DOE Prime Contractor procedure, PAD-ENM-5004, *Sample Tracking, Lab Coordination and Sample Handling Guidance*. Chains-of-custody will be included in data assessment packages for review as part of data verification and data assessment.	Internal	Sample and Data Management, Project Management, and QA Personnel, Contractor
Field and Laboratory Data	Field and analytical data are verified and assessed per DOE Prime Contractor procedure, PAD-ENM-5003, *Quality Assured Data*. Data assessment packages will be created per this procedure. The data assessment packages will include field and analytical data, chains-of-custody, data verification and assessment queries, and other project-specific information needed for personnel to review the package adequately. Data assessment packages will be reviewed to document any issues pertaining to the data and to indicate if data met the data quality objectives of the project.	Internal	Sample and Data Management, Project Management, and QA Personnel**, Contractor
Sampling Procedures	Evaluate whether sampling procedures were followed with respect to equipment and proper sampling support using audit and sampling reports, field change requests and field logbooks.	Internal	Sample and Data Management, Project Management, and QA Personnel**, Contractor
Laboratory Data	All laboratory data will be verified by the laboratory performing the analysis for completeness and technical accuracy prior to submittal to LATA Kentucky. Subsequently, LATA Kentucky will evaluate the data packages for completeness and compliance.	External/ Internal	Laboratory Manager, LATA Kentucky Sample and Data Management
Electronic Data Deliverables (EDDs)	Determine whether required fields and format were provided.	Internal	Sample and Data Management
QAPP	All planning documents will be available to reviewers to allow reconciliation with planned activities and objectives.	Internal	All data users

* It is understood that SOPs are contractor specific.
** QA specialist performs general QA review.

Worksheet #35
Validation (Steps IIa and IIb) Process Table

Step IIa/IIb	Validation Input	Description*	Responsible for Validation (Name, Organization)
IIa	Data Deliverables, Analytes, and Holding Times	The documentation from the contractual screening will be included in the data assessment packages, per DOE Prime Contractor procedure, PAD-ENM-5003, *Quality Assured Data*.	Sample and Data Management Personnel, Contractor
IIa	Chain-of-Custody, Sample Handling, Sampling Methods and Procedures, and Field Transcription	These items will be validated during the data assessment process as required by DOE Prime Contractor procedure, PAD-ENM-5003, *Quality Assured Data*. The documentation of this validation will be included in the data assessment packages.	Sample and Data Management Personnel, Contractor
IIa	Analytical Methods and Procedures, Laboratory Data Qualifiers, and Standards	These items will be reviewed during the data validation process as required by DOE Prime Contractor data validation procedures. Data validation will be performed in parallel with data assessment. The data validation report and data validation qualifiers will be considered when the data assessment process is being finalized.	Data Validation Subcontractor, and Sample and Data Management, Project, Contractor
IIa	Audits	The audit reports and accreditation and certification records for the laboratory supporting the projects will be considered in the bidding process.	QA Personnel
IIb	Deviations and qualifiers from Step IIa	Any deviations and qualifiers resulting from Step IIa process will be documented in the data assessment packages.	Sample and Data Management, Project, and QA Personnel, Contractor
IIb	Sampling Plan, Sampling Procedures, Co-located Field Duplicates, Project Quantitation Limits, Confirmatory Analyses, Performance Criteria	These items will be evaluated as part of the data verification and data assessment process per DOE Prime Contractor procedure, PAD-ENM-5003, *Quality Assured Data*. These items will be considered when evaluating whether the project met their Data Quality Objectives.	Sample and Data Management, Project, and QA Personnel, Contractor

* It is understood that SOPs are contractor specific.

Worksheet #36
Validation (Steps IIa and IIb) Summary Table

Step IIa/IIb	Matrix	Analytical Group	Concentration Level	Validation Criteria	Data Validator (title and organizational affiliation)
Step IIa/IIb	Soils/Sediments	All	All	National Functional Guidelines; Worksheets #12, #15, and #28; and PAD-ENM-0026, PAD-ENM-0811, PAD-ENM-5102, PAD-ENM-5105, PAD-ENM-5003, and PAD-ENM-5107	Data Validator, LATA
Step IIa/IIb	Water	All	All		Data Validator, LATA

Worksheet #37
Usability Assessment*

LATA Kentucky shall determine the adequacy of data based on the results of validation and verification. The usability step involves assessing whether the process execution and resulting data meet project quality objectives documented in the QAPP.

Summarize the usability assessment process and all procedures, including interim steps and any statistics, equations, and computer algorithms that will be used: Field and analytical data are verified and assessed per procedure PAD-ENM-5003, *Quality Assured Data*. Data assessment packages will be created per this procedure. Data assessment packages will include field and analytical data, chains-of-custody, data verification and assessment queries, and other project-specific information needed for personnel to review the package adequately. Data assessment packages will be reviewed to document any issues pertaining to the data and to indicate if data quality objectives of the project were met. For data selected for validation, the following procedures are used: PAD-ENM-0026, PAD-ENM-0811, PAD-ENM-5102, PAD-ENM-5105, and PAD-ENM-5107.

Describe the evaluative procedures used to assess overall measurement error associated with the project: PARCCS parameters (precision, accuracy, representativeness, comparability, completeness, and sensitivity) will be evaluated per procedure, PAD-ENM-5003, *Quality Assured Data*. This information will be included in the data assessment packages for review by project personnel. Data assessment also will include documentation of QC exceedances, trends, and/or bias in the data set. Data assessment will document any statistics used.

Identify the personnel responsible for performing the usability assessment: Project personnel, as verified by QA personnel.

Describe the documentation that will be generated during usability assessment and how usability assessment results will be presented so that they identify trends, relationships (correlations), and anomalies: Data assessment packages will be created, which will include data assessment comments/questions and laboratory comments. Data verification and assessment queries indicating any historical outliers and background soil exceedances also will be included in the data assessment packages.

* It is understood that SOPs are contractor specific.

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APPENDIX

GEOPHYSICAL SURVEY OF SOLID WASTE MANAGEMENT UNIT 4 AT THE PADUCAH GASEOUS DIFFUSION PLANT, PADUCAH, KENTUCKY

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TABLE

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ACRONYMS

CERCLA	Comprehensive Environmental Response, Liability, and Compensation Act
DOE	U.S. Department of Energy
EM	electromagnetic
GPR	ground penetrating radar
GPS	global positioning system
MHz	megahertz
mS/m	millisiemens/meter
mV	millivolts
PGDP	Paducah Gaseous Diffusion Plant
ppt	parts per thousand
SWMU	solid waste management unit

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A.1. INTRODUCTION

The Paducah Gaseous Diffusion Plant (PGDP) is located in western Kentucky, approximately 10 miles west of the city of Paducah, Kentucky, and approximately 3 miles south of the Ohio River. The PGDP is located on a 3,556 acre reservation that contains an active uranium enrichment facility and surrounding support facilities. The industrial portion of the PGDP is situated within a fenced security area consisting of approximately 650 acres. The PGDP is owned by the U.S. Department of Energy (DOE), and the uranium enrichment facilities are leased to and operated by the United States Enrichment Corporation.

Construction of the plant began in 1951. By 1952, the plant was operating. PGDP performs the first step in the uranium enrichment process. PGDP enriches the uranium-235 radionuclide in a physical separation process. Historical activities at PGDP have generated various nonhazardous, hazardous, and radioactive wastes that have been managed, stored, and/or disposed of by different methods. DOE is conducting environmental restoration activities at PGDP in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). PGDP was placed on the National Priorities List in 1994. DOE, the U.S. Environmental Protection Agency, and the Commonwealth of Kentucky entered into a Federal Facility Agreement in 1998 that established a regulatory framework for CERCLA projects at PGDP.

A geophysical survey using electromagnetic methods was performed from March 22 to April 15, 2010, to investigate potential burial sites at Solid Waste Management Unit (SWMU) 4, which is located in the industrial portion of the PGDP. Figure A.1, Site Location Map of SWMU 4, illustrates the location of SWMU 4 in relation to the plant site. These surveys were performed to identify previously unknown underground “anomalies” present within the surveyed areas and to confirm the presence and location of known underground items and utilities in these areas.

A geophysical survey using ground penetrating radar (GPR) methods was attempted May 4 and 5, 2010. The survey, however, was unsuccessful due to very limited ground penetration, approximately 2.5 ft, due to a combination of soil conditions and heavy rains in the prior days.

A.2. SITE DESCRIPTION

SWMU 4 totals approximately 6.5 acres in size. The site is a grassy area with small ditches on the north, east, and west sides of the site within the fenced area. Outside the fenced area to the north, the site is bound by Virginia Avenue. To the east and west, the site is bound by 6th Street and 4th Street, respectively. Immediately south of the fenced area there is a grassy area. The grassy area is bound by railroad tracks and Tennessee Avenue.

A.3. TECHNICAL APPROACH

The SWMU 4 area was first divided into several 200-ft by 200-ft north-south and east-west grids so as to allow for smaller survey areas. These areas were then surveyed using a Geonics® EM31-MK2 (EM31) and a Geonics® EM61-MK2 (EM61) coupled to a Trimble AG-114 that has submeter accuracy for global positioning system. Each area was surveyed in both the north-south and east-west directions using the EM31. SWMU 4 was surveyed in the north-south direction using the EM61. Both the EM31 and EM61 surveys were performed by walking the instruments across the areas along a system of parallel transect lines with a 5-ft line separation within the grid. The EM31 and EM61 data were recorded at a rate of 12 readings per second and merged with global positioning system (GPS) positional data being collected at one reading per second.

The EM31 and EM61 instruments were calibrated at established base stations at the beginning and end of each day's use. These locations were known to be free of metallic items. Additional daily testing was performed at areas that contained visible evidence of metallic items (such as a road crossing, a metal culvert, or near a metallic item on the surface) to ensure equipment responded appropriately.

Geophysical electromagnetic (EM) methods rely on contrasts in the characteristics of the target and the surrounding material. The geophysical surveys conducted during this investigation used EM devices that can detect targets, such as buried material, where significant contrasts exist in the electrical properties of these targets (signal) and the surrounding natural soil or rock. The presence of metal fences and other metal objects (e.g., rebar in concrete, street signs, train tracks) may mask the presence of material buried near them.

This survey anticipated using both geophysical EM methods supplemented with GPR; however, GPR attempts were not successful due to heavy rains saturating the soil in the days before the survey. Additional discussion of GPR is found in Section A.3.3 and Section A.5.

A.3.1 EM31 ELECTROMAGNETIC CONDUCTIVITY METER

The EM31 is a bulk ground conductivity meter that averages readings over a relatively wide area of influence (approximately 10-ft wide, 20-ft deep and 12-ft long). This is a one-person portable device equipped with a radio transmitter and receiver coil separated by a distance of approximately 12 ft. The EM31 operates by transmitting a very low frequency radio signal (9.8 kilohertz), which induces small electrical currents into the subsurface. The induced electrical currents have an associated secondary EM field. The transmitted EM field and the secondary field are detected by the device's receiver coil. The ratio and phase of the transmitted EM signal to the induced EM signal are proportional to the apparent conductivity and magnetic susceptibility of the surrounding soils, rock, groundwater, and any man-made objects. The quadrature phase component of the received signal measures ground conductivity and the in-phase component measures magnetic susceptibility, indicating metal.

A.3.2 EM61 ELECTROMAGNETIC TIME DOMAIN METAL DETECTOR

The EM61 is a high-resolution time domain metal detector with a focused area of influence (3-ft wide, 10-ft deep, and 2-ft long) used to identify subsurface metallic objects. The EM61 system consists of a backpack and a two-coil assembly with wheels that is pulled behind the operator. The EM61 generates 150 EM pulses per second and measures the off-time between pulses. After each pulse, secondary EM fields (eddy currents) are induced briefly in the ground and for a longer time in metallic objects. Between each pulse, the EM61 waits until the response from the ground decays and then measures the prolonged buried metal response. Under good conditions, the EM61 can detect a single 55-gal drum at a depth of over 9 ft below the surface and is relatively insensitive to nearby cultural interference, such as fences, buildings, and power lines.

The EM61 is a high resolution metal detector that records the measurements in millivolts (mV). Results in mV are from four components: the top coil (T), three time gates on the bottom coil (Z1, Z2, Z3), and the differential (D = bottom coil response subtracted from the top coil response). The top coil indicates metallic objects are closer to the surface. The three time gates indicate three successively deeper objects. The early time gate (Z1) from the bottom coil indicates shallow near surface targets, and the latest time gate indicates deeper targets. The middle time gate (Z2) indicates intermediate depths. The differential response indicates only deep targets since the shallow response from the bottom coil has been removed from the top coil response.

