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Primary Document

Remedial Action Work Plan for *In Situ* Source Treatment by Deep Soil Mixing of the Southwest Groundwater Plume Volatile Organic Source at the C-747-C Oil Landfarm (Solid Waste Management Unit 1) at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

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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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ACRONYMS

AAD	annual average discharge
ACGIH	American Conference of Governmental Industrial Hygienists
AHA	activity hazard assessment
ALARA	as low as reasonably achievable
ARAR	applicable or relevant and appropriate requirement
BMP	best management practice
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
CI	confidence interval
CQCP	construction quality control plan
CSM	conceptual site model
CRZ	contamination reduction zone
DMIP	Data Management Implementation Plan
DNAPL	dense nonaqueous-phase liquid
DOE	U.S. Department of Energy
DOECAP	Department of Energy Consolidated Audit Program
DPT	direct push technology
DQO	data quality objective
EDD	electronic data deliverable
EMS	Environmental Management System
EPA	U.S. Environmental Protection Agency
ER	environmental restoration
ES&H	environment, safety, and health
EVS-ES	C-Tech Environmental Visualization Systems Expert System
EZ	exclusion zone
FCR	Field Change Request
FFA	Federal Facility Agreement
FID	flame ionization detector
FLM	frontline manager
GIS	geographic information system
GM	Geiger-Müller
GWOU	groundwater operable unit
HAP	hazardous air pollutant
HASP	health and safety plan
HP	health physics
HU	hydrogeologic unit
IM	intermodal
ISMS	Integrated Safety Management System
KAR	*Kentucky Administrative Regulations*
KDEP	Kentucky Department for Environmental Protection
KPDES	Kentucky Pollutant Discharge Elimination System
LATA Kentucky	LATA Environmental Services of Kentucky, LLC
LDA	large diameter auger
LDR	land disposal restriction
LLW	low-level waste
LTM	Long-term monitoring
LUC	land use control

MCL	maximum contaminant limit
MSDS	material safety data sheet
NAL	no action level
NCP	National Contingency Plan
NESHAP	National Emission Standards for Hazardous Air Pollutants
O&M	operations and maintenance
OREIS	Oak Ridge Environmental Information System
OSHA	Occupational Safety and Health Administration
OU	operable unit
PARCCS	precision, accuracy, representativeness, comparability, completeness, and sensitivity
PC	personal computer
PEMS	Paducah Environmental Measurements System
PGDP	Paducah Gaseous Diffusion Plant
PID	photoionization detector
PPE	personal protective equipment
PRG	preliminary remediation goal
PSS	plant shift superintendent
PTW	principal threat waste
QA	quality assurance
QAPP	quality assurance project plan
QAPIP	quality assurance program and implementation plan
QC	quality control
RA	remedial action
RAD	radiological
RAO	remedial action objective
RAWP	remedial action work plan
RCRA	Resource Conservation and Recovery Act
RCT	radiological control technician
RDR	remedial design report
RDSI	remedial design support investigation
RGA	Regional Gravel Aquifer
RI	remedial investigation
ROD	record of decision
RPP	Radiation Protection Program
RTL	Ready to Load
RWP	radiological work permit
SAP	sampling and analysis plan
SHS	safety and health specialist
SI	site investigation
SMO	Sample Management Office
SOW	statement of work
SWMU	solid waste management unit
TBC	to be considered
TCLP	Toxicity Characteristic Leaching Procedure
TSCA	Toxic Substance Control Act
TSDF	treatment, storage, and disposal facility
UCRS	Upper Continental Recharge System
UIC	Underground Injection Control
VOC	volatile organic compound
WAC	waste acceptance criteria
WAG	waste area grouping

WMC	waste management coordinator
WMP	waste management plan
ZVI	zero-valent iron

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EXECUTIVE SUMMARY

The response action selected in the *Record of Decision for Solid Waste Management Units 1, 211-A, 211-B, and Part of 102 Volatile Organic Sources for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-2150&D2/R2 (DOE 2012a), satisfies, for volatile organic compound (VOC) contamination in the Upper Continental Recharge System soils, the mandates of the Comprehensive Environmental Response, Compensation, and Liability Act § 121 and the requirements of the National Contingency Plan to be protective of human health and the environment by addressing VOC contamination through active treatment and through interim land use controls (LUCs) for any residual VOC and non-VOC contamination. The action will contribute to the final remediation of the Groundwater Operable Unit by removing a portion of the contaminant volume of trichloroethene (TCE) and other VOCs at the C-747-C Oil Landfarm through treatment (DOE 2012a). The total expected TCE mass volume based on data from the Remedial Design Support Investigation performed in 2012, Waste Area Grouping 27 Remedial Investigation, and the Southwest Plume Site Investigation is estimated to be in the range of 1.4 to 29.3 gal.

The remedial action includes the design, installation, and operation of deep soil mixing with interim LUCs. The soil mixing will be supplemented by steam/hot air injection with vapor extraction and zero-valent iron injection, as required by the *Remedial Design Report In Situ Source Treatment Using Deep Soil Mixing for the Southwest Groundwater Plume Volatile Organic Compound Source at the C-747-C Oil Landfarm (Solid Waste Management Unit 1) at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-1276 (DOE 2013).

This remedial action work plan (RAWP) provides project background information, presents a summary of remedial action objectives, approach and the area to be treated, defines the project organization, and presents a project planning schedule. In addition, this RAWP addresses waste management and disposition, project health and safety, quality assurance and data management, and environmental compliance associated with implementing the project.

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1. INTRODUCTION

The Paducah Gaseous Diffusion Plant (PGDP), located approximately 10 miles west of Paducah, Kentucky, and 3.5 miles south of the Ohio River in the western part of McCracken County, is an active uranium enrichment facility owned by the U.S. Department of Energy (DOE). Bordering PGDP to the northeast, between the plant and the Ohio River, is the Tennessee Valley Authority Shawnee Fossil Plant (Figure 1).

This remedial action work plan (RAWP) has been prepared to implement the selected remedial action (RA), *In Situ* Source Treatment Using Deep Soil Mixing for the Southwest Groundwater Plume Volatile Organic Compound Source at the C-747-C Oil Landfarm [Solid Waste Management Unit (SWMU 1)]. The RA was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and is the response action selected in the *Record of Decision for Solid Waste Management Units 1, 211-A, 211-B and Part of 102 Volatile Organic Compound Sources for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (ROD), DOE/OR/07-0365&D2/R1 (DOE 2012a).

The C-747-C Oil Landfarm, SWMU 1, is a facility located inside the plant limited access area, near the west fence of the industrial section of PGDP. The facility is bound on the north by the C-745-A Cylinder Yard and by railroad tracks on the east, west, and south. The nearest plant streets would be the intersection of Tennessee Avenue and 4th street, which lies southeast of SWMU 1 (see Figure 2).

The Southwest Groundwater Plume refers to an area of groundwater contamination at PGDP in the Regional Gravel Aquifer (RGA), which is south of the Northwest Groundwater Plume and west of the C-400 Building (also known as the C-400 Cleaning Building). The plume was identified during the Waste Area Grouping (WAG) 27 remedial investigation (RI) in 1998 (DOE 1999). DOE conducted a site investigation (SI) of the Southwest Plume and four potential source areas in 2004 [*Site Investigation Report for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2007)]. Of the four areas investigated, the SI identified the C-720 Northeast and Southeast Sites and SWMU 1 as probable groundwater contributors to trichloroethene (TCE) groundwater contamination in the Southwest Plume.

1.1 REGIONAL GEOLOGY AND HYDROGEOLOGY

1.1.1 Regional Geology

PGDP is located in the Jackson Purchase Region of western Kentucky, which represents the northern tip of the Mississippi Embayment portion of the Coastal Plain. The Jackson Purchase region is an area of land that includes all of Kentucky west of the Tennessee River. The stratigraphic sequence in the region consists of Cretaceous, Tertiary, and Quaternary sediments unconformably overlying Paleozoic bedrock. Figure 3 summarizes the geologic and hydrogeologic systems of the PGDP region.

The area of the Southwest Plume lies within the buried valley of the ancestral Tennessee River in which predominately Pleistocene Continental Deposits (the fill deposits of the ancestral Tennessee River Basin) rest unconformably on Cretaceous marine sediments. (Pliocene through Paleocene sediments were removed by erosion in the ancestral Tennessee River Basin.) In the area of the Southwest Plume

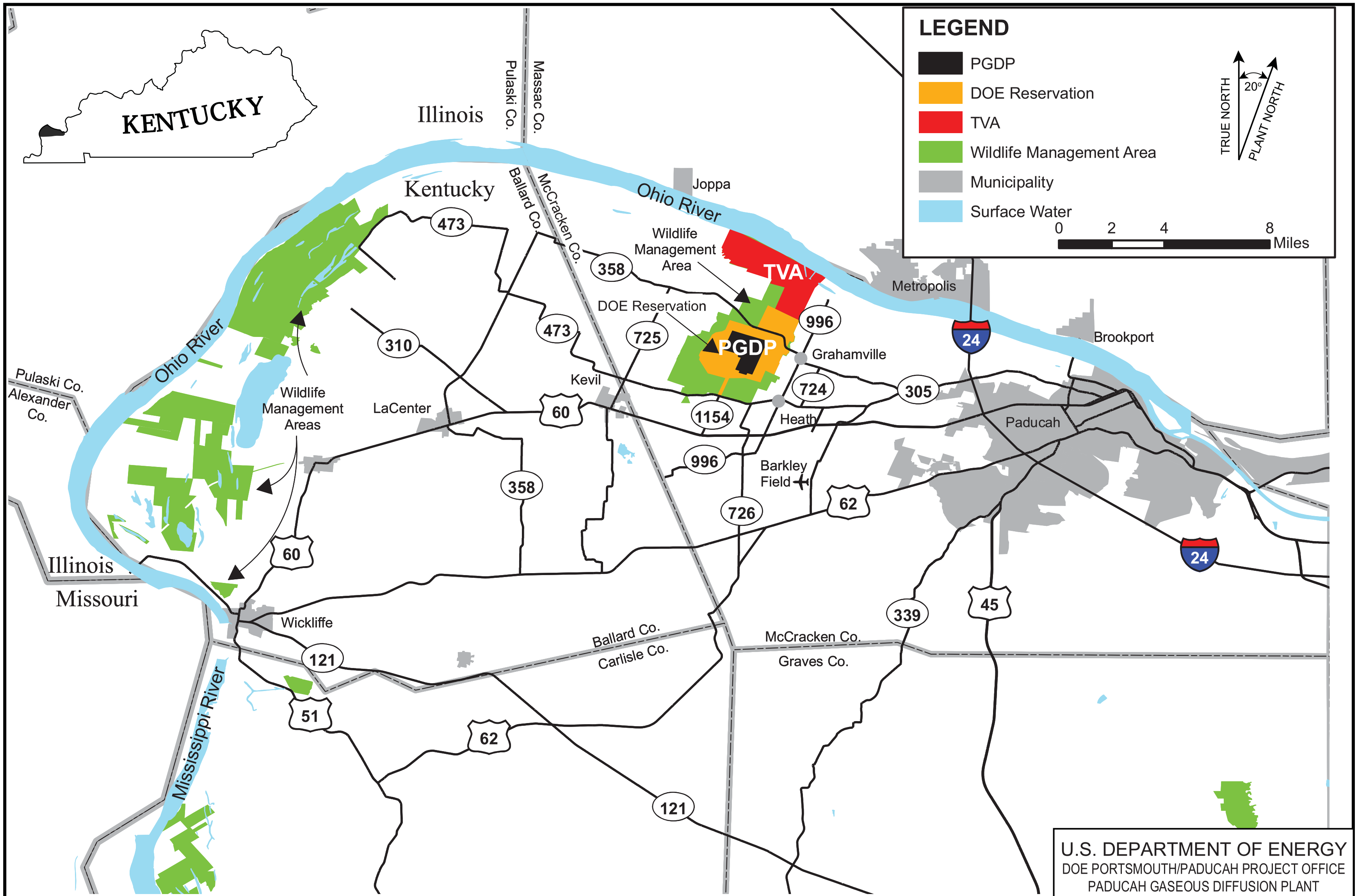

Figure 1. PGDP Site Location

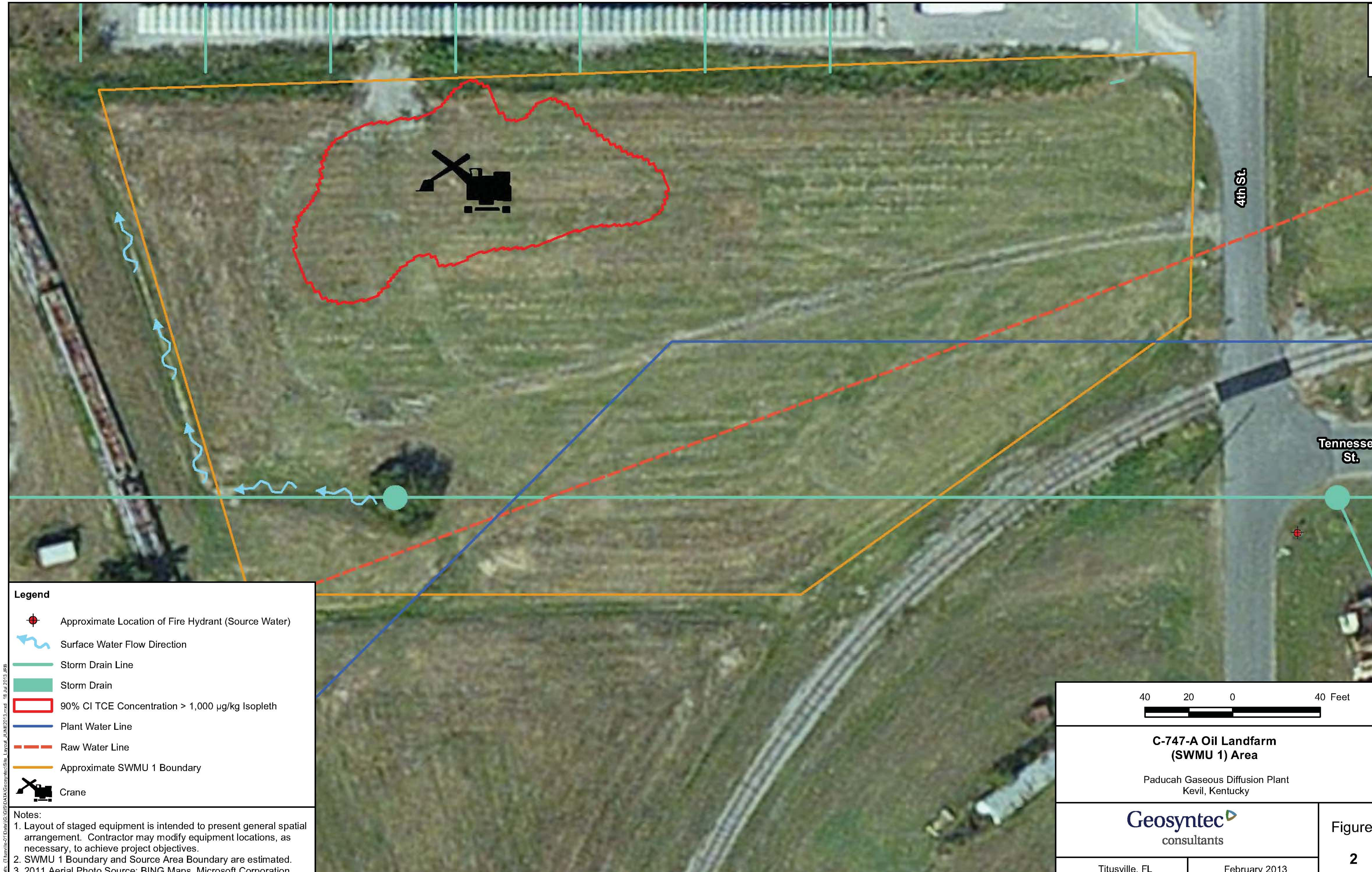

Figure 2. C-747-A Oil Landfarm (SWMU 1) Area

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SYSTEM	SERIES	FORMATION	THICKNESS (IN FEET)	DESCRIPTION	HYDROGEOLOGIC SYSTEMS
QUATERNARY	PLEISTOCENE AND RECENT	ALLUVIUM	0-40	Brown or gray sand and silty clay or clayey silt with streaks of sand.	Upper Continental Recharge System
	PLEISTOCENE	LOESS	0-43	Brown or yellowish-brown to tan unstratified silty clay.	
	PLEISTOCENE	CONTINENTAL DEPOSITS	3-121	Upper Continental Deposits (Clay Facies) - mottled gray and yellowish brown to brown clayey silt and silty clay, some very fine sand, trace of gravel. Often micaceous.	
TERTIARY	PLIOCENE-MIOCENE (?)			Lower Continental Deposits (Gravel Facies) - reddish-brown clayey, silty and sandy chert gravel and beds of gray sand.	Regional Gravel Aquifer
	EOCENE	JACKSON, CLAIBORNE, AND WILCOX FORMATIONS	0-200+	Red, brown or white fine to coarse grained sand. Beds of white to dark gray clay are distributed at random.	McNairy Flow System
			0-100+	White to gray sandy clay, clay conglomerates and boulders, scattered clay lenses and lenses of coarse red sand. Black to dark gray lignitic clay, silt or fine grained sand.	
	PALEOCENE	PORTERS CREEK CLAY	0-200	Dark gray, slightly to very micaceous clay. Fine grained clayey sand, commonly glauconitic in the upper part. Glauconitic sand and clay at the base.	
		CLAYTON FORMATION	Undetermined	Lithologically similar to underlying McNairy Formation.	
UPPER CRETACEOUS		McNAIRY FORMATION	200-300	Grayish-white to dark gray micaceous clay, often silty, interbedded with light gray to yellowish-brown very fine to medium grained sand with lignite and pyrite. The upper part is interbedded clay and sand, and the lower part is sand.	
		TUSCALOOSA FORMATION	Undetermined	White, well rounded or broken chert gravel with clay.	
MISSISSIPPIAN		MISSISSIPPIAN CARBONATES	500+	Dark gray limestone and interbedded chert, some shale.	

Adapted from Olive 1980.

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Figure 3. Generalized Lithostratigraphic Column of the PGDP Region

LATA Environmental Services of Kentucky, LLC and its sources, the Cretaceous upper McNairy Formation consists of 60 to 70 ft of interbedded units of silt and fine sand and underlies the Continental Deposits. Total thickness of the McNairy Formation is approximately 225 ft.

The Continental Deposits resemble a large low-gradient alluvial fan that covered much of the region and eventually buried the erosional topography. Thicker sequences of Continental Deposits, as found underlying PGDP, represent valley fill deposits and can be divided informally into a lower unit (gravel facies) and an upper unit (clay facies). The Lower Continental Deposits comprise a gravel facies consisting of chert gravel in a matrix of poorly sorted sand and silt that rests on an erosional surface representing the beginning of the valley fill sequence. In total, the gravel units average approximately 30-ft thick, but some thicker deposits (as much as 50 ft) exist in deeper scour channels. The Upper Continental Deposits are primarily a sequence of fine-grained, clastic facies varying in thickness from 15 to 60 ft that consist of clayey silts with lenses of sand and occasional gravel.

The surface horizons found in the vicinity of PGDP consist of loess and alluvium. Both units are composed of clayey silt or silty clay and range in color from yellowish-brown to brownish-gray or tan, making field differentiation difficult.

1.1.2 Regional Hydrogeology

The local groundwater flow system at the PGDP site occurs within the sands of the Cretaceous McNairy Formation, Pliocene terrace gravels, Plio-Pleistocene lower continental gravel deposits and upper continental deposits, and Holocene alluvium (Jacobs EM Team 1997; MMES 1992). Four specific components have been identified for the groundwater flow system and are defined as follows from lowest to uppermost.

(1) **McNairy Flow System.** Formerly called the deep groundwater system, this component consists of the interbedded and interlensing sand, silt, and clay of the Cretaceous McNairy Formation. Sand faces account for 40% to 50% of the total formation's thickness of approximately 225 ft. Groundwater flow is predominantly north.

(2) **Terrace Gravel.** This component consists of Pliocene(?)-aged gravel deposits (a question mark indicates uncertain age) and later reworked sand and gravel deposits found at elevations higher than 320 ft amsl in the southern portion of the plant site; they overlie the Paleocene Porters Creek Clay and Eocene sands. These deposits usually lack sufficient thickness and saturation to constitute an aquifer. Terrace Gravel is not present in the area of the Southwest Plume sources.

(3) **Regional Gravel Aquifer.** This component primarily consists of the Quaternary sand and gravel faces of the Lower Continental Deposits and Holocene alluvium found adjacent to the Ohio River and is of sufficient thickness and saturation to constitute an aquifer. These deposits are commonly thicker than the Pliocene(?) gravel deposits associated with the Terrace Gravel flow system, having an average thickness of 30 ft, and range up to 50 ft in thickness along an axis that trends east–west through the plant site. Prior to 1994, the RGA was the primary aquifer used as a drinking water source by nearby residents. The RGA has not been classified formally, but likely would be considered a Class II groundwater under U.S. Environmental Protection Agency (EPA) Groundwater Classification guidance (EPA 1986). Groundwater flow is predominantly north toward the Ohio River.

(4) **Upper Continental Recharge System.** Formerly called the shallow groundwater system, this component consists of the surficial alluvium and all but the lowermost sand of the Upper Continental Deposits. Sand and gravel lithofacies appear relatively discontinuous in cross-section, but portions

may be interconnected. The most prevalent sand and gravel deposits occur at an elevation of approximately 345 to 351 ft amsl; less prevalent deposits occur at elevations of 337 to 341 ft amsl.

The primary groundwater flow systems associated with the Southwest Plume are the Upper Continental Recharge System (UCRS) and the RGA. Figure 4 shows the different water-bearing zones and their relationships in the PGDP area.

Groundwater occurrence in the UCRS is primarily the result of infiltration from natural and anthropogenic recharge. The water table in the UCRS varies both spatially and seasonally due to lithologic heterogeneity and recharge factors (infiltration of focused run-off from engineered surfaces, seepage due to variations in cooling water line integrity, rainfall, and evapotranspiration) and averages approximately 17 ft in depth with a range of 2 to 50 ft of the area over PGDP.

Locally, the UCRS consists of three hydrogeological units (HUs): (1) an upper silt interval (HU1), (2) an intermediate horizon of sand and gravel lenses (HU2), and (3) a lower silt and clayey silt interval (HU3). Flow is predominantly downward into the RGA from the UCRS, which has a limited horizontal component in the vicinity of PGDP. Groundwater flow rates in the UCRS tend to be on the order of 0.1 ft per day.

The RGA consists of a discontinuous upper horizon of fine to medium sand of the Upper Continental Deposits (HU4) and a lower horizon of medium to coarse sand and gravel of the Lower Continental Deposits (HU5). The RGA is the main pathway for lateral flow and dissolved contaminant migration off-site.

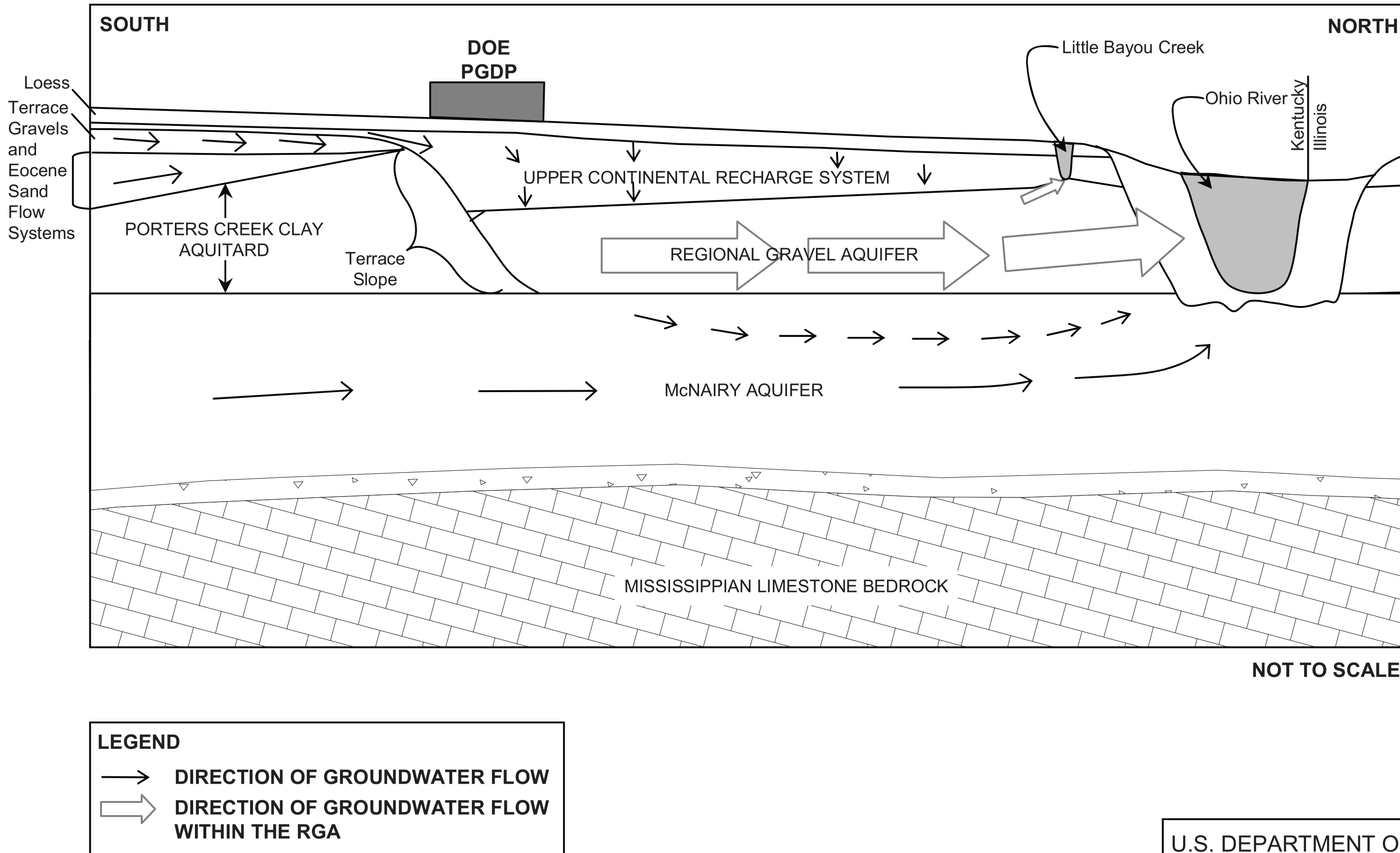
1.2 TREATMENT SITE LOCATION

The treatment location for this RA is the SWMU 1 C-747-C Oil Landfarm (Oil Landfarm) which is located near the western edge of the PGDP. The location of the SWMU 1 source area (Oil Landfarm) is shown in Figure 2. The SWMU 1 area has been investigated several times in support of remedy selection and development of this RAWP including the Phase II SI (1991); WAG 27 RI (1997); WAG 23; Southwest Plume SI (2007); and the remedial design support investigation (RDSI) (2012).

The RDSI was conducted in 2012 to gather supplemental data necessary for the design and implementation of the *in situ* source treatment deep soil mixing RA selected for SWMU 1. Data collected from 22 soil borings during the RDSI have allowed for a more refined delineation of the size and shape of the overall treatment area for this RA. The completion of this analysis, which is documented in the *Remedial Design Report In Situ Source Treatment Using Deep Soil Mixing for Southwest Groundwater Plume Volatile Organic Source at the C-747-C Oil Landfarm at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (RDR), DOE/LX/07-1276, (DOE 2013) identified the area to undergo treatment as approximately 12,427 ft^2 and is shown in Figure 5.

1.3 CONCEPTUAL SITE MODEL

The conceptual site model (CSM) is a three-dimensional “picture” that illustrates contaminant sources, release mechanisms, exposure pathways, migration routes, and potential human and ecological receptors. Figure 6 represents the CSM for the C-747-C Oil Landfarm. Figure 7 shows the conceptual exposure site model for the C-747-C Oil Landfarm Site. The assessments in the Southwest Plume SI, implemented in 2004, concluded that high concentration TCE soils and TCE dense nonaqueous-phase liquid (DNAPL), which would constitute principal threat waste (PTW), are present at the C-747-C Oil



Source: PRS 2009

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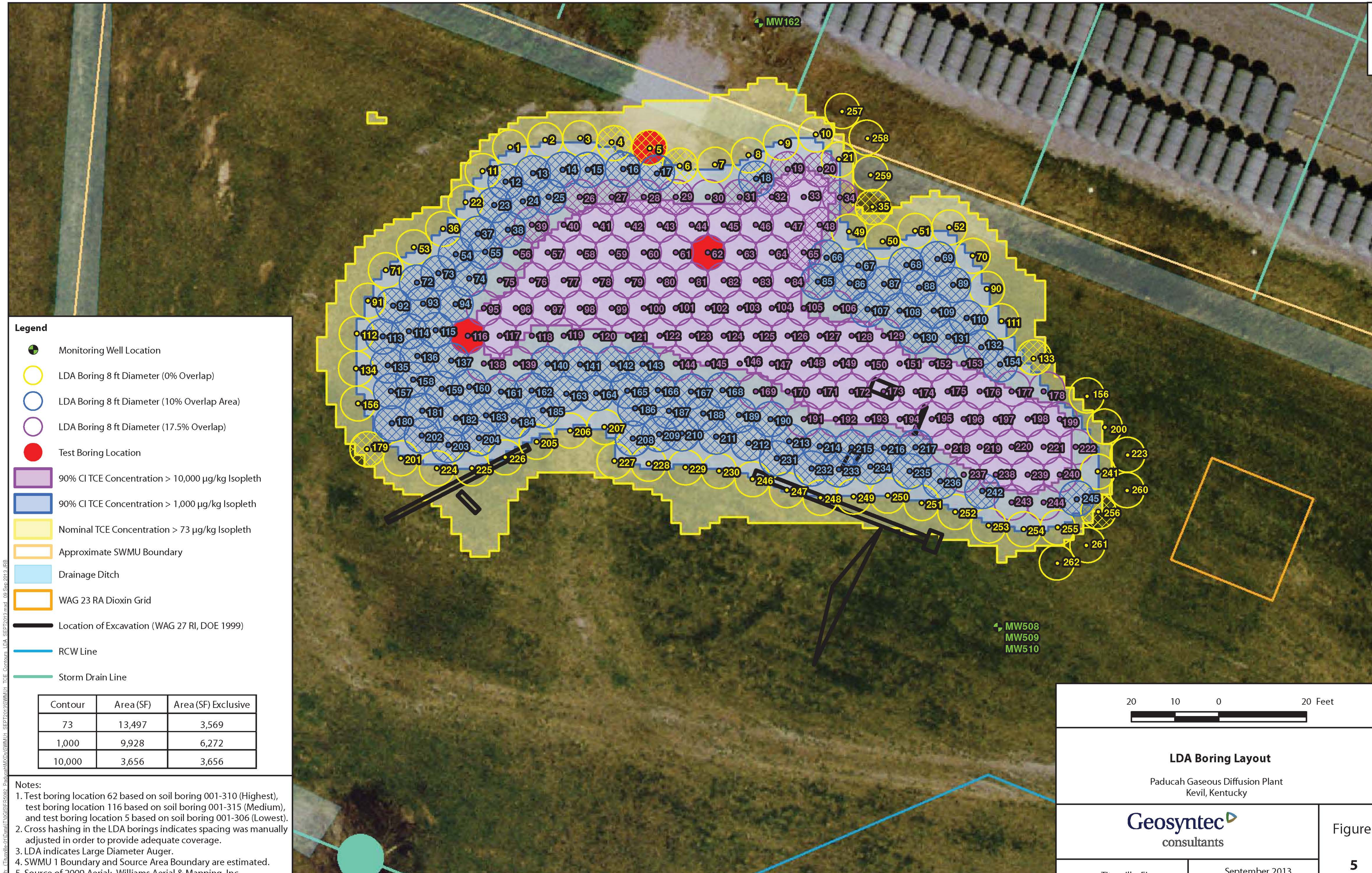
Figure 4. Water-Bearing Zones near the PGDP



Contour	Area (SF)	Area (SF) Exclusive
73	13,497	3,569
1,000	9,928	6,272
10,000	3,656	3,656

Notes:
1. Test boring location 62 based on soil boring 001-310 (Highest), test boring location 116 based on soil boring 001-315 (Medium), and test boring location 5 based on soil boring 001-306 (Lowest).
2. Cross hashing in the LDA borings indicates spacing was manually adjusted in order to provide adequate coverage.
3. LDA indicates Large Diameter Auger.
4. SWMU 1 Boundary and Source Area Boundary are estimated.
5. Source of 2009 Aerial: Williams Aerial & Mapping, Inc.