A.3.3 GROUND PENETRATING RADAR

GPR is a form of radar designed for subsurface imaging. GPR sends tiny pulses of radio waves into the ground via a sending antenna and contains a receiving antenna that detects the pulses when they bounce off an object below the ground surface. The pulses detected from the receiving antenna create an image of what is below the ground surface. Different antennas will determine how deep the GPR is capable of penetrating in the ground. The lower the frequency of the antenna the deeper the GPR will penetrate into the surface; however, the lower the frequency of the antenna the coarser the resolution of the image. A 200 megahertz (MHz) antenna will penetrate deeper than a 270 MHz antenna, but will result in a coarser image. There are a few items that will cause interference with GPR, and these items include cell phones, Nextels, and two-way radios while they are being used. The site condition with the largest effect that determines if GPR can penetrate the ground is the clay and water content of the soil.

The GPR survey was performed by utilizing a GSSI SIR 3000 GPR unit coupled to a 200 MHz and 270 MHz antennas. The data were collected on 5-ft line spacing and downloaded from the SIR 3000 GPR unit on to a laptop computer. The data were processed using RADAN® software.

A.3.4 LOCATION DATA

A Trimble® AG-114 GPS with OmniStar Satellite correction was used to provide locations for the EM31 and EM61 data collected at SWMU 4. The GPS data were collected with real time satellite differential correction at the fastest rate available (one position per second). The horizontal accuracy of mapping-grade GPS is reported as better than 3 ft (submeter). The GPS data and EM data were stored in an Allegro Cx data logger and downloaded to a laptop computer where data processing was performed.

The GPR unit used was not coupled to the GPS unit. However, the four corners of the survey boundary were captured using GPS and incorporated into the GPR data.

A.3.5 DATA PROCESSING

EM31 and EM61 data initially were downloaded and processed using Geonics® DAT31 and DAT61 software, respectively. EM data (collected at 12 reading/sec) were collected simultaneously with GPS data (1 reading/sec) and positions were interpolated using DAT31 and DAT61. Positions were collected in longitude/latitude (WGS84) and converted to U.S. State Plane feet, Kentucky South Zone (NAD83), using Geosoft® Oasis Montaj. The data then were contoured with Oasis Montaj using minimum curvature interpolation. Generally, blue indicates the lowest range of ground conductivity results, and then green; yellow is intermediate, then orange; with red and pink indicating the higher ranges of ground conductivity results.

Additional maps of the EM61 bottom soils, time gates 1, 2, and 3 (see Attachment Figures A1.3 and A1.5), were generated to breakdown further the scaled responses from the EM61. These maps were generated in ArcGIS using an inverse distance weighting. Light blue indicates the lowest range of results, yellow/green represent intermediate range, and red to gray represent the higher ranges.

A.4. RESULTS OF EM GEOPHYSICAL SURVEYS

The survey found surface metal at the site including the fence surrounding the 6.5 acre area and culverts located in the northeast, northwest, and southeast corners of the site. Two additional culverts were noted on the western side of the site at two gates near the fence, and a third culvert was located on the eastern side of the site where another gate exists. These features are included in Figure A.2, Site Features Map of SWMU 4.

A total of five anomalies has been detected in the EM31 and EM61 data maps. The strong positive responses and strong negative responses at Anomalies 1–4 indicate there are large amounts of buried metal ranging in depth from 3 to 10 ft bgs. The results of Anomaly 5 are less clear and could indicate buried metal, but at deeper depths, or something besides metal is buried. None of the Anomalies 1–5 are associated with surface metal at the site.

Anomaly 1

Anomaly 1 (A-1) is located in the southwest portion of the site. The anomaly is approximately 375-ft long from west to east and approximately 150-ft wide from north to south on the main portion of the anomaly. The anomaly is observed in the EM31 conductivity data, EM31 in-phase data (Figures A.3–A.6), and EM 61 data (Figures A.7–A.12). The signature acquired from the EM31 data north-south survey lines and east-west survey lines from the conductivity and in-phase modes shows a highly conductive feature ranging from 60 millisiemens/meter (mS/m) (orange in color) to greater than 180 mS/m (pink color), Figures A.3 and A.5. In-phase data show background readings varying from -0.1 parts per thousand (ppt) (light blue in color) to approximately 2.3 ppt (yellowish-green in color) (Figures A.4 and A.6). High in-phase readings are represented as red (10 ppt) to pink (greater than 21 ppt) in color (Figures A.4 and A.6). Based on the high in-phase readings and high conductivity readings, the items buried in A-1 consist of metals. Immediately south of the large anomaly, a strong negative response followed by a strong positive response is observed in the EM31 conductivity and in-phase modes, indicating some buried items may be near the surface less than 4 ft below the ground surface.

EM61 responses are shown in Figures A.7–A.11 with strong positive responses (red to pink in color) from the bottom coil time gates 1–3 (greater than 800 mV), the top coil, and the differential coil. Based on the top coil responses being greater than 1,500 mV, the items buried within Anomaly 1 appear to be located near the surface. Burial depth ranges from 3–10 ft below the ground surface, with most items likely buried nearer the 3 ft depth.

Anomaly 2

Anomaly 2 (A-2) appears in the EM31 conductivity and in-phase mode data maps (Figures A.3–A.6) to be approximately 125-ft wide from west to east and 250-ft long from north to south. In the conductivity mode (Figures A.3 and A.5), strong positive responses are observed ranging from 60 mS/m (orange in color) to 100 mS/m (red in color). Conductivity background values range from approximately 32 mS/m (light blue to blue) to 53 mS/m (light green to green in color). EM31 in-phase data maps (Figures A.4 and A.6) show that within Anomaly 2 there are some parts exhibiting strong positive responses surrounded by a strong negative response, which indicates parts of the anomaly may be buried near surface (approximately 3 ft below ground surface), while other portions of the anomaly are estimated to be buried at depths ranging from 3 ft to approximately 10 ft.

Results of the EM61 three bottom coil time gates (Figures A.7–A.9), top coil map, and differential component map confirm that Anomaly 2 contains items that more than likely are buried metal near the surface with parts of the anomaly showing stronger positive results (color in pink) than the remaining part of the anomaly (red in color). Background EM61 values range from -4.9 mV (dark blue in color) to approximately 40 mV (orange in color).

Anomaly 3

Anomaly 3 (A-3) is located on the northeast portion of the site. The anomaly is approximately 200-ft long from west to east and approximately 75-ft wide from west to east. The EM31 maps in the conductivity mode (north-south and east-west survey lines) indicate a strong positive response range from approximately 90 mS/m (red in color) (Figure A.3) to greater than 184 mS/m (pink in color) (Figure A.5). The EM31 in-phase component, north-south and east-west survey lines (Figures A.4 and A.6, respectively), exhibits strong positive responses greater than 21 ppt. The strong positive responses indicate that any object buried below the surface is buried approximately 3–10-ft deep.

The EM61 data confirm that the depth at which the items are buried is approximately between 3–10 ft based on all time gates (Figures A.7–A.9) and the top coil component (Figure A.10) have mV responses of 2,000 mV. Since the top coil was saturated with such a positive response, it indicates that the items are buried at a depth of approximately 3 ft. This also is confirmed by the differential component (Figure A.11) mV responses that are greater than 1000 mV.

Anomaly 4

Anomaly 4 (A-4) is located on the northwestern portion of the site. The anomaly is approximately 50-ft wide from west to east, and 125-ft long from north to south. Strong positive responses in the EM31 and EM61 data indicate the metal objects are buried near surface (approximately 3–10 ft) due to the saturation (high responses) of the conductivity, in-phase, bottom coil times gates, top coil, and differential component responses. These responses are shown in Figures A.3–A.11.

Anomaly 5

Anomaly A-5 is observed in the EM31 north-south and east-west survey lines conductivity component data maps (Figures A.3 and A.5), but is not observed in the EM31 in-phase component (Figures A.4 and A.6). High in-phase mode responses of the EM31 typically indicate buried metal is present. The anomaly is not well pronounced in the EM61 data, but there are mV responses ranging from approximately 90 mV to approximately 400 mV that were acquired in all three bottom time gates. The anomaly is well pronounced only in the EM31 conductivity mode and not in the in-phase mode; this could indicate that there are high conductive soils (55 mS/m to 65 mS/m) in comparison to background values ranging from 32 mS/m to 50 mS/m. Since the EM61 data for all three time gates indicate there are some anomalous high responses that are not well defined, it may indicate that there is buried metal but at deeper depths or something besides metal is buried below the ground surface.

36-Inch Metal Pipe Raw Water Line

In addition to locating the five anomalies, a linear anomaly was detected in all EM31 and EM61 data sets traversing the site from the southwestern portion of the site toward the northeastern portion of the site. After viewing utility maps for the site, the anomaly was confirmed to be a 36-inch diameter raw water line pipe. The pipe was confirmed visually in the field due to the pipe’s being exposed on the southwestern corner of the geophysical survey area.

Anomaly Locations

To support confirmation of the locations of the significant anomalies in the field at SWMU 4, the corners of the first four anomalies were marked in the field with 3-ft tall painted wood stakes. Anomaly 5 was not staked. The outline and corners of the anomalies are shown on the EM31 Vertical Mode, Conductivity Component data in Figure A.12. Table 1 includes the GPS coordinates of the corners of the anomalies and 36-inch metal pipe raw water line. These GPS corners, outlines of the anomalies, and pipe are illustrated in Figure A.13 to show the location of the stakes on the site. The GPS coordinates of the corners of the anomalies are included on Figure A.13. The 36-inch metal pipe raw water line was not staked in the field.

Additional EM61 Maps

The EM 61 figures were reviewed during a January 2011 SWMU 4 sampling scoping meeting. As a result of this meeting, the data were reprocessed in a manner designed to enhance the contrast of the figures. As a result of this reprocessing, additional EM61 maps were generated using ArcGIS. Figure A1.1 (Attachment) shows a box surrounding Anomaly 5 and the location of the fence surrounding the five major anomalies. Figure A1.2 shows the GPS corners of Anomaly 5 and the location of the fence drawn around the anomalies. Figures A1.3 to A1.5 represent the EM61 Geophysical Survey Bottom Coil, Time Gates 1, 2, and 3, respectively, in the North-South direction as the data were processed using ArcGIS.

Scaling and colors of the maps were changed to show a better breakdown of the colors and millivolt response of items buried below the ground surface. One can observe the anomaly shapes are very similar to those processed in Oasis Montaj.

A.5. RESULTS OF GROUND PENETRATING RADAR

GPR was performed at SWMU 4 May 4 and 5, 2010. The geophysical team tested the GPR unit with 270 MHz and 200 MHz antennas to observe which antenna provided the best penetration on the site. After testing the antennas, the 200 MHz antenna was chosen as the antenna that could provide the best penetration into the ground. The 200 MHz antenna was used to survey over one anomaly, Anomaly 3 (A-3). Results of the GPR survey showed the ground penetration achieved was approximately 2.5 ft and A-3 could not be detected. This limited penetration is attributed to the heavy rains (between 5 and 8 inches) that occurred in the area from May 1–3, 2010, and the large amount of clay material at the site. Based on the GPR results over A-3 and site conditions, GPR was not performed on the remaining anomalies.

A.6. CONCLUSION

Five anomalies were found at SWMU 4 inside the fenced area. None of the anomalies indicate the presence of surface metal. A 36-inch diameter metal raw water line pipe that traverses the southern portion of the site was detected in the geophysical survey and confirmed to be on the site utility maps.

Based on the EM31 in-phase readings and EM61 bottom coil time gate results, top coil and differential component results anomalies, Anomalies A-1 to A-4 appear to contain buried metal at a depth of approximately 3–10 ft below the ground surface with possibly parts of the anomalies buried closer toward the surface. Based on the EM31 in-phase readings and EM61 bottom coil time gate results, top coil and differential component results anomalies A-1 to A-4 contain large amounts of metal buried at a depth of approximately 3-10 below ground surface and possibly with parts of the anomalies buried toward the surface.

Anomaly A-5 is not as well defined as the others. The anomaly is well pronounced only in the EM31 conductivity mode and not in the in-phase mode; this could indicate that there are high conductive soils in comparison to background values. However, since the EM61 data for all three time gates indicate there are some anomalous high responses that are not well defined, it may indicate that there is buried metal but at deeper depths, or something other than metal is buried below the ground surface.

All of the anomalies (A-1 to A-5) appear to exist within the fenced area of SWMU 4 with the exception of the southwest corner of A-1, which may extend several ft under the southern fence. None of the anomalies appear to extend under the roads surrounding SWMU 4.

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FIGURES

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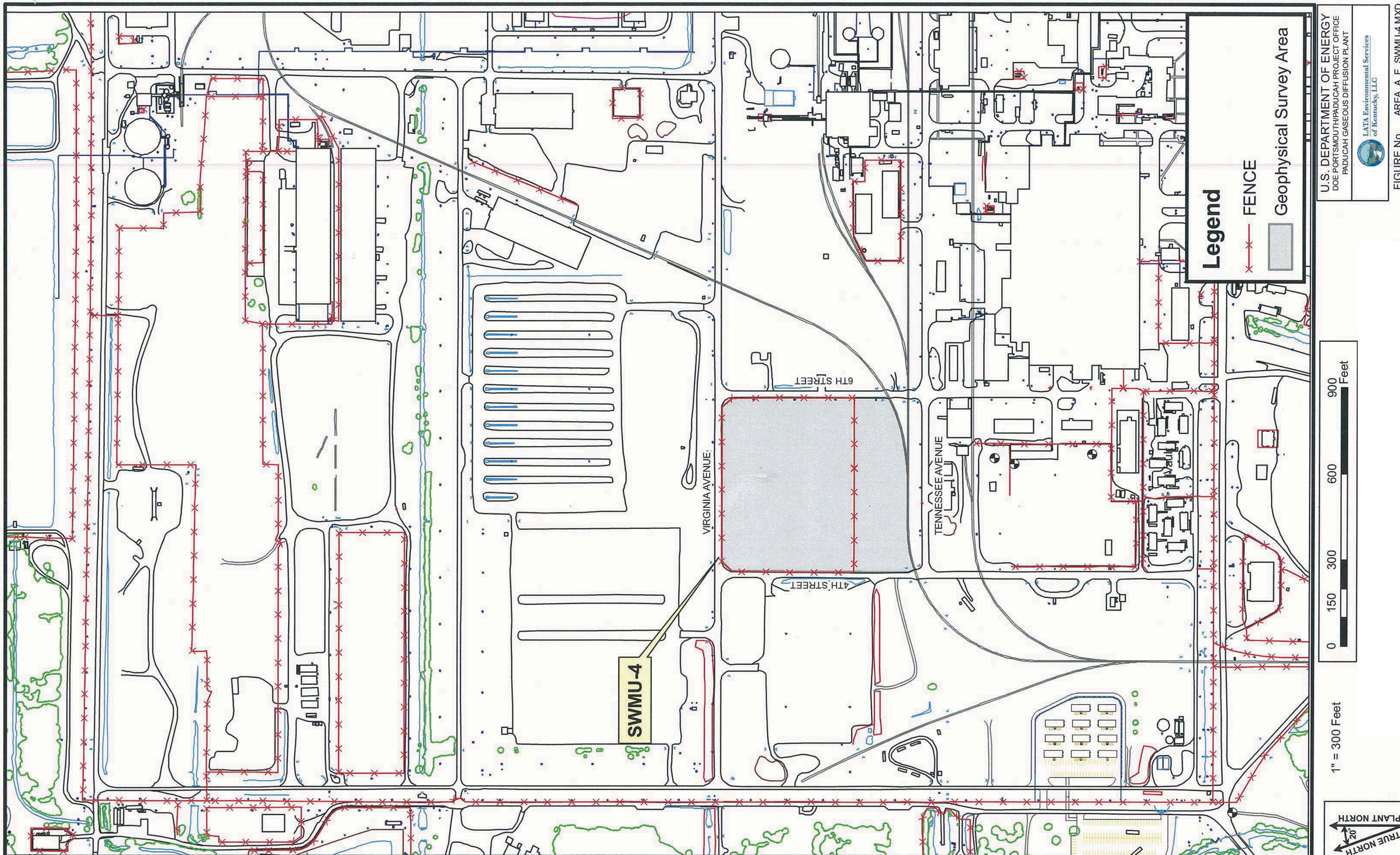

Figure A.1. Location Map of SWMU 4

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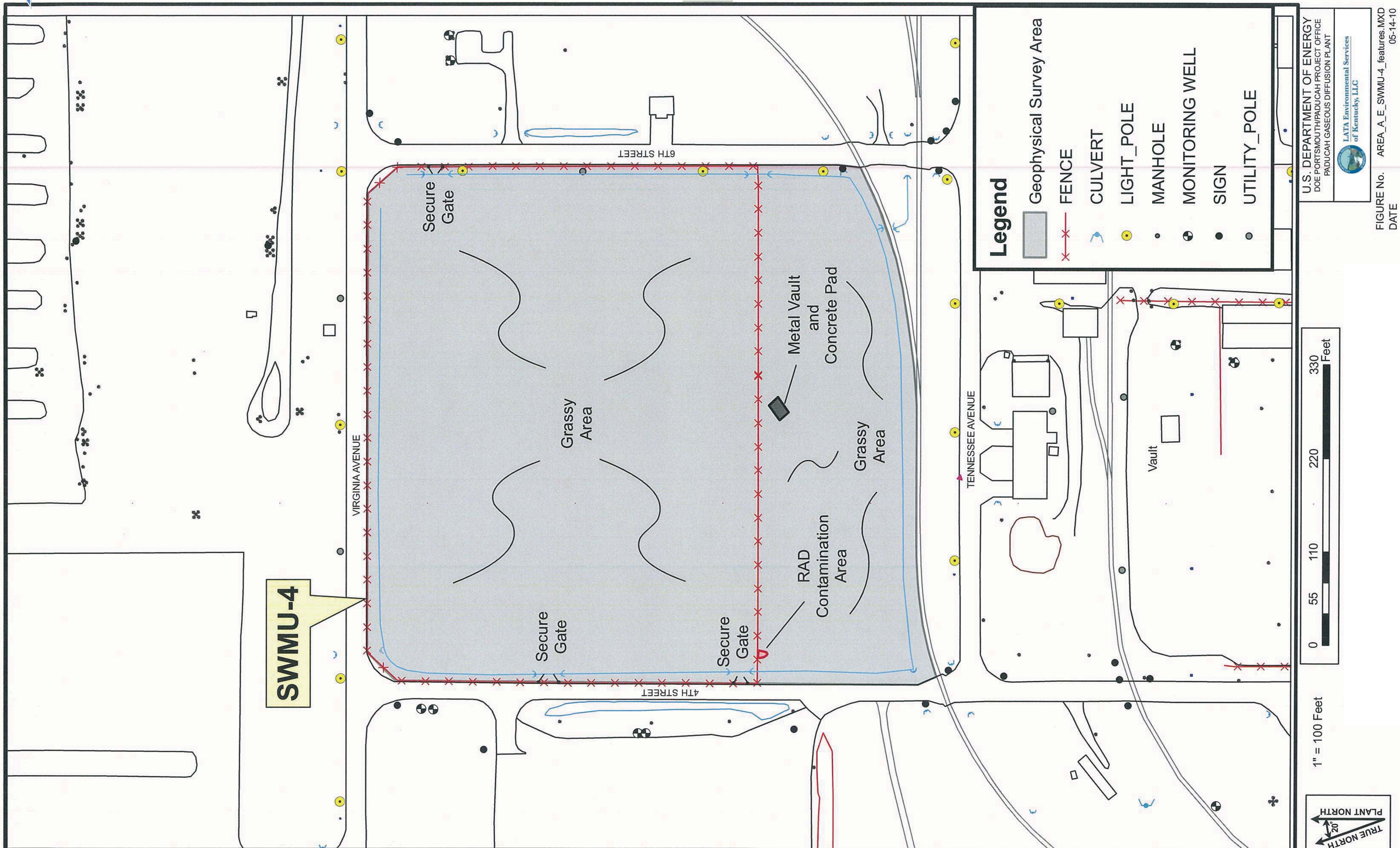

Figure A.2. Features Map of SWMU 4

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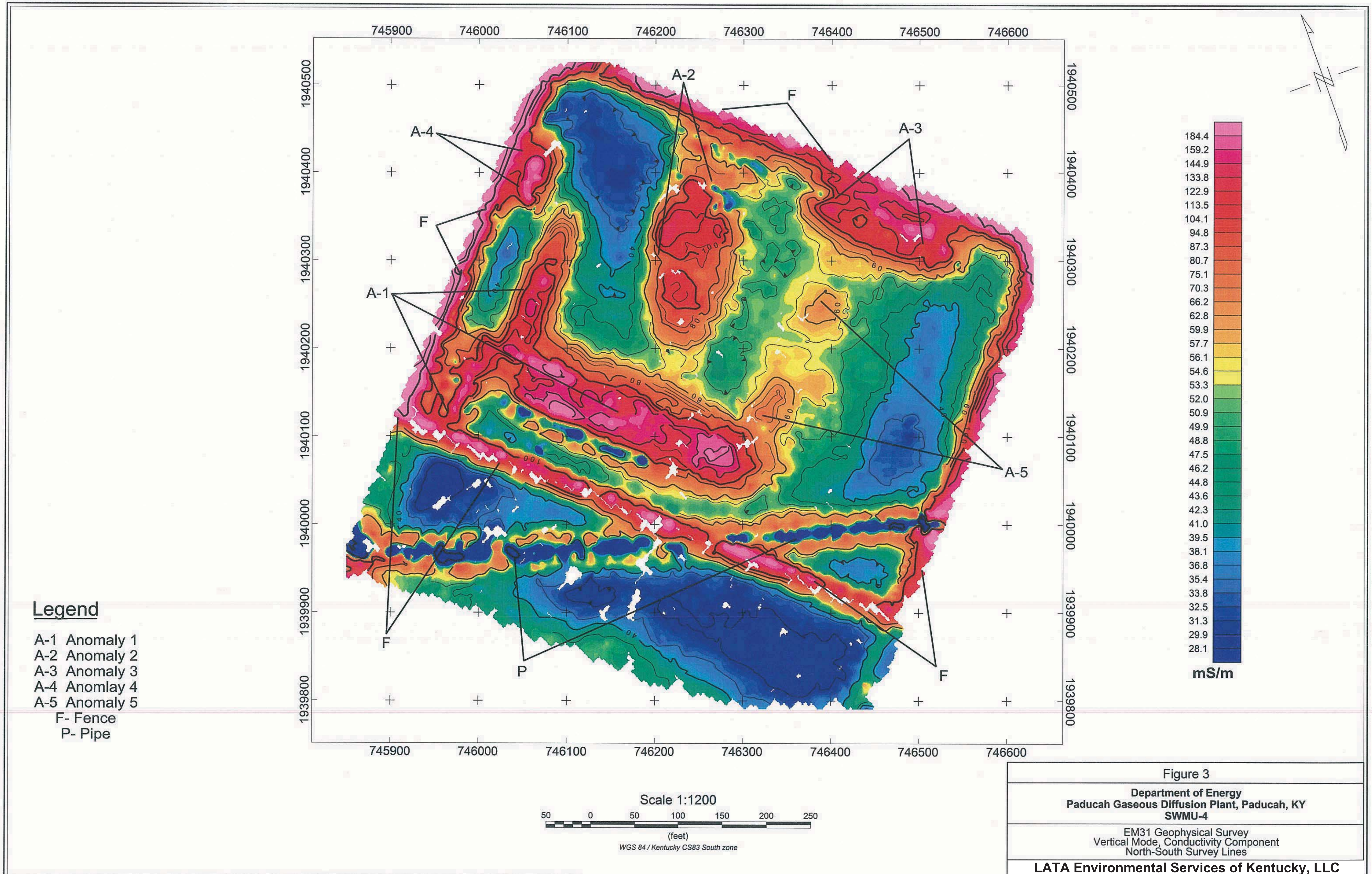

Figure A.3. SWMU 4 EM31 Vertical Mode, Conductivity Component North-South Survey Lines

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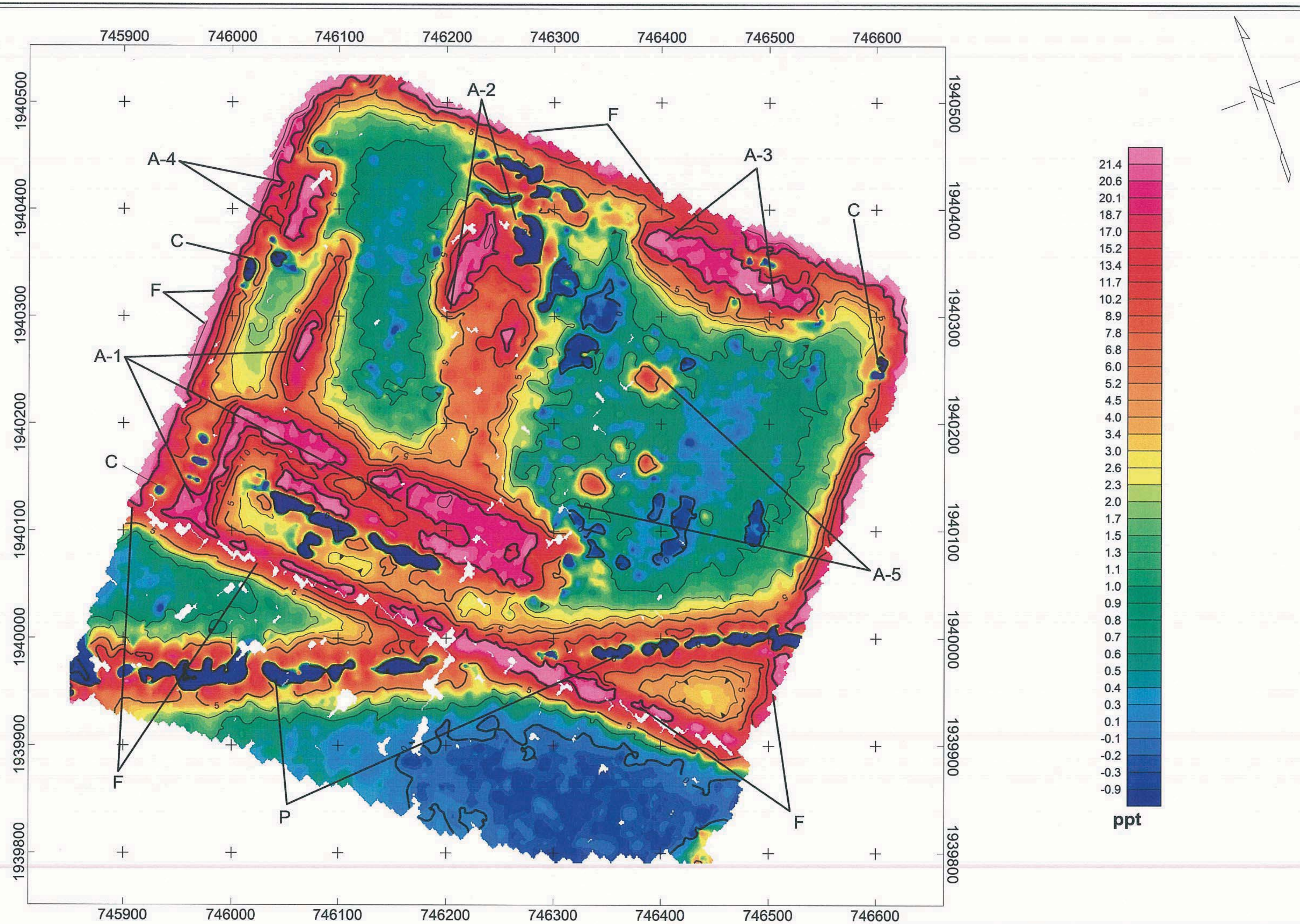