Figure 5. Conceptual Source Treatment Area SWMU 1 - Oil Landfarm

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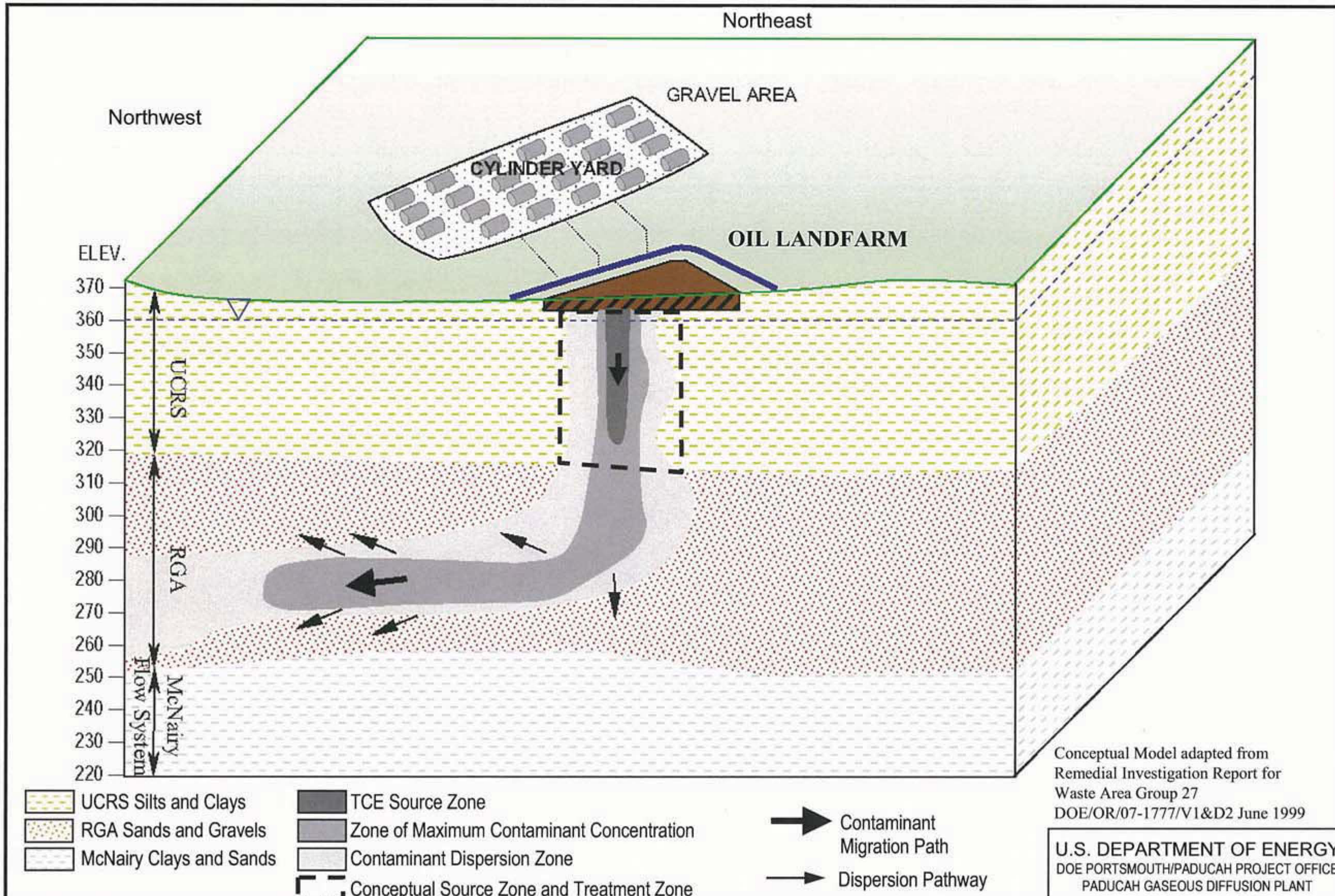

Figure 6. Conceptual Site Model for the SWMU 1 TCE Source Area

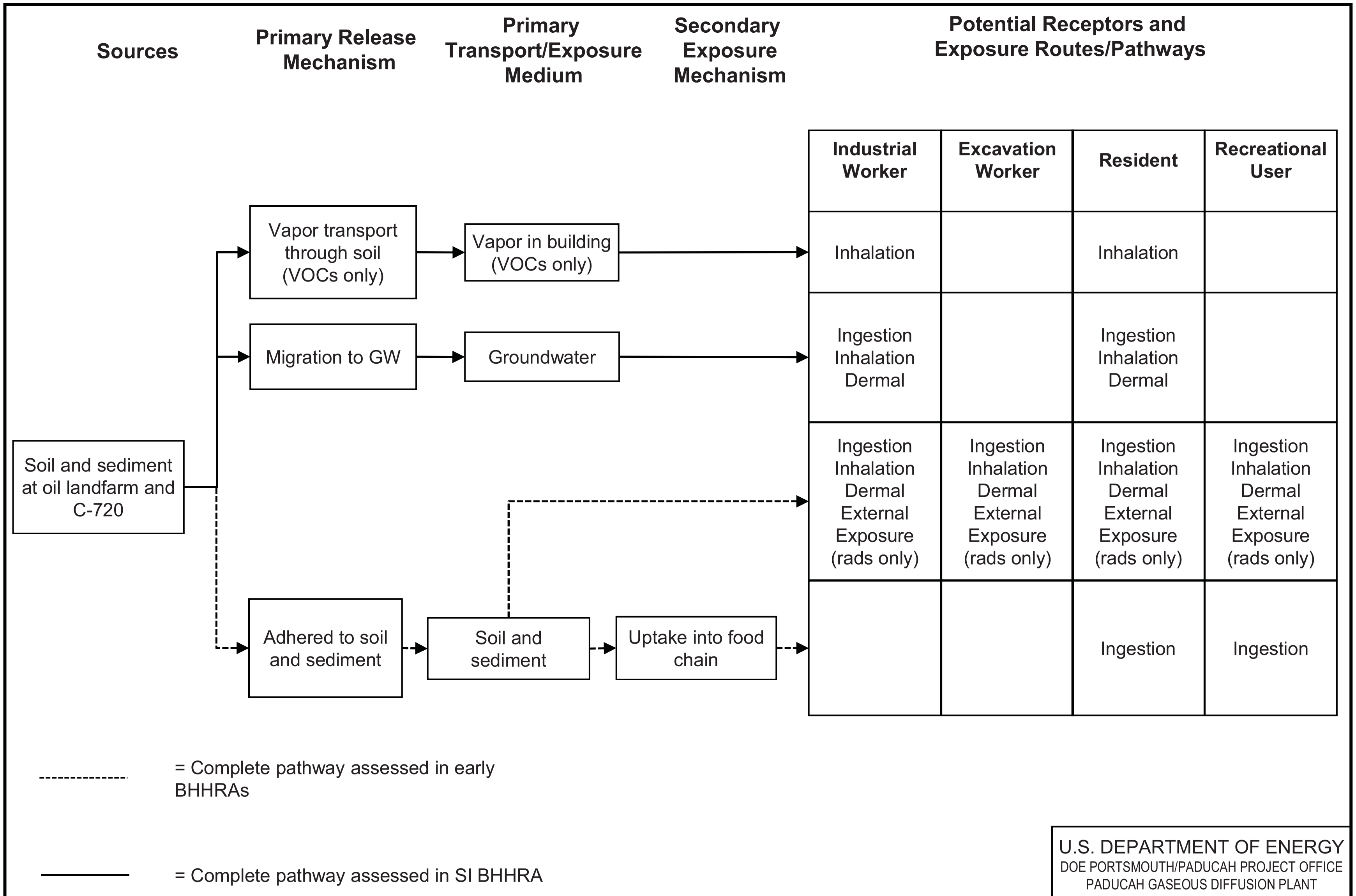

Figure 7. Exposure Route/Pathway Conceptual Model for the Southwest Plume SWMU 1 Source Area

*Figure derived from Figure 1.19, D2 Revised Focused Feasibility Study, DOE/LX/07-0362&D2, May 2011.

Landfarm. These residual source zones of TCE are found in the upper 18.3 m (60 ft) of soils. Samples from MW161, located immediately adjacent to SWMU 1 and screened in the RGA, contain TCE showing that the RGA is contaminated with TCE at SWMU 1. The much lower hydraulic conductivity of the McNairy Formation, underlying the RGA, limits vertical migration of dissolved contamination below approximately 30.5 m (100 ft). RDSI data were collected to support selecting the area of the Oil Landfarm to be soil mixed. The RDSI data, however, did not modify the SWMU 1 conceptual model that was developed by the SI of the Southwest Plume (DOE 2007). It did, however, further identify the area requiring RA through the additional data collected. No lateral migration in the UCRS outside the SWMU area has been identified or is expected, because vertical flow is the predominant direction of migration for the TCE contaminant.

The RDSI provided updated information on the TCE concentrations in the area to be treated. Mass quantity estimates were interpolated using the RDSI data, WAG 27 RI data and the Southwest Plume SI data and the C Tech Environmental Visualization Systems Expert System (EVS-ES) for TCE. Volume estimates were calculated using kriging, kriging using the 90% confidence interval (CI), investigation-derived waste, and nearest neighbor. The results of the EVS-ES modeling using the historical results and the RDSI soil results ranged from 1.4 gal with inverse distance weighting to 29.3 using the kriging 90% CI. From a mass distribution perspective, the 90% CI kriging interpolation indicates that 96% of the estimated mass is located within the greater than 1,000 µg/kg isocontour area. The EVS estimated weight calculated is lower than the weight estimated in the SI. The horizontal extent of the 73 µg/kg isocontour using nominal kriging interpolation is estimated to be approximately 13,500 ft^2. The 1,000 µg/kg and 10,000 µg/kg isocontours using the 90% CI kriging interpolation are estimated to be approximately 9,900 ft^2 and 3,700 ft^2, respectively. The RDR contains a detail summary of the EVS modeling performed (DOE 2013).

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2. TREATMENT TECHNOLOGY

2.1 *IN SITU* SOURCE TREATMENT USING DEEP SOIL MIXING DESCRIPTION

In situ soil mixing with a large diameter auger (LDA) with hot air/steam and zero-valent iron (ZVI) treatment technology consists of the following major elements.

- Soil mixing—A large steel flat-blade auger, somewhat resembling a drill bit, is used to churn and mix the soil in the subsurface to increase air flow within the soil column.

- Hot air/steam generation and delivery—Potable water is used to generate steam and hot air that is pumped down the drill-stem or Kelly and injected into the subsurface. The steam and hot air warm the mixed soil and volatile contaminants present.

- Vapor extraction—Volatilized contaminant vapors, water vapor, and some entrained water are removed from the soil column as it is mixed by pulling a vacuum on soil within a steel shroud located over the LDA.

- Vapor conditioning—The volatilized contaminant vapors are treated to remove water vapor and entrained water. The contaminant vapors then are heated to lower the relative humidity of the contaminant stream. The vapor stream then is passed through activated carbon beds to remove the volatile contaminants. The vapor stream is sampled during this process and prior to release to ensure that it is compliant with applicable or relevant and appropriate requirements (ARARs).

- Liquid treatment—Recovery of entrained water or condensed vapor is separated from the vapor phase and treated to remove volatile contaminants using liquid-phase activated carbon. The cleaned water is stored, sampled, and then released to a nearby ditch that ultimately flows into a PGDP outfall, such as Outfall 008 or 015.

- ZVI—After the initial passes of the soil mixing augers and the removal of the portion of the contamination to the degree possible, the augers will cycle through the mixing column again and spread a mixture of ZVI and guar gum into the soil. The ZVI mixture concentrations to be spread will be predicated on the requirements contained in the project RDR. The ZVI iron/guar gum injectate will foster abiotic reduction of TCE that remains in the soil after soil mixing is complete.

A number of minor elements are associated with application of the technology including the following:

- Conditioning of water for generating steam
- Generation of steam and electrical power for system operations
- Operation control interfaces and system interlocks
- Operation sampling and monitoring of contaminant recovery
- ZVI mixing system operation
- Solids waste management
- Health and safety and radiological (RAD) control
- Decontamination operations
- Posttreatment soil sampling
- Posttreatment monitoring well installation and sampling

2.2 APPLICABILITY TO THE PGDP SITE

The contamination at SWMU 1 includes volatile organic compounds (VOCs), and VOCs are the contaminants being addressed by implementing this RA. Specifically, TCE and its degradation components are present in unconsolidated soils, which are both unsaturated and saturated. The maximum target depth of the contamination at SWMU 1 is the base of the HU4 zone at a depth of down to 62 ft below ground surface (bgs). The Kelly bar, which transmits the rotational energy to the subsurface, is 70 ft with an 8 ft auger in total length with a workable depth of approximately 60 ft. Maximum contaminant levels for TCE based on analyses performed as part of the 2012 RDSI range upward to 960,000 µg/L with smaller concentrations of degradation compounds present.

Large diameter augering, also known as deep soil mixing, was developed for unconsolidated formations. The LDAs, which are 6 ft or more in diameter and have a single discontinuous flight-like lead solid-stem and hollow-stem augers of open-borehole drilling, are limited to unconsolidated soils. The targeted SWMU 1 contamination is in the UCRS and HU4, which are all unconsolidated soils. The HU4 zone, which is the upper portion of the RGA, is predominately sand.

The technology enhancements of steam and vapor extraction and ZVI are remedial technologies in their own right. They can be applied by other methods besides with LDAs. The UCRS and HU4 soils are conducive to vapor extraction due to the silty nature of our soils as enhanced by the mixing process. TCE, the main SWMU 1 contaminant, has azeotropic and natural boiling points of 165°F and 189°F, respectively, both of which are well below boiling point of water. This allows water/steam to an effective energy carrier for volatilizing the TCE contamination. The augers create secondary permeability in the soil, allowing the steam and vapor extraction to be more effective.

The soil mixing with steam enhancement and ZVI injection has been utilized successfully at three TCE contamination sites similar to PGDP. Two of the RA sites were located in the state of Florida near the Cape Canaveral Space Center. The third location is in Arlington, Nebraska, at the former Offutt Air Force Base Atlas “D” Missile Site 2.

The Offutt missile site has soil and contaminant conditions similar to SWMU 1. Subsurface soil at the site is a silty-clay loess. The subsurface soil is underlaid by a glacial till with discontinuous interbedded layers of sand and gravel. Groundwater is encountered at 5 ft to 10 ft below grade. The maximum depth target for the soil mixing with LDAs with enhanced steam and ZVI placement was 40 ft bgs. Results of the Offutt RA showed a reduction of TCE in soil and groundwater of more than 99% (COE 2012).

The soil and hydrogeologic conditions at the two RA sites at Cape Canaveral were not as similar to the SWMU 1 area; however, both actions resulted in volatile contaminant reductions generally of 90% in both actions (USAFSC 2007a; USAFSC 2007b). Both locations were in Florida and have poorly sorted coarse to fine sands and shell material with little to no silts and clays to approximately 35 ft bgs. Clay content increases from 35 ft to approximately 48 ft where a significant marl (clay layer) is encountered. Groundwater saturation is approximately 4 ft bgs.

3. TREATMENT SYSTEM OBJECTIVES AND UNCERTAINTY MANAGEMENT

3.1 INTERIM REMEDIAL ACTION OBJECTIVES

The remedial action objectives (RAOs) for the SWMU 1 RA, as defined by Section 2.8 of the ROD (DOE 2012a), are as follows:

1. Treat and/or remove the PTW consistent with the National Contingency Plan (NCP).

2a. Prevent exposure to VOC contamination in the source areas that will cause an unacceptable risk to the excavation workers (< 10 ft).

2b. Prevent exposure to non-VOC contamination and residual VOC contamination through interim land use controls (LUCs) within the Southwest Plume source areas (i.e., SWMU 1, SWMU 211-A, and SWMU 211-B) pending remedy selection as part of the Soils Operable Unit (OU) and the Groundwater Operable Unit (GWOU).

3. Reduce VOC migration from contaminated subsurface soils in the treatment areas at the Oil Landfarm (SWMU 1) and the C-720 Northeast (SWMU 211-A) and Southeast (SWMU 211-B) sites so that contaminants migrating from the treatment areas do not result in the exceedance of maximum contaminant levels (MCLs) in the underlying RGA groundwater.

The RDR presents the design of the treatment systems that address the RA objectives (DOE 2013) (see Section 3, Treatment System Objectives; Section 4, Technical Design; and Section 5, Construction Requirements for additional details).

3.2 CRITERIA FOR CEASING REMEDIAL ACTION SYSTEM OPERATIONS

There are two goals of operations at SWMU 1 that will be addressed in this RA. The long-term goal is attaining the soil cleanup levels, as documented in the ROD, that would allow the RAOs to be met, thus completing the RA as a whole. This goal is expected to be reached only after some extended period of time following the main field activities. The second goal will be the incremental completion of individual field activities that are intended to remove the VOC contaminants. These field activities consist of two sequential steps:

1. Performing soil mixing with passes of LDAs while adding steam and hot air to volatilize contamination, allowing the volatilized contamination to be vacuum extracted from the subsurface and to be treated; and

2. Placing ZVI in the subsurface utilizing LDAs to allow for long-term abiotic reduction of the volatile organic contamination.

The protocol for evaluating the number of treatment passes using the LDAs with steam and hot air will be determined at each treatment cell based on the peak TCE concentration in UCRS soils and in the upper RGA (HU4), as evaluated by the data collection system during the first treatment pass. Once the peak off-gas VOC values are collected from the first treatment pass, the cell treatment protocol will be characterized into one of three categories that will determine if additional passes are needed with the augers, steam, and hot air. The criteria for determining which of three categories a cell belongs in is contained in the following paragraphs and in the RDR (DOE 2013).

(1) Low VOC concentration target threshold (less than 100 ppm response)—Requires a minimum of one complete thermal pass, a shroud temperature of 160°F maintained throughout the treatment pass, and monitoring of VOC concentrations to ensure that they are below the established low target threshold.

(2) Greater than the low target on the first treatment pass, but less than the low target treatment threshold on second treatment pass—Requires a minimum of two complete thermal passes, a shroud temperature of 160°F maintained throughout the complete final pass, and monitoring of VOC concentrations to ensure that they are below the established low target threshold.

(3) Greater than the low target on the first and second treatment passes—Requires a minimum of four complete thermal passes and a shroud temperature of 160°F maintained throughout the entire complete final pass. Depth-focuses passes could be implemented after the second pass; however, the final pass must have completed from total treatment depth to top of target treatment interval, and to obtain completion criteria of an flame ionization detection (FID) concentration, after subtracting the methane value, less than 50% of the highest FID value obtained during the final pass, or VOC concentrations less than low target threshold, or reach a maximum hot air/steam treatment time of 240 minutes.

The second protocol is used for determining the percent of iron to be included with each placement of ZVI slurry into each boring. A slurry mixture consisting of granular ZVI, water, and guar gum (to facilitate ZVI injection into the soil) will be delivered based upon a percentage mass of ZVI to mass of soil application. The criteria for determining this slurry mixture will be based upon contaminant monitoring data collected during hot air/steam mixing phase, as shown above, and is contained in Section 4.4.2.2, Description of ZVI Dosing, in the RDR (DOE 2013).

The amount of ZVI delivered to an LDA boring location will be established based on the observed photoionization detector (PID)/FID response value of VOCs from the first thermal treatment pass, according to the following criteria (DOE 2013).

- If a maximum PID/FID reading of 1,000 ppm or less (after subtracting the methane value) is observed on the first thermal treatment pass, an application of 0.5% ZVI will be applied.

- If a PID/FID reading of 1,000 to 5,000 ppm (after subtracting the methane value) is observed on the first thermal treatment pass, an application of 1.0% ZVI will be applied.

- If a PID/FID reading of 5,000 ppm (after subtracting the methane value) is observed on the first thermal treatment pass, an application of 1.5% ZVI will be applied.

- Based on RDSI soil sampling results, the area within the greater than 10,000 µg/kg TCE isoconcentration contour area will be treated with a default application of no less than 1.5%, but not greater than 2%, ZVI regardless of PID/FID response. This range of concentration has been presented based on practical limitations to injection of 2% ZVI observed at other sites.

The ZVI dosing concentration will be measured as a percentage of weight of the column of soil being treated.

4. REMEDIAL ACTION APPROACH

The DOE environmental restoration (ER) contractor has overall contractor responsibility for the design, implementation/construction, sampling and analysis, operations and maintenance (O&M), waste management, and disposal associated with the remedy. The major activities for this RA are outlined in this section.

Table 1 is a general list of activities typically governed by procedures. Procedures referenced in the table are those followed by the current DOE prime contractor. If a change in DOE prime contractor occurs, the procedures followed by the new DOE prime contractor will be substantially equivalent to those referenced below. The most current versions of all contractor procedures are to be used. The quality assurance (QA) project plan (QAPP), RAWP, RDR, and all applicable procedures will be readily available in the field to all project personnel, including subcontractors, either in hard copy or electronic format.

Table 1. General Activities Governed by Procedures

Activity	**Applicable Procedure**
Accident/Incident Reporting	PAD-SH-1007, *Initial Incident/Event Reporting*
Analytical Laboratory Interface	PAD-ENM-5004, *Sample Tracking, Lab Coordination, & Sample Handling*
Calibration of Measuring and Test Equipment	PAD-QA-1020, *Control and Calibration of Measuring and Test Equipment*
Chain-of-Custody	PAD-ENM-2708, *Chain-of-Custody forms, Field Sample Logs, Sample Labels, and Custody Seals*
Collection of Samples	PAD-ENM-0018, *Sampling Containerized Waste* PAD-ENM-0023, *Composite Sampling* PAD-ENM-2101, *Groundwater Sampling* PAD-ENM-2300, *Collection of Soil Samples* PAD-ENM-2704, *Trip, Equipment, and Field Blank Preparation* PAD-IH-5560, *Workplace Industrial Hygiene Sampling*
Conducting Assessments	PAD-QA-1420, *Conduct of Management Assessments* PAD-REG-0003, *Performing Environmental Compliance Assessments and Identification and Reporting of Environmental Issues*
Construction Equipment Inspection	PAD-SM-0006, *Construction Equipment Inspection and Maintenance*
Control of Sample Temperature	PAD-ENM-0021, *Temperature Control for Sample Storage*
Data Verification and Validation	PAD-ENM-0026, *Wet Chemistry and Miscellaneous Analyses Data Verification and Validation* PAD-ENM-0811, *Pesticide and PCB Data Verification and Validation* PAD-ENM-5102, *Radiochemical Data Verification and Validation* PAD-ENM-5103, *Polychlorinated Dibenzodioxins-Polychlorinated Dibenzofurans Verification and Validation* PAD-ENM-5105, *Volatile and Semivolatile Data Verification and Validation* PAD-ENM-5107, *Inorganic Data Verification and Validation*
Decontamination of Large Equipment	PAD-DD-2701, *Large Equipment Decontamination*
Decontamination of Sampling Equipment	PAD-ENM-2702, *Decontamination of Sampling Equipment and Devices*
Document Control	PAD-PD-1107, *Development, Approval, and Change Control for LATA Kentucky Performance Documents*

Table 1. General Activities Governed by Procedures (Continued)

Activity	Applicable Procedure
Documenting and Controlling Field Changes to Approved Plans	PAD-WC-0021, *Work Release and Field Execution* PAD-ENG-0027, *Field Change Request (FCR), Field Change Notice (FCN), and Design Change Notice (DCN) Process*
Evaluations for Suspect/Counterfeit Items	PAD-QA-1009, *Identification, Control, and Disposition of Suspect/Counterfeit Items*
Monitoring Well	PAD-ENM-0069, *Monitoring Well and Associated Infrastructure Installation*
Fall Prevention	PAD-SH-2004, *Fall Prevention and Protection*
Field Engineering Inspections and Surveys	PAD-ENG-0001, *Field Engineering Inspections and Surveys*
Field Logbooks	PAD-ENM-2700, *Logbooks and Data Forms*
Graded Approach	PAD-QA-1650, *Graded Approach*
Handling, Transporting, and Relocating Waste Containers	PAD-WD-0661, *Transportation Safety Document for On-Site Transport within the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*
Hoisting and Rigging Operations	PAD-ENG-0012, *Hoisting and Rigging Operations*
Inspection and Test Plans and Review of Vendor/Supplier QA Program	PAD-QA-1208, *Approved Supplier Selection and Evaluation*
Issue Management (includes corrective action)	PAD-QA-1210, *Issues Management*
Lithologic Logging	PAD-ENM-2303, *Borehole Logging*
Nonconforming Items and Services	PAD-QA-1440, *Control of Nonconforming Items, Services, Procedures, and Processes* PAD-SH-2001, *Identifying Defective Equipment*
Powered Industrial Trucks	PAD-SH-2007, *Powered Industrial Trucks*
Quality Assured Data	PAD-ENM-5003, *Quality Assured Data*
Quality Assurance Program	PAD-PLA-QM-001, *Quality Assurance Program and Implementation Plan for the Paducah Environmental Remediation Project, Paducah Kentucky*
Radiation Protection	PAD-PLA-HS-002, *Radiation Protection Program for the Paducah Remediation Services Project*
Records Management	PAD-RM-1009, *Records Management, Administrative Record, and Document Control*
Revisions to Procedures or Work Packages	PAD-PD-1107, *Development, Approval, and Change Control for LATA Kentucky Performance Documents* PAD-WC-0018, *Work Planning and Control Program for the Paducah Environmental Remediation Project Paducah, Kentucky* PAD-WC-0021, *Work Release and Field Execution*
Shared Site Issue Resolution	PAD-WC-4010, *Shared Site Issues*
Shipping Samples	PAD-WD-9503, *Off-Site Shipments by Air Transport*
Subcontract Management	PAD-CP-0008, *Receipt and Evaluation of Proposals*
Suspend/Stop Work	PAD-SH-2018, *Stop/Suspend Work (Safety Related)*
Temperature Extremes	PAD-IH-5134, *Temperature Extremes*
Training	PAD-TR-0702, *Conduct of Training* PAD-TR-0710, *Assignment of Training* PAD-TR-0750, *Required Reading*
Transmission of Data	PAD-ENM-1001, *Transmitting Data to the Paducah Oak Ridge Environmental Information System (OREIS)*
Vendor/Supplier Evaluations	PAD-QA-1208, *Approved Supplier Selection and Evaluation*
Waste Management and Disposition	PAD-WD-0016, *Waste Handling and Storage in DOE Waste Storage Facilities* PAD-WD-0437, *Waste Characterization and Profiling* PAD-WD-3010, *Waste Generator Responsibilities for Temporary On-Site Storage of Regulated Waste Materials at Paducah*

4.1 DESIGN

An RDR has been developed to support the specific implementation of this RA (DOE 2013). The general design considerations for the RA include the following:

- LDA soil mixing with hot air/steam treatment and ZVI amendment will be performed over the surface area, as shown in Figure 5 in the D2/R1 RDR (DOE 2013) and Figure 5 of this D2 RAWP, and is estimated at 12,427 ft^2.

- Due to the significant operation flexibility provided by this technology, the actual number of LDA borings completed may change based on remedial team discussion (to include representatives from EPA, KDEP, DOE, and DOE design team) that may occur during remedial implementation based on analysis of real-time field-collected data from the remedial equipment.

- Following the completion of the of the outermost ring of LDA borings and completion of interior test cells (to be conducted in the first phases of remedial implementation), as shown in Figure 5, the project team (to include representatives from EPA, KDEP, DOE, and DOE design team) will discuss the potential need to conduct step-out LDA borings based on the outermost ring results and the specific criteria that will be used for decision making protocol.

- Granular ZVI in a guar gum solution also will be delivered to the subsurface via LDA injection, as a polishing step, to provide treatment of residual VOCs within the source area.

- Soil mixing will be implemented to a depth equivalent to the bottom of the HU4 as shown in Figure 4 of the RDR (DOE 2013), which also is approximated at 60 ft bgs when allowance is given for excavation of 4 ft of surface soil to coordinate with the Soils OU.

- Critical design parameters addressed in Section 4.2, Critical Parameters, of the RDR include these:

  — Soil and groundwater temperature
  — Percentage of auger boring overlap
  — Soil properties/mixing rate
  — VOC vapor extraction rate
  — Concentration of VOCs in extracted vapor
  — ZVI dosing concentration
  — Guar gum concentration
  — Impact to surrounding structures, utilities, and operations
  — Contaminants to be treated

- Vapor treatment system will be utilized that includes real-time monitoring for data evaluation and to provide a real-time indication of the level of contamination in specific zones being treated.

- Real-time monitoring will assist in controlling the process parameters to maximize VOC removal, control of operating treatment equipment, and support operation of the LDA and injection systems.

- Remediation contaminant cleanup levels (see Table 2).

Table 2. Contaminant Cleanup Levels

Contaminant of Concern	Cleanup Level, mg/kg
TCE	7.30E-02
1,1-DCE	1.30E-01
cis-1,2-DCE	6.00E-01
trans-1,2-DCE	1.08E-00
Vinyl chloride	3.40E-02

Note: See ROD Tables 17 and 18 for the UCRS Soil Cleanup Levels for VOCs (DOE 2012a).

- Process flow
- Equipment: augering, vapor phase, and water treatment
- Electrical and water requirements
- Equipment and equipment staging layout

4.2 CONSTRUCTION

The progress of the construction phase of the SWMU 1 RA will be phased and is outlined below.

- Contracting/Procurement
  - Site Preparation Contract
  - LDA Soil Mixing Contract
  - Posttreatment Sampling Contract
- Mobilization
- Site Preparation
  - Surface Soil Removal
  - Waste Management and Decontamination
  - Surveying
- Large Diameter Augering with Vapor and Liquid Treatment
  - Soil Mixing with Steam/Hot Air
    - Operations Monitoring
    - Power and Steam Generation
    - Vapor Phase Treatment with Monitoring
    - Liquid Phase Treatment with Monitoring
  - Soil Mixing with ZVI Placement
  - Waste Management and Decontamination
  - Site Closure
- Posttreatment Sampling and Long-Term Monitoring

Two procurements are expected to be needed, but depending on the capabilities of the qualified subcontractors, one additional subcontract procurement may be warranted. The first procurement will be to perform earthwork to prepare the site for soil mixing that includes the removal of 4 ft of the surface soils and surveying. The second will be to perform the large diameter augering for the soil mixing with steam/hot air injections and ZVI placements. Depending on the qualifications of the potential bidders, the site preparation and large diameter augering subcontracts might be combined. The final procurement will be to perform posttreatment sampling of the area that is expected to be a drilling contract for sampling and monitoring well installation.

The mobilization for the action will include moving the necessary equipment and supplies to the site to perform the specific component of the action and then for necessary inspections prior to initiation of operations. The mobilization phase also will include monitoring and training the workforce necessary to perform the field implementation, developing work controls, and assessing and developing (as required) procedures. The mobilization phase is completed when an internal field readiness assessment is successfully completed allowing fieldwork to begin.

Site preparation will be composed of multiple components: (1) surveying, (2) surface soil removal, (3) stockpiling of excavated soils, (4) drainage control, (5) respreading excavated soils, (6) closure, and (7) waste management. Surveying will be performed to lay-in control points for both the excavation of the upper 4 ft of surface soil and to provide control for the actual soil mixing processes. To protect the aboveground treatment system from potential PCB contamination and to facilitate greater depths in soil mixing prior to implementing the deep soil mixing RA, the top 4 ft of the treatment/source area soil to be mixed, as defined in Figure 5, will be removed, stockpiled adjacent to the mixing area, and then respread in the excavation after soil mixing action is complete. During excavation of the top 4 ft of soil, the exposed area to be soil mixed will be inspected visually and will be probed with hand tools to determine if engineered layers of gravel are present near the surface that could inhibit effective vacuum extraction through the soil mixing hood. If the presence of such engineered gravels is detected, the graveled areas will be excavated and stockpiled, with the upper 4 ft of soil to be used for spreading after the soil mixing operations have been completed. Surface soil removal will be performed with heavy equipment to remove, handle, manage, and stockpiling of the surface soil as discussed in Section 1.5, Sequencing with Other Remedies, in the RDR. Information concerning the nature and extent of contamination in the subsurface soils and surface soils in SWMU 1 is located in the *Soils Operable Unit Remedial Investigation Report at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0358&D2/R1 (DOE 2012b). In summary, this information states that no VOCs, radioactive compounds, or semivolatile organic compounds exceeded the no action level (NAL) in the surface soils in the area to be soil mixed. For subsurface soils in SWMU 1, VOCs, PCBs, and metals exceed NALs in the planned soil mixing zone. No radionuclide or semivolatiles exceed NALs in the planned soil mixing zone. During mixing operations, the flow and infiltration of rainwater will be controlled with best management practice (BMP) sediment controls. Following completion of the soil mixing, the excavated soil will be respread over the mixing area and graded to the general contours of the area and then reseeded and strawed. The sediment controls will remain in place until the area has been revegetated.

Large diameter augering phase will include the major components of soil mixing with steam and hot air and then placement of the ZVI. A number of other supporting activities are necessary that include treatment of vapors and water that are recovered during the extraction process. Monitoring and operational sampling are internal to the treatment train to ensure the contaminants are capture by the processes. Wastes will be generated during the augering and treatment operations and will be managed consistent with the requirements discussed in waste management plan (WMP), Section 12. Following the completion of the augering activities, the treated area will be closed by replacing surface soils and regrading to match surrounding contours as described in Section 1.5, Sequencing with Other Remedies, in the RDR.

Prior to full active remedial implementation, at least two test cells will be performed during implementation in the SWMU 1 treatment area to simulate active remediation, to ensure the system is functioning efficiently as designed, and to troubleshoot problems or issues that developed prior to active remediation. The test treatment cells will be conducted in an area of highest detected concentration and in an exterior cell of anticipated lowest concentrations at the site. If the LDA test cell mixing borings are performed without indication of major failures, the outermost ring of LDA borings will be performed in parallel with the posttreatment soil sampling at each test cell to minimize downtime of the LDA mixing equipment. At each of the test cell locations, soil samples will be collected from land surface to the total

LDA boring depth at 5 ft increments within two weeks of completion of the test cells using hot soil sampling techniques. Collected soil samples will be analyzed for VOC contaminants of concern to assess the effectiveness of the LDA borings in achieving soil cleanup criteria (with consideration that the ZVI will continue to reduce residual concentrations over time). As a result of this analysis and subsequent review by the Federal Facility Agreement (FFA) parties, adjustments to the mixing approach will be considered, if feasible. Among the parameters that could be modified are these:

- Rate of vertical ascent/descent,
- Number of auger revolutions per minute during steaming/mixing,
- Minimum steam delivery rate,
- Number of auger revolutions per minute during ZVI placement,
- Adjustment of the vacuum pressure in the shroud, and
- Number of vertical mixing passes.

The implementation parameters listed above are not presented in order of prioritization of implementations. The need for implementation of these adjustments and the prioritization of adjustments will be discussed with the FFA parties following the completion of test cell mixing and the receipt of sample results. The information collected during the conduct of test cells will be used to discuss potential modifications to treatment decision criteria, if needed. Following test cell implementation, the test cell evaluation will include testing of the vapor condensate and off-gas discharges to help ensure that they are being managed appropriately.

In order to monitor the impacts of the RA on the continued presence and potential migration of the volatile contamination in the UCRS soils during the RA at SWMU 1, a postremedial sampling and analysis assessment will be performed. The RDSI performed in 2012, as well as previous sampling efforts, provides a baseline level of contamination at the SWMU from which to judge the effectiveness of the action. Following the completion of the field activities, an assessment will be performed to determine the effectiveness. The assessment will include collection of soil samples adjacent to the RDSI boring for comparison and also will install monitoring wells to allow the progress in meeting the cleanup levels for the action to be checked.

4.3 SAMPLING AND ANALYSIS

Operational sampling as well as posttreatment sampling will be performed as part of this RA. The approach to each type of sampling is discussed in Section 8.

4.4 OPERATIONS, MAINTENANCE, AND MONITORING

The LDA soil mixing with steam/hot air injection followed by placement of ZVI does not have a separate O&M and construction phasing. The performance of active portions of the remedy all coincide with the field activities. The only portion of the RA that continues to be active beyond the completion is the ZVI. The ZVI is passive in nature and cannot be monitored on real-time basis, but can be monitored through the monitoring well system to be installed as part of the posttreatment sampling. This sampling also will be utilized to support the five-year evaluations required under CERCLA.

During soil mixing, operational sampling will be performed in a number of areas as stipulated in the RDR, Section 4.4.1.7, Real-time data collection and monitoring system. These key areas of monitoring include the following:

- Temperature, flow rate, pressure, and VOCs in the combined vapor and entrained water stream being extracted from the subsurface during soil mixing;

- Temperature, flow rate, pressure, and VOCs in the vapor stream prior to treating with activated carbon bed;

- VOCs in the vapor stream after the activated carbon treatment and prior to being released to the atmosphere;

- VOCs analysis on the water stream during treatment with liquid phase carbon and ion exchange; and

- VOCs and outfall parameters of the water stream prior to release to an outfall, such as Outfall 008 or 015.

Section 4.4.1.7 of the RDR contains a specific discussion of the operational sampling to be performed during the implementation of the RA. The above monitoring will be performed during system operation and will be operational if the vapor extraction, vapor treatment, and water treatment components are operating. At the end of each work shift, if the soil mixing equipment is located over the most recently complete or partially complete soil mixing boring, the vapor extraction shroud will be left engaged with the ground surface to minimize the release of fugitive emissions. As a best management practice, prior to moving to a new location when the shroud is left engaged at ground surface following the end of a work shift, the vapor recovery system will be operated to remove any accumulated vapors. The RA system will not be an automatic or 24 hours per day, 7 days per week operation. The system will be manned and operated during daylight hours only and for a period during the day not likely to exceed 10 hours per work day.

4.5 WASTE MANAGEMENT AND DISPOSITION

Waste generated during installation, operations, and decommissioning of the SWMU 1 Oil Landfarm, RA will be managed and dispositioned in accordance with the WMP and ARARs. Waste characterization will be performed using analytical results from waste sample analysis discussed in Section 8.3 and from process knowledge where applicable. Refer to the WMP in Section 12 for additional detail concerning waste management and disposition.

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5. PROJECT ORGANIZATION

The project organization chart is provided as Figure 8. Plan-of-the-day/prejob briefings will provide personnel an opportunity to discuss daily activities and any issues. Field changes will be made and documented in accordance with Section 9.17. All personnel have "stop work authority" and the responsibility to use this authority in accordance with PAD-SH-2018, *Stop/Suspend Work (Safety Related)*, when they perceive the safety of workers or the public to be at risk.

- DOE—Lead agency. DOE performs oversight of LATA Environmental Services of Kentucky, LLC, (LATA Kentucky) and the project. DOE reviews and approves project documents and participates, as needed, in Readiness Reviews. DOE also is responsible for communications with the U.S. Environmental Protection Agency (EPA) and state regulatory agencies.

- LATA Kentucky Project Manager—Serves as the primary point of contact with DOE to implement all aspects of the DOE Prime Contact activities within LATA Kentucky.

- LATA Kentucky Manager of Projects—Serves as the primary point of contact with DOE to implement sitewide environmental restoration programs. Performs work in accordance with the baseline scope and schedule and directs the day-to-day activities of DOE contractor personnel performing environmental monitoring and restoration activities.

- LATA Kentucky GWOU Project Manager—Serves as the RA primary point of contact and is responsible for the performance, quality, schedule, and budget. Provides overall project direction and execution, implements corrective actions as necessary, verifies compliance with safety and health requirements, and participates in the readiness assessment. Leads the effort to define the scope of an environmental problem or facility operation. Directs the project team in determining potential of existing data, identifying the study area and/or facility to be addressed by the project, and selecting the most effective data collection approach to pursue. May be the technical contact for subcontracted project support and should ensure that the flow down of data management requirements is defined in a statement of work (SOW).

- LATA Kentucky QA Manager—Responsible for coordination with the project QA staff to ensure an appropriate level of QA oversight. Schedules audits and surveillances needed to verify compliance with quality commitments and requirements. Has overall responsibility of approving, tracking, and evaluating effectiveness of corrective actions. Receives copies of field changes and approves field changes related to quality. The QA manager is independent of the project.

- LATA Kentucky QA Specialist—Performs oversight to verify work is completed in accordance with the QAPP and/or the data management and implementation plan (DMIP). Responsible for reviewing project documentation to determine if the project team followed applicable procedures.

- LATA Kentucky Field Team Manager/Site Superintendent—Oversees all field activities and verifies that field operations follow established and approved plans and procedures. Supervises the field team activities and field data collection. Ensures that all field activities are properly recorded and reviewed in the field logbooks and on any necessary data collection forms. Responsibilities include identifying, recording, and reporting project nonconformances or deviations. Interfaces with the RA project manager during field activities.

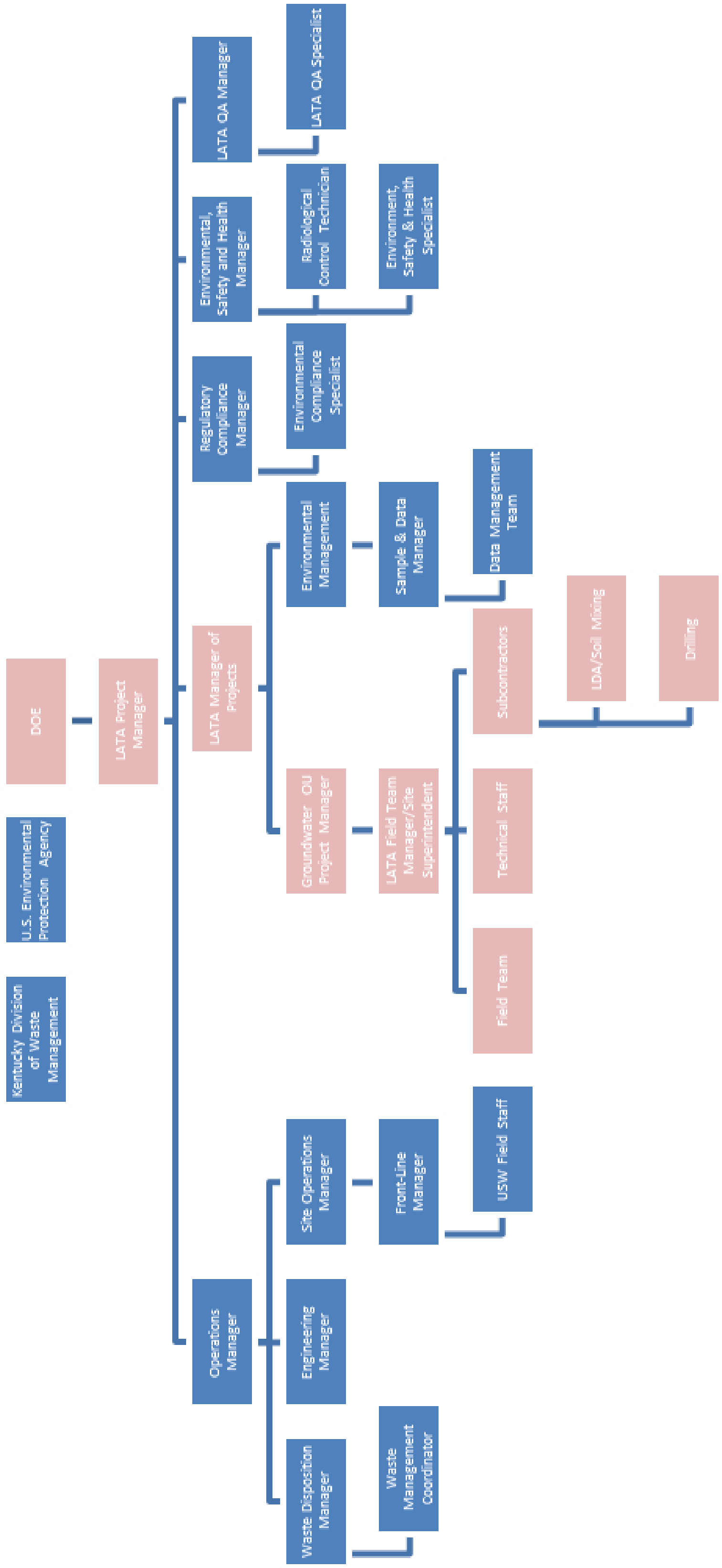

Figure 8. Project Organization

- Frontline Manager (FLM)—Coordinates field activities and logistics and provides the communications between the project team and the field team as well as other support groups. The FLM also ensures that on-site personnel comply with the Worker Safety and Health Program, work packages, and applicable procedures.

- Radiological Control Technician (RCT) (from the radiological control group)—Provides support and guidance to the project and assists the FLM with implementation of radiological controls and as low as reasonably achievable (ALARA) principles. The RCT observes the work area before/during activities for radiological hazards and authorizes entry into and exit from the radiological work area. Implements the day-to-day programmatic aspects of the Radiation Protection Program (RPP). Perform air sampling, radiation surveys, radioactive contamination control and monitoring, access control, posting and labeling, completion and management of records, responding to accidents and emergencies, vehicle and equipment control, instrumentation source check, personnel decontamination, and minor equipment decontamination during the course of surveying. Generates radiological data records and reports.

- Regulatory Compliance Manager and Organization—Provide environmental support and oversight to the project to ensure that the planning and fieldwork are being performed properly and in accordance with all applicable regulations, DOE directives, and relevant plans and procedures.

- Waste Management Coordinator (WMC)—Provides waste management support to the project to coordinate waste containers and removal of waste from the worksite while complying with the Worker Safety and Health Program, as well as environment, safety, and health (ES&H) and work control requirements.

- Field Team—Samplers, drillers, operators, maintenance mechanics, and electricians perform work as specified in work packages, adhering to the Worker Safety and Health Program, HASP, radiological work permits (RWPs), project procedures, and AHAs. Field team personnel also participate in the identification of the hazards and development of the work controls to be utilized during the work.

- ES&H Specialist—Develops the health and safety plan (HASP) and oversees implementation of Integrated Safety Management System (ISMS) and the overall safety and health of employees, both in the field and the office. Provides direct support to the GWOU project manager concerning the safety and health of project personnel and the general public and impacts to property and the environment. Ensures that each task has the proper safety and health controls in place before work begins, meeting all federal, state, and local regulations.

- Environmental Compliance Specialist—Ensures project activities are conducted in compliance with ARARs including environmental laws and regulations and, but not limited to, National Environmental Policy Act and Clean Air Act, permits, regulatory agreements and documents, DOE Orders and Directives, and company policies and procedures. Reviews and prepares technical and regulatory documents/reports, National Emission Standards for Hazardous Air Pollutants (NESHAP) reports, SWMU notifications and assessment reports, and permit applications/modifications. Conducts regulatory research and reporting, performs field inspections, and supports waste minimization and pollution prevention activities. Supports implementation of the ISMS and Environmental Management System (EMS).

- Technical Staff—Provides direct support to the field team manager/site superintendent and GWOU project manager concerning technical aspects of the project during remedial design, construction, civil survey, operational permits, and associated operations.

- Sample and Data Management Manager—Responsible for the coordination of all sampling activities. Ensures that all quality control (QC) sampling requirements are met, and chain-of-custody forms are generated properly. Responsible for managing data generated during the remedial design, construction, and operation in accordance with the DMIP.

- Data Management Team—Responsible for entering project information into the project records file and/or database and ensuring that all information has been entered correctly. Ensures that hard copy data records are processed according to data records management requirements. Works with field teams to facilitate data collection and verification and with data users to ensure easy access to the data. Performs data reviews, verification, and assessment, as appropriate. Determines project data usability by comparing the data against predefined acceptance criteria and assessing that the data are sufficient for intended use. Ensures that analytical methods, detection limits, minimum detectable activities, laboratory QC requirements, and deliverable requirements are specified in the SOW and that the SOW incorporates necessary deliverables so that data packages from the laboratory will be appropriate for verification and validation. Responsible for contracting any fixed-base laboratory utilized during sampling activities. Incorporates any existing data or new project data into the project's hardcopy data record file or database, as appropriate. Performs data reviews, verification, and assessment, as appropriate. Ensures that analytical and field data are validated, as required, against a defined set of criteria that includes evaluating associated QC samples to ensure that analyses were preformed within specified control parameters. Performs data reviews, as appropriate [e.g., quality checks; assessing sensitivity, precision, accuracy, representativeness, comparability, completeness, and sensitivity (PARCCS) parameter conformance; evaluating adherence to data quality requirements]. Ensures that the project data are properly incorporated into Paducah Oak Ridge Environmental Information System (OREIS).

- Subcontractor(s)—A number of subcontractors are expected to be utilized in performing this RA. An LDA/soil mixing specialty subcontractor will be hired to provide equipment and expertise during the implementation of the RA. Depending on subcontractor qualifications, a separate subcontractor may be needed for the removal of the 4 ft of surface soil. A drilling subcontractor will be hired to install all subsurface borings for soil sampling and to install monitoring wells. A subcontract laboratory will be utilized for sample analysis.

6. PROJECT PLANNING SCHEDULE

A generalized project planning schedule is shown in Table 3.[1] A task-level-specific schedule will be developed and updated by the selected LDA contractor. Once these schedules are available, they will be provided to the FFA parties for use.

Table 3. Project Planning Schedule

Activity	Date
Completion of the RDSI	Completed October 2012
Initiate Soil Mixing with Steam and ZVI Placement	June 10, 2014
Complete Soil Mixing and ZVI Placement	January 2, 2015
Initiate Posttreatment Sampling and Monitoring Well Installation	January 26, 2015
Initiate Long-Term Monitoring	March 20, 2015
Issue D1 RA Completion Report	May 15, 2015

[1] Projected schedules for completion of activities set forth herein are estimates provided for informational purposes only and are not considered to be enforceable elements of the remedial action or this document. The enforceable milestones for performance of activities included as part of the remedial action are set forth in the FFA (EPA 1998). Any additional milestones, timetable, or deadlines for activities included as part of the remedial action will be identified and established independent of this RAWP, in accordance with existing FFA protocols.

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7. HEALTH AND SAFETY PLAN

This HASP has been developed as an overview to discuss the general standards and practices to be used during execution of the Oil Landfarm/SWMU 1 *In Situ* Treatment Using Deep Soil Mixing RA to protect the safety and health of workers and the public. Site-specific hazards and controls will be established for each task and location prior to performing work. These hazards and controls will be documented in the form of a site-specific HASP, activity hazard assessments (AHAs), work control documents, procedures, or an approved combination thereof. Personnel will be familiar with the hazards, controls, applicable procedures, and work control documents prior to performing work in the affected areas. This work will be performed in accordance with the DOE's ISMS and its environmental compliance and health and safety requirements; these establish a goal of zero-accident performance. Hazard controls will include access restrictions, operator-training requirements, exclusion of nonessential personnel from the work zone, use of engineering/administrative controls, and use of personal protective equipment (PPE).

7.1 INTEGRATED SAFETY MANAGEMENT/ENVIRONMENTAL MANAGEMENT

This RA project will utilize an ISMS, which integrates the Safety Management System, the EMS, and the Quality Management System to ensure personnel and environmental safety and quality are integrated into management and work practices at all levels so that missions are accomplished while protecting the public, the workers, and the environment. The concepts of the ISMS/EMS will be utilized to provide a formal, organized process to ensure the safe performance of work. The ISMS/EMS Plan identifies the methodologies that will be used to address previously recognized hazards and how the hazards are mitigated using accepted health and safety practices.

This project will pursue the DOE's goal of zero accident performance through project-specific implementation of ISMS. The core functions and guiding principles of ISMS/EMS will be implemented by complying with 10 *CFR* § 851, *Worker Safety and Health Program*, and incorporating applicable DOE Orders, policies, technical specifications, and guidance. A brief description of the five ISMS/EMS core functions is provided in the following sections.

7.1.1 Define Scope of Work

Defining and understanding the scope of work is the first critical step in successfully performing any specific activity in a safe manner. Each member of the project team will participate in discussions conducted to understand the scope and contribute to the planning of the work. The project team will conduct a project team-planning meeting to discuss the team's general understanding of the scope and the technical and safety issues involved. This meeting is conducted to ensure all parties are in agreement on the scope and general approach to complete the scope.

7.1.2 Analyze Hazards

In the course of planning the work, the project team will identify hazards associated with the performance of the work. Hazards may be identified and assessed by performing a site visit, reviewing lessons learned, and reviewing project plans or historical data.

7.1.3 Develop and Implement Hazard Controls

After potential safety hazards and environmental risks are identified, controls necessary to protect workers, the public, and the environment are identified and implemented. These controls are identified in the work planning process that develops how the scope of work will be performed, identifies the applicable standards, requirements, and controls that are needed. Then those processes must be established and implemented in the appropriate work control document, such as procedures, work instructions and AHAs.

Applicable work control documents/AHAs will be reviewed with the personnel who will perform the work. Participants in this review will sign and date the appropriate documentation to signify that they understand all hazards, controls, and requirements. A copy of the work control documents with appropriate signatures shall be maintained at the work location.

7.1.4 Perform Work Within Controls

Prior to commencing work, the project team will verify that the appropriate work control documents are in place and have been reviewed and approved by authorized personnel. The project team also will ensure that all the requirements and controls have been communicated to the project team. These requirements and controls are communicated through the following applicable methods:

- Training
- Required reading/briefings
- Prejob meetings
- Permits
- Plan-of-the-day/prejob briefings
- AHAs
- RWPs
- Signs and postings

The project team will strictly adhere to the requirements established in approved contractor performance documents and work controls at all times. If a performance document or work control cannot be followed or clearly interpreted, the task will not be performed until a clear and operable document can be provided for the performance of the work.

7.1.5 Feedback and Continuous Improvement

Feedback and continuous improvement is accomplished through several channels including ISMS/EMS audits, self-assessments, employee suggestions, lessons learned, and prejob briefings. These actions will be used to solicit worker feedback, as well as to identify, address, and communicate lessons learned using standard corrective action planning and continuous improvement processes.

Project management will encourage employees to freely submit suggestions that offer opportunities for continuous improvement and constructive criticism on the activities. Project management will conduct periodic inspections and meetings with project personnel at the work site to discuss project status, priorities, expectations, safety/environmental issues, and/or concerns as well as other relevant topics.

During field activities, meetings and briefings will provide opportunities for project personnel to communicate the following:

- Lessons learned and any other topics relevant to the work performed;
- How work steps/procedures could be modified to promote a safer working environment;
- How communications could be improved within the project team; and
- Overall issues or concerns they may have regarding how the work was performed.

7.2 FLOWDOWN TO SUBCONTRACTORS

The ISMS/EMS approach to ES&H ensures that personnel, including subcontractors, are aware of their roles, responsibilities, and authorities for worker/public safety and protection of the environment. All organizations will be responsible for compliance with the prime contractor's Worker Safety and Health Program, ISMS Program, RPP, Environmental Protection Program, and QA Program. In addition, subcontract requirements will flow down to lower-tier subcontractors, as applicable. Personnel will have the appropriate medical qualifications and health and safety training required by appropriate federal regulations, but also will undergo site-specific prejob training, including safety and environmental, to ensure that ES&H issues related to the activities to be performed or specific to the work site are clearly understood. Documentation of training will be available for review prior to starting work.

7.3 SUSPENDING/STOPPING WORK

In accordance with 10 *CFR* § 851.20 and the DOE prime contractor's Worker Safety and Health Program and procedures, employees and subcontractors have suspend/stop-work authority. Individuals involved in any aspect of the project have the authority and responsibility to suspend or stop work for any perceived threat to the safety and health of the workers, the public, or to the environment. Concerns shall be brought to the attention of the FLM and safety and health specialist (SHS), will be evaluated by project management personnel, and actions will be taken to rectify or control the situation. In the case of imminent danger or emergency situations, personnel should halt activities immediately and instruct other affected workers to pull back from the hazardous area. The appropriate authority/responders shall be notified immediately in accordance the emergency response plans.

7.4 ISMS/EMS BRIEFINGS

Plan-of-the-day/prejob briefings detailing the specific hazards of the work to be performed and safety precautions and procedures specific for the job shall be conducted by the FLM and/or SHS at the beginning of each shift. During these briefings, work tasks and the associated hazards and mitigating controls will be discussed using approved procedures, work control documents, AHAs, and/or lessons learned as guidance.

Prior to performing work on the site, personnel shall be required to read or be briefed on the DOE prime contractor's Worker Safety and Health Program, applicable AHAs, the work package, and other applicable documents. This shall be documented as required reading, acknowledgement forms, or briefing sheets. Visitors will also be briefed to the applicable plans and potential hazards that they may encounter.

7.5 KEY PROJECT PERSONNEL AND RESPONSIBILITIES

One of the primary underlying principles of a successful project organization is the establishment of clearly defined roles and responsibilities and effective lines of communication among employees and among the prime contractor, subcontractors, and other organizations involved in the project. Ensuring that personnel fully understand their roles and responsibilities and that they have a thorough understanding of the scope of work and other project requirements will provide the foundation for successful and safe completion of the project. The roles and responsibilities of key field team members are briefly described in Section 5.

7.6 GENERAL PROJECT HAZARDS

7.6.1 Operation of Project Vehicles and Heavy Equipment

All field personnel operating vehicles and heavy equipment shall have the appropriate training/license for the type of vehicle/equipment being operated, drive responsibly, and comply with posted speed limits. All vehicle/equipment occupants shall use seat belts while in operation, and the use of cellular phones or other potentially distracting activities while driving on company business is prohibited. Operators should walk around the vehicle and check for obstacles and material prior to backing up and use spotters as necessary.

Large vehicles and heavy equipment, such as excavators, cranes, and forklifts, have blind spots and the potential for pinch and crush hazards. Heavy equipment shall have a functioning backup alarm or a spotter will be required when the vehicle is backing up in congested areas. The spotter shall not stand directly behind the equipment while backing. Equipment operations will be in accordance with appropriate contractor procedures.

7.6.2 Tools and Equipment

Tools and equipment shall be inspected visually before each use to ensure that the devices are in good working order. All guards and safety devices (e.g., power tools) shall be in place when the equipment is in use. The individual conducting an inspection should look for signs of wearing (e.g., frayed power cords, loose parts), missing components (e.g., lock pins, guards), and any indication of a potentially unsafe condition. Deficiencies affecting safe operation of project equipment shall cause the equipment to be taken out of service until properly repaired. Field sampling equipment shall be operated only by knowledgeable personnel with appropriate work experience and awareness of the hazards and safe operating procedures of the devices.

7.6.3 Material and Drum Handling

Material handling will be accomplished using safe lifting procedures. Vehicles, mechanical lifts, and/or carts will be used whenever possible. Whenever moving or lifting objects, travel paths and actions should be considered prior to initiating the work. Drum-handling activities include the general handling, transport, and opening and closing of drums along with the storage of wastes within the drums.

7.6.4 Fire Safety

Refueling equipment can present a significant fire/explosion hazard if subjected to sparks, static electricity, or other ignition sources. Containers dispensing and receiving flammable/combustible liquids shall be appropriately bonded prior to use. Only safety containers approved by the Factory Mutual Research, Underwriters Laboratories, or the U.S. Department of Transportation will be used to transport and store these liquids. Site personnel are to ensure that the equipment used to transfer the liquids is approved for the material being handled. Safety cans shall be labeled as to their contents and properly secured during transport. When applicable, equipment should be given adequate time to cool down before refueling. During refueling operations, a 20-BC rated fire extinguisher will be within 50 ft of the operation.

Smoking is not allowed in the work area or radiologically controlled areas. Smoking will be allowed in designated areas and cigarette butts properly discarded so as not to create litter or pose a fire risk.

7.6.5 Housekeeping

Good housekeeping, including routine site cleanup and waste management, shall be practiced at all times to improve the general safety of the site activities. Housekeeping efforts may include eliminating or minimizing slip, trip, and fall hazards. Sanitary trash shall be containerized and disposed of periodically. When not in use, supplies, materials, and ancillary equipment should be stowed properly inside trailers in and away from walk areas.

7.6.6 Slips, Trips, and Falls

Much of the work locations associated with the project will be in wooded areas with rough terrain and possible obstructions that may pose hazards that could cause slips, trips and/or falls. Care should be taken when working around uneven terrain and obstructions should be avoided as much as possible. If slipping and/or tripping hazards cannot be completely eliminated, obstructions should be marked and/or the area shall be barricaded and posted with the appropriate hazard postings.

7.6.7 Inclement Weather

Weather forecasts and conditions shall be monitored for potential inclement weather and lightning. All field activities shall be paused during thunderstorms or high wind conditions. Personnel will safely secure equipment and materials and move to the designated assembly point or storm shelter as necessary.

7.6.8 Head, Eye, Hand, and Foot Hazards

Work activities have potential hazards that may result in injuries to the head, eyes, hands, or feet. The use of engineering controls or administrative controls may have limited applications for these hazards. The use of PPE may be necessary to adequately address these hazards. Where these hazards exist, the task-specific AHA and/or work control document will specify the use of appropriate protective equipment, including hard hats, safety eye protection, and/or steel-toe safety footwear.

7.6.9 Temperature Extremes

Heat stress and cold stress are serious hazards to workers during field activities, especially heat stress, when layers of PPE are required for protection from radiological and/or chemical hazards. Personnel will be familiarized on the symptoms of heat and cold stress during training and proper controls implemented, such as work rest regimens, in accordance applicable work controls and procedures.

7.6.10 Biological Hazards

Biological hazards that may be present at the site include snakes, insects, ticks, and poisonous plants (e.g., poison ivy, oak, or sumac). Personnel should be aware of the presence of potential hazards and prevent insects and ticks with repellant and avoid hazards as much as possible. Personnel who are or may be hypersensitive to plants and insects stings should report their condition to their supervisor. Some ticks are of a particular concern due to the potential to carry Lyme disease and Southern Tick Associated Rash Illness; therefore, controls will be implemented in the work control and/or AHA.

7.6.11 Noise

Equipment such as generators, pneumatic hammers, slide hammers, and hand and power tools may produce noise exceeding 85 decibels. Sound levels will be assessed and/or measurements will be taken for specific equipment and activities as necessary and controls/protection will be identified in applicable work control documentation. Personnel shall be trained and hearing tested in accordance with procedures.

7.7 SITE CONTROL

A combination of work zones will be utilized to control access, to minimize the number of individuals potentially exposed to site hazards, and to ensure that individuals who enter follow the required procedures. Following is a description of the different types of zones that may be established at the site.

- Exclusion Zone (EZ)—The area where work is being performed and chemical, physical, and/or radiological hazards exist. Entry into this area is controlled and the area clearly marked with barrier tape, rope, or flagging and/or signage. Applicable signage will be posted to adequately communicate hazards and entry requirements. Unauthorized entry into these areas is strictly prohibited.

- Contamination Reduction Zone (CRZ)—The transition area between the EZ and support area. This area will provide a buffer area to reduce the probability that contamination will leave the EZ and reduce the possibility of the support area becoming contaminated by site hazards. The degree of contamination in the CRZ decreases as the distance from the contaminants increases.

- Support Area—The outermost area of the work site. This area is uncontaminated where workers provide operational and administrative support. The support area is clean and will not be entered by contaminated equipment or personnel, except under emergency or evacuation conditions. Normal work clothes are appropriate within this area.

- Construction Zone—The area outside of potential contamination, but encompassing work activities and possible hazards associated with construction activities. Entry into this area is controlled and the area clearly marked with barrier tape, rope, flagging and/or signage. Applicable signage will be posted to adequately communicate hazards and entry requirements.

7.8 HAZARD COMMUNICATION

The Occupational Safety and Health Administration's (OSHA's) 29 *CFR* § 1910.1200, "Hazard Communication Standard," states that all employees handling or using hazardous or potentially hazardous materials be advised and informed of the health hazards associated with those materials.

7.8.1 Material Safety Data Sheet

A material safety data sheet (MSDS) provides specific material identification information; ingredients and hazards; physical data; fire and explosion information; reactivity data; health hazard information; spill, risk, and disposal procedures; special protection information; and special precautions required for materials manufactured for use. It is the manufacturer's responsibility to provide this information to the user for any materials that contain hazardous or potentially hazardous ingredients. Each employee is to be made aware that the MSDSs are available. The project and subcontractors shall maintain copies of all MSDSs for chemicals brought on-site and shall have them readily available.

7.8.2 Chemical Inventory

A hazardous material inventory of all chemicals brought on-site will be maintained by the appropriate hazardous material custodian. Prior to bringing hazardous materials on-site, personnel/subcontractors must submit an MSDS and receive approval from the facility manager and SHS.

It is the responsibility of the user to ensure that all potentially hazardous materials taken to a project site are labeled properly as to the contents of the container and with the appropriate hazard warnings.

7.9 EMERGENCY MANAGEMENT

In the event of an emergency, all site personnel shall follow the requirements and provisions of the PGDP Emergency Management Plan. Emergency response shall be provided by the PGDP emergency response organization. The site superintendent and SHS will be in charge of personnel accountability during emergency activities. All personnel working on-site will be trained to recognize and report emergencies to the safety and health specialist or the site superintendent. The SHS or site superintendent will be responsible for notifying the PGDP emergency response organization.

The PGDP emergency response organization will be contacted for emergency response to time-urgent medical emergencies, fires, spills, or other emergencies. The plant shift superintendent (PSS) will coordinate 24-hour emergency response coverage. The requirements of this section will be communicated to site workers. Any new hazards or changes in the plan also will be communicated to site workers.

7.9.1 Potential Emergencies

Potential emergencies that could be encountered during this project include, but are not limited to, fires, spills, and personnel exposure or injury. An emergency response plan, which contains explicit instructions and information about required emergency actions and procedures, is located in the site-specific HASP and/or in the prime contractor's facilities.

7.9.2 Fires

In the event of a fire, the PSS shall be notified immediately. If it is safe to do so, and they are properly trained, on-site personnel may attempt to extinguish an incipient fire with the available fire extinguisher and isolate any nearby flammable materials. If there is any doubt about the safety of extinguishing the fire, all personnel must evacuate to an assembly location and perform a head count to ensure that personnel are accounted for and are safely evacuated. The site superintendent or designee will provide the fire department with relevant information.

7.9.3 Spills

In the event of a spill or leak, the employee making the discovery will immediately vacate the area and notify other personnel and his/her supervisor. The site superintendent or designee will determine whether the leak is an incidental spill or whether an emergency response is required. If there is a probability that the spill will extend beyond the immediate area, result in an environmental insult, or exceed the capabilities of the on-site personnel, the site superintendent is to inform the PSS, who will determine whether a response by the PGDP spill response team is warranted. If emergency response crews are mobilized, the site superintendent or knowledgeable employee will provide the responders with relevant information.