Legend

A-1 Anomaly 1
A-2 Anomaly 2
A-3 Anomaly 3
A-4 Anomaly 4
A-5 Anomaly 5
C- Culvert
F- Fence
P- Pipe

Scale 1:1200

50 0 50 100 150 200 250

(feet)

WGS 84 / Kentucky CS83 South zone

Figure 4
Department of Energy **Paducah Gaseous Diffusion Plant, Paducah, KY** **SWMU-4**
EM31 Geophysical Survey Vertical Mode, In-Phase Component North-South Survey Lines
LATA Environmental Services of Kentucky, LLC

Figure A.4. SWMU 4 EM31 Vertical Mode, In-Phase Component North-South Survey Lines

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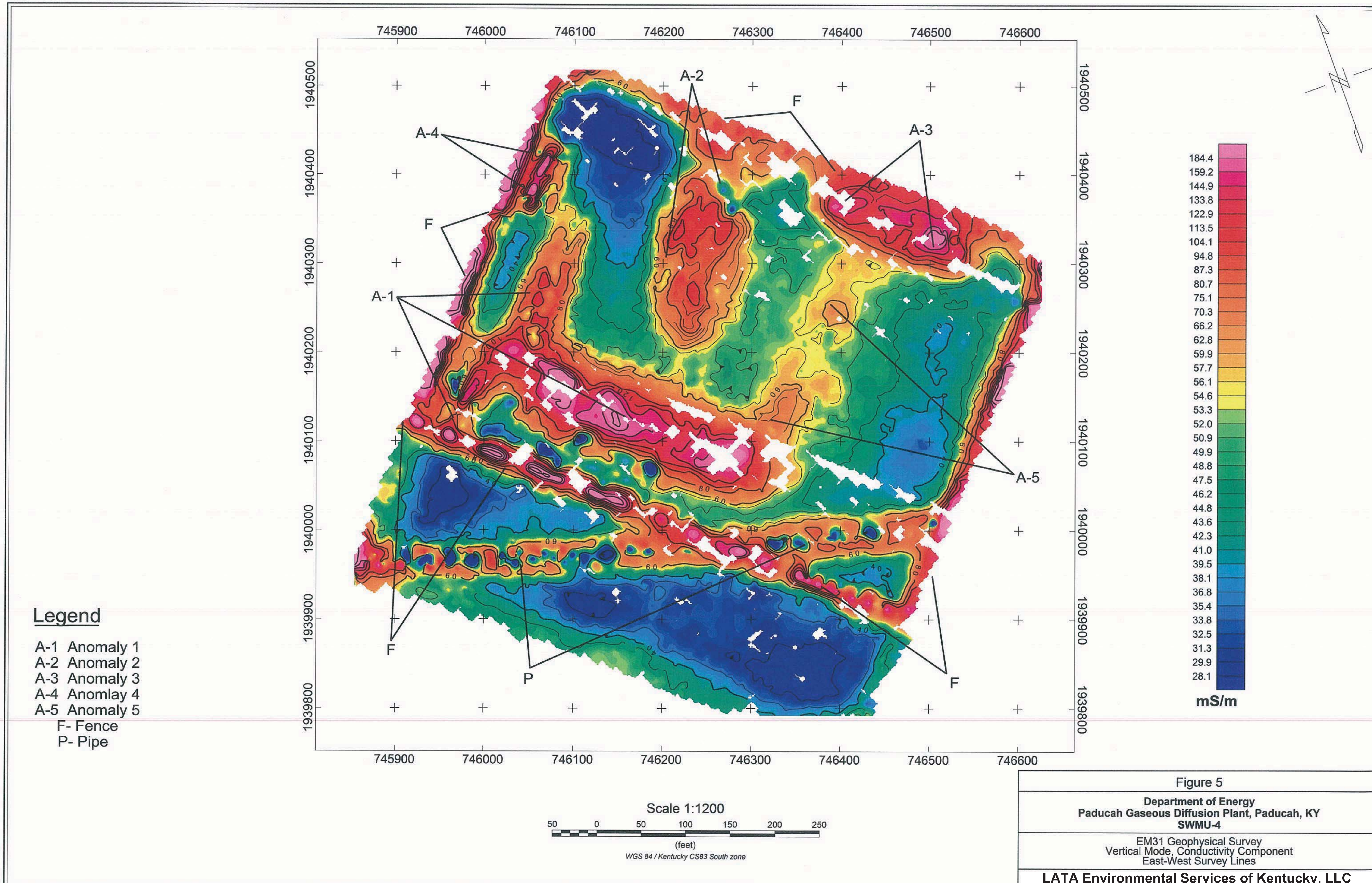

Figure A.5. SWMU 4 EM31 Vertical Mode, Conductivity Component East-West Survey Lines

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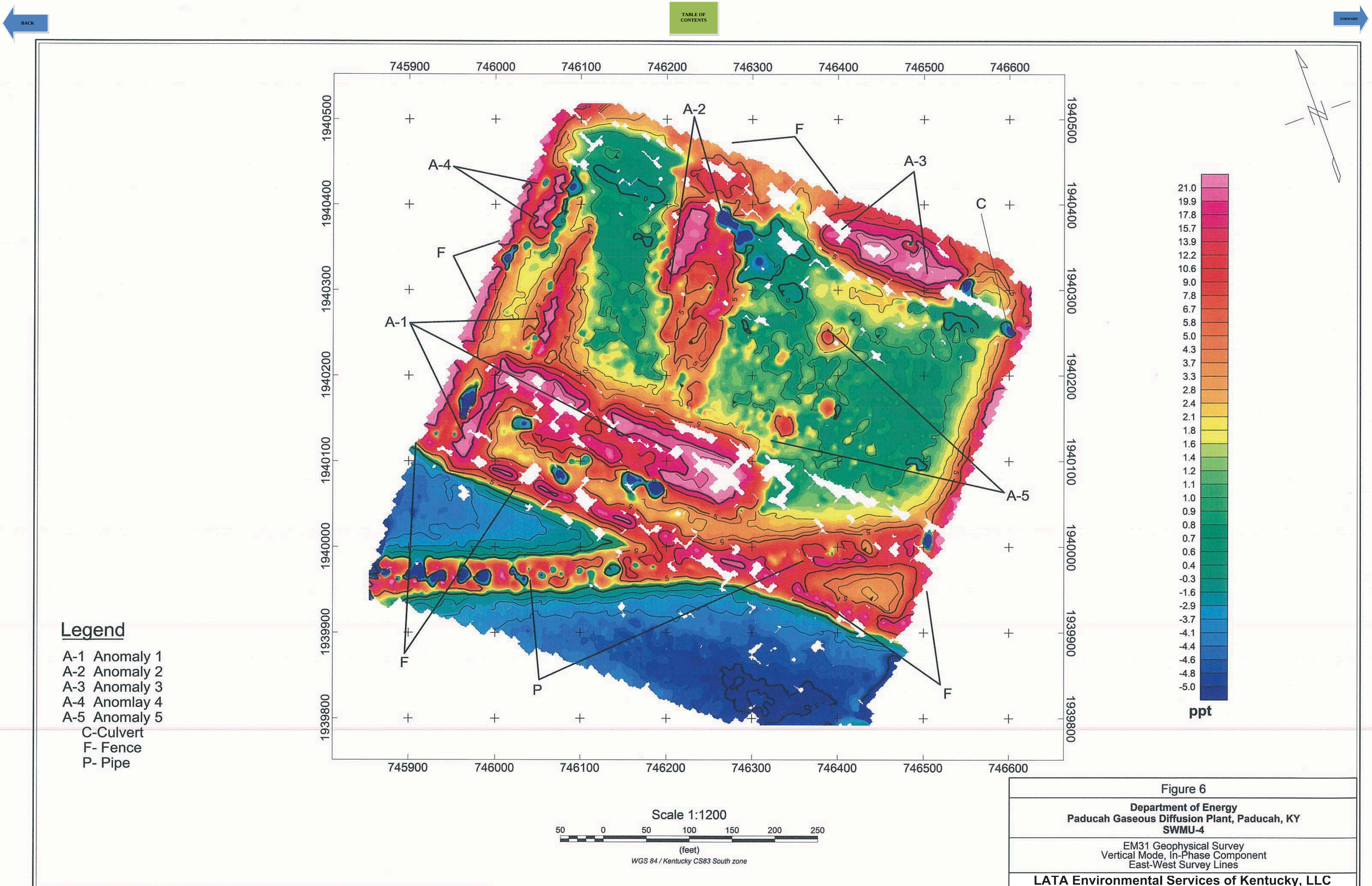

Figure A.6. SWMU 4 EM31 Vertical Mode, In-Phase Component East-West Survey Lines

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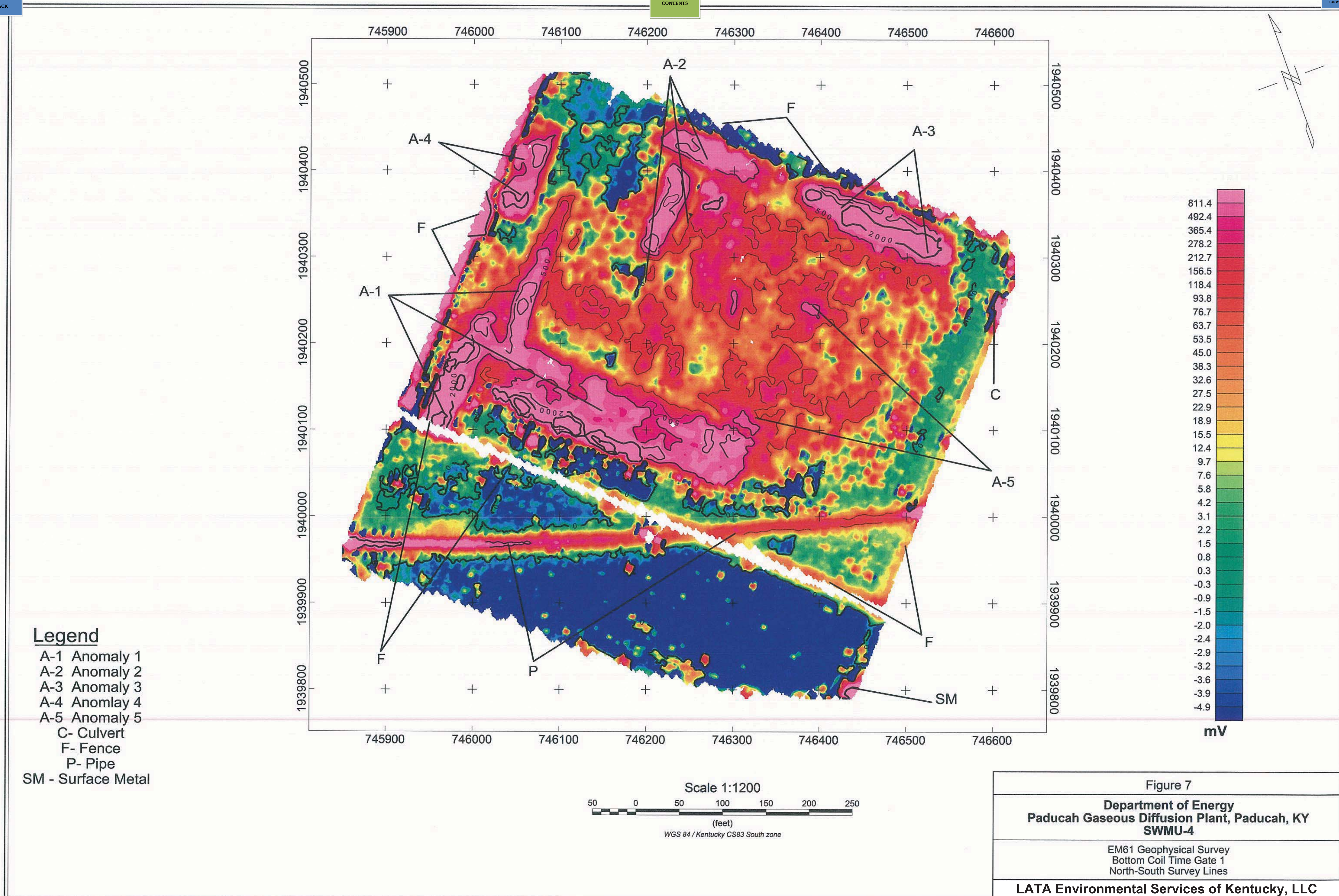