7.9.4 Medical Emergencies

Personnel with current first aid or first responder training will serve as the designated first aid provider. Any event that results in potential employee exposure to bloodborne pathogens will require a post-event evaluation and follow-up consistent with 29 *CFR* § 1910.1030. A person knowledgeable of the location and nature of the injury will meet the emergency response personnel to guide them to the injured person.

The PGDP emergency response organization will be contacted for emergency response to time-urgent medical emergencies, fires, spills, or other emergencies. Site personnel may take workers with injuries that are more severe than can be addressed by first aid, but that do not constitute a medical emergency, to designated medical facility. The site superintendent, SHS, and GWOU project manager must be informed immediately that the worker has been taken to the medical facility and the nature of the injury.

7.9.5 Reporting an Emergency

Project personnel will be able to communicate by two-way radio, plant radio, or cellular telephone on-site.

7.9.6 Telephone

The Oil Landfarm/SWMU 1 is located inside the PGDP security perimeter. Inside the PGDP security perimeter, if a plant telephone is accessible, dial 6333. With a cellular phone, dial 270-441-6333. Describe the type and the location of the emergency. Identify who is calling. Identify the number on the phone being used. Tell whether an ambulance is needed. Listen and follow any instructions that are given. Do not hang up until after the Emergency Control Center has hung up.

7.9.7 Fire Alarm Pull Boxes

Pulling a fire alarm box at PGDP automatically transmits the location of the emergency to the fire department and the Emergency Control Center. The person pulling the alarm should remain at the alarm box, or nearest safe location, and supply any needed information to the emergency responders. Work personnel should note the location of pull boxes in each project area, where applicable.

7.9.8 Radio

Channel 16 is designated as the emergency channel on the plant radio system. By calling radio call number Alpha 1 and declaring "EMERGENCY TRAFFIC, EMERGENCY TRAFFIC," the PSS is alerted of the emergency. Describe the type and the location of the emergency and who is calling.

7.10 ALARM SIGNALS

7.10.1 Project-Specific Alarm

A prolonged blast of an air horn or vehicle horn will signal immediate work stoppage and evacuation to a predesignated area.

7.10.2 Evacuation Alarms

PGDP facility evacuation alarms are denoted by a steady or continuous sound from the site public address system. Proceed to the predetermined assembly station. The assembly station director will provide further instruction.

7.10.3 Radiation Alarms

PGDP radiation alarms are denoted by a steady sound from a clarion horn and rotating red beacon lights. Evacuate the site or area and proceed to the predetermined assembly station. The assembly station director will give further instruction.

7.10.4 Take-Cover Alarms

PGDP take-cover alarms are denoted by an intermittent or wailing siren sound from the site public address system. Seek immediate protective cover in a strong sheltered part of a building. Evacuate mobile structures to a permanent building or underground shelter.

7.10.5 Standard Alerting Tone

The standard alerting tone at PGDP is a high/low tone from the public address system and is repeated on the plant radio frequencies. Listen carefully; an emergency announcement will follow.

7.10.6 Evacuation Procedures

The SHS or site superintendent will designate the evacuation routes. Every on-site worker should familiarize himself/herself with the evacuation routes. In the event of an evacuation, proceed to the predetermined assembly station or designated area and wait for further instructions.

7.10.7 Sheltering In Place

Certain emergency conditions (e.g., chemical or radioactive material release, tornado warning, fire, security threat) may require that personnel be sheltered in place. Notification of a recommendation of "sheltering in place" is carried out by the PGDP emergency director on the emergency public address system and plant radio frequencies. Requirements for "sheltering in place" follow these steps:

- Go indoors immediately (the nearest substantial facility to the Oil Landfarm is the C-720 Building complex);
- Close all windows and doors;
- Turn off all sources of outdoor air (e.g., fans and air conditioners);
- Shut down equipment and processes, as necessary for safety; and
- Remain indoors and listen for additional information on radios and/or the public address system.

7.10.8 On-Site Relocation

Certain emergency conditions (e.g., chemical or radioactive material release, tornado warning, fire, security threat) may require that on-site personnel be relocated from their normal workstations and activities to locations more suitable to withstand the threat. Notification of on-site relocation is carried out by the PGDP emergency director on the public address system and plant radio frequencies. Specific instructions about where to relocate will be given with the message.

7.10.9 Facility Evacuation

For evacuations related to emergencies inside PGDP, the PGDP emergency director initiates notification of facility evacuation over the public address system. Assembly stations serve as gathering points for evacuating personnel. In the event of an evacuation alarm, employees will evacuate to the designated assembly point for the area and immediately report to the site superintendent or the assembly station director. An accounting will be conducted of all personnel who have evacuated. Further instructions and information about the emergency situation will be given to employees by the assembly station director or over the site public address system and plant radio.

7.10.10 Emergency Equipment

The following items of emergency equipment will be maintained at the work location:

- Hard-wired or cellular telephone and radios;
- First aid kit including bloodborne pathogen PPE;
- ABC-rated fire extinguishers; and
- Basic spill kit suitable to handle small spills.

7.11 HEAT AND COLD STRESS

Common types of stress that affect field personnel are from heat and cold. Heat stress and cold stress may be one of the most serious hazards to workers at hazardous waste sites. In light of this, it is important that all employees understand the signs and symptoms of potential injuries/illnesses associated with working in extreme temperatures.

7.11.1 Heat Stress

Heat stress occurs when the body's physiological processes fail to maintain a normal body temperature because of excessive heat. The body reacts to heat stress in a number of different ways. The reactions range from mild (e.g., fatigue, irritability, anxiety, and decreased concentration) to severe (e.g., death). Heat-related disorders generally are classified in four basic categories: (1) heat rash, (2) heat cramps, (3) heat exhaustion, and (4) heat stroke.

7.11.2 Preventive Measures

A number of steps can be taken to minimize the potential for heat stress disorders.

- Acclimate employees to working conditions by slowly increasing workloads over extended periods of time. Do not begin site work activities with the most demanding physical expenditures.

- Conduct strenuous activities during cooler portions of the day, such as early morning or early evening, as practicable.

- Provide employees with lots of tempered water and encourage them to drink it throughout the work shift; discourage the use of alcohol during nonworking hours. It is essential that fluids lost through perspiration be replenished. Total water consumption should equal 1 to 2 gal/day.

- Rotate employees wearing impervious clothing during hot periods.

- Provide cooling devices, as appropriate. Mobile showers and/or hose-down facilities, powered air purifying respirators, and ice vests all have proven effective in helping prevent heat stress.

7.11.3 Heat Stress Monitoring

For strenuous field activities that are part of ongoing site activities in hot weather, physiological monitoring may be used to monitor the individual's response to heat. Physiological monitoring will be implemented in accordance with PAD-IH-5134, *Temperature Extremes*. The guidelines set forth in the current issue of the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values and Biological Indices shall be used to determine the work/rest regimen for working in environments conducive to heat stress.

7.11.4 Cold Stress

Persons working outdoors in low temperatures, especially at or below freezing, are subject to cold stress disorders. Exposure to extreme cold for even a short period of time can cause severe injury to the body surfaces and/or profound cooling, which can lead to death. Areas of the body that have high surface-area-to-volume ratios (e.g., fingers, toes, and ears are the most susceptible).

Two basic types of cold disorders exist: localized (e.g., frostbite) and generalized (e.g., hypothermia).

7.11.5 Preventive Measures

A number of steps can be taken to minimize the potential for cold stress.

- Individuals can achieve a certain degree of acclimation when working in cold environments as they can for warm environments. The body will undergo some changes that increase the body's comfort and reduce the risk of cold injury.

- Working in cold environments causes significant water losses through the skin and the lungs as a result of the dryness of the air. Increased fluid intake is essential to prevent dehydration, which affects the flow of blood to the extremities and increases the risk of cold injury. Warm drinks or soups should be readily available.

- The skin should not be exposed continuously to subzero temperatures.

7.11.6 Cold Stress Monitoring

Air temperature alone is not a sufficient criterion on which to judge the potential for cold-related disorders in a particular environment. Heat loss from convection (air movement at the surface of the skin) is probably the greatest and most deceptive factor in the loss of body heat. For this reason, wind speeds as well as air temperatures need to be considered in the evaluation of the potential for cold stress disorders. The ACGIH Threshold Limit Values and Biological Indices provide additional guidance on cold stress evaluation and the establishment of the work/rest regimen in environments conducive to cold stress.

7.12 EXPOSURE MONITORING

Air monitoring shall be used to identify and quantify airborne levels of hazardous substances and health hazards in order to determine the appropriate level of employee protection needed on-site.

7.12.1 Routine Air Monitoring Requirements

Air monitoring will be performed during the following activities:

- Intrusive activities such as drilling and opening sampling tubes are being done;
- Work begins on a different portion of the site;
- Contaminants other than those previously identified are being handled;
- A different type of operation is initiated; or
- Personnel are opening drums that contain material.

7.12.2 Site-Specific Air Monitoring Requirements

Measurements of airborne VOCs (primarily TCE) will be conducted in the work area during intrusive activities by using PID or equivalent. VOC monitoring primarily will be focused on the breathing zones of employees. Air monitoring results will be used to determine the effectiveness and/or need for control measures.

7.12.3 Time Integrated Sample Collection

Verification sampling will be completed for VOCs and potentially specific contaminants of concern. Integrated sampling methodology will be evaluated by the industrial hygiene program supervisor and may be revised during the course of work based on real-time monitoring/sampling results and changing site conditions.

7.13 RADIOLOGICAL PROTECTION

The radiological contaminant of concern is technetium-99 (Tc-99). Due to the presence of radionuclides, including Tc-99, the work associated with the remedial action will be performed under an RWP. The following sections provide detail of the provisions, training requirements, and work practices provided by the RWP.

7.13.1 Radiation Protection Plan

All workers will operate under the DOE-approved RPP when performing activities where a potential hazard is posed by radiation exposure. The DOE contractor will assess all radiological hazards that may be encountered. This has been accomplished primarily through the preparation of the HASP and the work control process. Based on these evaluation activities, appropriate engineering, administrative, and PPE controls will be selected and implemented. Whenever possible, work will be arranged to avoid (or at least minimize) entry into radiological areas. The radiation safety work practices focus on establishing controls and procedures for conducting work with radioactive material, while maintaining radiation exposures ALARA.

All work associated with radiological issues will be conducted in accordance with the RPP, and, as a result, the DOE contractor will provide radiological support activities with potential radiation exposure. RCTs also may perform surveys and monitoring, identify radiological areas, and implement RWPs. All personnel/subcontractors will implement and maintain any controls identified as a result of these activities.

7.13.2 Contractor/Subcontractor Responsibilities

The DOE contractor and subcontractor responsibilities may include the following:

- Provide and erect any radiological barriers, barricades, warning devices, or locks needed to safely control the work site.

- Follow the requirements of the RWPs, including daily briefings, and requirements for signing in on all RWPs.

- Submit bioassay samples and use external dosimeters.

- Notify the GWOU project manager after any employee declares a pregnancy.

- Establish radiation control measures that comply with the requirements specified by radiological personnel supporting the project.

- Determine required radiological PPE based on appropriate work processes and AHAs.

7.13.3 Site-Specific Radiation Safety Work Practices

The DOE contractor and all subcontractors will implement the following radiation safety work practices when working in radiological areas.

- All personnel will adhere to the action levels and hold points identified in the RWP addressing the potential radiological hazards posed by work activities. Work practices and PPE will be altered according to changing radiological requirements as prescribed by the RWP and/or the RCT.

- All work activities to be performed will be designed and performed ensuring minimization of material brought into the Radiological Areas. Management, design engineers, and field personnel will jointly identify the materials and equipment needed to perform this work. Only equipment and supplies necessary to successfully accomplish the various tasks to be performed will be taken into the EZ. Work also will be planned and conducted in a manner that minimizes the generation of waste materials. All activities will be designed, before commencement of field activity to maintain radiation exposures and releases ALARA. Emphasis will be placed on engineering and administrative controls over the use of PPE, when feasible.

- All personnel working in, or subject to, work in the Radiological Areas will read the applicable RWP. The RCT or the SHS also will verbally review the RWP during the initial prework safety briefing. The site superintendent, the RCT and the safety and health specialist will continuously monitor worker compliance with the RWP. The site superintendent and/or the safety and health specialist will communicate changes to the RWP immediately to all affected personnel, and work practices will be changed accordingly. Radiological controls specified by the RWP, such as PPE and work activity hold points, will be reviewed during preshift briefings.

- Engineering and administrative controls will be utilized to minimize and control the spread of airborne and surface contamination. If airborne contamination is identified, water mist will be used to eliminate or reduce this hazard. The contaminated water will be contained by plastic sheeting covering the work area. Surface contamination, in the form of waste, will be containerized properly throughout the project.

- Personnel will be instructed in the proper use and care of external dosimeters before commencement of field activities and periodically during prework tailgate briefings. Personnel will be instructed to wear the dosimeters only during activities posing an occupational ionizing radiation exposure. This will include all field activities. Personnel will be instructed to wear their dosimeters outside of company clothing in the front torso area of the body. They are not to expose the dosimeters to excessive heat or moisture. Dosimeters must be exchanged on a quarterly basis.

- All personnel will participate in the DOE contractor bioassay program. All personnel may be required to submit a baseline bioassay sample before receiving an external dosimeter and participating in any fieldwork. Periodic bioassays also will be submitted in a timely manner as directed by the radiological control organization. Personnel not complying with these requirements will be subject to removal from the project.

- The site superintendent and the safety and health specialist will conduct a continuous observance of work in progress and of field personnel performance with respect to ALARA. Additional reviews of performance will be discussed during "tailgate" safety meetings with all field personnel.

- Applicable lessons learned will be reviewed with personnel during the project. Work practices will be modified to incorporate lessons learned.

7.13.4 Radiation Safety Training

The DOE contractor and all personnel will observe the radiological training requirements, which require General Employee Training and Radworker II Training for all general employees who will perform hands-on work in radiological areas. The applicability of this training will be determined for each activity. Personnel, including visitors, who are not necessary to the performance of the scope of work and who are not appropriately trained and qualified, will not enter any work areas where radiological exposures may occur. In areas where visitors are essential or otherwise approved to be present, they will be restricted from Contamination Areas, High Contamination Areas, High Radiation Areas, Very High Radiation Areas, or Airborne Radiation Areas. In all other radiological areas, visitors may be present only if escorted by a qualified radiological worker and will perform no hands-on activities.

7.14 HOISTING AND RIGGING PRACTICES

All hoisting and rigging will meet the DOE contractor hoisting and rigging requirements, in PAD-ENG-0012, *Hoisting and Rigging Operations.* Hoisting and rigging equipment will not be modified such that manufacturer's specifications are invalidated.

In order to ensure that personnel are not injured or equipment is not damaged during hoisting and rigging operations, the following safe working guidelines will be utilized. These guidelines include those outlined by OSHA and the DOE Hoisting and Rigging Standard, DOE-STD-1090-2011. A competent person will be on-site during all lifting activities.

8. SAMPLING AND ANALYSIS

8.1 POSTTREATMENT SAMPLING AND ANALYSIS

Following the cessation of active remedial operations with *in situ* soil mixing with hot air/steam and ZVI injection, monitoring will be conducted to assess the near-term performance of the RA and to support the required performance assessment in the CERCLA five-year reviews.

Posttreatment sampling and analysis is intended to achieve three main goals:

1. Assessment of the heating of the subsurface,

2. Assessment of the placement of ZVI for continued VOC reduction,[2] and

3. Assessment of the success of deep soil mixing to achieve the primary project goal of reduction of VOC concentrations to the RA cleanup levels in the treated source zone.

In addition, post-treatment actions will include the installation of upper RGA wells at the perimeter of the treated source zone to monitor the progress of contaminant reduction in the RGA groundwater following soil mixing. It is expected that a reduction in the VOC contaminant concentrations in the RGA groundwater over time after the RA is indicative of supporting Goal 3.

In the area of the treated source zone, soil temperatures may be significantly elevated due to injection of steam/hot air. In addition, the soil may be inherently unstable because soil mixing will destroy soil structure and hot air/steam injection may result in decreased soil density and strength. These subsurface conditions require that the implementation of posttreatment sampling and installation of monitoring wells will be delayed by six months following the completion of soil mixing. The delay is advantageous because contaminant concentrations may remain elevated until the guar carrier for the ZVI degrades, allowing the VOC contamination to be reduced by the ZVI.

8.1.1 Soil Sampling

The RDSI for SWMU 1 included soil sampling and VOC analysis in 22 locations to determine the areal extent and depth of the source zone. These VOC analyses, along with other SWMU subsurface soil VOC analysis, provide a baseline for evaluating the effectiveness of the RA in reducing the VOC concentrations in the treated areas to the cleanup levels. The posttreatment characterization fieldwork will duplicate the collection of VOC contaminant concentrations in the UCRS soils by twinning the boring locations and collecting samples. The samples will be collected utilizing the same approach utilized in the RDSI. The project then will be able to evaluate how effective the soil mixing was as a RA for reducing the VOC contaminant concentrations in the UCRS soils. The posttreatment characterization fieldwork will include continuous logging of soil conductivity and temperature and sampling of soil borings to the total depth of mixing in 11 of the original RDSI soil boring locations (Figure 9). Eight of the soil borings will be located within the treated source zone, and 3 of the soil borings will be located on the perimeter. Four additional soil borings will be installed at contingent locations based on the data collected as a result of the soil mixing. The final soil boring locations will be assessed by the FFA parties and may be adjusted based on the results of the information collected during implementation of the remedial action. These

[2] The VOCs of interest to this remedial action are 1,1-dichloroethene; *cis*-1,2-dichloroethene; *trans*-1,2-dichloroethene; TCE; and vinyl chloride. VOC samples will be analyzed using EPA's SW-846 Method 8260.

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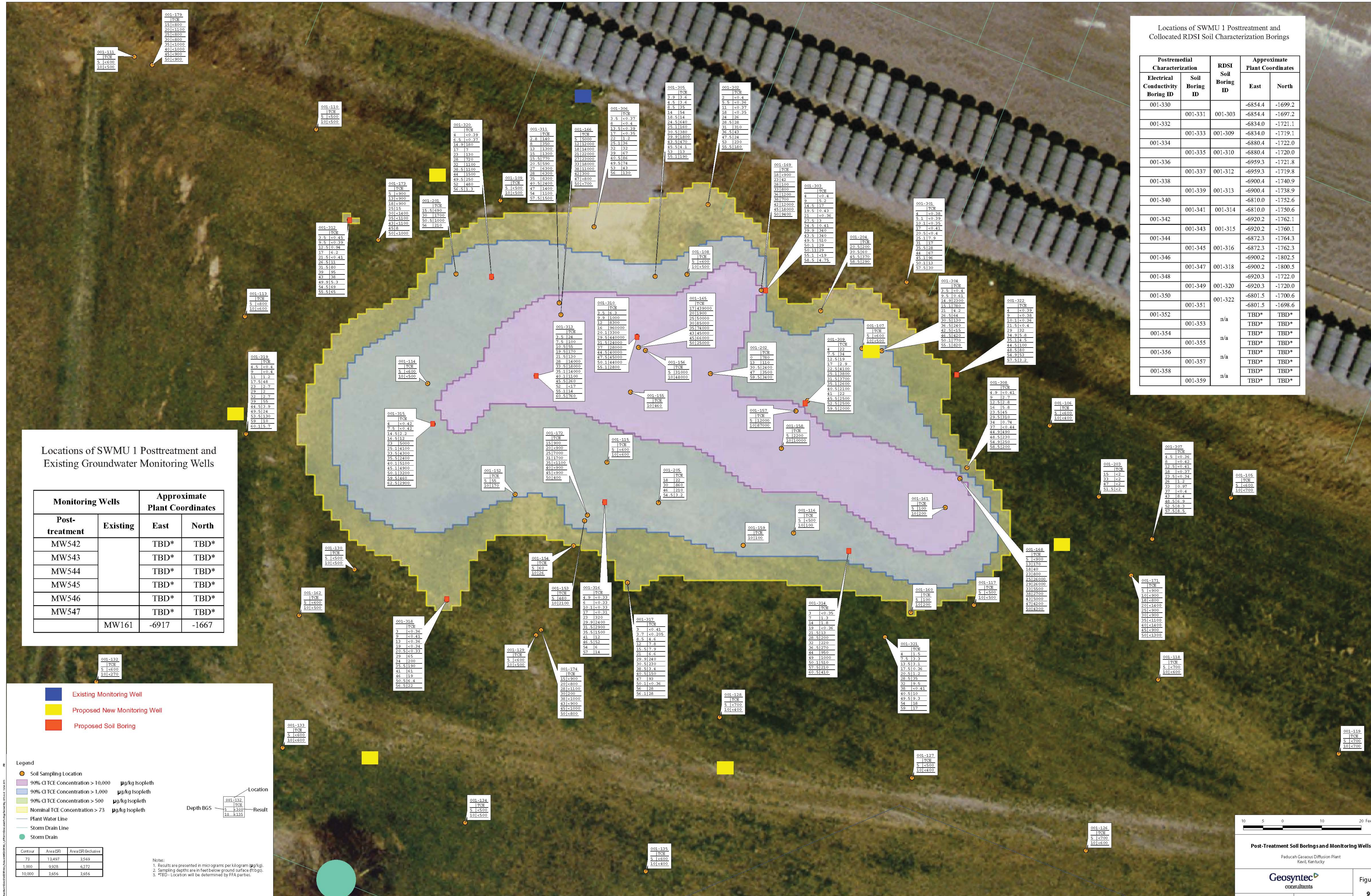

Locations of SWMU 1 Posttreatment and Existing Groundwater Monitoring Wells

Monitoring Wells		Approximate Plant Coordinates	
Post-treatment	Existing	East	North
MW542		TBD*	TBD*
MW543		TBD*	TBD*
MW544		TBD*	TBD*
MW545		TBD*	TBD*
MW546		TBD*	TBD*
MW547		TBD*	TBD*
	MW161	-6917	-1667

Locations of SWMU 1 Posttreatment and Collocated RDSI Soil Characterization Borings

Postremedial Characterization		RDSI Soil Boring ID	Approximate Plant Coordinates	
Electrical Conductivity Boring ID	Soil Boring ID		East	North
001-330			-6854.4	-1699.2
	001-331	001-303	-6854.4	-1697.2
001-332			-6834.0	-1721.1
	001-333	001-309	-6834.0	-1719.1
001-334			-6880.4	-1722.0
	001-335	001-310	-6880.4	-1720.0
001-336			-6959.3	-1721.8
	001-337	001-312	-6959.3	-1719.8
001-338			-6900.4	-1740.9
	001-339	001-313	-6900.4	-1738.9
001-340			-6810.0	-1752.6
	001-341	001-314	-6810.0	-1750.6
001-342			-6920.2	-1762.1
	001-343	001-315	-6920.2	-1760.1
001-344			-6872.3	-1764.3
	001-345	001-316	-6872.3	-1762.3
001-346			-6900.2	-1802.5
	001-347	001-318	-6900.2	-1800.5
001-348			-6920.3	-1722.0
	001-349	001-320	-6920.3	-1720.0
001-350		001-322	-6801.5	-1700.6
	001-351		-6801.5	-1698.6
001-352		n/a	TBD*	TBD*
	001-353		TBD*	TBD*
001-354		n/a	TBD*	TBD*
	001-355		TBD*	TBD*
001-356		n/a	TBD*	TBD*
	001-357		TBD*	TBD*
001-358		n/a	TBD*	TBD*
	001-359		TBD*	TBD*

Contour	Area (SF)	Area (SF) Exclusive
73	13,497	3,569
1,000	9,928	6,272
10,000	3,656	3,656

Figure 9. Postremedial Action Soil Borings and Monitoing Wells

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locations (see Table 4) are representative of both the range of VOC contamination and the areal extent of the treated source zone.

Table 4. Locations of SWMU 1 Posttreatment and Collocated RDSI Soil Characterization Borings

Postremedial Characterization		RDSI Soil Boring ID	Approximate Plant Coordinates	
Electrical Conductivity Boring ID	Soil Boring ID		East	North
001-330		001-303	-6854.4	-1699.2
	001-331		-6854.4	-1697.2
001-332		001-309	-6834.0	-1721.1
	001-333		-6834.0	-1719.1
001-334		001-310	-6880.4	-1722.0
	001-335		-6880.4	-1720.0
001-336		001-312	-6959.3	-1721.8
	001-337		-6959.3	-1719.8
001-338		001-313	-6900.4	-1740.9
	001-339		-6900.4	-1738.9
001-340		001-314	-6810.0	-1752.6
	001-341		-6810.0	-1750.6
001-342		001-315	-6920.2	-1762.1
	001-343		-6920.2	-1760.1
001-344		001-316	-6872.3	-1764.3
	001-345		-6872.3	-1762.3
001-346		001-318	-6900.2	-1802.5
	001-347		-6900.2	-1800.5
001-348		001-320	-6920.3	-1722.0
	001-349		-6920.3	-1720.0
001-350		001-322	-6801.5	-1700.6
	001-351		-6801.5	-1698.6
001-352		n/a	TBD*	TBD*
	001-353		TBD*	TBD*
001-354		n/a	TBD*	TBD*
	001-355		TBD*	TBD*
001-356		n/a	TBD*	TBD*
	001-357		TBD*	TBD*
001-358		n/a	TBD*	TBD*
	001-358		TBD*	TBD*

*Location of contingency borings will be selected based on data collected during the soil mixing operations.

A direct push technology (DPT) rig equipped with an electrical conductivity probe and a thermocouple will provide the continuous logs of electrical conductivity and temperature of the soil column throughout the depth of the treated source zone. These logs will support assessments of the vertical distribution of ZVI and the residual heat in the treated source zone.[3] The soil sampling to support the posttreatment assessment will remain consistent with the data quality objectives (DQOs) and QAPP developed for the RDSI. The DPT rig will be used to sample soils within the treated source zone and at perimeter locations, with similar methods used during the RDSI. Analyses of these soil samples will support an assessment of the reduction of VOC levels within the treated source zone and verify the distribution of ZVI.

As during the RDSI field characterization, soil samples will be collected consistent with PAD-ENR-0020, *Collection of Soil Samples with Direct Push Technology Sampling*. For this field characterization effort, the DPT rig will use a dual tube sampling system. A common sampler in use is the Dual Tube 22 sampler of Geoprobe®. The Dual Tube 22 sampler is a direct push system for collecting continuous core sample of unconsolidated materials from within a sealed casing of 2.25-inch DPT probe rods. The system collects and retrieves the samples within a liner that is threaded onto the leading end of a string of center rods. Center rods hold the liner in place as the outer casing is driven to fill the liner with soil. The inner rods then are retracted to retrieve the full liner. This system eliminates the generation of side slough in the sample and prevents cross-contamination. Thin-walled stainless steel sample tubes, with a 1.375-inch outside diameter, will be used to contain and retrieve the core samples due to elevated subsurface temperatures.

If DPT alone cannot advance a sampler to the depth of the treated source zone, small diameter hollow stem augers may be used in conjunction with the sampler system.

Continuous Electrical Conductivity and Temperature Survey: A DPT rig equipped with an electrical conductivity probe and a thermocouple will be used to continuously log the electrical conductivity and temperature of the soil column throughout the depth of the treated source zone. The conductivity/temperature log boreholes will be located 2 ft removed from planned VOC/ZVI soil sample borings (these placed at the original locations of RDSI soil borings) to allow comparison of the conductivity/temperature log to ZVI sample results. In addition to the primary goals of the electrical conductivity and temperature surveys, these logs can be used to anticipate the need for additional soil subsamples and to guide the selection of PPE for the sampling crew. The temperature log also will provide subsurface information for selecting material types for construction of the monitoring wells.

Sampling for VOC Analysis: The process for collection of soil subsamples for VOC analysis for this field investigation will be as follows:

Collection of postoperation soil samples will be performed using a DPT sample system. The DPT soil sample cores will be collected in stainless steel liners. Postoperation soil sampling will be performed in accordance with procedure PAD-ENR-0020, *Collection of Soil Samples with Direct Push Technology Sampling*, with the additional steps that follow. The following steps for high temperature soil sampling will be used to supplement contractor sampling procedures. Because the areas to be drilled will have been steamed during the soil mixing process, the subsurface soils will be hot and will require special health and safety handling, as required in Exhibit G. The soil samples in stainless steel liners also will require special handling, as discussed below, due to the volatile nature of the contamination.

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[3] ZVI is significantly more electrically conductive than native soil. Any significant inhomogeneity of ZVI distribution will be apparent on the electrical conductivity log.

- The field crew will cap and seal the ends of the stainless steel liners and submerge them in an ice bath to lower the soil temperature and minimize the off-gassing of VOCs.
- The stainless steel liner will be removed from the bath, and the samplers will remove the end seals, extrude the core, and collect the sample following contractor sampling procedures.
- If the DPT system is not able to complete the postoperation sampling to the required depth, then appropriate drilling techniques, such as hollow stem auger, will be deployed for collection of these soil samples in accordance with PAD-ENM-2300, *Collection of Soil Samples*.
- The field crew will collect one sample for laboratory analysis from each 5-ft depth interval (plus QC samples). Twelve samples will be collected for each 60-ft deep boring. The drillers will use a Macro Core sample, or similar system, equipped with a series of 6-inch length, stainless steel liners, to retrieve the combined 5-ft core.
- Upon cooling all sample liners for a 5-ft interval for 30 minutes, the field crew will scan inside the bottom end of each 6-inch sample with a ppbRAE 3000 or equivalent PID to identify the sample with highest VOC levels from the 5-ft interval for subsampling for laboratory analysis. The field crew will extrude the core identified by the screening step and immediately subsample the mid-length of the 6-inch core using an Encore sampler, while measuring and determining field PID scanning points to represent 0.5 ft depth increments of the soil core.[4]
- Where the highest PID response is detected, a soil subsample will be collected for VOC analysis using an En Core® sampler. As directed by the sample team leader, additional soil samples for VOC analysis may be collected to bracket an interval of elevated PID response.
- If no elevated PID response is measured, the soil subsample will be collected based on observations of greater sand content, if present and apparent. If no sandy zones are obvious, the soil subsample for VOC analysis will be collected from the middle point of the length of the soil core.

If subsurface temperatures allow the use of polyvinyl chloride (PVC) core liners, the following steps will be used in collecting the individual macro-cores for laboratory analysis.

- Scan the soil core with the field PID by inserting a clean awl through the PVC core liner and into the soil, creating a small void in the soil core, at each 0.5 ft depth increment and immediately scanning the soil core with a PID (using a water separator on the PID sample tube) at each 0.5-ft point of access. Record each PID reading in a field logbook. The field PID measurements will be used to identify sections of the soil core containing higher VOC levels (if present) for subsampling with an En Core® sampler.
- Cut open the soil core liner. Perform a radiological scan of the soil core if required by the field radiological technician to ensure the safety of the field sample crew.

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[4] Although the soil core will be collected in 5 ft depth increments, the retrieved core may be longer or shorter than 5.0 ft, depending upon swelling, compaction, or loss of soil core. Where swelling or compaction accounts for a discrepancy in the core length, the sample points will be adjusted to represent 0.5 ft depth intervals in the subsurface. Where it is apparent that soil has been lost in the sampling process, the samplers will note the lost core interval in the field logbooks and identify the sample locations to represent the remaining 0.5 ft depth intervals in the subsurface.

- Where the highest PID response is detected, collect a soil subsample for VOC analysis using an En Core® sampler. As directed by the sample team leader, additional soil samples for VOC analysis may be collected to bracket an interval of elevated PID response.

- If no elevated PID response is measured, collect the soil subsample based on observations of greater sand content, if present and apparent. If no sandy zones are obvious, collect the soil subsample for VOC analysis from the middle point of the length of the soil core.

Sampling and Analysis for ZVI Content: After the field sample crew collects the subsample(s) for VOC analysis in each 5-ft interval of soil, an additional sample will be collected from the soil core adjacent to the depth of the VOC sample(s) for a qualitative measurement of weight percent ZVI (not corrected for moisture content). Each of these samples will consist of a 0.33-ft length of soil core that will be containerized in a separate, sealed plastic bag until analysis.

For the analysis, each sample will be weighed on a portable laboratory scale and the weight recorded in a project logbook. Sample preparation will consist of placing the sample (each with an approximate volume of 0.1 liters) along with approximately 0.3 liters of potable water in a 0.5-liter, sealed, wide-mouth plastic sample jar and shook vigorously to disassociate the soil sample. A strong magnet placed on the top of the bottle will be used to separate the ZVI content from the soil slurry and the mass of the ZVI will be weighed on the portable laboratory scale; the weight will be recorded in the project logbook. The weight percent ZVI (as a decimal fraction) for each sample will be determined by dividing the initial mass of the soil sample by the weight of the ZVI.

8.1.2 Monitoring Well Construction and Sampling

Placement and Construction of RGA Monitoring Wells: MW161 is a RGA monitoring well located immediately downgradient of the treated source zone, screened over the interval 78–83 ft bgs (elevation 289 to 294 ft amsl). (The HU5 gravel interval of the RGA extends over the approximate elevations of 270 to 310 ft amsl.) Previous sampling and analysis of MW161 documents TCE levels between 1,000 and 2,000 µg/L since 2005. This RA is expected to reduce the transport of dissolved VOCs to the RGA and to result in declining TCE levels in MW161.

To provide for a broader and continuing assessment of future dissolved VOC levels in the area of the treated source zone, six monitoring wells will be installed in the top of the HU5 gravel interval of the RGA as part of the posttreatment field sampling efforts (two upgradient of the treated source zone and two downgradient) (Figure 9). Table 5 provides the geographic location for the monitoring wells to be installed. FFA parties will convene prior to monitoring well installation and review data collected from the soil mixing operations and will reach a consensus on the monitoring well placement strategy. The six monitoring wells will be constructed of 4-inch PVC with 5-ft length screen (screened approximately 65–70 ft below the original average soil grade; well screen elevations of 302.5 to 307.5 ft amsl). Screen levels will be selected by the field geologist based on subsurface conditions and the lithologic cores collected from the well location. Temperature probe results obtained from soil borings, as discussed in Section 8.1.1, Soil Sampling, will provide subsurface temperature information to determine whether PVC is a viable well construction material or stainless steel will be needed. Each of these wells will be equipped with dedicated sampling pumps. Trends in dissolved VOC levels in MW161 and the six wells to be installed will be criteria for future assessment of this SWMU 1 RA until cleanup levels are met in the UCRS soils. The design drawings for the monitoring wells are provided in Appendix A.

Sampling Analysis and Schedule: The RDSI for SWMU 1 included groundwater sampling and analysis in MW161 to assess preremediation VOC levels and indicators of VOC biodegradation activity. The focus of near-term monitoring as part of the posttreatment action will be to assess the decline in dissolved

VOC levels directly resulting from soil mixing and the degradation of VOCs associated with the injection of steam/hot air and ZVI. Groundwater sampling to support the posttreatment assessment will remain consistent with the DQOs and QAPP developed for the RDSI. Groundwater samples will be collected in compliance with PAD-ENM-2101, *Groundwater Sampling*. An assessment of the level of biodegradation activity may be of interest in the future if follow-on RA is required.

Table 5. Locations of SWMU 1 Posttreatment and Existing Groundwater Monitoring Wells

Monitoring Wells		**Approximate Plant Coordinates**	
Posttreatment	**Existing**	**East**	**North**
MW542		TBD*	TBD*
MW543		TBD*	TBD*
MW544		TBD*	TBD*
MW545		TBD*	TBD*
MW546		TBD*	TBD*
MW547		TBD*	TBD*
	MW161	-6917	-1667

*TBD; location will be determined by FFA parties.

To assess the potential near-term decline in VOC levels in the monitoring wells, groundwater samples will be collected for VOC analysis on a quarterly basis for a one-year term following construction of the monitoring wells and will be collected semiannually during the second year. Subsequent sampling frequencies and requirements of the SWMU 1 monitoring wells will be incorporated into the EMP as agreed to by the FFA parties for the SWMU 1 CERCLA selected remedy. Groundwater samples will be obtained from the monitoring wells that will be installed following the soil mixing and from existing wells. The monitoring wells will provide a means for determining the level of the removal of UCRS soil VOC contaminant source will have on the RGA groundwater in the area of the SWMU 1.

8.2 OPERATION AND MAINTENANCE SAMPLING

Throughout the treatment system start-up, testing, and routine operation, vapor and water samples will be collected and analyzed to assess the progress of the interim RA, to monitor the aboveground treatment system effectiveness, and to verify compliance with discharge criteria.

To assess the progress of the RA, vapor samples will be collected from sample ports located within the treatment system. Vapor samples will be collected periodically from various points in the vapor treatment stream to monitor the effectiveness of the treatment units. Water samples also will be collected from various sample ports throughout the water treatment system in order to monitor the operational effectiveness of the treatment system. The sample locations, analytes, and sampling frequency are discussed in the Section 6 of the RDR.

8.3 WASTE CHARACTERIZATION SAMPLING AND ANALYSIS PLAN

Wastes generated from sites designated as potentially contaminated will be characterized to classify the waste for proper handling, recordkeeping, transfer, storage, and disposal. Waste analyses will be performed using the EPA-approved procedures, as applicable. Analyses required for hazardous waste classification will reference EPA SW-846 or other EPA-approved methods, as required. Wastewater analyses will reference the applicable analytical requirements in PGDP's Kentucky Pollutant Discharge Elimination System (KPDES) permit, Clean Water Act, or Safe Drinking Water Act. QA/QC requirements and data management requirements, as specified in Sections 9 and 10 and the appendix of this document, will be followed for waste characterization sampling activities.

Characterization requirements and guidance are provided in the site waste acceptance criteria (WAC) and PAD-WD-0437, *Waste Characterization and Profiling*. Section 8.3.2 lists the analytical testing methods that will be used for analysis. The evaluation of the analytical results is discussed in Sections 9 and 10. The WMC will coordinate with the DOE prime contractor GWOU project manager and DOE contractor sample and data management group for required analyses and guidance on collection and transfer of characterization samples to a Sample Management Office (SMO)-approved fixed-base laboratory that has been audited under the DOE Consolidated Audit Program (DOECAP).

8.3.1 Contained-In/Contaminated-With Determinations

Some of the waste debris, other than PPE, and environmental media, such as soil and groundwater, generated during this project will be characterized and the results compared to health-based standards to determine whether any concentrations of TCE and 1,1,1-trichloroethane (TCA) are above health-based levels listed in Table 6. If the concentrations are below health-based levels, then the waste will be deemed not to contain or not to be contaminated with a Resource Conservation and Recovery Act (RCRA)-listed waste (based on TCE/TCA content) for the purposes of management at the site.

Table 6. Health-Based Levels for TCE and 1,1,1-TCA

Constituent	Concentration in Solids (ppm)	Concentration in Aqueous Liquids [parts per billion (ppb)]
TCE	39.2	30
1,1,1-TCA	2,080	If aqueous liquids are below health-based level for TCE, then 1,1,1-TCA is declared below contained-in levels.

Because data from previous sampling events indicate that conditions for C-746-U Landfill disposal potentially will be met, characterization for C-746-U Landfill disposal will be undertaken at the same time as the sampling for the RA constituents. Land disposal restrictions (LDRs) generally apply to media and debris generated from this project that no longer contain or are no longer contaminated with RCRA hazardous waste. If a contained in determination is made, the LDR is satisfied.

Health-based standards of 39.2 parts per million (ppm) TCE and 2,080 ppm 1,1,1-TCA in solids will be used as the criteria for making contained-in/contaminated-with determinations for environmental media and debris designated for disposal at the C-746-U Landfill. Solid wastes disposed of at landfills other than C-746-U will be subject to a contained-in/contaminated-with determination that will be approved by the Commonwealth of Kentucky and the state in which the receiving landfill is located. The Kentucky Department for Environmental Protection (KDEP) has agreed to consult with DOE and the state where the off-site facility is located to reach agreement on the appropriate health-based standard for making such determinations for waste that is to be shipped to such a facility.

Groundwater and any related aqueous wastes generated from well sampling, well development, and well purging shall be excluded from the definition of hazardous waste at the point of generation, if the TCE concentrations are below 1 ppm and the 1,1,1-TCA concentrations are below 25 ppm, provided that the subject aqueous waste will be further treated in an on-site wastewater treatment unit and discharged through a PGDP KPDES-permitted outfall consistent with 401 *KAR* 31:010 § 3. Other aqueous environmental media waste contaminated with TCE or 1,1,1-TCA that do not qualify for the exemption cited herein will use a health-based concentration of 0.030 ppm as the criterion for making contained-in determinations for media destined for on-site treatment and discharge through a KPDES-permitted outfall. This self-implementing waste characterization and RCRA status determination will be used to decide on treatment requirements, if applicable, and the appropriate waste disposal facility for the waste. Aqueous waste (including, but not limited to, well sampling, well development, well purging, and decontamination waters) that has undergone wastewater treatment and meets the KPDES discharge limits shall be considered to "no longer contain" listed hazardous waste (i.e., TCE). This treated wastewater may be discharged directly to permitted KPDES outfalls or on-site ditches that flow to permitted KPDES outfalls.

In lieu of providing notification to KDEP, as set forth in paragraph 63 of the October 3, 2003, *Agreed Order* (KNREPC 2003) (a procedural requirement), the contained-in/contaminated-with determination and supporting data will be documented in the post-ROD file and will be made available upon request.

8.3.2 Waste Characterization

Waste characterization sampling will be performed in accordance with procedure PAD-WD-0437, *Waste Characterization and Profiling.* Based on sample analyses, existing data, or process knowledge, the waste may be classified into one of the following categories:

- RCRA-listed hazardous waste
- RCRA characteristic hazardous waste
- Polychlorinated biphenyl (PCB) waste
- Transuranic (TRU) waste
- Low-level waste (LLW)
- Mixed waste or
- Nonhazardous solid waste

Tables 7, 8, 9, and 10 list the analytical testing methods that will be used for analysis.

Table 7. TCLP Parameters for Analysis of Solid Waste

Constituent	Method	TCLP Regulatory Limit (mg/L)	20 Times TCLP Regulatory Limit (mg/kg)
1,1-Dichloroethene	8240/8260	0.7	14
1,2-Dichloroethane	8240/8260	0.5	10
Arsenic	7060/6010/6020	5.0	100
Barium	6010/6020	100.0	2,000
Benzene	8240/8260	0.5	10
Cadmium	6010/6020	1.0	20
Carbon tetrachloride	8240/8260	0.5	10
Chlorobenzene	8240/8260	100.0	2,000
Chloroform	8240/8260	6.0	120
Chromium	6010/6020	5.0	100
Lead	7421/6010/6020	5.0	100
Mercury	7470/6020	0.2	4
Methylethylketone	8240/8260	200.0	4,000
Selenium	7740/6010/6020	1.0	20
Silver	6010/6020	5.0	100
Tetrachloroethene	8240/8260	0.7	14
Trichloroethene	8240/8260	0.5	10
Vinyl chloride	8240/8260	0.2	4

Table 8. Analytical Parameters for Classification of Solid Waste as TRU, LLW, or PCB Wastes

Constituent	Detection limit	Method
Total uranium	150 pCi/g	ICP/Mass Spectroscopy
Neptunium-237	3 pCi/g	Alpha Spectroscopy
Plutonium-239/240	3 pCi/g	Alpha Spectroscopy
Plutonium-238	3 pCi/g	Alpha Spectroscopy
Thorium-230/232	5 pCi/g	Alpha Spectroscopy
Technetium-99	500 pCi/g	Liquid Scintillation Counting
Cesium-137	5 pCi/g	Gamma Spectroscopy
PCB	0.1 mg/kg	8082

Table 9. Waste Characterization Requirements for Solid Waste

Constituent	Method
TCLP VOCs	SW-846 1311, 8260
TCLP metals	SW-846 1311, 6010/7470
Toluene	8260

Table 10. KPDES Characterization Requirements for Decontamination, Development, and Purge Water

Analyte Parameter[a]	Discharge Limit, Daily Maximum
Discharge Temperature, °F	Report
Oil and Grease, mg/L	15
Total Residual Chlorine, mg/L	Report
Total Phosphorous, mg/L	1.0
Polychlorinated Biphenyls, µg/L	Report
Trichloroethylene, mg/L	Report
Hardness, mg/L ($CaCO_3$)	Report
Total Recoverable Metals[b]	Report
Total Uranium, mg/L	Report
Technetium-99, ρCi/L	Report
pH, standard units	6–9

[a] No discharge of floating solids or visible foam or sheen in other than trace amounts.
[b] Total recoverable metals: antimony, arsenic, beryllium, cadmium, chromium, copper, iron, lead, nickel, calcium, silver, uranium, zinc, and mercury.
Source: KPDES Permit Number KY0102083

8.3.2.1 RCRA-listed hazardous waste

Based on process knowledge and existing historical sample data, the generation of RCRA-listed hazardous waste is expected on this project. The waste is listed-hazardous due to the presence of TCE in the RGA underlying the majority of the area in which the soil borings and wells are to be installed. Waste generated during soil borings (i.e., drilling cuttings, purge water, sample residuals) will be classified as RCRA-listed hazardous wastes with waste codes F001, F002, and U228 if analytical results for the associated soil samples and water samples are above the health-based levels discussed in Table 6. If the concentrations are below the levels contained in Table 6, then the waste will be deemed not to contain or not to be contaminated-with a RCRA listed waste (based on TCE/TCA content) for the purposes of on-site management. If the WAC is met, the waste will be properly disposed of in the C-746-U Landfill.

An aboveground treatment system will be utilized to treat groundwater extracted during operation of the soil mixing process. The treatment system will remove VOCs and, as necessary, Tc-99 from the groundwater. Treated groundwater will be containerized and sampled prior to discharge to an on-site ditch, which drains to KPDES-permitted outfall, such as Outfall 008 or 015.

Aqueous waste (including, but not limited to, well sampling, well development, well purging, and decontamination waters) that has undergone wastewater treatment and meets the KPDES discharge limits shall be considered to "no longer contain" listed hazardous waste (i.e., TCE). This treated wastewater may be directly discharged to permitted KPDES outfalls or on-site ditches that flow to permitted KPDES outfalls.

8.3.2.2 RCRA-characteristic hazardous waste

Based on process knowledge and existing historical sample data, the generation of RCRA characteristic-hazardous waste is possible during this RA. Any waste determined to be RCRA characteristic-hazardous waste will be treated in the same manner as RCRA listed-hazardous waste for storage and disposal requirements.

8.3.2.3 PCB wastes

If waste characterization analyses or additional process knowledge indicates the presence of PCBs in concentrations regulated under 40 *CFR* Part 761, then the wastes will be managed, transported, and disposed of in accordance with the requirement under that Part.

8.3.2.4 TRU wastes

TRU wastes are those that are contaminated with elements that have an atomic number greater than 92, including neptunium, plutonium, americium, and curium that are in concentrations greater than 100 nCi/g. Although it is possible that TRU elements may be detected in characterization samples collected on this project, it is unlikely that any of the waste generated will be at or above the TRU threshold limit.

8.3.2.5 LLW

LLWs are described as any nonhazardous, non-PCB, and are not classified as high-level waste, TRU waste, spent nuclear fuel, or by-product material. LLW may be generated from materials removed from the Radiological Areas. All wastes from this project have the potential to be classified as LLW.

8.3.2.6 Mixed wastes

Mixed waste contains both hazardous waste and source, special nuclear, or by-product material subject to the Atomic Energy Act of 1954. The generation of mixed waste is possible on this project.

8.3.2.7 Nonhazardous wastes

Waste that does not meet the classification requirements of RCRA hazardous wastes, PCB wastes, LLW, TRU waste, or mixed wastes will be classified as nonhazardous solid waste.

8.3.3 Sampling and Analysis of Waste

The WMC will be responsible for sampling the solid and liquid waste as needed. During sampling, all appropriate health and safety concerns will be addressed. All samples will be screened for radioactivity based on the RWP and appropriate actions taken to prevent the spread of contamination. Sample materials from different containers will not be mixed unless they are from the same waste stream, and only containers requiring further characterization will be sampled. Samples will be assigned a unique identifier. The following text summarizes the waste characterization requirements.

For solid wastes, the "20 times" rule will be used in accordance with *Use of Total Waste Analysis in Toxicity Characteristic Determinations*, EPA 540/R-94-005a (EPA 1994), to determine if the waste is characteristically hazardous. That is, if the total concentrations of RCRA constituents are less than 20 times the Toxicity Characteristic Leaching Procedure (TCLP) limits in 40 *CFR* § 261.24, then the waste will be considered not to be characteristically hazardous. Where the total concentrations of RCRA constituents are greater than 20 times the TCLP limits, TCLP analyses will be performed to confirm the result.

The performance of the remedial action is expected to generate a number of different waste streams including aqueous wastes and solid wastes. Shown below are the estimated waste quantities expected to be generated and the estimated waste samples expected to be taken from the specified waste streams:

- Vapor phase carbon — 375 ft^3 (3)
- Liquid phase carbon — 190 ft^3 (1)
- Excavated waste soil — 5,000 ft^3 (4)
- Ion exchange resins — 50 ft^3 (2)
- Drill cuttings — 121 ft^3 (1)
- Decontamination wastewater — 34,000 gal (4)
- Well development water — 6,000 gal (1)
- Guar gum and ZVI mixtures (waste) — 60 ft^3 (1)
- Sample residuals — 33 ft^3 (0)
- Personnel protective equipment — 160 ft^3 (0)
- Noncontaminated debris and construction waste — 540 ft^3 (0)
- Treated water from system — 1.5 million gal (75)

Additional analyses to meet off-site disposal WAC also may be required and will be specified upon selection of the disposal site.

8.3.3.1 Aqueous Waste

An aboveground treatment system will be utilized to treat groundwater extracted during operation of the soil mixing process. The treatment system will remove VOCs and, as necessary, Tc-99 from the groundwater. Treated groundwater will be containerized and sampled prior to discharge to an on-site ditch, which drains to a KPDES-permitted outfall, such as Outfall 008 or 015. Aqueous waste (including, but not limited to, well sampling, well development, well purging, and decontamination waters) that has undergone wastewater treatment and meets the KPDES discharge limits shall be considered to "no longer contain" listed hazardous waste (i.e., TCE). This treated wastewater may be discharged directly to permitted KPDES outfalls or on-site ditches that flow to permitted KPDES outfalls.

8.3.4 Waste Water Treatment

Water from the decontamination of drilling equipment will be collected and stored as CERCLA waste. Decontamination waters that has undergone wastewater treatment and meets the KPDES discharge limits shall be considered to "no longer contain" listed hazardous waste (i.e., TCE). This treated wastewater may be discharged directly to permitted KPDES outfalls or on-site ditches that flow to permitted KPDES outfalls.

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9. QUALITY ASSURANCE PLAN

A QAPP for implementing the *In Situ* Source Treatment Using Deep Soil Mixing and the associated posttreatment sampling and analysis for the SWMU 1/Oil Landfarm RA, based on guidelines in *Uniform Federal Policy for Quality Assurance Project Plans,* is presented in Appendix B.

The governing QA documents for this RA include, but are not limited to the QAPP and the *Quality Assurance Program and Implementation Plan for the Paducah Environmental Remediation Project*, PAD-PLA-QM-001 (QAPIP) (LATA Kentucky 2011).

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10. DATA MANAGEMENT AND IMPLEMENTATION PLAN

10.1 INTRODUCTION

The purpose of this DMIP is to identify and document data management requirements, applicable procedures, expected data types and information flow, and roles and responsibilities for data management activities associated with the *In Situ* Treatment Using Deep Soil Mixing with Interim LUCs during remedial design, implementation, and operation of the treatment system. Data management provides a system for efficiently generating and maintaining technically and legally defensible data that provide the basis for making sound decisions regarding environmental and waste characterization at PGDP.

Data types to be managed for the project include field data and analytical data. Historical data is downloaded from Paducah OREIS, if available. Field data are collected in field logbooks or field data forms and are entered into Paducah Project Environmental Measurements System (PEMS), as appropriate, for storage. Analytical data are planned and managed through Paducah PEMS and transferred to Paducah OREIS for long-term storage and reporting. Radiological survey results are stored and reported separately from Paducah PEMS and Paducah OREIS. In addition to the above, during the soil mixing process, real-time operational process data is collected. This data provides a means for determining the quantity of contaminants being removed by the system and their depth location, modifying operational parameters, and assisting in determining ZVI dosing rates to be included. Subsurface temperatures at depth are also recorded to assist in making sure that target subsurface temperatures are met.

To meet current regulatory requirements for DOE environmental management projects, complete documentation of the information flow must be established. Each phase of the environmental data management process (planning, collection, analysis, management, verification/validation, assessment, reporting, consolidation, and archival) must be planned and documented appropriately. The project team and the sample and data management organization are responsible for data collection and data management for this project.

The scope of the DMIP is limited to environmental information collected during the design, implementation, and operation of the treatment system. This information includes electronic and/or hard copy records that describe environmental processes or conditions. Information generated by the project (e.g., analytical results from samples collected) and obtained from sources outside the project (e.g., historical data) falls within the scope of this DMIP. Certain types of information, such as personnel or financial records, are outside the scope of this DMIP.

10.1.1 Project Mission

The mission of the SWMU 1 RA is the reduction of the VOC source (TCE and breakdown products) in the UCRS subsurface soils at the Oil Landfarm/SWMU 1 source area through soil mixing with LDAs with steam injection and placement of ZVI down to an estimated 60 ft bgs. As part of the SWMU 1 RA, two distinct phases of sampling and analysis will occur: operational and postoperational. Baseline sampling and analysis, which is typically a third phase, was performed previously as part of the RDSI. Operational sampling and analysis will be used to measure progress and to determine what effects are occurring to the subsurface contaminants by the RA and will help identify the mixing rate and ZVI dosing concentration. Results from post-operational sampling and analysis will be compared to baseline results to determine the reduction in VOC levels in the treatment area and the degree to which RA goals have been achieved.

Specific activities involving data include, but are not limited to, collecting environmental and waste samples; storing, analyzing, and, if necessary, shipping samples; collecting operational and maintenance data; and evaluating, verifying, validating, assessing, and reporting analytical results.

10.2 DATA MANAGEMENT ACTIVITIES

Data management for the RA will be implemented throughout the life cycle of environmental measurements and waste characterization data. This life cycle occurs from the planning of data, through the collection, review, use of the data for decision making purposes and the long-term storage of data. The following sections contain a detailed description of these data management activities:

- Acquire existing data;
- Plan data collection;
- Prepare for field activities;
- Collect field data;
- Process field data;
- Collect field samples;
- Submit samples for analysis;
- Process laboratory analytical data;
- Review data;
- Verify data;
- Coordinate and perform data validation;
- Assess data;
- Consolidate, analyze, and use data and records; and
- Submit data to the Paducah OREIS.

10.2.1 Acquire Existing Data

The primary background data to be used for this project consist primarily of analytical data. All available historical data pertaining to the area included in the SWMU 1 RA will be downloaded from Paducah OREIS and utilized as necessary.

10.2.2 Plan Data Collection

Other sections and subsections in this RAWP provide additional information for the tasks of project environmental data collection, including the posttreatment sampling plan, HASP, the QAPP, and the WMP. In addition, a laboratory SOW will be developed in accordance with PAD-ENM-5004, *Sample Tracking, Lab Coordination, and Sample Handling*, following approval of this work plan.

10.2.3 Prepare for Field Activities

The data management tasks involved in field preparation activities, as specified in PAD-ENM-5004, *Sample Tracking, Lab Coordination, and Sample Handling*, include identifying all sampling locations and preparing descriptions of these stations, developing summaries of all the samples and analyses to be conducted at each sampling location, developing field forms for capturing field data, coordinating sample shipment/delivery with off-site laboratories, and coordinating screening analyses with designated laboratories. The data management team will conduct these activities in accordance with PAD-ENM-5007, *Data Management Coordination*. The site superintendent and the data management team will coordinate data management activities with field sampling activities.

Before the start of field sampling, the data management team will specify and provide the contents of sample kits, which will include sample containers, labels, preservatives, chain-of-custody records, and any necessary sampling data forms. Samples will be collected according to contractor-approved procedures. Logbooks, sample labels, and chain-of-custody will be completed according to PAD-ENM-2708, *Chain-of-Custody Forms, Field Sample Logs*, *Sample Labels*, *and Custody Seals*. A comprehensive sampling list will be developed and used as the basis for finalizing the sample containers to do the following:

- Be used for sample collection;
- Order sufficient amount of containers and other supplies; and
- Verify the numbers of samples presented in the laboratory scope of work.

As a result of the type of remediation, there are real-time process field samples that will be collected during operations. These samples will be collected periodically by the process equipment and analyzed by field analytical equipment that is internal and external to the soil mixing process. The measurement of these samples and readings will be performed by field instruments that require periodic calibration consistent with the manufacturer's direction.

10.2.4 Collect Field Data

Field data will be collected, documented, and maintained according to the sampling and analysis plans (SAPs) contained within this document and in the approved RDR and contractor-approved procedures.

10.2.5 Process Field Data

Field measurements will be recorded on appropriate field forms or in field data compilers. These forms will be checked against the field logbooks, and the data will be manually entered into Paducah PEMS using approved procedures.

Paducah PEMS is used to identify, track, and monitor each sample and associated data from the point of collection through final data reporting. Project documentation includes field logbooks, chain-of-custody records, and hard copy analytical results.

Data management requirements for field logbooks and field forms specify that (1) sampling documentation must be controlled from initial preparation to completion, (2) sampling documentation generated must be maintained in a project file, and (3) modifying planned activities and deviating from procedures will be recorded.

This data will be provided in a format specified by the sample/data management manager. Once this data has been loaded to Paducah PEMS, it will be compared to the original files submitted by the project to ensure that it was loaded correctly.

10.2.6 Collect Field Samples

Personnel collecting samples for the project will record pertinent sampling information on the chain-of-custody, along with maintaining a field logbook. The data management team will manually enter information from the chain-of-custody forms and field forms into Paducah PEMS. Sampling locations will be surveyed using a Global Positioning System (or other appropriate methods), which will have at least sub-meter accuracy. Sample coordinates will be transferred to the PGDP coordinate system.

10.2.7 Real-Time Process Sampling and Analysis

Process field samples and monitoring data will be collected during soil mixing operations. These samples are collected from a continuous stream of extracted gas from the subsurface during mixing operations. This process sampling includes real-time analysis of the vapor extraction rate, VOC and degradation concentrations in vapor extraction, and real-time temperature in the vacuum shroud. These extraction rates are compared against quantities of material being injected into the mixing process. The gas streams are then measured by a series of equipment including photoionization and flame ionization detectors and gas chromatograph. These measurements are taken throughout the soil mixing operation, and the results are monitored by operators for determining the need for changes to the mixing process. The results also are recorded in a Microsoft Excel format for use later. Additional discussion of the process sampling and analysis is contained in Section 4.2, Critical Parameters, and 4.4.1.7, Real-time data collection and monitoring system sections of the D2/R1 RDR document.

10.2.8 Submit Samples for Analysis

Before the start of field sampling, the data management team will coordinate the delivery of samples, and the receipt of results with the SMO contract laboratories, according to PAD-ENM-5004, *Sample Tracking, Lab Coordination, and Sample Handling*. The data management team will present a general sampling schedule to the off-site laboratories. The receipt of sample shipments and containers will be coordinated with the laboratories, and any requirements for laboratory permission to ship will be met. The data management team will ensure that hard copy deliverables and electronic data deliverables (EDDs) from the laboratories contain the appropriate information and are in the correct formats.

10.2.9 Process Laboratory Analytical Data

Data packages and EDDs received from the laboratory will be tracked, reviewed, and maintained in a secure environment. Paducah PEMS will be used for tracking project-generated data from point of collection through final data reporting. The data management team is responsible for these tasks. The following information will be tracked, as applicable:

- Sample delivery group number,
- Date received,
- Number of samples,
- Sample analyses,
- Receipt of EDD, and
- Comments.

The data management team will compare the contents of the data package with the chain-of-custody form and identify discrepancies. Discrepancies will be reported immediately to the laboratory and the sample/data coordinator. Copies of the Form I's from the data package will be distributed as necessary.

The laboratory EDDs are checked as specified in PAD-ENM-5007, *Data Management Coordination*. To evaluate their quality, the first two EDDs from each laboratory will be 100% checked against the hard copy data packages. After the first two EDDs from each laboratory are checked, every fifth EDD will be 100% checked. The results from the EDD will be checked, as will the format of all fields provided. The data management team will report immediately any discrepancies to the sample/data coordinator, so that the laboratory can be notified and EDDs can be corrected.

10.2.10 Review Data

The data management team will review the contents of the data package to ensure all necessary information is present and consistent with expectations. Reviewing data includes laboratory contractual screening, the process of evaluating a set of data against the requirements specified in the analytical SOW to ensure that all requested information is received. The contractual screening includes, but is not limited to, the analytes requested, methods used, EDDs, units, holding times, and reporting limits achieved. Contractual screening is performed for 100% of the data. The sample/data coordinator primarily is responsible for the contractual screening upon receipt of data from the analytical laboratory according to PAD-ENM-5003, *Quality Assured Data.*

Real-time process data is reviewed by the system operator through the data acquisition system. The real-time data collected will be shared with the project team on a weekly basis.

10.2.11 Verify Data

Verifying data is the process for comparing a data set against a set standard or contractual requirement. Verification is performed by the sample and data management organization electronically, manually, or by a combination of both, according to PAD-ENM-5003, *Quality Assured Data*. Verification is performed for 100% of data. Data verification includes contractual screening defined above and criteria specific to the RA. Verification qualifiers may be applied to the data based on holding time exceedance, criteria exceedance, historical exceedance, or background exceedance. Verification qualifiers are stored in Paducah PEMS and transferred with the data to Paducah OREIS. Additional information relating to data verification is included in the QAPIP.

10.2.12 Coordinate and Perform Data Validation

The data management team is responsible for coordinating data validation and for implementation of validation through the appropriate data validation procedures. Data validation is the process performed by a third-party, qualified individual. Third party validation is defined as validation performed by persons independent from sampling, laboratory, and decision making for the program/project (i.e., not the program/project manager). Data validation evaluates the laboratory adherence to analytical-method requirements and applies only to definitive data. Data validation is managed and coordinated with the sample and data management organization. Data validation is documented in a formal deliverable from the data validator. Data validation will be performed on 100% of the selected data packages. Validation will be performed on a minimum of 10% of the environmental data collected. Validators not associated with the project will perform validation following contractor-approved procedures. A validation SOW is generated specifying the requirements for the validation of the data. Validation problems must be identified and appropriately resolved. Qualifiers and reason codes may be assigned to the data to indicate usability concerns. Validation qualifiers are input and stored in Paducah PEMS and transferred with the data to Paducah OREIS.

10.2.13 Assess Data

Data assessment will be conducted and documented by a technical reviewer in conjunction with other project team members, according to PAD-ENM-5003, *Quality Assured Data*. Data assessment follows data verification and data validation (if applicable) and must be performed at a rate of 100% to ensure data are useable. The data review process determines whether a set of data satisfies the data requirements defined in the project-scoping phase and assures that the type, quality, and quantity of data are appropriate for their intended use. It allows for the determination that a decision (or estimate) can be made with the desired level of confidence, given the quality of the data set. This process involves the integration and evaluation of all information associated with a result.

Data review consists of an evaluation of the following: data authenticity, data integrity, data usability, outliers, and PARCCS parameters. Additional requirements for data assessment and review are included in the QAPIP. Assessment qualifiers are stored in Paducah PEMS and transferred with the data to Paducah OREIS. Any problems found during the review process are resolved and documented in the data assessment package. Data are made available for reporting upon completion of the data assessment, and associated documentation is stored with the project files.

10.2.14 Consolidate, Analyze, and Use Data and Records

The data consolidation process consists of the activities necessary to prepare the evaluated data for the users. The project team will evaluate the field and analytical data from the environmental and waste samples in support of operational decision making and to characterize the project waste before disposal. The data will be stored in the Paducah OREIS database for future use.

Project reports are generated for the purpose of evaluating the data for the project. These reports include the status of the sampling event, reports of data compared to various criteria, and reports of the complete set of data. Data analysis will be documented in sufficient detail to allow re-creation of the analysis. Project reports may be generated from PEMS. Official data reports to outside agencies will be generated from data stored in Paducah OREIS that has been through the data review process, as applicable. All data reported has the approval of the sample/data management manager.

10.2.15 Submit Data to the Paducah OREIS

Upon completion of the data assessment, verification, and validation, the data will be transferred from Paducah PEMS to Paducah OREIS for future use in accordance with PAD-ENM-1001, *Transmitting Data to OREIS*. The data management team is responsible for transferring the data to Paducah OREIS.

10.3 DATA MANAGEMENT INTERACTIONS

The sample/data management manager oversees the use of Paducah PEMS and ensures that data deliverables meet project requirements. The data management team will enter information related to the fixed-base laboratory data packages and the tracking associated with the samples once the samples have been shipped and the receipt of the samples has been verified. The data management team will load the fixed-base laboratory hard copy data, the EDDs, and the field measurement data into Paducah PEMS. The data management team is responsible for transferring the data from the Ready to Load (RTL) files to the Paducah OREIS database.

The sample/data coordinator will develop the SOW to be performed by an approved analytical laboratory that has been audited under DOECAP. Analytical methods, laboratory QC requirements, and deliverable requirements will be specified in this SOW. The data management team will receive EDDs, perform contractual screenings, and distribute data packages. The data management team will interface with the contract laboratory to ensure that hard copy and electronic deliverable formats are properly specified and the requirements are understood and met.

10.4 DATA NEEDS AND SOURCES

10.4.1 Data Types

Multiple data types will be generated and/or assessed during this project. These data types include field measurements, inspection checklists, historical data, analytical data (including environmental data and waste data), real-time process measurements, and geographic information system (GIS) data.

10.4.2 Historical Data

Historical data consist primarily of analytical data. Existing and historical data will be evaluated prior to field activities (e.g., sampling, field measurements). Paducah OREIS and the Paducah OREIS Data Catalog will be queried, as necessary, for existing information relating to the project. Historical data that are available electronically will be downloaded from Paducah OREIS, as needed, and will be evaluated when necessary.

10.4.3 Field Measurements

Field measurements that may be collected include field measurements of environmental and waste samples and global positioning system readings for each sample location. Field measurements will also include samples of waste streams flowing through and from active treatment systems using field measurement equipment. Field measurements may be recorded on appropriate data log sheets. The data management team will enter the data from these sheets, manually, into Paducah PEMS. A QC check of this data entry, which involves comparing printouts of the data in the project Paducah PEMS to the original field logbook or data log sheet, will be made.