Figure A.7. SWMU 4 EM61 Bottom Coil Time Gate 1 North-South Survey Lines

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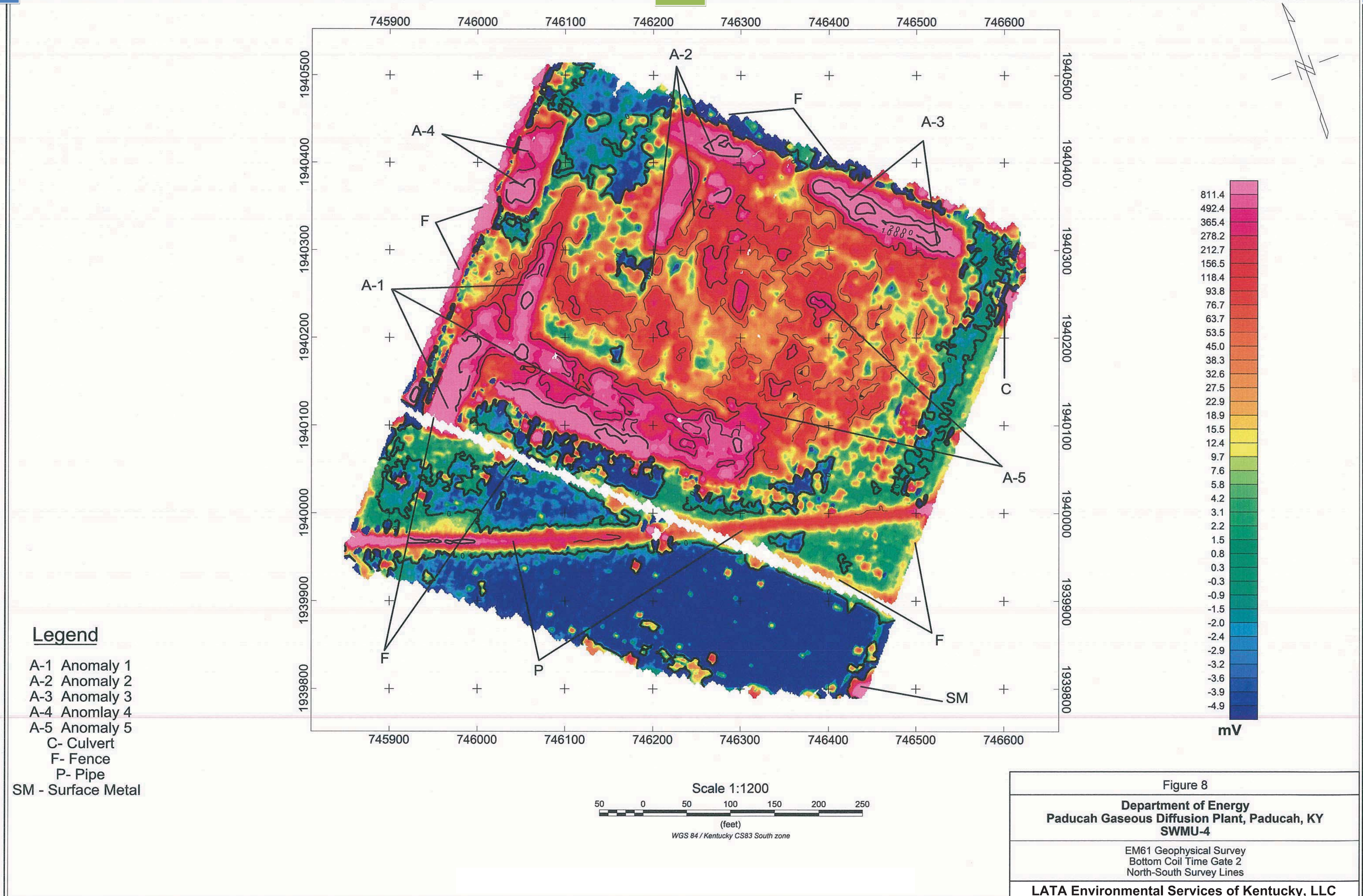

Figure A.8. SWMU 4 EM61 Bottom Coil Time Gate 2 North-South Survey Lines

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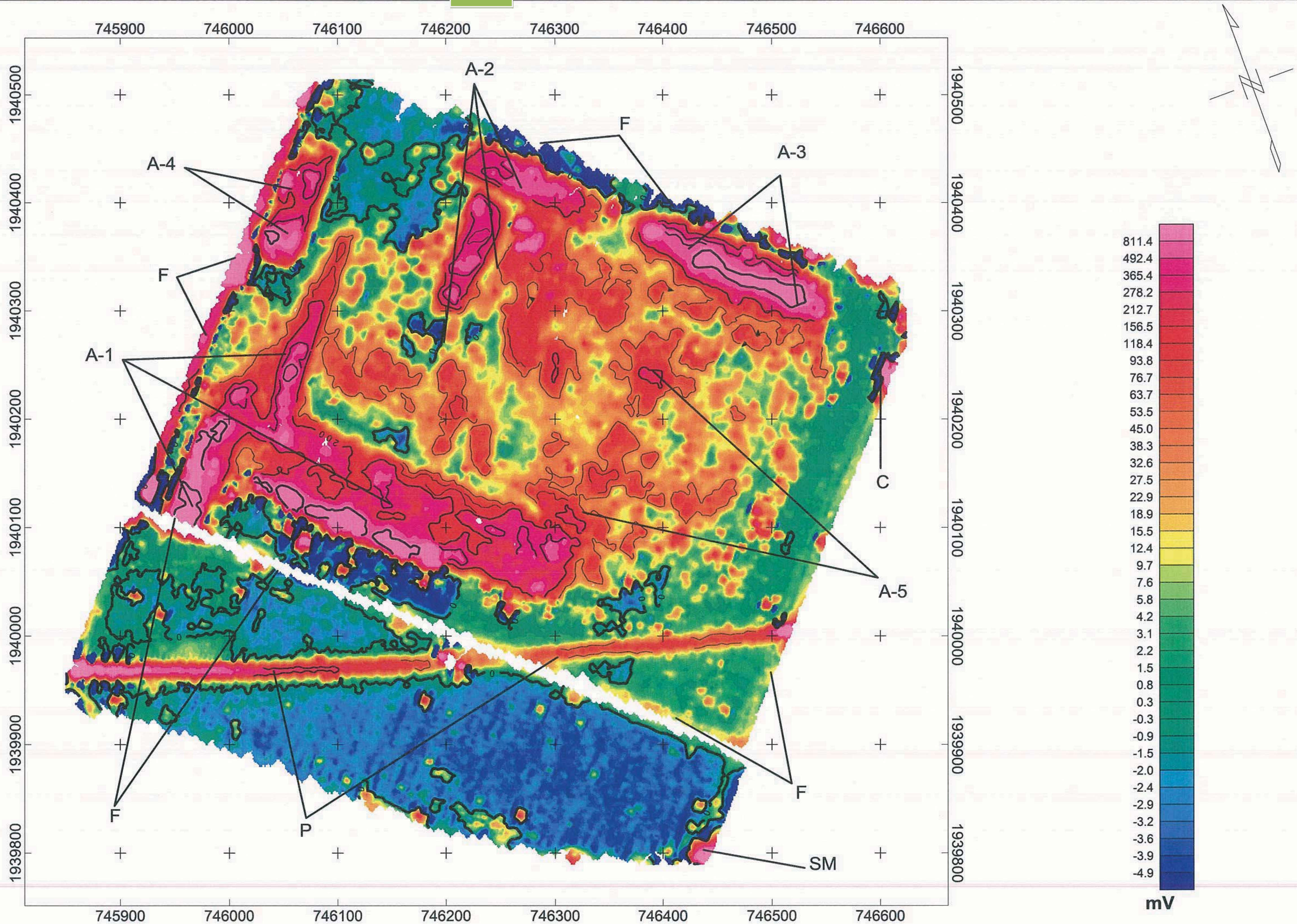

Legend

A-1 Anomaly 1
A-2 Anomaly 2
A-3 Anomaly 3
A-4 Anomlay 4
A-5 Anomaly 5
C- Culvert
F- Fence
P- Pipe
SM - Surface Metal

Scale 1:1200

50 0 50 100 150 200 250

(feet)

WGS 84 / Kentucky CS83 South zone

Figure 9

Department of Energy
Paducah Gaseous Diffusion Plant, Paducah, KY
SWMU-4

EM61 Geophysical Survey
Bottom Coil Time Gate 3
North-South Survey Lines

LATA Environmental Services of Kentucky, LLC

Figure A.9. SWMU 4 EM61 Bottom Coil Time Gate 3 North-South Survey Lines

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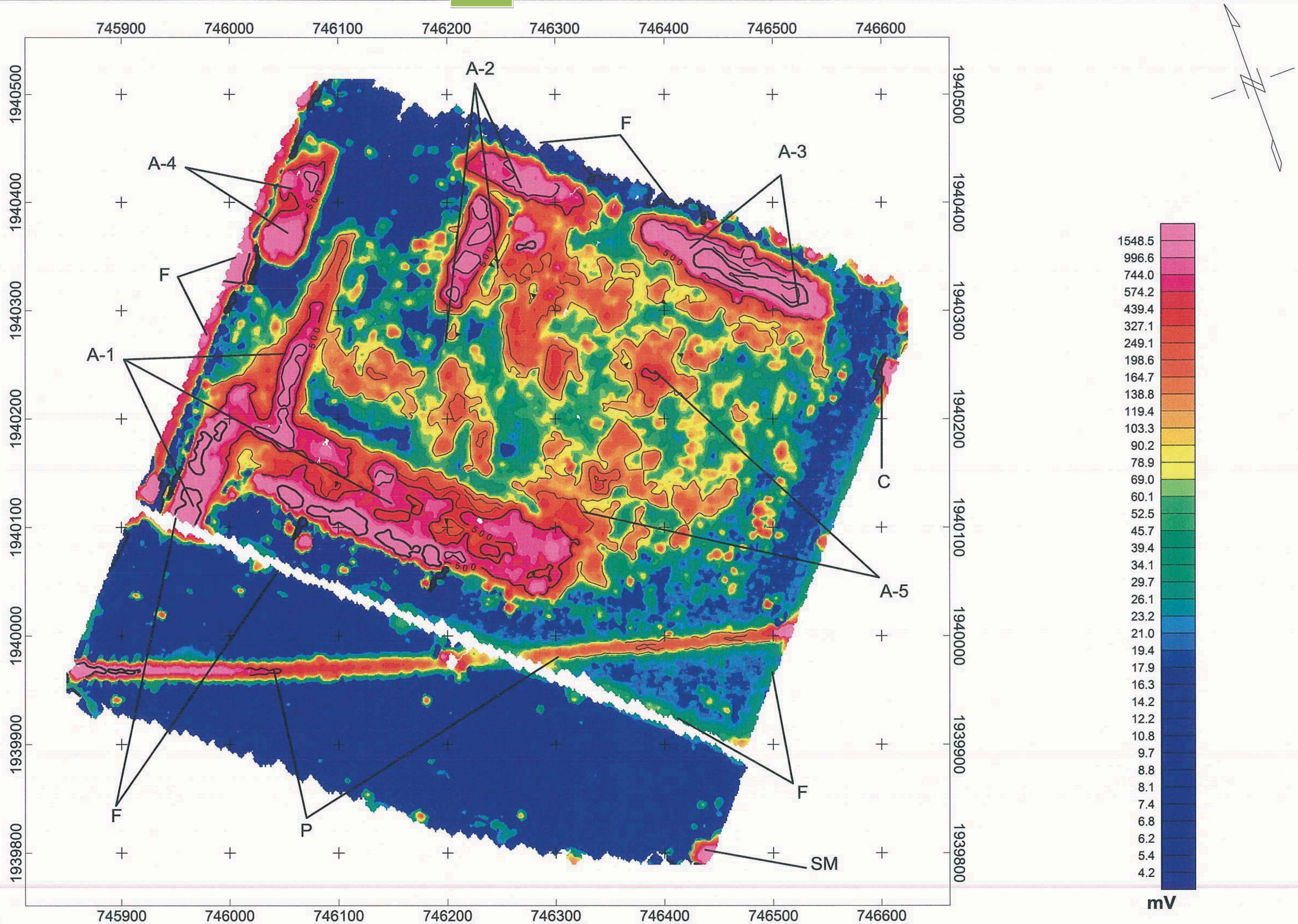