10.4.4 Analytical Data

Analytical data that will be collected includes volatile, semivolatile, and radionuclides from soil and groundwater samples. Paducah PEMS will be used to plan, track, and manage the collection of all analytical data. The tracking system for the project will include field logbooks, field forms, chain-of-custody records, and hard copy data packages, as well as EDDs. Following completion of the appropriate data verification, validation, and assessment activities, the final data set will be uploaded from Paducah PEMS to Paducah OREIS.

10.4.5 Real-time Process Measurements

The effective application of the *in situ* LDA soil mixing with hot air/steam and ZVI injection system involves real-time data collection and monitoring to allow for field-based decision processes regarding the following:

- Depth penetration rate, auger rotational rate, torque, and down-hole temperature of LDA soil mixing;
- Injection temperature, pressure, and flow rate of hot air and steam;
- Temperature, pressure, flow rate, relative humidity, and VOC concentrations in the vapor extraction and conditioning systems;
- Injection temperature, pressure, and flow rate of the ZVI slurry injection system; and
- VOC concentration of the vapor-phase treatment system effluent.

The real-time process measurements will be collected by the data acquisition system and in logbooks. The information from the data acquisition system is stored in Microsoft Excel files and, at the end of the project, will be placed in the project records by the project records coordinator.

10.5 GEOGRAPHIC INFORMATION SYSTEM DATA

The Paducah GIS network will be used to prepare maps to be used in data analysis of both historical and newly generated data and reporting. Coverage anticipated for use during the project is as follows:

- Stations (station coordinates will be downloaded from Paducah OREIS)
- Facilities
- Plant roads
- Plant fences
- Streams
- Topographic contours (as available from the 1990 and most recent flyover)

10.6 DATA FORMS/LOGBOOKS

Field logbooks, site logbooks, diskette logs, chain-of-custody forms, data packages with associated QA/QC information, and field forms are maintained according to the requirements defined in procedure PAD-RM-1009, *Records Management, Administrative Record, and Document Control*.

Duplicates of field records will be maintained until the completion of the project according to contractor-approved procedures. Logbooks and field documentation will be copied periodically. The originals will be forwarded to the project files; the copies will be maintained in a separate location. The project file will be considered the record copy and, as such, will be stored in accordance with contractor-approved procedures.

Electronic versions also will be stored in the project file; the originator or the original recipient of the diskette will maintain backup copies.

10.6.1 Field Forms

Sample information is environmental data describing the sampling event and consists of the following: station (or location), date collected, time collected, and other sampling conditions. This information is recorded in field forms, such as logbooks, chain-of-custody forms, or sample labels. This information is entered directly into Paducah PEMS by the data entry specialist. Field chain-of-custody forms contain sample-specific information recorded during collection of the sample. This information is entered directly into Paducah PEMS by the data management team. The SAP provides detailed information on sampling locations, types of samples, sample parameters required at each location, and the frequency of collection for samples. Any deviations from the sampling plan will be noted on the field chain-of-custody form. The sampler will review each field chain-of-custody form for accuracy and completeness, as soon as practical, following sample collection.

Chain-of-custody forms will be generated from Paducah PEMS with the following information:

- **Information that is preprinted**

  — Chain-of-custody number
  — Project name or number
  — Sample ID number
  — Sampling location (e.g., 001-001)
  — Sample type (e.g., REG = regular sample)
  — Sample matrix (e.g., SO = soil)
  — Sample preservation type
  — Analysis (e.g., Tc-99)
  — Sample container (e.g., volume, type)

- **Information that is entered manually**

  — Sample date and time
  — Top and bottom depths and units
  — Sample comments (optional)

Sample identification numbers are identified in Paducah PEMS, assigned by the sample/data management manager, and uniquely identify each sample. Sample labels shall contain sufficient information to identify the sample in the absence of other documentation. The label shall be affixed to the sample container; shall be completed with black, indelible ink; and shall include the following, at a minimum:

- Project number
- Unique sample number
- Sample location
- Sample media
- Analysis to be performed
- Sampling date and time
- Organization collecting the sample
- Preservation method

An example of the sample identification scheme is as follows:

001nnnMA000

where:

001	Identifies the SWMU
nnn	Identifies the sequential boring number
M	Identifies the media type (W identifies the sample as groundwater, S identifies the sample as soil)
A	Identifies the sequential sample (usually “A” for a primary sample and “B” for a secondary sample). If additional rounds of sampling are required, the sequential letter designations will continue.
000	Identifies the planned depth of the sample in ft bgs

10.7 DATA AND DATA RECORDS TRANSMITTALS

10.7.1 Paducah OREIS Data Transmittals

Official data reporting, contained in other reports to outside agencies, will be generated from data stored in Paducah OREIS for any applicable data stored there. The data management team will submit data to be stored in Paducah OREIS prior to reporting once verification, validation, and assessment have been completed.

10.7.2 Data Records Transmittals

Upon completion of the project, record copies will be forwarded to the PGDP Document Management Center according to contractor-approved procedures.

10.8 DATA MANAGEMENT SYSTEMS

10.8.1 Paducah PEMS

Paducah PEMS is the data management system that supports the project's sampling and measurements collection activities, and the generation of Paducah OREIS RTL files. Appropriate project staff can access Paducah PEMS throughout the life cycle of the project. Paducah PEMS will be used for the following functions:

- Initiate the project,
- Plan for sampling,
- Record sample collection and field measurements,
- Record sample shipment information,
- Receive and process analytical results,
- Evaluate and verify data,
- Analyze and access data,
- Transfer project data (in RTL format) to Paducah OREIS, and
- Store non-Paducah OREIS data.

Paducah PEMS is used to generate sample chain-of-custody forms, import laboratory-generated data, update field and laboratory data based on data verification, data validation if applicable, data assessment, and transfer data to Paducah OREIS. Requirements for addressing the day-to-day operations of Paducah PEMS include backups and security.

The information technology group performs system backups daily. The security precautions and procedures implemented by the sample and data management organization are designed to minimize the vulnerability of the data to unauthorized access or corruption. Only users approved by the sample and data management organization have access to the project's Paducah PEMS and the hard copy data files. Users have installed password-protected screen savers.

10.8.2 Paducah OREIS

Paducah OREIS is the centralized, standardized, quality assured, and configuration-controlled data management system that is the long-term repository for environmental data (measurements and geographic) for environmental management projects. Paducah OREIS is comprised of hardware, commercial software, customized integration software, an environmental measurements database, a geographic database, and associated documentation. Paducah OREIS will be used for the following functions:

- Access to existing data,
- Access to project data,
- Report generation, and
- Long-term storage of project data (as applicable).

10.8.3 Paducah Analytical Project Tracking System

The Paducah Analytical Project Tracking System is the business management information system that manages analytical sample analyses for all environmental projects within the Paducah Site. The Paducah Analytical Project Tracking System supplements the SMO tracker in cradle-to-grave tracking of sampling and analysis activities. The Paducah Analytical Project Tracking System generates the SOW, tracks collection and receipt of samples by the laboratory, flags availability of the analytical results, and allows invoice reconciliation. The Paducah Analytical Project Tracking System interfaces with Paducah PEMS (output from the Paducah Analytical Project Tracking System automatically goes to Paducah PEMS).

10.8.4 Data Acquisition System for Soil Mixing

The Data Acquisition System will consist of the two SRI GCs 8610 (or equivalent) and field instruments served by three Automation Direct 205 programmable logic controllers (or equivalent) that provide data input to a personal computer (PC) (or approved equivalent). The data will be monitored and recorded in real time. The data will be displayed and recorded in engineering units in real time. PC application software will display, in real time, selected parameters and will record at a selected rate of six times a minute. The recorded data will be viewed and saved in a Microsoft Excel spreadsheet.

10.9 DATA MANAGEMENT TASKS AND ROLES AND RESPONSIBILITIES

10.9.1 Data Management Tasks

The data management activities are described in Section 10.2. Contractor-approved procedures will be used to complete all of the necessary data management tasks.

10.9.2 Data Management Roles and Responsibilities

The following project roles are defined, and the responsibilities are summarized for each data management task described in the previous subsection.

10.9.2.1 Oil Landfarm/SWMU 1 RA project manager

The Oil Landfarm/SWMU 1 RA project manager is responsible for the day-to-day operation of the project. The project manager ensures the requirements of policies and procedures are met. The project manager or designee assesses data in accordance with PAD-ENM-5003, *Quality Assured Data*. The project manager is responsible to flowdown data management requirements to subcontractors as required.

10.9.2.2 Project team

The project team consists of the technical and support staff (including the data management team) and the FFA parties who conduct the various tasks required to successfully complete the project.

10.9.2.3 Data user

Data users are members of the project team who require access to project information to perform reviews, analyses, or ad hoc queries of the data. The data user determines project data usability by comparing the data against predefined acceptance criteria and assessing that the data are sufficient for the intended use.

10.9.2.4 Data entry specialist

The data entry specialist enters the data into Paducah PEMS, including chain-of-custody information, field data, data assessment and data validation qualifiers, and any pertinent sampling information. After receiving a notification that a fixed-base laboratory EDD is available to download, the data entry specialist loads the EDD to Paducah PEMS, performs electronic verification of the data, and then compiles the data assessment package. The data entry specialist also may prepare data for transfer from Paducah PEMS to Paducah OREIS.

10.9.2.5 Project records coordinator

The project records coordinator is responsible for the long-term storage of project records. The Oil Landfarm/SWMU 1 project team will interface with the project records coordinator and will transfer documents and records in accordance with DOE requirements.

10.9.2.6 QA specialist

The QA specialist is part of the project team responsible for reviewing project documentation to determine if the project team followed applicable procedures.

10.9.2.7 Sample/data management manager

The sample/data management manager is responsible for long-term storage of project data and for transmitting data to external agencies according to the *Data and Documents Management and Quality Assurance Plan for Paducah Environmental Management and Enrichment Facilities,* DOE/OR/07-1595&D2, and the Paducah Data Management Policy. The sample/data management manager ensures compliance with procedures relating to data management with respect to the project and that the requirements of PAD-ENM-5003, *Quality Assured Data,* are followed.

10.9.2.8 Laboratory coordinator

The sample/data coordinator is responsible for contracting any fixed-base laboratory utilized during the sampling activities. The sample/data coordinator also provides coordination for sample shipment to the laboratory, contractual screening of data packages, and transmittal of data packages to the Document Management Center.

11. ENVIRONMENTAL COMPLIANCE

11.1 INTRODUCTION

Environmental regulatory compliance will be facilitated during the implementation of the SWMU 1 RA by adhering to ARARs that have been identified throughout the project planning, scoping and decision making process, and documented in the signed ROD. CERCLA, as amended, requires, in part, that RAs for cleanup of hazardous substances comply with promulgated requirements and/or standards under federal or more stringent state environmental laws and regulations. These requirements are identified as those being specific to the hazardous substances or particular circumstances at a site and must be complied with, or be waived, as part of a total RA, under the CERCLA decision making process [40 *CFR* § 300.430(f)(1)(ii)(B)]. ARARs include only federal and state environmental or facility siting laws/regulations and do not include occupational safety or worker radiation protection requirements. Per 40 *CFR* § 300.405(g)(3), nonpromulgated advisories, criteria, or guidance, known as to be considered (TBC), may be considered in determining remedies. Because this RA will be conducted in accordance with Section XXI of the FFA for the PGDP and Section 121(e)(1) of CERCLA, on-site activities are exempted from procedural requirements to obtain federal, state, and local permits.

In Situ Source Treatment Using Deep Soil Mixing with Interim LUCs will result in reducing the source of TCE and other VOC contaminants reaching groundwater in the SWMU 1 area. On completion of the RA, a continued decrease in concentrations of TCE and other VOCs in the UCRS soils and subsequent migration through groundwater is expected.

A brief summary of the ARARs/TBCs associated with this RA follows.

11.2 CHEMICAL-SPECIFIC ARARs/TBCs

These requirements provide health or risk-based concentration limits or values in environmental media for hazardous substances, pollutants, or contaminants. Consistent with the ROD, there were no chemical-specific ARARs/TBCs identified for this RA.

11.3 LOCATION-SPECIFIC ARARs/TBC

Location-specific requirements establish restrictions on activities conducted within protected or environmentally sensitive areas. In addition, these requirements establish restrictions on permissible concentrations of hazardous substances within these areas. Section 11.5 includes a table that lists the federal and state location-specific ARARs for protection of sensitive resources.

11.3.1 Protection of Wetlands

Performance of the remedial activities and installation of treatment systems may impact nondelineated wetlands during the remedy implementation. As required at 10 *CFR* § 1022 and 33 *CFR* § 323 all activities will be designed to avoid or minimize impacts to wetlands identified within or nearby the area of deployment of the remedy. The use of BMPs and proper siting of equipment and construction areas will be considered and conducted, as necessary, to comply with these substantive requirements.

11.3.2 Protection of Aquatic Ecosystems

Performance of the RA will include the placement of backfill material. As required at 40 *CFR* § 230.10 and 33 *CFR* § 323, all activities will be designed to avoid or minimize impacts to waters of the United States within the area of deployment of the RA. The use of BMPs and proper siting of equipment and construction areas and placement of sediment control migration material will be considered and placed or conducted, as necessary, to comply with these substantive requirements.

11.4 ACTION-SPECIFIC ARARs/TBCs

Action-specific ARARs include requirements that pertain to the operation, performance, and design of a remedial response and are based on waste types, media being treated, and treatment technology being implemented. Component actions include soil mixing, vapor and entrained groundwater extraction, treatment, placement of ZVI and system monitoring; well installation and development and sampling; waste management; and transportation. ARARs/TBCs for each component action are listed in a table included in Section 11.5. The substantive requirements of applicable requirements and the approach to meeting those requirements during the RA implementation are described below.

11.4.1 Fugitive Dust Emissions

Substantive requirements for the control of fugitive dust and storm water runoff potentially provide ARARs for all construction and site preparation activities. Reasonable precautions must be taken, including the use of BMPs for erosion control to prevent runoff and application of water on exposed soil/debris surfaces to prevent particulate matter from becoming airborne. The substantive requirements are contained in 401 *KAR* 63.010. In addition, diffuse or fugitive emissions of radionuclides to the ambient air from remediation activities, which are only one of potentially many sources of radionuclide emissions at a DOE facility, must comply with the Clean Air Act of 1970, as amended, requirements in 40 *CFR* § 61.92 (substantive requirements). Substantive requirements for these ARARs for these actions include radiation emission requirements for the public and control of potential fugitive emissions of TCE and other VOCs, as applicable.

General surface activities have the potential to create dust. Soil handling during excavation and backfilling operations will utilize water sprays and covers to prevent surface dust emissions. Additionally, as necessary, surface dust emissions will be minimized by covering ground surfaces with geotextile fabrics and/or gravel. If dust is observed, a water spray will be used to control the observed dust. No particulate emissions are anticipated for the below grade activities.

11.4.2 Toxic Emissions

SWMU 1 potential hazardous air pollutants (HAPs) have been identified based on characterization of the soils and in the remedial design work plan and earlier decision documents. The potential HAPs identified are TCE, vinyl chloride, *trans*-1,2-DCE, *cis*-1,2-DCE, and 1,1-DCE. These HAPs will be removed from the subsurface using LDA soil mixing with steam additions and vacuum extraction. The treated vapor/gases must comply with the contaminant concentration requirements of 401 *KAR* 63:020. An off-gas treatment system shall be employed to ensure contaminant emissions do not exceed allowable levels. This system will include such equipment as condensers and/or filters to accomplish the required contaminant removal.

In accordance with 401 *KAR* 63:020, the concentration of each of the HAPs that is released must be not be more than a value calculated that would be protective of human health and the environment. This is accomplished by ensuring that HAPs concentrations at the property boundary of the facility are less than the values required under 401 *KAR* 63:020. The required air concentrations were calculated using values in the EPA Toxics Table, Prioritized Chronic Dose-Response Values for Screening Risk Assessments at http://www.epa.gov/ttn/atw/toxsource/table1.pdf and may have their basis in either Region 9 Preliminary Remediation Goals (PRGs) values at http://www.epa.gov/region09/waste/sfund/prg or Integrated Risk Information System values. Allowable concentrations then were calculated using the methods outlined in EPA's *Air Toxics Risk Assessment Reference Library, Volume 2, Facility Specific Assessment*. These values are based on the cancer and non-cancer risks posed by long-term exposure to HAPs. The chemicals that are a cancer risk have an associated concentration that will result in a receptor at the property boundary having an increase of less than one in one million (1×10^{-6}) of getting cancer from exposure to a carcinogen over a 70-year time period. The health effects of exposure to chemicals that are a noncancer risk are measured by a hazardous index; with a hazard index of 1 being an indication of a boundary-located receptor having detrimental health effects from exposure to that chemical. The SWMU 1 RA HAPs are both carcinogenic and noncarcinogenic, with the greater of the two risks for each chemical as follows:

- Noncancer—1,1-DCE, *trans*-1,2-DCE, *cis*-1,2-DCE
- Cancer—TCE, vinyl chloride

11.4.3 Emissions Estimate

This section summarizes the air dispersion analysis of potential HAP emissions from the implementation of the SWMU 1 RA. The property boundary concentrations for these potential hazardous air pollutant emissions were estimated utilizing using BREEZE AERMOD GIS Pro v5.1.7.

11.4.3.1 Remedial action fugitive emissions

During implementation of the RA, fugitive emissions will be released. The fugitive emissions occur when the LDAs are mixing the subsurface soils with steam injection and vacuum extraction is removing vapors. To control contaminant releases, vapor emissions will be treated through vapor-phase carbon prior to release. The off-site limit, estimated fugitive emission rate (controlled), and resulting maximum off-site concentration for each HAP are shown in Table 11.

Table 11. Estimated Off-site Concentrations for Fugitive Emissions

Chemical	Off-site Limit	Fugitive Emission Rate (Controlled)	Annual Average Maximum Off-site Concentration
	µg/m^3	g/s	µg/m^3
TCE	0.24	7.87E-4	1.37E-2
Vinyl chloride	0.11	2.96E-8	5.14E-7
trans-1,2-Dichloroethene	210	6.02E-9	1.04E-7
cis-1,2-Dichloroethene	37	6.94E-6	1.2E-4
1,1-Dichloroethene	63	1.76E-8	3.05E-7

The estimated air concentration for each hazardous air pollutant is less than the off-site limit. This demonstrates that emissions associated with this action are not expected to be harmful to the health and welfare of humans, animals, or plants and will compliant with 401 *KAR* 63:020 in this area.

11.4.3.2 Operations emissions

During operation of the project, the hazardous constituents in the subsurface will be volatilized underground and recovered by a vapor phase extraction system. The system will capture the soil vapors, which will be treated and released through a stack. The current design utilizes activated carbon filtration to remove hazardous constituents from the off-gas with a second activated carbon filtration unit to polish the treatment prior to discharge to the atmosphere. The current design criteria for the treatment system is such that the concentrations of an individual HAP in the exhaust stack will not exceed 20 ppmv. Off-gas emissions from the treatment system will be monitored by a photoacoustic analyzer. The analyzer will communicate with a control system to shut down the vapor extraction and vapor treatment system and notify operations personnel (via signal light) in the event of an exceedance of discharge criteria, allowing a suspension of operations, as needed. Analyzer results will be recorded at 2 minute intervals during initial operations. The sampling frequency will be evaluated after initial operation to determine if the frequency for sampling adequately records the data. The frequency of sampling may be adjusted with the concurrence of EPA and KDEP. Calibration/functional checks will be performed in accordance with manufacturer specifications.

11.4.4 Monitoring Well Installation

Subsurface components will consist of a LDA with associated steam injection and ZVI injection nozzles and temperature monitoring equipment. These components will be temporarily installed in the subsurface during operations but will be removed once each auger boring is completed. Monitoring wells will be installed in the remediation area to monitor the long-term goals of attaining the cleanup levels and reducing contaminant migration to the groundwater. Temporary soils boring will also be utilized after LDA work is complete to obtain soil samples and determine the effectiveness of removing the contaminants from the UCRS soils. Consistent with 401 *KAR* 6:350 these subsurface components will be installed to minimize the potential for the introduction of pollutants into the subsurface aquifer during operations. A Commonwealth of Kentucky licensed well driller will be utilized for the monitoring well installation.

11.4.5 Discharge of Storm Water and Treated Groundwater

Management of aqueous wastes will include procedures to minimize the possibility of spills and releases to the environment. Berms and dikes will be constructed to minimize contact of waste with surface water run-on and runoff. Where precipitation accumulates in the diked areas that hold contaminated wastes, it will be managed as contaminated until analyses show otherwise. It will be treated, as needed, to meet the KPDES-permitted outfall (e.g., 008 or 015) discharge limits prior to discharge.

Contaminated water, including decontamination fluid, development groundwater, and condensate from the off-gas treatment system, will be treated as necessary to meet discharge limits. Where these waters meet the acceptance criteria for on-site treatment facilities at the PGDP, treatment is expected to occur on-site with discharge through a KPDES-permitted outfall, such as Outfall 008 or 015. Where these waters do not meet on-site acceptance criteria or result in exceedances of on-site treatment capacity, they will be shipped to an appropriate off-site wastewater treatment facility for treatment and subsequent discharge. Shipment to any off-site facility shall be conducted in accordance with the applicable requirements of 40 *CFR* § 300.440 *et seq.* (CERCLA Off-site Rule).

Condensate from off-gas treatment will include special handling procedures for the releasing the treated water. The condensate will be treated with liquid phase carbon, containerized in tanks, sampled for KPDES Outfall 008 parameters, or similar outfall parameters, and released once the release criteria are met. The treatment will meet the substantive requirements associated with 40 *CFR* § 122.4, 401 *KAR* 5:065, and DOE Order 5400.5, which has been superseded by DOE Order 458.1.

The use of the tanks for containerizing the treated water effluents will allow for batch sampling. The Memorandum of Agreement for Resolution of Informal Dispute for the Focused Feasibility Study for the Southwest Plume Volatile Organic Compound Sources (DOE 2010), paragraph 2, requires that the method for calculating the annual average discharge (AAD) of Tc-99 shall be detailed. Because effluent water will be containerized and sampled prior to discharge, this same process will be used to determine annual average discharge of Tc-99. Each tank will be filled to capacity and then disconnected from the treatment system. Each tank will be sampled and analyzed for the Tc-99 activity present in the water contained in the tank. The volume of the filled tank will be noted upon sampling. These two data points will be collected for each filled tank throughout the project. The laboratory results for the Tc-99 and volumes of the tanks then will be used to calculate a volume weighted average discharge for the project.

The field implementation portion of the project is expected to be completed in less than six months and, as such, annual average discharge of Tc-99 does not require normalizing for multiple fiscal/calendar years. If the project operation does overlap fiscal/calendar years, the average annual discharge for Tc-99 will be calculated for the operational discharges that occurred during each fiscal/calendar year. The following equation provides the detail for the AAD calculation.

Where:

AAD = Annual Average Discharge, pCi/L

N = Total Number of Wastewater Tanks, #

X_N = Tc-99 activity in each tank, pCi/L

V_N = Volume of water in tank N, gal

$$AAD = [(X_1V_1 + X_2V_2 + X_3V_3 + \ldots X_NV_N)/(V_1 + V_2 + V_3 + \ldots V_N)]$$

Note: The soil mixing project life cycle is expected to be less than one year; therefore, the AAD does not require normalization for multiple years.

11.4.6 Hazardous Waste Management

All primary wastes (i.e., groundwater and contaminated soils) and secondary wastes (i.e., treatment residuals and decontamination wastewaters) generated during remedial activities will be characterized as RCRA wastes (solid or hazardous); PCB waste; radioactive waste(s); and/or mixed waste(s), as appropriate, and be managed in accordance with appropriate RCRA, Toxic Substances Control Act (TSCA), or DOE Order/Manual requirements. Wastes managed on-site must comply with the substantive requirements of the ARARs contained in 11.5. When wastes are transferred off-site, waste management must be conducted in compliance with all applicable laws and regulations. Shipment of CERCLA wastes to any off-site facility shall be conducted in accordance with the approval requirements of 40 *CFR* § 300.440 *et seq.* (CERCLA Off-site Rule).

For contained-in/no-longer-contaminated-with determinations for environmental media and debris, DOE will apply the contained-in/no-longer-contaminated levels of 39.2 ppm TCE in solids and 0.081 ppm TCE in aqueous wastes generated by this interim RA. The analytical results will be compared against the contained-in, health-based levels listed above, and a determination made. LDRs continue to apply to media and debris for which a contained-in/no-longer-contained-in or a no-longer-contaminated-with determination has been made.

11.4.7 PCB Waste Management

One of the substantive requirements of TSCA is that wastes that have concentrations of PCBs greater than ≥ 50 ppm must be managed in accordance with 40 *CFR* § 761. These requirements include labeling, characterization, manifesting, and disposal in a facility that is designed for and permitted to receive PCB-contaminated wastes.

Soils containing PCBs in excess of 50 ppm have not been identified in the soil mixing treatment area. PCBs, however, have been identified in soils of SWMU 1 and are discussed in the Soils OU RI (DOE 2012b). To protect the aboveground treatment system from potential PCB contamination and to facilitate greater depths in soil mixing, prior to implementing the deep soil mixing RA, the top 4 ft of the treatment/source area soil to be mixed, as defined in Figure 5, will be removed, stockpiled adjacent to the mixing area on a synthetic liner, covered with a liner to prevent erosion, and respread in the excavation after soil mixing action is complete. The soils identified in DOE 2012b, grid 001-014, will be characterized and disposed of due to the expected PCBs level of > 1 ppm. Kentucky regulations prevent the placement of soils with greater than 1 ppm as documented in 401 *KAR* 47:030 § 8, Polychlorinated Biphenyls, "A solid waste site or facility shall not exist or occur which places solid waste containing concentrations of polychlorinated biphenyls (PCBs) equal to or greater than one (1) mg/kg (dry weight) on the land." The remaining soils will be stockpiled and then used as backfill in the soil mixing area, graded and seeded. The soil pile generated from the 4 ft soil excavation will be located over the grid 001-028 from the Soils OU RI (DOE 2012b). The soil pile will be underlaid with a liner, which will provide a barrier to separate the excavated soil from grid 001-028 soil. Because the soil in the grid will be under the liner, the spread of contamination from the grid 001-028 soil will be controlled.

11.4.8 National Emission Standards for Hazardous Air Pollutants

EPA regulations also include limitations on the radiological dose allowed to members of the public in the NESHAP regulations in 40 *CFR* § 61 (and 401 *KAR* 57:002, which incorporates the federal regulations by reference). Codified at 40 *CFR* § 61.92, there is a limit of 10 millirem (mrem)/year from all radioactive air emissions at a DOE facility to the most exposed member of the public from radionuclide emissions to the atmosphere.

In accordance with 40 *CFR* § 61, Appendix D,

> If any nuclide is heated to a temperature of 100 degrees Celsius or more, boils at a temperature of 100 degrees Celsius or less, or is intentionally dispersed into the environment, it must be considered to be a gas.

The soil mixing process with steam injection is not expected to heat any Tc-99 present to in excess of 100ºC and remain there through the complete system. The steam will have a temperature at injection of greater than 100°C, but, upon mixing with soil condensation, will occur with the resulting temperature being below the critical temperature. At extraction vapors are expected to be approximately 70°C, which is below the 100°C parameter. Also, vapors at the surface will be passed through a chiller to reduce their temperature to below 32°C. This also will result in the technetium partitioning to the liquid phase. The liquid phase is then treated along with the entrained groundwater using liquid phase carbon and ion exchange beds. Since the technetium ultimately will remain in the liquid phase, which then is treated with ion exchange, there is no release of vapor phase technetium that exceeds the 10 mrem limit.

11.4.9 Transportation

Any remediation wastes transferred off-site or transported in commerce along public rights-of-way must meet all applicable requirements found in the federal and Commonwealth of Kentucky transportation laws and regulations. These transportation requirements include provisions for proper packaging, labeling, marking, manifesting, recordkeeping, licensing, and placarding that must be complied with fully for shipment. Before shipment of CERCLA wastes to any off-site facility, DOE must ensure the acceptance of the receiving site under the CERCLA Off-site Rule (40 *CFR* § 300.440 *et seq.*).

11.4.10 Underground Injection Control

The project design for the RA requires that potable water heated to become steam be injected into the subsurface to enhance heating of the soil near the augers. The injection of steam is necessary to assist in the volatilization and removal of the VOC contaminants through the vapor extraction process. Prior to creating steam, the potable water will be treated to remove dissolved solids to protect the steam generators and injection equipment. ZVI with a guar gum/potable water mixture as a carrier also will be placed in the subsurface to enhance the removal of VOC contamination.

Injection of steam, iron, and guar gum, which are not hazardous wastes, into the UCRS trigger certain ARARs under the Underground Injection Control (UIC) program of the Safe Drinking Water Act. Accordingly, the following substantive requirements of the UIC regulations are considered relevant and appropriate: (1) 40 *CFR* § 144.12(a), and 144.82(a) state that no owner or operator shall construct, operate, maintain, covert, plug, abandon, or conduct any other injection activity in a manner that allows the movement of fluid containing any contaminant into underground sources of drinking water, if the presence of that contaminant may cause a violation of any primary drinking water regulation under 40 *CFR* § 142 or may otherwise adversely affect the health of persons.

The injection of these components, as described in the earlier paragraph, is expected to beneficially contribute to the efficiency of the operation and result in an overall reduction in TCE concentrations in treated zones upon completion of the action. The area affected by the injection is expected to be limited to the immediate area within the treatment zone as a result of hydraulic control measures that will be implemented during operation to reduce contaminant migration. Hydraulic controls include the use of controlled injection volumes and vapor extraction to reduce subsurface pressures. Controlling the injection volumes at various depths reduce the ability for contamination to migrate to an exterior location by keeping subsurface pressures low. The vapor extraction provides a low pressure center along the vertical axis of soil boring which reduces the possibility of contaminant migration. Additionally, the completion of the outermost ring of LDA mixing borings (lower contaminant concentration) first provides a mechanism for treating contamination that may migrate laterally from the interior higher contamination soil borings. The design of this remedy is intended to meet the substantive requirements of 40 *CFR* § 144.12(a) and 144.82(a). The injections are designed to maintain control of injected material to prevent movement of fluid containing any contaminant into underground sources of drinking water. The RAWP will be approved by the EPA and Commonwealth of Kentucky, which qualifies for an exemption under 40 *CFR* § 144.13(c). The plugging and abandonment of the boring by leaving the mixed soil in place meets the substantive requirements for closure under 40 *CFR* § 144.23(b)(1) and 144.82(b). Each of the borings will upon mixing leave the original soil from the boring in place. At completion, the original surface soil will be respread to return the site to its original conditions.

11.5 SUMMARY OF ARARS

The RA will be performed using the location-specific and action-specific ARARs/TBCs for the selected remedy as documented in the ROD (2012a). No chemical-specific ARARs/TBCs were identified for this RA.

12. WASTE MANAGEMENT PLAN

12.1 OVERVIEW

This WMP provides information, which may or may not be included in the LATA Kentucky PGDP site WMP, PAD-PLA-ENV-001, for the management and final disposition of waste generated during the *In Situ* Source Treatment Using Deep Soil Mixing with Interim LUCs for the Southwest Groundwater Plume VOC sources at the Oil Landfarm (SWMU 1). The Southwest Groundwater Plume and the source area at SWMU 1 were identified during the WAG 27 RI in 1998 (DOE 1999). Additional work to characterize the plume was performed as part of the WAG 3 RI (DOE 2000a) and Data Gaps Investigation (DOE 2000b). As discussed in these reports, the primary groundwater contaminant of concern for the Southwest Groundwater Plume (hereinafter referred to as the Southwest Plume) is TCE. SWMU 1 was identified as containing source material in the UCRS soils to an expected depth of 60 ft that generates the contamination in the Southwest Groundwater Plume. This RA is being implemented consistent with a CERCLA ROD. The major components of the action are these:

- Deep soil mixing with LDAs of UCRS soils to a depth of 60 ft;
- Steam injection during the mixing process to enhance volatilization of VOCs;
- Injection of zero valent iron and guar mixture in areas exhibiting recalcitrance to the soil mixing process and meeting the design criteria for placement of ZVI;
- Extraction of vapors and entrained water during mixing process;
- Treatment to remove the contamination from the extracted vapors and entrained water via vapor phase and liquid phase carbon;
- Treatment of wastewater via ion exchange for technetium, as necessary;
- Sampling and release of treated vapors;
- Sampling and release of treated wastewater to an outfall (e.g., 008 or 015); and
- Excavation and replacement of the upper 4 ft of surface soil in the soil mixing area.

These actions will produce the waste materials covered by this WMP and include the following:

- Vapor phase carbon
- Liquid phase carbon
- Excavated waste soil
- Ion exchange resins
- Drilling cuttings
- Decontamination wastewater
- Purge and development wastewater
- Excess ZVI and guar mixture
- Sample and core residuals
- PPE
- Noncontaminated debris from general construction and operations

This WMP addresses the management of wastes generated on this project from the point of generation through final disposition. This RA is being conducted as a part of the ER activities at PGDP and consistent with a CERCLA ROD. The DOE contractor will be responsible for waste management activities associated with this project. Standard practices and procedures outlined in this WMP regarding the generation, handling, transportation, and storage of waste will comply with all DOE requirements, RCRA requirements, and TSCA requirements (should PCBs become an issue).