Legend

A-1 Anomaly 1
A-2 Anomaly 2
A-3 Anomaly 3
A-4 Anomaly 4
A-5 Anomaly 5
C- Culvert
F- Fence
P- Pipe
SM - Surface Metal

Scale 1:1200

50 0 50 100 150 200 250

(feet)

WGS 84 / Kentucky CS83 South zone

Figure 10

Department of Energy
Paducah Gaseous Diffusion Plant, Paducah, KY
SWMU-4

EM61 Geophysical Survey
Top Coil
North-South Survey Lines

LATA Environmental Services of Kentucky, LLC

Figure A.10. SWMU 4 EM61 Top Coil North-South Survey Lines

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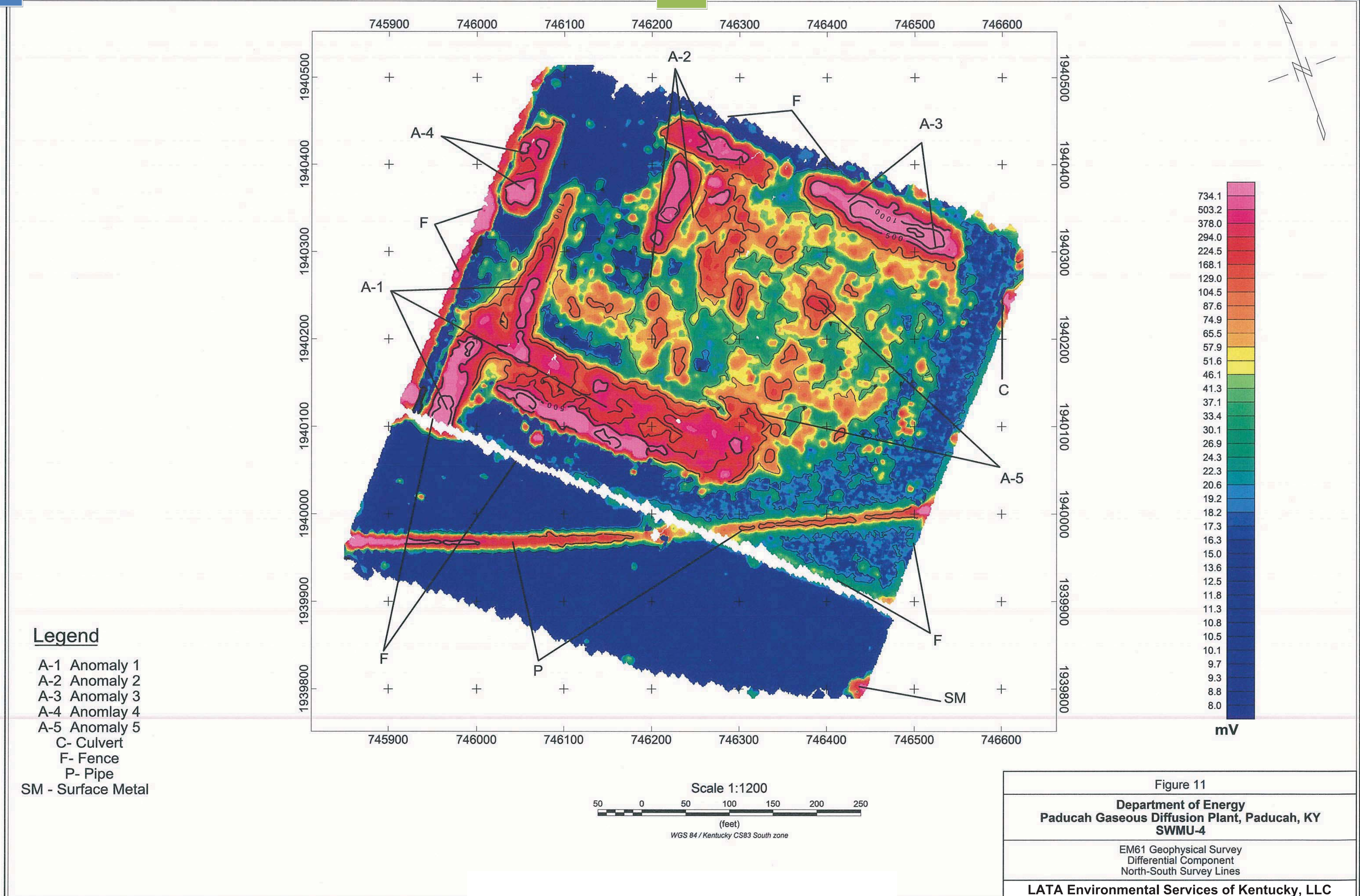

Figure A.11. SWMU 4 EM61 Differential Component North-South Survey Lines

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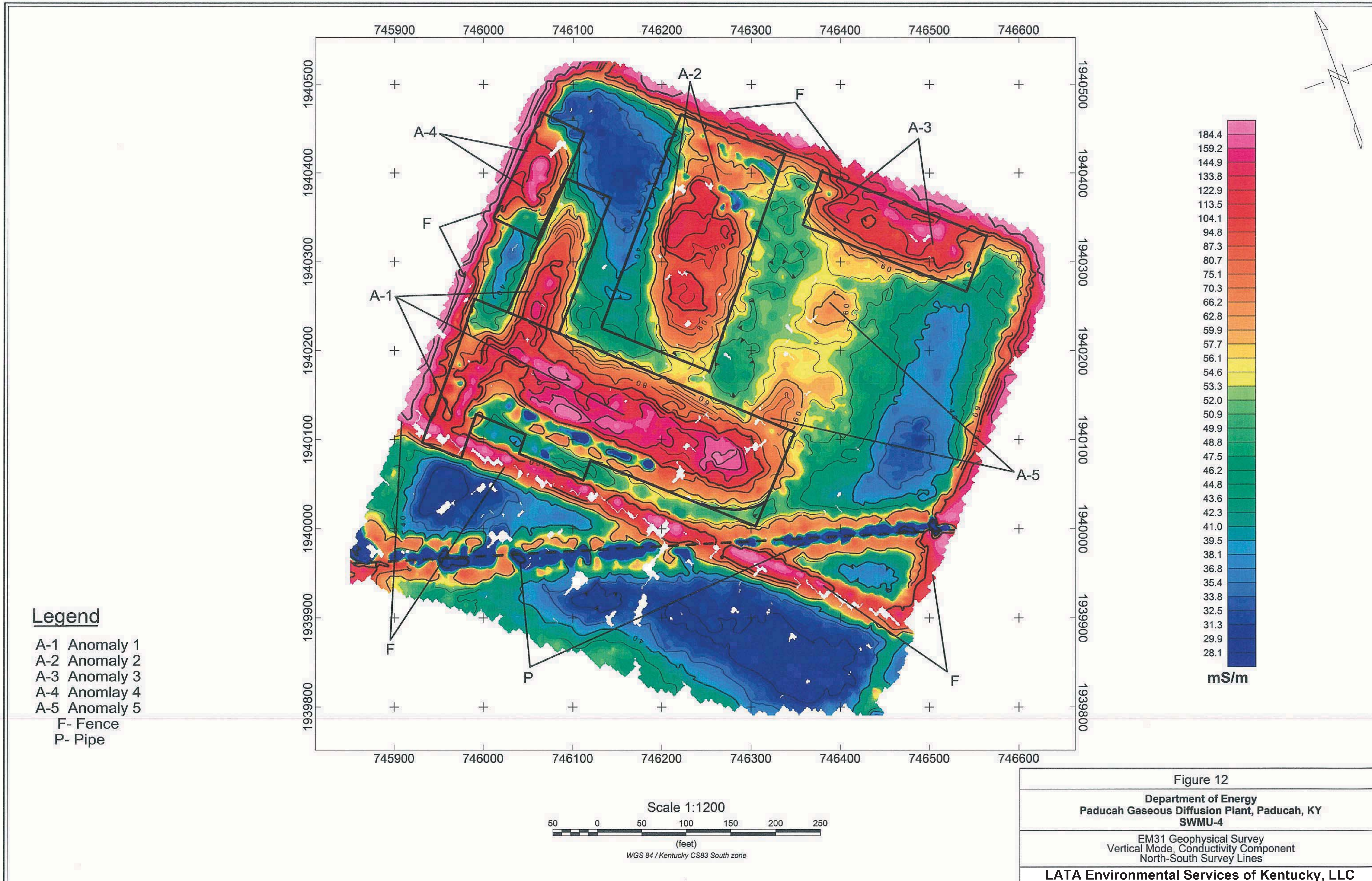

Figure A.12. SWMU 4 EM31 Vertical Mode, Conductivity Component Outlines of Anomalies, North-South Survey Lines

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Coordinates of Anomalies & Pipe

Anomaly 1

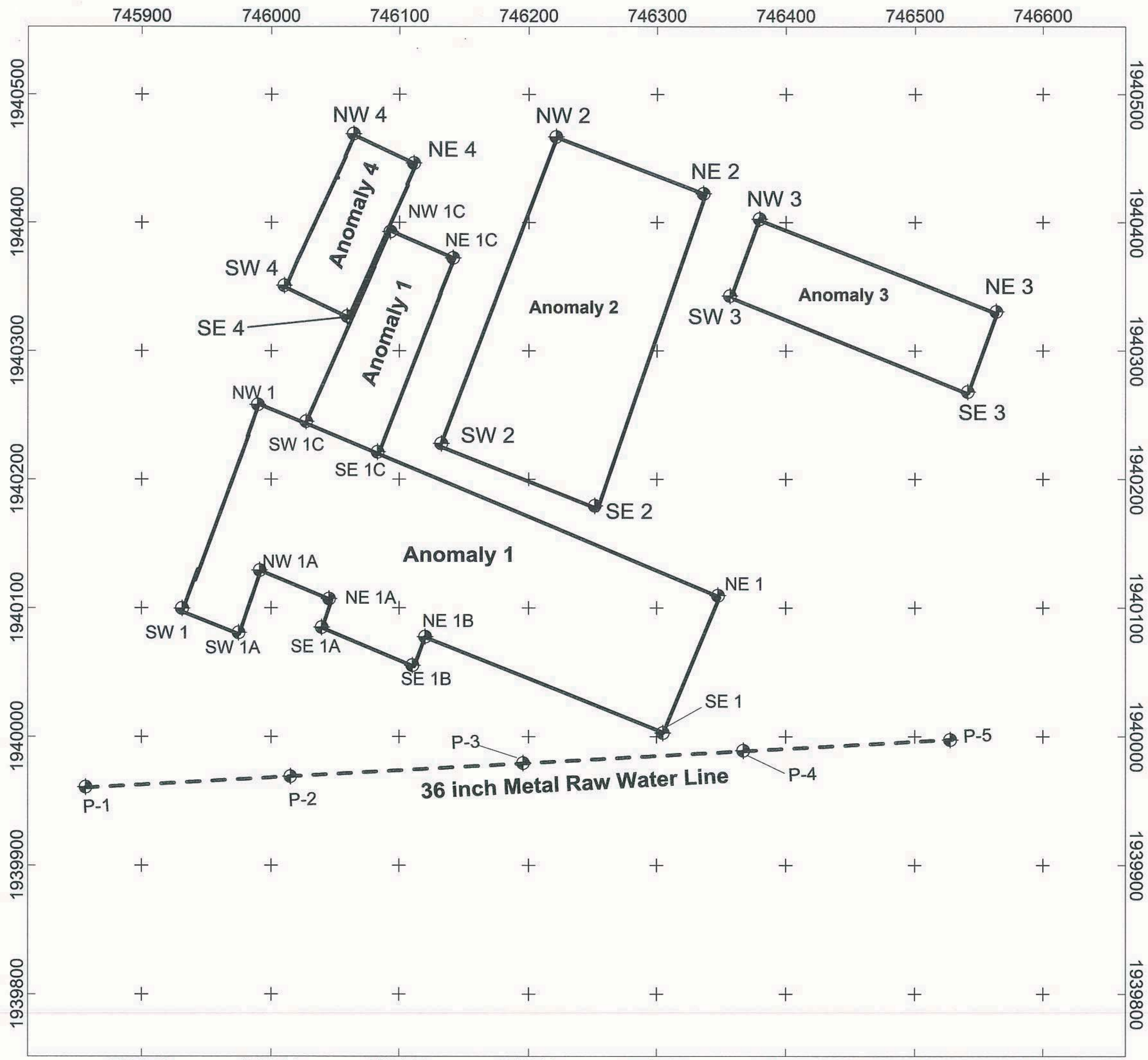
Point	Easting	Northing
NW 1	745990.4	1940258
SW 1	745931.3	1940098
NE 1	746347.7	1940109
SE 1	746304.8	1940004
SW 1A	745974.2	1940081
NW 1A	745991.6	1940129
NE 1A	746046.5	1940107
SE 1A	746039.7	1940085
SE 1B	746110.8	1940056
NE 1B	746119.7	1940077
SW 1C	746026.4	1940244
NW 1C	746092.7	1940394
NE 1C	746142	1940373
SE 1C	746083.5	1940220