The WMC will be responsible for daily oversight of all waste management activities and for ensuring overall compliance with the WMP.

The approach outlined in this WMP emphasizes the following objectives:

- Management of the waste in a manner that is protective of human health and the environment;
- Minimization of waste generation, thereby reducing unnecessary costs (e.g., analytical costs), and use of the permitted storage and disposal facilities that are limited in number;
- Compliance with ARARs; and
- Selection of storage and/or disposal alternative(s) for the waste.

Waste management activities must comply with this WMP, ARARs, applicable procedures, the site WAC, and WAC for other specific treatment, storage, and disposal facilities (TSDFs) that are designated to receive the waste. The decision has not been made as to the final TSDF that will be used. Potential off-site TSDFs that may be used include, but are not limited to, Energy*Solutions*, Nevada Nuclear Security Site, Perma-Fix, and Waste Control Specialists. Potential on-site TSDFs that could be used for soils and drill cuttings may include C-747-U Landfill.

During the course of this project, additional PGDP and DOE waste management requirements may be identified. Necessary revisions to the WMP will ensure the inclusion of these additional requirements into the daily activities of waste management personnel. DOE will inform the FFA parties of any substantive changes to the WMP or to any other of the C-747-C Oil Landfill RA project CERCLA documents, and changes will be made in accordance with Section XX.J, Subsequent Modification of Final Document, of the FFA.

12.2 WASTE GENERATION AND PLANNING

12.2.1 Waste Generation

A variety of waste will be generated during this project, including the following:

- Vapor phase carbon
- Liquid phase carbon
- Excavated waste soil
- Ion exchange resins
- Drilling cuttings
- Decontamination wastewater
- Purge and development wastewater
- Excess ZVI and guar mixture
- Sample and core residuals

- Sediment and mud from wastewater treatment
- Treated groundwater
- Filter media and filter bags/cloths
- Personal protective equipment
- Noncontaminated debris from general construction and operations

The waste generated from field-related activities of this RA has the potential to contain contaminants related to known or suspected past operations; therefore, this waste must be stored and disposed of in accordance with ARARs. Waste that is likely to have either hazardous or radiological contamination typically will be stored on-site in containers in CERCLA waste storage areas in accordance with PAD-WD-3010, *Waste Generator Responsibilities for Temporary On-Site Staging of Waste Materials at Paducah*, during the characterization period and prior to treatment/disposal. Consistent with EPA policy, the generation, storage, and movement of waste during a CERCLA project and storing it on-site does not trigger the administrative RCRA storage or disposal requirements. On-site waste storage areas will be managed in accordance with the substantive RCRA hazardous waste storage standards. Among the substantive requirements are compatible containers in good condition, regular inspections, containment to control spills or leaks, and characterization of run-on and run-off, either by process knowledge or by sampling. In the event that any wastes are stored in temporary staging piles, plastic sheeting will be placed on the ground under the waste, and additional plastic sheets will be used to cover it to prevent the spread of contamination from rainfall in accordance with substantive RCRA standards for such piles. Final disposition of the materials will depend on final characterization.

Sections 12.2.2 through 12.2.11 provide a brief description of each potential waste stream.

12.2.2 Drill Cuttings from Soil Borings

Drilling cuttings will be generated from installation of the new soil borings and wells. It is assumed that all drill cuttings will have a 25% swell factor. An estimated total of 95 ft^3 of this waste is expected to be generated.

All drill cuttings will be containerized as they are generated, labeled, and managed on-site according to the substantive requirements of RCRA, until they are either determined not to be RCRA waste or dispositioned to an appropriate disposal facility. Wastes will be stored in a CERCLA storage area during characterization. The CERCLA storage area is managed according to the substantive requirements of RCRA. The soil will be sampled and analyzed as described in Section 8.3 for proper waste determination.

Drill cutting waste may be containerized in drums, ST-90 boxes, 25-yd^3 intermodal (IM) containers, or other applicable container during generation. The IM is preferred because it is the most reusable container and its greater size reduces both physical risk and cost by minimizing container movements as well as sampling activities. Dry drill cuttings generally will be loaded first into a self-tipping hopper attached to a forklift. The hopper will be dumped into the top of an IM that, at least, has been partially lined with a poly-liner to facilitate unloading and decontamination. This operation will continue until the IM container is approximately half-full, ensuring that the weight limit for the transport vehicle is not exceeded. If sampling does not occur prior to loading waste into the IM, then the waste will be sampled for waste characterization, as discussed in Section 8.3.3.1.

A portion of the drill cuttings from inside the areas mapped to have free-phase DNAPL may be determined to be characteristically hazardous and will be managed on-site in accordance with substantive requirements of RCRA. Wastes determined to be hazardous will be transferred to an on-site, permitted RCRA storage facility until such time as it is transferred off-site to an approved RCRA treatment and disposal facility.

The remainder of the drill cuttings that are not from the mapped areas of free-phase DNAPL is assumed not to be characteristically hazardous. This waste will be characterized and the concentrations of listed constituents, TCE, will be compared to health-based levels for a "no longer contains" determination. If the concentrations are less than health based levels, the waste will not be managed as a RCRA-listed waste. If analytical results show that this waste meets the WAC of the C-746-U Landfill, the waste will be disposed of there as nonhazardous waste.

12.2.3 Personal Protective Equipment

PPE will be worn as specified in the HASP, Chapter 7 of this work plan, by personnel performing the field tasks during the SWMU 1 RA. While site personnel use procedures and BMPs to minimize opportunities for contacting TCE-contaminated media and equipment, it is likely that some PPE or related debris (e.g., plastic sheeting) will come into contact with TCE-contaminated materials during the remediation process. Process knowledge, visual inspections, or direct sampling will be used to characterize PPE and any related debris. Based on the results of the characterization, any PPE or the related debris determined by site personnel to be contaminated by a listed waste or exhibiting a RCRA characteristic will be managed as hazardous waste, decontaminated, or a no longer contaminated-with determination will be made pursuant to Section 8.3.1. In cases where site personnel conclude, based on the above characterization process, that the PPE or related debris has not been contaminated by a listed waste or does not exhibit a characteristic, then the materials will not be considered a RCRA hazardous waste. An estimated total 160 ft^3 of this waste is expected to be generated as nonhazardous waste.

12.2.4 Purge/Decontamination/Drilling Water

Wastewater will be generated during the installation and development of newly constructed monitoring wells and when decontaminating the equipment used in performing the remedial operations. Groundwater and any related aqueous wastes generated from well sampling, well development, and well purging shall not be considered a hazardous waste at the point of generation, if the TCE concentrations are below 1 ppm provided that the subject aqueous waste will be further treated in an on-site wastewater treatment unit and discharged through a PGDP KPDES-permitted outfall consistent with paragraph 117 of the 2003 Agreed Order (File No. DWM-31434-042) referencing 401 *KAR* 31:010 § 3 [40 *CFR* § 261.3(a)(2)(iv)(A)]. Other aqueous environmental media waste contaminated with TCE that does not qualify for the exemption cited herein will use a health-based concentration of 0.081 ppm as the criterion for making contained-in determinations for media destined for on-site treatment and discharge through a KPDES-permitted outfall.

Wastewater will be accumulated and stored on-site until it can be processed through the treatment system for removal of suspended solids, as necessary After solids removal, the water will be collected in a manner that will minimize the possibility of spills; then it will be sampled to ensure it meets the appropriate acceptance criteria and treated to the on-site C-612 Northwest Plume Groundwater System, the on-site C-613 Sediment Basin, or other acceptable facility for treatment and/or disposal through KPDES-permitted Outfall 008 or 015. The C-612 facility has adequate additional capacity to treat the 1,200 gal per day expected to be generated.

Aqueous waste (including, but not limited to, well sampling, well development, well purging, and decontamination waters) that has undergone wastewater treatment and meets the KPDES discharge limits shall be considered to "no longer contain" listed hazardous waste (i.e., TCE). This treated wastewater may be directly discharged to permitted KPDES outfalls or on-site ditches that flow to permitted KPDES outfalls.

The proposed target analytes for this waste are those required to meet KPDES discharge limits and include TCE, PCBs, oil and grease, total residual chlorine, total phosphorous, total metals, Tc-99, hardness, dissolved and suspended alpha, beta, total uranium, and pH.

12.2.5 Sediment and Mud from Separation of Decontamination and Purge Water

Decontamination water and mud (soil sediment/mud) will be generated during cleaning of the drilling and mixing equipment and sampling equipment. An estimated total of 100 ft^3 is expected to be generated. The water will be collected in a sump in the decontamination facility, decanted on-site, and collected in a manner that will minimize the possibility of spills, to the extent possible, and added to the purge/decontamination/drilling water waste stream described in Section 12.2.4. The mud, which is assumed to be 2% of the total water generated, will be containerized as it is removed from the sump, then sampled and managed similarly to drill cuttings (Section 12.2.2). It is assumed that absorbent in the amount of 10% will be added to the mud to remove excess water.

12.2.6 Treated Groundwater

An aboveground treatment system will be utilized to treat groundwater extracted during operation of the soil mixing process. The treatment system will remove VOCs and, as necessary, Tc-99 from the groundwater. Treated groundwater will be containerized and sampled prior to discharge to an on-site ditch, which drains to KPDES-permitted Outfall 008 or 015. The system will have a treatment capacity of approximately 20 gal per minute (gpm).

The treatment system discharge parameters are shown in the Table 12.

Table 12. Liquid Treatment System Discharge Criteria Relative to Outfall Release

Analyte Parameter*	Discharge Limit, Daily Maximum
Flow	N/A
Discharge Temperature, °F	Report
Oil and Grease, mg/L	15
Total Residual Chlorine, mg/L	Report
Total Phosphorous, mg/L	1.0
Polychlorinated Biphenyls, µg/L	Report
Trichloroethylene, mg/L	Report
Hardness, mg/L ($CaCO_3$)	Report
Total Recoverable Metals	Report
Total Uranium, mg/L	Report
Technetium-99, ρCi/L	Report
pH, standard units	6-9

*No discharge of floating solids or visible foam or sheen in other than trace amounts.
Source: KPDES Permit Number KY0102083

During operations treated water will be sampled prior to discharge to verify that the system is adequately treating the groundwater.

Aqueous waste (including, but not limited to, well sampling, well development, well purging, and decontamination waters) that has undergone wastewater treatment and meets the KPDES discharge limits shall be considered to “no longer contain” listed hazardous waste (i.e., TCE). This treated wastewater may be directly discharged to permitted KPDES Outfalls or on-site ditches that flow to permitted KPDES outfalls.

12.2.7 Carbon Media and, Ion Exchange Resin, Zeolite Media, and Cloth Filters

During the implementation of the SWMU 1 soil mixing, the aboveground treatment system will contain several types of media used in the treatment of VOC-contaminated extracted groundwater and vapors including activated carbon, ion exchange resin, and cloth filters. In addition to the materials used to treat the contaminated groundwater, water will be treated prior to being utilized for steam. This treatment will result in spent ion exchange materials. If any of these waste materials upon analysis indicate that the waste is characteristically hazardous or a listed-hazardous waste, the waste will be managed and disposed of as such.

The carbon, ion exchange resin and zeolite are recyclable, which is the preferred disposition for these materials if health physics (HP) survey indicates that radiological contamination is less than free-release limits. If the analytical results show that the wastes are not characteristically hazardous but the HP survey indicates that radiological contamination is too high for recycling (free release), but less than the authorized limits of the C-746-U Landfill, they will be disposed of there if other disposal criteria are met. An estimated total of 565 ft^3 of carbon media is expected to be generated. Spent filter cloths are included with the PPE waste estimate stated in Section 12.2.3 since they are a similar waste stream. Ion exchange resin, if needed, will generate an estimated 50 ft^3 during the project.

12.2.8 Excavated Soil

The top 4 ft of the treatment/source area soil to be mixed (as defined in Figure 5), will be removed, stockpiled adjacent to the mixing area on a synthetic liner, covered with a liner to prevent erosion, and respread in the excavation after the soil mixing action is complete. This will be done to protect the aboveground treatment system from potential PCB contamination, to facilitate greater depths in soil mixing, to allow the removal of the alumina pellets and other waste materials from the subsurface, and to increase worker protection.

The site preparation will include removal of soil from the approximately 12,427 ft^2 area to be soil mixed. The estimated area from which the soil will be removed will be nominally larger than the approximate 12,427 ft^2 area to allow for smooth surface contours and machine accessibility during mixing operations. The soil that will be removed has been identified in the Soils OU RI as exceeding the NAL for some metals and PCBs (DOE 2012b). The soils located in Soils OU RI grid 001-014 also will be disposed of after removal due to PCB content exceeding 1 part per million. (See Figure 10.) The removal of the soils will support key objectives of the soil mixing project by providing the following:

- It will remove contamination in the mixing area that may be captured by the vapor extraction system and could contaminate the system equipment.

- Will allow soil mixing to the target depth of 62 ft bgs. (Soil mixing equipment is mechanically limited to a depth of 60 ft bgs.)

The soils that will be disposed of upon removal will be packaged, characterized, transported, and disposed of appropriately. All other soils removed will be returned to the mixing area, consistent with the approach contained in Section 1.5, Sequencing with Other Remedies, in the RDR. It is expected that alumina pellets and other waste materials (e.g., drum rings and lids) are present in portions of the shallow subsurface at SWMU 1. The excavation operation will be performed with operational controls that are specifically intended to allow the removal of the alumina pellets and other waste materials from the subsurface. The following steps will be performed during the excavation operations.

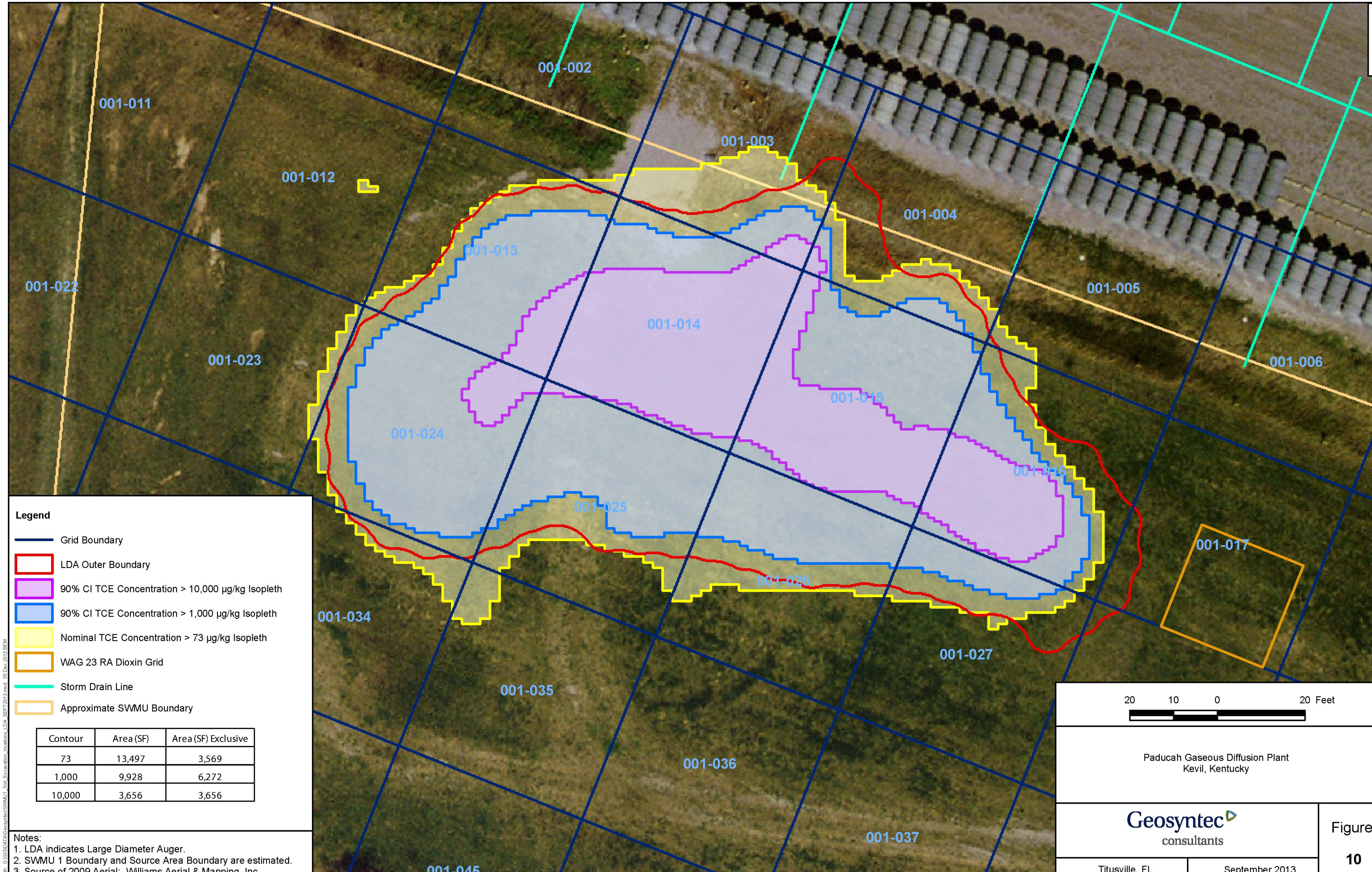

Figure 10. Soil Excavation Grid Locations

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1. Remove the upper 4 ft of soil to expose subsurface soil. Observe the soil during removal for signs of waste materials (e.g., drum lids, drum rings, or alumina pellets). Waste materials will be removed and containerized. Excavated soil will be stockpiled.

2. Perform a coordinate survey and establish (flagging/paint/etc.) the grid used by the Soils OU RI that is located within the area of soil excavation as shown in Figure 10.

3. RCTs will establish average background count rates in each grid using a Geiger- Müller (GM) probe.

4. If background counts per minute (CPM) vary by more than 25% in each grid, the grid will be subdivided into two parcels along an appropriate axis based on field measurements. Further parcel subdivisions will be performed as necessary to meet the 25% variation. Each parcel will be identified by the original grid number followed by a dash and sequential number beginning with 1 (001-012-1).

5. An RCT will conduct a survey of the grids using a GM probe. Any area within each grid with count rate measurements in excess of the established Trigger Level as shown in Table 13 will be flagged for further inspection.

Table 13. Soil Radiological Trigger Levels for Identification of Potential Waste Materials

Background Counts Per Minute Range	Trigger Level Net Counts Per Minute Above Background
< 250	Background + 200
≥ 250 and < 500	Background + 300
≥ 500 and < 750	Background + 400
≥ 750 and < 1,000	Background + 500
≥ 1,000	Background + 600

6. Flagged areas within each grid will be inspected using hand tools or an excavator to determine if waste materials are present near the surface (4-6 inches).

7. If waste materials are located, the materials will be removed and containerized, and RCTs will conduct a secondary survey to determine postexcavation radiological count rate of soil for health and safety purposes.

8. If waste materials are not located in flagged area during Step 6 or the secondary survey in Step 7, then no further excavation is necessary.

9. If waste is identified at a location during the secondary survey in Step 7, then repeat Step 7.

10. Once all radiologically flagged areas have been cleared of visible waste materials, proceed with deep soil mixing.

11. Backfill soil mixing area with excavated soils. If alumina or other waste material is encountered during replacement of stockpiled soil, segregate and package for disposal consistent with Section 12, Waste Management Plan, and associated procedures.

12. Characterize and dispose of all excavated alumina and other waste material.

12.2.9 Excess Zero-Valent Iron and Guar Mixture

ZVI and guar will be mixed and injected into the UCRS soils at locations where soil mixing with steam injection are not removing VOC contamination sufficiently. Excess quantities or waste quantities are expected to be generated as part of this process but will not be contaminated because they will not have been injected into the subsurface. The material will be containerized and disposed of appropriately. It is expected that the guar portion of the mixture will degenerate over time leaving a water and iron mixture. This material will not be contaminated with VOCs, radioactive elements, or other contaminants since it will not have been in contact with the contaminated soil or groundwater. An estimated total of approximately 60 ft^3 of this waste is expected to be generated from this project.

12.2.10 Process Piping and Equipment Waste

During the implementation of the soil mixing with steam enhancement and use of ZVI RA, a premanufactured and constructed mobile aboveground treatment system will be brought in and operated. Following completion of the soil mixing, the treatment system and equipment will be decontaminated and returned to the appropriate vendor following decontamination activities. Some of the purchased equipment, such as activated carbon, may be recycled or disposed of in the C-746-U Landfill or as otherwise appropriate. In some rare instances, some process piping or equipment cannot be decontaminated. Any process piping and equipment that cannot be successfully decontaminated will be disposed of off-site at an appropriately permitted waste facility. Due to a lack of actual equipment conditions, an estimate of the quantity of this material cannot be generated.

12.2.11 Miscellaneous Noncontaminated Clean Trash

DOE has implemented waste management activities for the segregation of all clean trash (i.e., trash that is not chemically or radiologically contaminated). Examples of clean trash are office paper, aluminum cans, packaging materials, glass bottles not used to store potentially hazardous chemicals, aluminum foil, and food items. During implementation of this WMP, all clean trash will be segregated according to those guidelines and then collected and recycled/disposed of by the WMC once it has been approved for removal. An estimated total of 540 ft^3 of this waste is expected to be generated.

12.3 WASTE MANAGEMENT ROLES AND RESPONSIBILITIES

12.3.1 Waste Management Tracking Responsibilities

Waste generated during sampling activities at PGDP will require a comprehensive waste-tracking system capable of maintaining an up-to-date inventory of waste. The inventory database will be used to store data that will enable determination of management, storage, treatment, and disposal requirements for the waste.

12.3.2 Waste Management Coordinator

The WMC will ensure that all waste activities are conducted in accordance with PGDP facility requirements and this WMP. Responsibilities of the WMC also include coordinating activities with field personnel, overseeing daily waste management operations, and maintaining a waste management logbook that contains a complete history of generated waste and the current status of individual waste containers. Designated waste operators also may complete the waste management logbook.

The WMC will ensure that procurement and inspection of equipment, material or services critical for shipments of waste to off-site TSDFs are conducted in accordance with appropriate procedures. In addition, the WMC will ensure that wastes are packaged and managed in accordance with applicable requirements (e.g., the WAC for the landfill).

Additional responsibilities of the WMC include the following:

- Maintaining an adequate supply of labels;
- Maintaining drum/container inventories at sites;
- Interfacing with all necessary personnel;
- Preparing Requests for Disposal;
- Tracking generated waste;
- Ensuring that drums are properly labeled;
- Coordinating waste recycling, disposal, or transfers;
- Sampling waste containers to characterize wastes;
- Coordinating pollution prevention and waste minimization activities;
- Transferring characterization data to DOE prime contractor's data manager; and
- Ensuring that temporary project waste storage areas are properly established, maintained, and closed.

The WMC and waste operators will perform the majority of waste handling activities. These activities will involve coordination with the DOE prime contractor Southwest Plume RA project manager or designee who will perform periodic inspections to verify that drums are labeled in accordance with the WMP guidelines.

The WMC will be responsible for ensuring characterization sampling of the waste in accordance with the procedures outlined in this plan. When sampling is complete, the WMC will transfer the waste into the waste holding area established for this project, if necessary.

12.3.3 Coordination with Field Crews

The WMC will be responsible for daily coordination with all field crews involved in activities that generate waste. The WMC will perform daily rounds of each of the work sites to oversee the waste collection and will verify that procedures used by the field crews comply with the WMP guidelines. Deficiencies will be documented in the waste management logbook, and appropriate direction will be given to the field crews. Site visits will be documented in the field logbook.

12.3.4 Coordination with Treatment, Storage, and Disposal Facilities

The waste streams generated on the soil mixing with LDAs may be managed and disposed of in a variety of ways depending on characterization and classification. Waste will be stored temporarily on-site, as previously discussed. Waste that is to be shipped to an off-site TSDF must be done so in accordance with applicable DOE contractor procedures and U.S. Department of Transportation requirements and applicable ARARs.

12.3.5 Waste Management Training

The WMC and other project personnel with assigned waste management responsibilities will be trained and qualified in accordance with DOE contractor-approved Training Position Descriptions.

12.4 TRANSPORTATION OF WASTE

The Oil Landfarm area where the soil mixing by LDAs will be conducted is on DOE property. Transportation of waste on DOE property will be conducted in accordance with applicable DOE, PGDP, and DOE prime contractor policies and procedures. In the event that it becomes necessary to transport known or suspected hazardous waste over public roads, coordination will be initiated with PGDP Security, as necessary, which may result in the temporary closing of roads. Once hazardous wastes are transported from a CERCLA site, they are subject to full RCRA regulation; therefore, all transportation and TSDF requirements under RCRA must be followed. Off-site shipments must be accompanied by a manifest. Off-site disposal of hazardous wastes will occur only at a RCRA facility in a unit in full compliance with the Subtitle C requirements. Transportation of known or suspected hazardous waste on public roads will be conducted in accordance with applicable U.S. Department of Transportation regulations (*CFR* Title 49).

12.4.1 Screening of Analytical Samples

During the course of the field activities, screening of samples in the field and in an on-site laboratory routinely will be performed to protect the health and safety of on-site personnel to ensure compliance with regulatory requirements.

12.4.2 Field Screening

Field screening for health and safety will be conducted during project field activities and sample collection. The field screening to be performed will incorporate the use of instrumentation to monitor for organic vapors, as well as radiation meters capable of detecting alpha and beta/gamma radioactivity. An elevated reading from field monitoring may be cause for reevaluation of current waste classification, labeling, and handling activities.

12.4.3 On-Site Laboratory Radiation Screening

A fixed-base laboratory will analyze all waste characterization samples. All samples to be shipped off-site for laboratory analysis will be screened for radiation at an on-site laboratory before shipment and will receive approval for off-site shipment.

12.5 SAMPLE RESIDUALS AND MISCELLANEOUS WASTE MANAGEMENT

The SMO-approved analytical laboratory that has been audited under DOECAP will generate sample residuals and laboratory wastes. The laboratory will manage the disposal of the sample residuals or return waste sample residuals to the project. Nonhazardous wastes generated during analyses will be disposed of by the laboratory.

12.6 WASTE MINIMIZATION

Waste minimization requirements that will be implemented, as appropriate, include those established by the 1984 Hazardous and Solid Waste Amendments of RCRA; DOE Orders 5400.1, 5400.3, 435.1; and DOE contractor’s requirements. Requirements specified in the DOE contractor’s WMP regarding waste generation, waste tracking, waste reduction techniques, and the waste reduction program, in general, also will be implemented.

To support DOE's commitment to waste reduction, an effort will be made during field activities to minimize waste generation as much as possible, largely through ensuring that potentially contaminated wastes are localized and do not come into contact with any clean media (which could create more contaminated waste). Waste minimization also will be accomplished through waste segregation, immediate containerization of waste, selection of PPE, and waste handling (spill control). Efforts will be made to avoid stockpiling soil waste, use coveralls only when necessary, attempt to reuse coveralls, and segregate visibly soiled coveralls from clean coveralls.

12.7 HEALTH AND SAFETY ISSUES RELATED TO WASTE ACTIVITIES

Waste management activities will be conducted in accordance with health and safety procedures documented in the HASP included as Section 7 of this work plan.

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APPENDIX A

MONITORING WELL DESIGN

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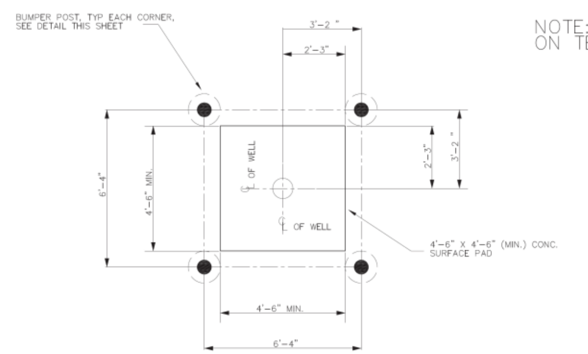
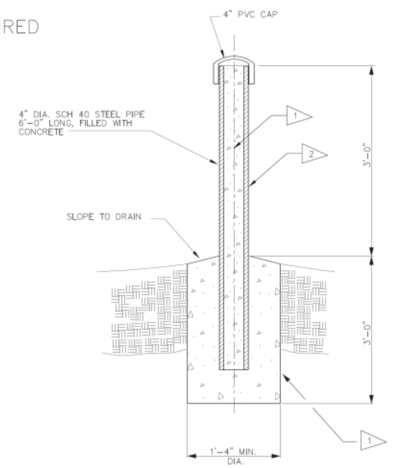
NOTE: PAD AND BOLLARDS ARE NOT REQUIRED ON TEMPORARY PIEZOMETERS



CONCRETE PAD AND BOLLARD LOCATION PLAN

NOT TO SCALE



TYPICAL BOLLARD DETAIL

NOT TO SCALE

GENERAL NOTES:

1. CONCRETE FOR BOLLARDS SHALL BE CLASS "A" IN ACCORDANCE WITH KDH STANDARD SPECIFICATION SECTION 601.
2. BOLLARD SHALL BE CLEANED ACCORDING TO SSPC-SP6 AND PRIMED WITH TNEMEC SERIES 37-77W @ 3-5 MILS AND FINISHED WITH TNEMEC SERIES 82-BW56 @ 2-3 MILS, OR CONTRACTOR ACCEPTED EQUAL.