Anomaly 2

Point	Easting	Northing
NW 1	746221.9	1940466
SW 1	746131.3	1940226
SE 1	746253.2	1940178
NE 1	746337.1	1940422

Anomaly 3

Point	Easting	Northing
NW 3	746379.4	1940402
SW 3	746357.3	1940342
NE 3	746563.6	1940330
SE 3	746541.4	1940267



Coordinates of Anomalies & Pipe

Anomaly 4

Point	Easting	Northing
NW 4	746064.5	1940468
SW 4	746010.6	1940350
NE 4	746112	1940446
SE 4	746059.6	1940326

36 inch Metal Raw Water Line

Point	Easting	Northing
P-1	745856.3	1939962
P-2	746014.7	1939970
P-3	746195	1939980
P-4	746366.5	1939990
P-5	746527.5	1939999

Note: All Coordinates listed are in WGS 84 Kentucky CS83 South zone not in Plant Coordinates

Figure 13

Department of Energy
Paducah Gaseous Diffusion Plant, Paducah, KY
SWMU-4

Labels of Corners, Coordinates, Outlines of Anomalies and Pipe Detected

LATA Environmental Services of Kentucky, LLC

Figure A.13. Labels of Corners, Coordinates, Outlines of Anomalies and Pipe Detected

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TABLE

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Table A.1. GPS Coordinates of the Corners of the Anomalies and Pipe

Anomaly 1		
Corners of Anomaly	Easting	Northing
NW 1	745990.4	1940258
SW 1	745931.3	1940098
NE 1	746347.7	1940109
SE 1	746304.8	1940004
SW 1A	745974.2	1940081
NW 1A	745991.6	1940129
NE 1A	746046.5	1940107
SE 1A	7460397	1940085
SE 1B	746110.8	1940056
NE 1B	746119.7	1940077
SW 1C	746026.4	1940244
NW 1C	746092.7	1940394
NE 1C	746142	1940373
SE 1C	746083.5	1940220
Anomaly 2		
NW 1	746221.9	1940466
SW 1	746131.3	1940226
SE 1	746253.2	1940178
NE 1	746337.1	1940422
Anomaly 3		
NW 3	746379.4	1940402
SW 3	746357.3	1940342
NE 3	746563.6	1940330
SE 3	746541.4	1940267
Anomaly 4		
NW 4	746064.5	1940468
SW 4	746010.6	1940350
NE 4	746112	1940446
SE 4	746059.6	1940326
Anomaly 5		
NW5	746359.7	1940317
SW5	746285.7	1940136
NE5	746450.5	1940283
SE5	746381.4	1940094
36-Inch Raw Water Line		
P1	745856.3	1939962
P2	746014.7	1939970
P3	746195	1939980
P4	746366.5	1939990
P5	746527.5	1939999

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ATTACHMENT

REVISED GEOPHYSICAL MAPS

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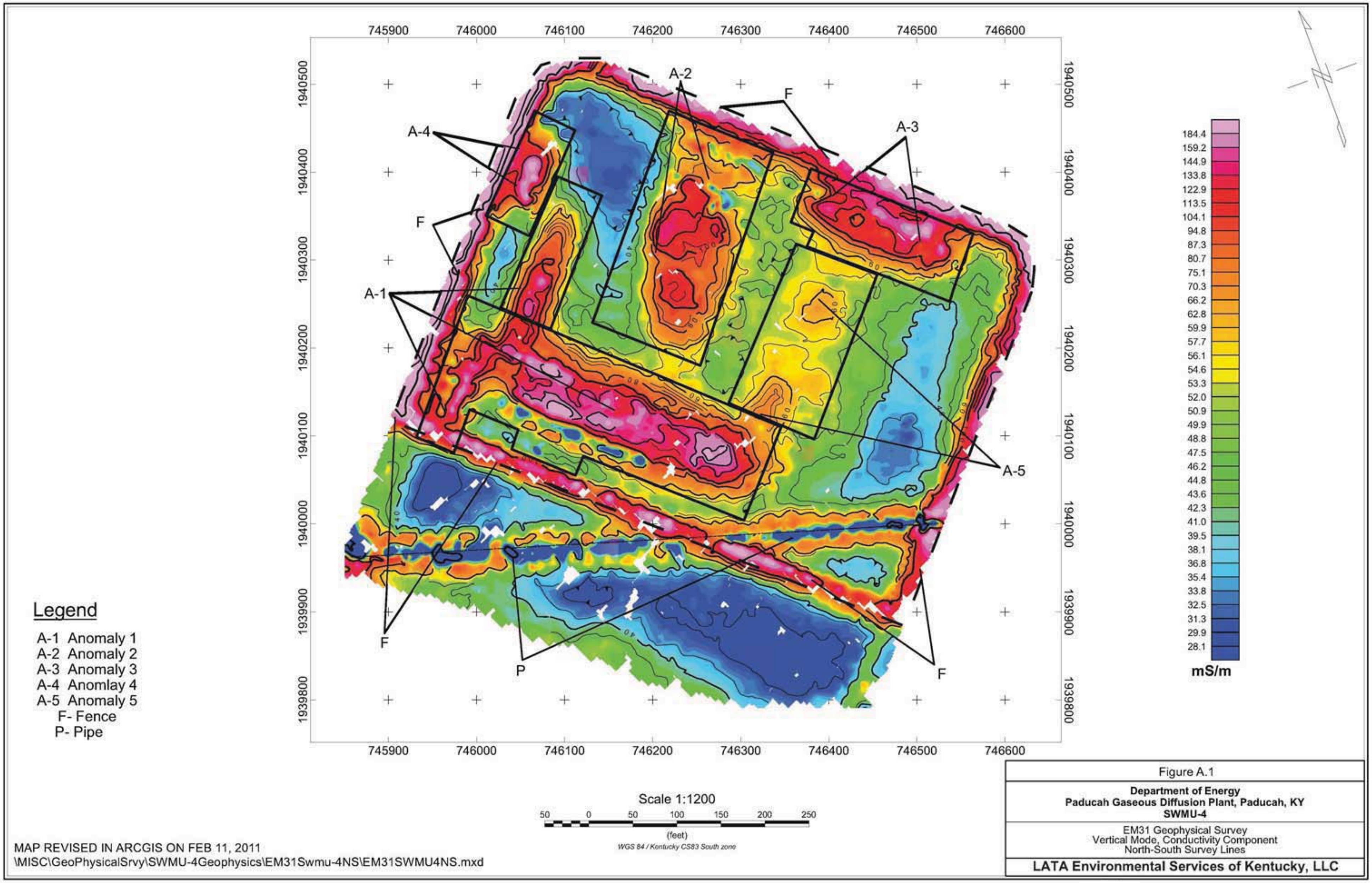


A1.1.EM31 Vertical Mode, Conductivity Component Outlines of Anomalies, North-South Survey Lines (Anomalies A-1 to A-5)

Coordinates of Anomalies & Pipe

Anomaly 1

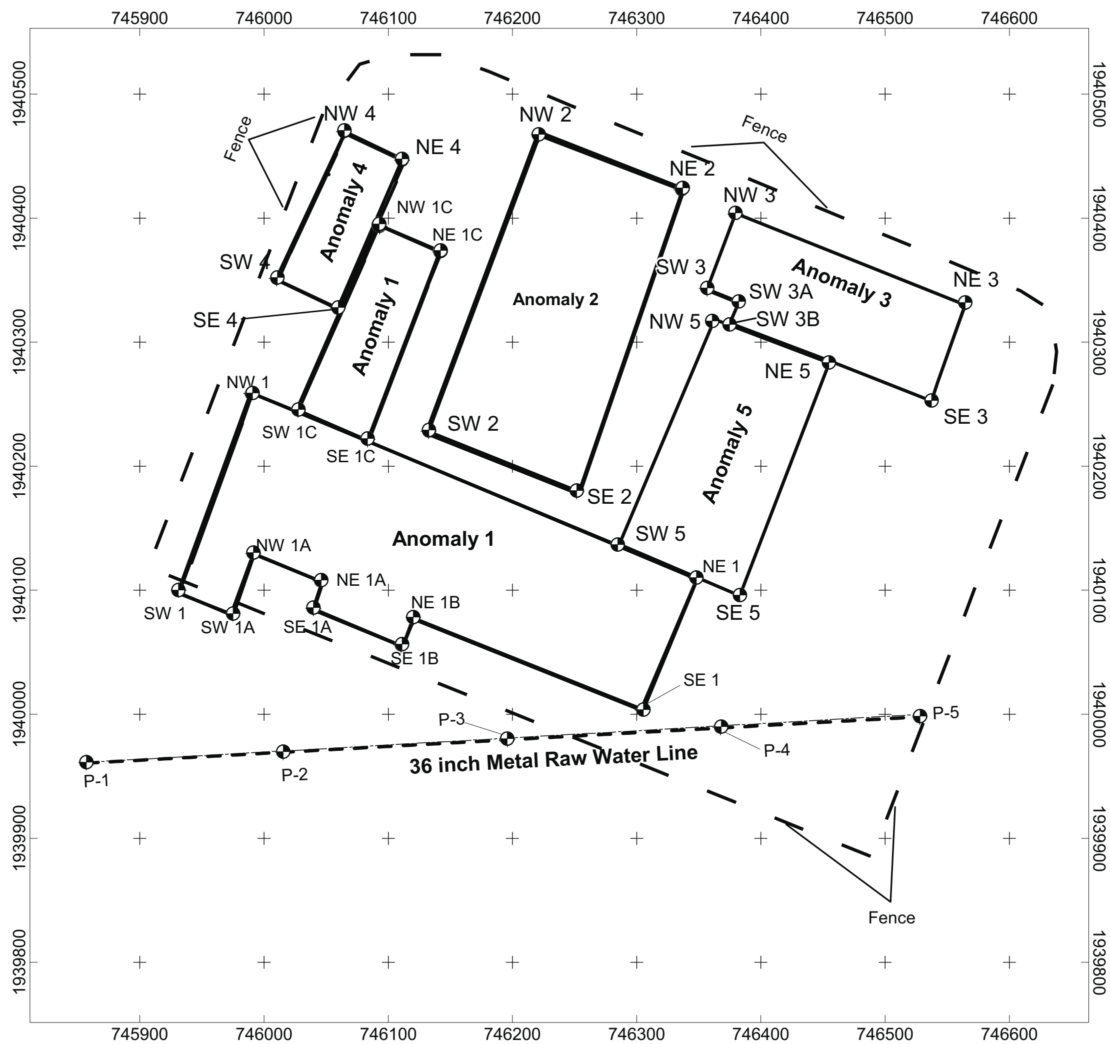
Point	Easting	Northing
NW 1	745990.4	1940258
SW 1	745931.3	1940098
NE 1	746347.7	1940109
SE 1	746304.8	1940004
SW 1A	745974.2	1940081
NW 1A	745991.6	1940129
NE 1A	746046.5	1940107
SE 1A	746039.7	1940085
SE 1B	746110.8	1940056
NE 1B	746119.7	1940077
SW 1C	746026.4	1940244
NW 1C	746092.7	1940394
NE 1C	746142	1940373
SE 1C	746083.5	1940220

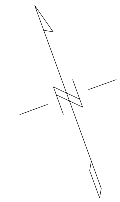
Anomaly 2

Point	Easting	Northing
NW 2	746221.9	1940466
SW 2	746131.3	1940226
SE 2	746253.2	1940178
NE 2	746337.1	1940422

Anomaly 3

Point	Easting	Northing
NW 3	746379.4	1940402
SW 3	746357.3	1940342
NE 3	746563.6	1940330
SE 3	746532.7	1940253
SW 3A	746379.3	1940331
SW 3B	746372.7	1940313





Coordinates of Anomalies & Pipe

Anomaly 4

Point	Easting	Northing
NW 4	746064.5	1940468
SW 4	746010.6	1940350
NE 4	746112	1940446
SE 4	746059.6	1940326

36 inch Metal Raw Water Line

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P-3	746195	1939980
P-4	746366.5	1939990
P-5	746527.5	1939999

Anomaly 5

Point	Easting	Northing
NW 5	746359.7	1940317
SW 5	746285.7	1940136
NE 5	746450.5	1940283
SE 5	746381.4	1940094

Note: All Coordinates listed are in WGS 84 Kentucky CS83 South zone not in Plant Coordinates

Scale 1:1200

50 0 50 100 150 200 250 (feet)

WGS 84 / Kentucky CS83 South zone

MAP REVISED IN ARCGIS ON FEB 11, 2011
\MISC\GeoPhysicalSrvy\SWMU-4Geophysics\EM31Swmu-4NS\EM31SWMU4OOA.mxd

Figure A.2
Department of Energy **Paducah Gaseous Diffusion Plant, Paducah, KY** **SWMU-4**
Labels of Corners, Coordinates, Outlines of Anomalies and Pipe Detected
LATA Environmental Services of Kentucky, LLC

A1.2.Revised Labels of Corners, Coordinates, Outlines of Anomalies and Pipe Detected (Anomalies A-1 to A-5)

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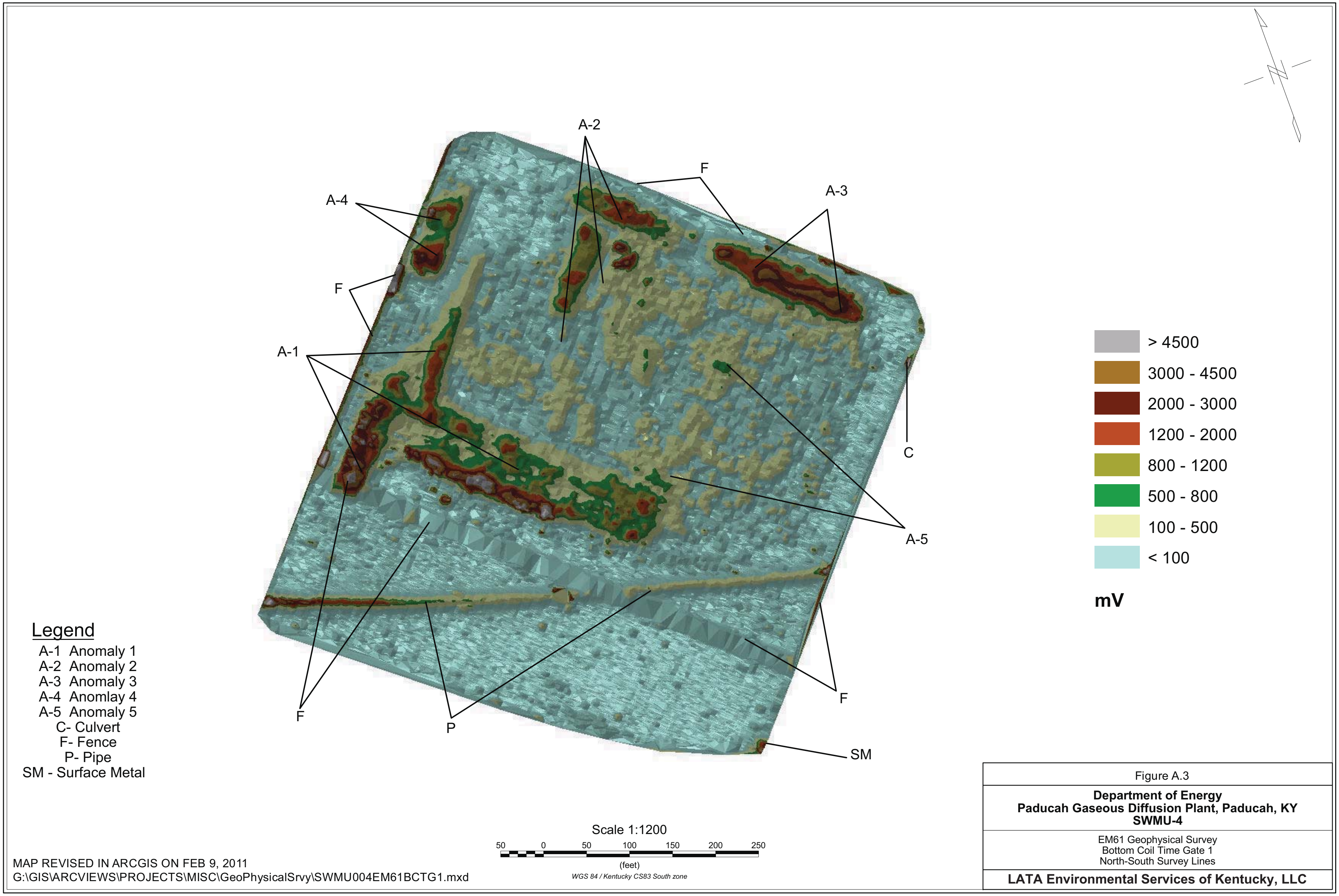
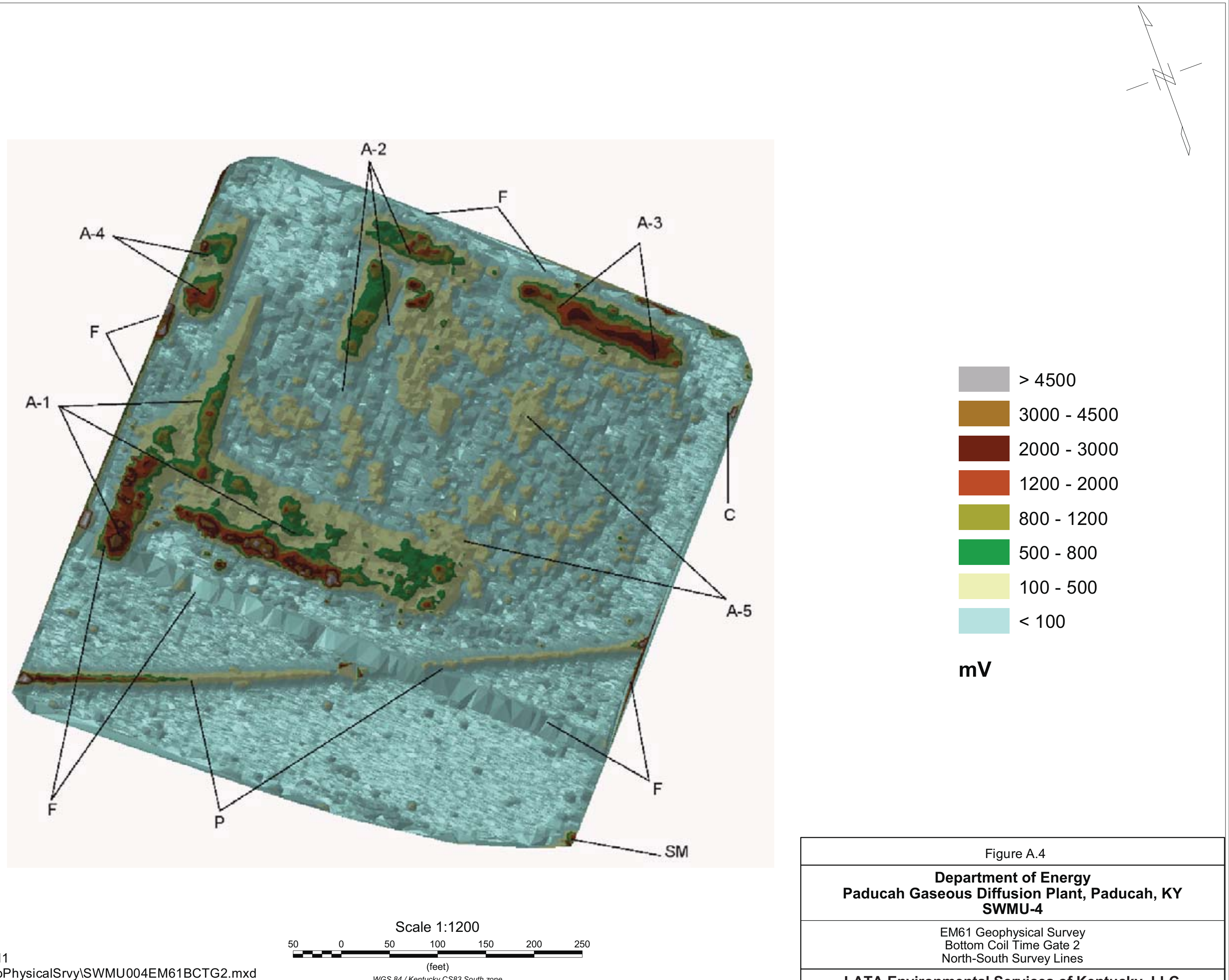


A1.3.EM61 Geophysical Survey Bottom Coil Time Gate 1 North-South Survey Lines (ArcGIS Processed)



Legend
A-1 Anomaly 1
A-2 Anomaly 2
A-3 Anomaly 3
A-4 Anomlay 4
A-5 Anomaly 5
C- Culvert
F- Fence
P- Pipe
SM - Surface Metal

MAP REVISED IN ARCGIS ON FEB 9, 2011
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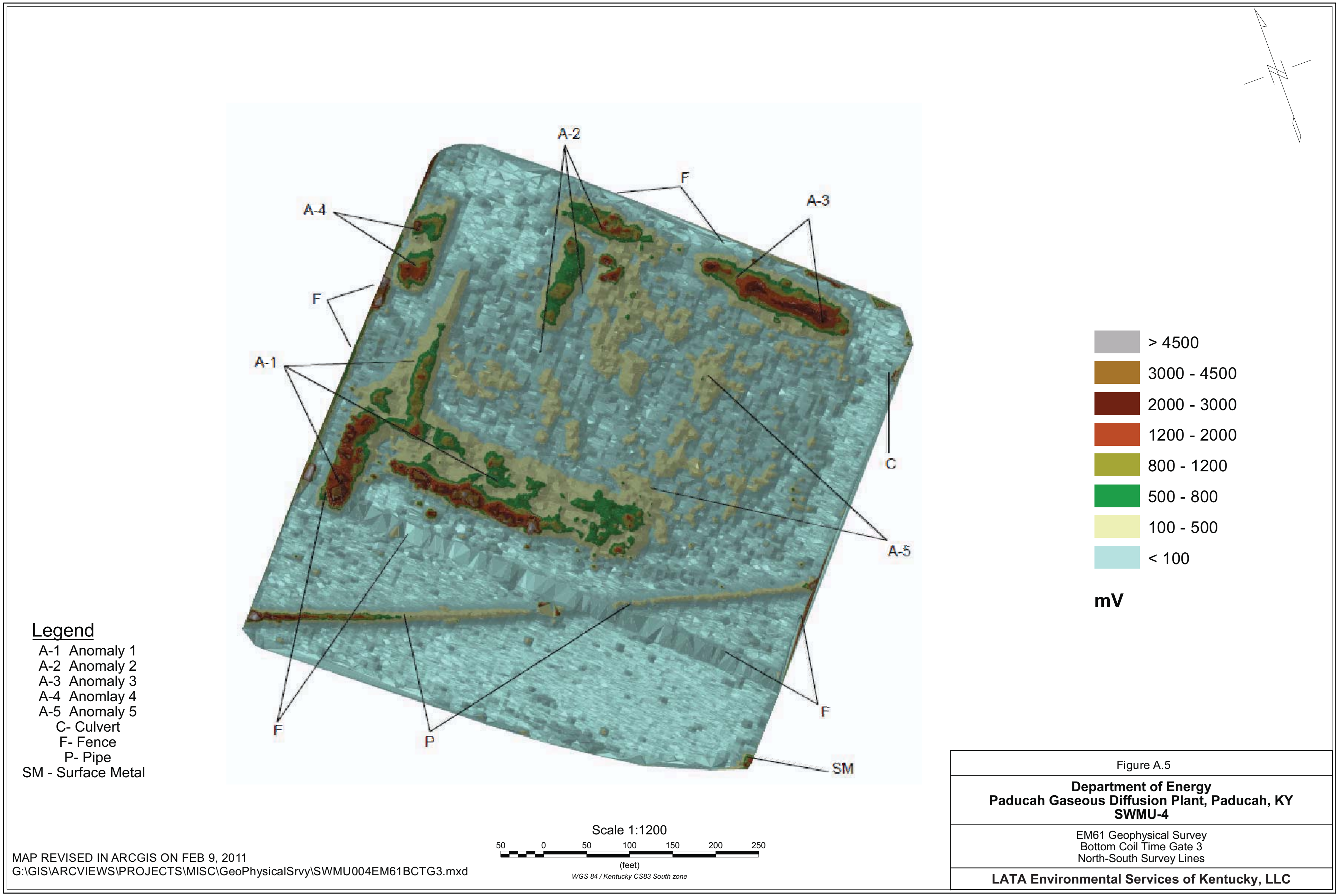
Figure A.4
Department of Energy Paducah Gaseous Diffusion Plant, Paducah, KY SWMU-4
EM61 Geophysical Survey Bottom Coil Time Gate 2 North-South Survey Lines
LATA Environmental Services of Kentucky, LLC

A1.4.EM61 Geophysical Survey Bottom Coil Time Gate 2 North-South Survey Lines (ArcGIS Processed)



A1.5.EM61 Geophysical Survey Bottom Coil Time Gate 3 North-South Survey Lines (ArcGIS Processed)

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