REFERENCE DRAWINGS	DRAWING NO.
GROUND WATER MONITORING WELLS INSTALLATION DETAILS	C7DCWELLSA003

SECTION AND DETAIL KEY: SECTION NUMBER OR DETAIL LETTER; DRAWING ON WHICH SECTION OR DETAIL IS TAKEN; DRAWING ON WHICH SECTION OR DETAIL IS SHOWN

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PAUL A. CRABTREE 18316
6/28/13
DATE
PROFESSIONAL SEAL

REV.	DATE	DESCRIPTION	DRAWN BY	DRAFT CHK	PROJ ENGR	LEAD ENGR	CONF CHKL/ NUCL SFTY	FAC MGR	DATE MGR
1	6/28/13	GENERAL REVISIONS	KTW	PAC	KRD	PAC	N/A	CTD	PAC

DRAWING REVISIONS

U.S. DEPARTMENT OF ENERGY
PADUCAH, PORTSMOUTH PROJECT OPERATIONS, PADUCAH GASEOUS DIFFUSION PLANT

LATA Environmental Services of Kentucky, LLC — managed for the DEPARTMENT OF ENERGY under U.S. GOVERNMENT contract DE-AC30-10CC40020, Paducah, Kentucky

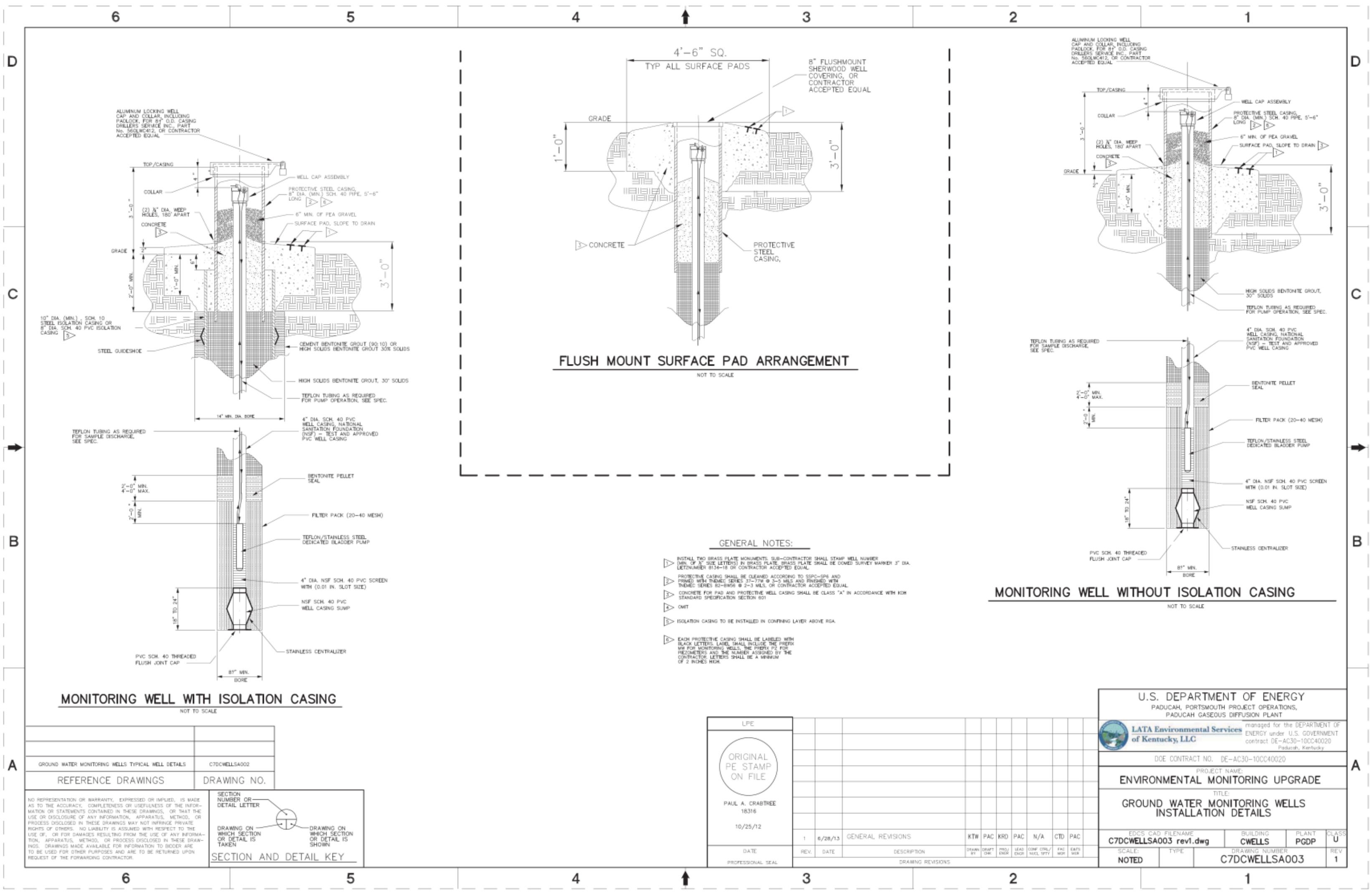
DOE CONTRACT NO. DE-AC30-10CC40020

PROJECT NAME: ENVIRONMENTAL MONITORING UPGRADE

TITLE: GROUND WATER MONITORING WELLS TYPICAL WELL DETAILS

EDCS CAD FILENAME	BUILDING	PLANT	CLASS
C7DCWELLSA002 rev1.dwg	CWELLS	PGDP	U

SCALE	TYPE	DRAWING NUMBER	REV
NOTED		C7DCWELLSA002	1



MONITORING WELL WITH ISOLATION CASING
NOT TO SCALE
ALUMINUM LOCKING WELL CAP AND COLLAR, INCLUDING PADLOCK, FOR 8" O.D. CASING DRILLERS SERVICE INC., PART No. 560LWC412, OR CONTRACTOR ACCEPTED EQUAL
TOP/CASING
COLLAR
WELL CAP ASSEMBLY
PROTECTIVE STEEL CASING, 8" DIA. (MIN.) SCH. 40 PIPE, 5'-6" LONG
(2) ⅜" DIA. WEEP HOLES, 180° APART
CONCRETE
6" MIN. OF PEA GRAVEL
SURFACE PAD, SLOPE TO DRAIN
GRADE
3'-0"
10" DIA. (MIN.), SCH. 10 STEEL ISOLATION CASING OR 8" DIA. SCH. 40 PVC ISOLATION CASING
STEEL GUIDESHOE
CEMENT BENTONITE GROUT (90:10) OR HIGH SOLIDS BENTONITE GROUT 30% SOLIDS
HIGH SOLIDS BENTONITE GROUT, 30" SOLIDS
TEFLON TUBING AS REQUIRED FOR PUMP OPERATION, SEE SPEC.
14" MIN. DIA. BORE
TEFLON TUBING AS REQUIRED FOR SAMPLE DISCHARGE, SEE SPEC.
4" DIA. SCH. 40 PVC WELL CASING, NATIONAL SANITATION FOUNDATION (NSF) - TEST AND APPROVED PVC WELL CASING
BENTONITE PELLET SEAL
2'-0" MIN. 4'-0" MAX.
FILTER PACK (20-40 MESH)
TEFLON/STAINLESS STEEL DEDICATED BLADDER PUMP
4" DIA. NSF SCH. 40 PVC SCREEN WITH (0.01 IN. SLOT SIZE)
NSF SCH. 40 PVC WELL CASING SUMP
18" TO 24"
PVC SCH. 40 THREADED FLUSH JOINT CAP
STAINLESS CENTRALIZER
8" MIN. BORE
FLUSH MOUNT SURFACE PAD ARRANGEMENT
NOT TO SCALE
4'-6" SQ.
TYP ALL SURFACE PADS
8" FLUSHMOUNT SHERWOOD WELL COVERING, OR CONTRACTOR ACCEPTED EQUAL
GRADE
1'-0"
3'-0"
CONCRETE
PROTECTIVE STEEL CASING,
MONITORING WELL WITHOUT ISOLATION CASING
NOT TO SCALE
HIGH SOLIDS BENTONITE GROUT, 30" SOLIDS
GENERAL NOTES:
1 INSTALL TWO BRASS PLATE MONUMENTS. SUB-CONTRACTOR SHALL STAMP WELL NUMBER (MIN. OF ⅜" SIZE LETTERS) IN BRASS PLATE. BRASS PLATE SHALL BE DOMED SURVEY MARKER 3" DIA. LIETZNUMBER 8134-18 OR CONTRACTOR ACCEPTED EQUAL.
2 PROTECTIVE CASING SHALL BE CLEANED ACCORDING TO SSPC-SP6 AND PRIMED WITH TNEMEC SERIES 37-77W @ 3-5 MILS AND FINISHED WITH TNEMEC SERIES 82-BW56 @ 2-3 MILS, OR CONTRACTOR ACCEPTED EQUAL.
3 CONCRETE FOR PAD AND PROTECTIVE WELL CASING SHALL BE CLASS "A" IN ACCORDANCE WITH KDH STANDARD SPECIFICATION SECTION 601
4 OMIT
5 ISOLATION CASING TO BE INSTALLED IN CONFINING LAYER ABOVE RGA.
6 EACH PROTECTIVE CASING SHALL BE LABELED WITH BLACK LETTERS. LABEL SHALL INCLUDE THE PREFIX MW FOR MONITORING WELLS, THE PREFIX PZ FOR PIEZOMETERS AND THE NUMBER ASSIGNED BY THE CONTRACTOR. LETTERS SHALL BE A MINIMUM OF 2 INCHES HIGH.
GROUND WATER MONITORING WELLS TYPICAL WELL DETAILS
C7DCWELLSA002
REFERENCE DRAWINGS
DRAWING NO.
SECTION NUMBER OR DETAIL LETTER
DRAWING ON WHICH SECTION OR DETAIL IS TAKEN
DRAWING ON WHICH SECTION OR DETAIL IS SHOWN
SECTION AND DETAIL KEY
LPE
ORIGINAL PE STAMP ON FILE
PAUL A. CRABTREE
18316
10/25/12
DATE
PROFESSIONAL SEAL
1
6/28/13
GENERAL REVISIONS
KTW
PAC
KRD
PAC
N/A
CTD
PAC
REV.
DATE
DESCRIPTION
DRAWING REVISIONS
U.S. DEPARTMENT OF ENERGY
PADUCAH, PORTSMOUTH PROJECT OPERATIONS,
PADUCAH GASEOUS DIFFUSION PLANT
LATA Environmental Services of Kentucky, LLC
managed for the DEPARTMENT OF ENERGY under U.S. GOVERNMENT contract DE-AC30-10CC40020
Paducah, Kentucky
DOE CONTRACT NO. DE-AC30-10CC40020
PROJECT NAME
ENVIRONMENTAL MONITORING UPGRADE
TITLE
GROUND WATER MONITORING WELLS
INSTALLATION DETAILS
EDCS CAD FILENAME
C7DCWELLSA003 rev1.dwg
BUILDING
CWELLS
PLANT
PGDP
CLASS
U
SCALE
NOTED
TYPE
DRAWING NUMBER
C7DCWELLSA003
REV
1

APPENDIX B

QUALITY ASSURANCE PROJECT PLAN

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CONTENTS

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QAPP WORKSHEETS

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ACRONYMS

CA	corrective action
CAS	Chemical Abstracts Service
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CF	condition report
COPC	chemical of potential concern
CRQL	contract-required quantification limit
DOE	U.S. Department of Energy
DOECAP	U.S. Department of Energy Consolidated Audit Program
DPT	direct push technology
ECD	electron capture detector
EDD	electronic data deliverable
EPA	U.S. Environmental Protection Agency
FFA	Federal Facility Agreement
FFS	focused feasibility study
FID	flame ionization detector
GC	gas chromatograph
GWOU	Groundwater Operable Unit
ID	identification
KDEP	Kentucky Department for Environmental Protection
LATA Kentucky	LATA Environmental Services of Kentucky, LLC
MBWA	Management by Walking Around
MCL	maximum contaminant limit
MDL	method detection limit
MS	mass spectroscopy
N/A	not applicable
NAL	no action level
NCR	nonconformance report
OREIS	Oak Ridge Environmental Information System
PGDP	Paducah Gaseous Diffusion Plant
PID	photoionization detector
PQL	practical quantitation limit
PT	proficiency testing
QA	quality assurance
QA	quality control
QAPP	quality assurance program plan
RAO	remedial action objective
RCT	radiological control technician
RDSI	remedial design support investigation
RG	remediation goal
RGA	Regional Gravel Aquifer
SDG	Sample Delivery Group
SI	site investigation
SOP	standard operating procedure
SW	southwest
SWMU	solid waste management unit
TBD	to be determined
UCRS	Upper Continental Recharge System

VOA	volatile organic analyte
VOC	volatile organic compound
WAG	waste area group
ZVI	zero-valent iron

QAPP Worksheet #1
Title Page

Document Title: *Remedial Action Work Plan for In Situ Source Treatment by Deep Soil Mixing of the Southwest Groundwater Plume Volatile Organic Source at the C-747-C Oil Landfarm (Solid Waste Management Unit 1) at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-1287

Lead Organization: U.S. Department of Energy (DOE)

Preparer's Name and Organizational Affiliation: 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

Preparation Date (Month/Year): 12/2013

Document Control Number:	DOE/LX/07-1287&D1	
LATA Kentucky Environmental Remediation Project Manager	Signature Mark J. Duff	Date
LATA Kentucky Regulatory Manager	Signature Myrna Espinosa Redfield	Date
LATA Kentucky Sample/Data Management Manager	Signature Lisa Crabtree	Date
LATA Kentucky Groundwater Operable Unit Project Manage	Signature Jeff Carman	Date

NOTE: This quality assurance program plan (QAPP) provides the names of the current position holders. The document will be maintained but not resubmitted if the designated position is filled by a different individual. In the event the contactor changes, DOE will notify the U.S. Environmental Protection Agency (EPA) and the Kentucky Department for Environmental Protection (KDEP) of the change and the status of the programmatic QAPP.

QAPP Worksheet #2
QAPP Identifying Information

Site Name/Project Name: Paducah Gaseous Diffusion Plant (PGDP)

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: N/A

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: February 4, 2010

QAPP Worksheet #2 (Continued)
QAPP Identifying Information

NOTE: The above date was the scoping meeting held for scoping the remedial design support investigation (RDSI), but also supports the scoping of the posttreatment sampling and analysis assessment. The posttreatment action sampling and analysis assessment is to provide data to be used to determine the effect the remedial action had on the presence of the contamination in the Solid Waste Management Unit (SWMU) 1 area. By drilling soil borings adjacent to the earlier RDSI soil borings ("twinning") and sampling the posttreatment borings in a similar way as the RDSI borings, before and after (remedial action) contaminant concentrations can be measured and compared to earlier subsurface soil volatile organic compound (VOC) sampling results. Based on the VOC concentration decrease or increase in posttreatment soil and comparing to the baseline values provides a method for identifying the area where contamination exceeds the agreed to cleanup level. Groundwater samples will be obtained from the monitoring wells that will be installed following the soil mixing and from existing wells. The monitoring wells will provide a means for determining the effect of the removal of UCRS soil VOC contaminant source will have on the RGA groundwater in the area of the SWMU 1.

No operational sampling and analysis will be performed that will be covered by this QAPP. The operational sampling is performed utilizing photoionization detector (PID), flame ionization detector (FID), and gas chromatographs (GCs) utilizing a slip-stream sampling line with continuous feed to the PID and FID and period automatic sampling for the GC. Each of these analytical instruments are calibrated and operated consistent with manufacturer's requirements and consistent with the soil mixing contractor's QAPP.

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	10/5/1998
Quality Assurance Project Plan, Attachment A5, Appendix B, Remedial Design Work Plan for Solid Waste Management Units 1, 211-A, and 211-B Volatile Organic Compound Sources for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/LX/07-1268&D2/R2	6/2012

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.

QAPP Worksheet #2 (Continued)
QAPP Identifying Information

Required QAPP Element(s) and Corresponding QAPP Section(s)	Required Information	Worksheet No.
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

QAPP Worksheet #2 (Continued)
QAPP Identifying Information

Required QAPP Element(s) and Corresponding QAPP Section(s)	Required Information	Worksheet No.
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, 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

QAPP Worksheet #2 (Continued)
QAPP Identifying Information

Required QAPP Element(s) and Corresponding QAPP Section(s)	Required Information	Worksheet No.
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	N/A	N/A
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	N/A	N/A

QAPP Worksheet #3
Minimum Distribution List

Controlled copies of the QAPP will be distributed according to the distribution list below. This list will be updated, as needed, and kept by the LATA Kentucky records management department. Each person receiving a controlled copy also will receive and updates/revisions. If uncontrolled copies are distributed, it will be the responsibility of the person distributing the uncontrolled copy to provide updates/revisions.

Position Title	Organization	QAPP Recipients	Current Telephone Number	Current E-mail Address	Document Control Number
Acting Paducah Site Lead	DOE	Rachel H. Blumenfeld	(270) 441-6806	rachel.blumenfeld@lex.doe.gov	1
Project Manager	DOE	Dave Dollins	(270) 441-6819	dave.dollins@lex.doe.gov	2
Environmental Remediation Project Manager	LATA Kentucky	Mark Duff	(270) 441-5030	mark.duff@lataky.com	3
Regulatory Manager	LATA Kentucky	Myrna Redfield	(270) 441-5113	myrna.redfield@lataky.com	4
Manager of Projects	LATA Kentucky	Craig Jones	(270) 441-5114	craig.jones@lataky.com	5
FFA Manager	KDEP	Todd Mullins	(502) 564-6716	todd.mullins@ky.gov	6
FFA Manager	EPA	Jennifer Tufts	(404) 562-8513	jennifer.tufts@epamail.epa.gov	7
Remedial Project Manager	EPA	Jennifer Tufts	(404) 562-8513	jennifer.tufts@epamail.epa.gov	8
Risk Assessment Manager	LATA Kentucky	Joe Towarnicky	(270) 441-5134	joe.towarnicky@lataky.com	9
FFA Manager	LATA Kentucky	Jana White	(270) 441-5185	jana.white@lataky.com	10
Quality Assurance Manager	LATA Kentucky	Michelle Dudley	(270) 441-5058	michelle.dudley@lataky.com	11
Environmental Monitoring and Reporting Program Manager	LATA Kentucky	Kelly Layne	(270) 441-5217	kelly.layne@lataky.com	12
Environment, Safety, and Health Manager	LATA Kentucky	Dave Kent	(270) 441-5404	dave.kent@lataky.com	13
Regulatory Compliance Manager	LATA Kentucky	Michael Gerle	(270) 441-5069	michael.gerle@lataky.com	14
Sample/Data Management Manager	LATA Kentucky	Lisa Crabtree	(270) 441-5135	lisa.crabtree@lataky.com	15

NOTE: Distribution is based on the position title. A change in the individual within an organization will not trigger a resubmission of the programmatic QAPP. DOE may choose to update the sheet and submit changes to the programmatic document holders. This change will not require a review by the FFA stakeholders as it is not a substantive change. These managers will be responsible for distribution to their staff assigned to project-specific field sampling plans.

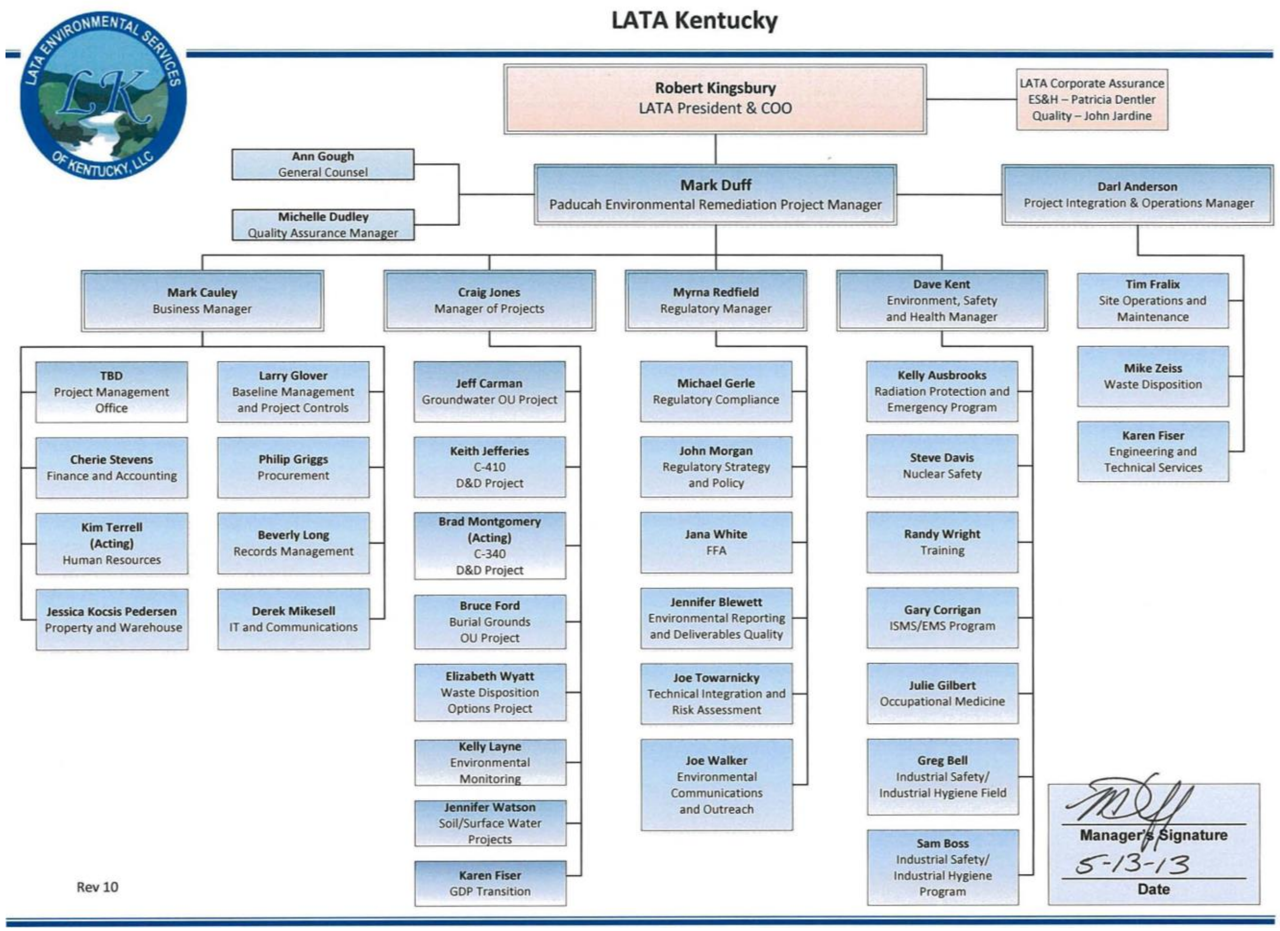
QAPP Worksheet #4
Project Personnel Sign-Off Sheet

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 and will be made available upon request.

Project Position Title	Organization	Signature	Date
Project Manager			
Task Lead			
Data Coordinator			
Data Validator			
Data Reviewer			
QA Specialist			
Project Geologist			
Environmental Sampling Lead			
Sampler			

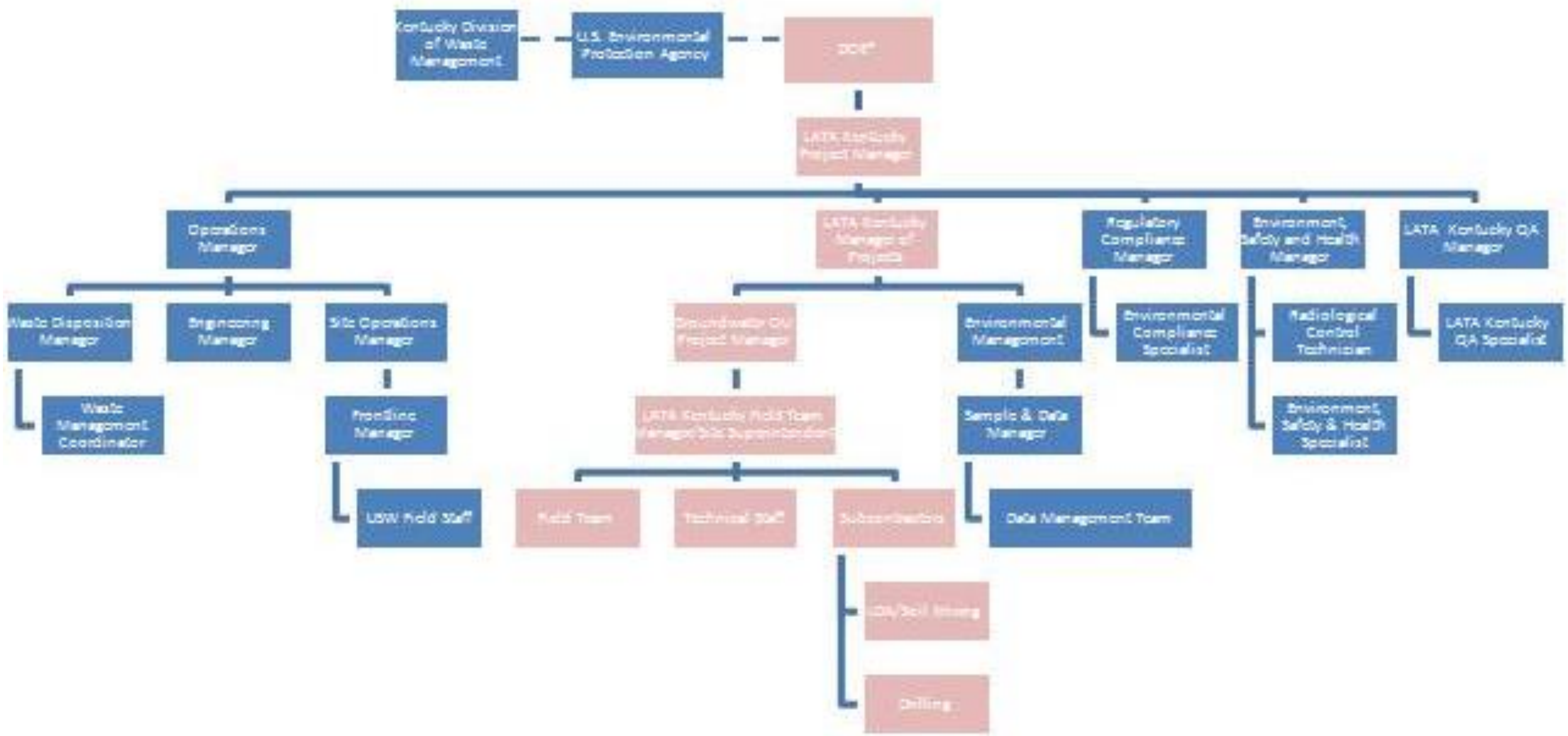
QAPP Worksheet #5-A
Project Contractor Organizational Chart*

This portion of the QAPP addresses the project organization as it provides for quality assurance (QA)/quality control (QC) coordination and responsibilities. This QAPP includes the overall project organization at the Environmental 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.

QAPP Worksheet #5-B
Project Level Organizational Chart



*Mauve background indicates main project team organization.

QAPP 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	Paducah FFA Manager	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.

QAPP 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
Field and Analytical Corrective Actions	LATA Kentucky	Quality Assurance Specialist	Quality Assurance Manager	All internal communications regarding corrective actions for field and analytical issues
QAPP Amendments	LATA Kentucky	Environmental Monitoring and Reporting Project Manager	Environmental Monitoring and Reporting Project Manager	All internal communications regarding major changes to the QAPP

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

QAPP 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
Quality Assurance Manager	LATA Kentucky	Project quality assurance responsibility	Bachelor degree plus > 1 year relevant experience
Field Project Manager	LATA Kentucky	Project compliance with the Characterization Plan	> 4 years relevant work experience

QAPP Worksheet #7 (Continued)
Personnel Responsibility and Qualifications Table

Position Title Responsible	Organization Affiliation	Responsibilities	Education and Experience Qualifications
Environmental Sampling Lead	LATA Kentucky	Project sampling responsibility	> 4 years relevant work experience
Project Geologist	LATA Kentucky	Geologic characterization and interpretation of investigation-derived data	Bachelor degree plus relevant experience

QAPP 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 field sampling plan; the package will list specific project-level training requirements.

Project Function	Specialized Training—Title or Description of Course	Training Provider	Training Date	Personnel/Groups Receiving Training	Personnel Titles/ Organizational Affiliation	Location of Training Records/Certificates*
Drill Rig Operator	Kentucky Certified Well Driller	State of Kentucky	TBD	Drill Rig Operator	Drill Rig Operator/TBD	TBD

*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

QAPP Worksheet #9
Project Scoping Session Participants Sheet

Project scoping is the key to the success of any project and is part of the systematic planning process. A scoping meeting was held to develop the data quality objectives of the project. The scoping meeting identified the borings for the RDSI as well as the posttreatment sampling and analysis. The RDSI VOC analytical soil data obtained provides the basis for the determining the changes in the VOC contaminant levels following the treatment action. The posttreatment sampling analysis will twin these RDSI soil borings and the associated sample collection. Additionally, the posttreatment sampling will collect, to the degree possible, twin samples for non-RDSI samples collected in previous investigation efforts. These changes in VOC contaminant levels, although not expected to result in the attainment of the required cleanup levels, will provide a means of determining the effects the remedial action had on the VOC contamination in the source area.

NOTE: The scoping meeting held February 4, 2010, for the RDSI also supports this remedial action. The RDSI scope covered both the SWMU 1 area as well as the SWMUs at the C-720 Building included in the ROD. This remedial action is limited to the SWMU 1 area. The portion of the RDSI implemented at SWMU 1 along with previous investigations provided the baseline for the VOC contamination present at SWMU requiring remedial action. The RDSI data was utilized to identify the area that is to undergo the soil mixing and placement of ZVI; therefore, the RDSI further provides the baseline for measuring the success of the treatment by Soil Mixing and support the posttreatment sampling. Section 8.1 of this RAWP provides the sampling to be performed as part of the posttreatment activities.

QAPP Worksheet #9
Project Scoping Session Participants Sheet (Continued)

Name of Project: ***In Situ* Source Treatment Using Deep Soil Mixing for the Southwest Groundwater Plume Volatile Organic Compound Source at the C-747-C Oil Landfarm (SWMU 1)---Composed of the** RDSI characterization plan for the C-747-C Oil Landfarm and C-720 Northeast and Southeast Site and posttreatment sampling and analysis for SWMU 1 remedial action

Date of Session: February 4, 2010

Scoping Session Purpose: Develop data quality objectives

Position Title	Affiliation	Name	Phone #	E-mail Address	Project Role
Project Manager	Portage	John Keck	208-419-4149	jkeck@portageinc.com	Project management
Groundwater Operable Unit (GWOU) Manager	LATA Kentucky	Jeff Carman	270-441-5229	jeff.carman@lataky.com	Program management
Risk Manager	Portage	Charleen Roberts	208-377-3281	croberts@portageinc.com	Technical support
Engineer	LATA Kentucky	Mike Clark	270-441-5791	michael.clark@lataky.com	Technical support
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QAPP Worksheet #10
Problem Definition

The problem to be addressed by the project:

PGDP Southwest Plume consists of groundwater in the Regional Gravel Aquifer (RGA) contaminated primarily with trichloroethene (TCE). The C-747-C Oil Landfarm (SWMU 1) is a source of contamination to the Southwest Plume. A revised focused feasibility study (FFS) was performed for the Southwest Plume source area. remedial action objectives (RAOs) defined in the revised Southwest Plume FFS include these:

(1) Treat and/or remove the principal threat waste consistent with the National Contingency Plan;

(2a) Prevent exposure to VOC contamination in the source areas that will cause an unacceptable risk to excavation workers (< 10 ft);

(2b) Prevent exposure to non-VOC contamination through interim land use controls within the Southwest Plume source areas (i.e., SWMU 1, SWMU 211-A, and SWMU 211-B) pending remedy selection as part of the Soils Operable Unit and the GWOU; and

(3) Reduce VOC migration from contaminated subsurface soils in the treatment areas at the Oil Landfarm and C-720 Northeast and Southeast sites so that contaminants migrating from the treatment areas do not result in an exceedance of maximum contaminant limit (MCLs) in underlying RGA groundwater.

Soil remediation goals (RGs), volume-averaged TCE Upper Continental Recharge System (UCRS) soil concentrations that would meet RAO 3, calculated in the revised Southwest Plume FFS Appendix C, are listed below:

- Oil Landfarm source area: 7.3E-02 mg/kg

Previous investigations documented in the Waste Area Group (WAG) 27 remedial investigation and the site investigation (SI) report did not completely define either the areal and vertical extent of soil contaminated above RGs in the source area nor the presence or extent of dense nonaqueous-phase liquid TCE. These were identified in the Southwest Plume revised FFS as data gaps and were resolved in the RDSI. The RDSI along with previous analytical results for VOCs in UCRS soil provide the baseline for determining the soil mixing treatment effectiveness.

The environmental questions being asked:

1. What is the areal and vertical extent of TCE and other VOCs present at SWMU 1 at volume-averaged concentrations compared to RGs at the Southwest Plume source area following completion of the active treatment of soil mixing and placement of ZVI?

QAPP Worksheet #10 (Continued)
Problem Definition

Observations from any site reconnaissance reports:

Characterization data from the WAG 27 RI, Southwest (SW) Plume SI, and Section 1.3 RDSI, *Remedial Design Report In Situ Source Treatment Using Deep Soil Mixing for the Southwest Groundwater Plume Volatile Organic Compound Source at the C-747-C Oil Landfarm (Solid Waste Management Unit 1)*, DOE/LX/07-1276, provide the pretreatment concentrations of TCE and VOCs in the UCRS soils at SWMU 1.

A synopsis of secondary data or information from site reports:

- Section 1 of the *Remedial Design Report In Situ Source Treatment Using Deep Soil Mixing for the Southwest Groundwater Plume Volatile Organic Compound Source at the C-747-C Oil Landfarm (Solid Waste Management Unit 1)* provides the baseline data for the SWMU 1 UCRS Source Area.

- Section 8 of *Remedial Action Work Plan for In Situ Source Treatment Using Deep Soil Mixing of the Southwest Groundwater Plume Volatile Organic Source at the C-747-C Oil Landfarm (Solid Waste Management Unit 1)*, DOE/LX.07-1287&D2, contains the associated information for the implementation of the posttreatment sampling and assessment.

The possible classes of contaminants and the affected matrices:

Contaminants are VOCs.

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

UCRS Soils and UCRS Groundwater and RGA groundwater

The rationale for inclusion of chemical and nonchemical analyses:

Worksheet #11 presents rationale for inclusion of non-VOC chemical and nonchemical analyses.

Information concerning various environmental indicators:

Groundwater investigations have indicated that the SWMU 1 is a contributor to the TCE contamination in the SW Plume RGA groundwater.

QAPP Worksheet #10 (Continued)
Problem Definition

Project decision conditions ("If..., then..." statements): Project decision statements are not required for the Posttreatment Sampling and Analysis. The posttreatment sampling and assessment will follow the treatment of soil mixing and placement of ZVI by approximately 6 months due to high subsurface temperatures and potential instability in the ground surface. Since the sampling and assessment follows the active treatment, no modifications to the soil mixing treatment or additional soil columns or placement of additional ZVI will be possible without a separate field mobilization. If adjustments or additional activities are determined to be necessary, that determination would be made later after posttreatment project has left the field. A follow-on project or projects would be responsible for implementing the additional active remedial activities. No operational sampling and analysis will be performed that will be covered by this QAPP. The operational sampling is performed utilizing PID, FID and GCs utilizing a slip-stream sampling line with continuous feed to the PID and FID and period automatic sampling for the GC. Each of these analytical instruments are calibrated and operated consistent with manufacturer's requirements and consistent with the soil mixing contractor's quality assurance project plan. These instruments are integrated into the Soil Mixing and ZVI placement large diameter auguring equipment. They will provide the data necessary to make the active treatment decisions. Section 3.2, Criteria for Ceasing Remedial Action System Operations located in the main text of this document provides the criteria for determining the number of passes with the soil mixing augers and steam and what percent of ZVI will injected into the UCRS soils on the last pass of the soil mixing augers. This information is not presented here but is referenced since it provides the basis for using the real-time data provided by the PID, FID and the GCs. The reader is directed to Section 3.2 in the main text for specific information on the data and process for making these operational decisions.

No operational sampling and analysis will be performed that will be covered by this QAPP. The operational sampling is performed utilizing PID, FID and GCs utilizing a slip-stream sampling line with continuous feed to the PID and FID and period automatic sampling for the GC. Each of these analytical instruments are calibrated and operated consistent with manufacturer's requirements and consistent with the soil mixing contractor's quality assurance project plan.

QAPP Worksheet #11
Project Quality Objectives/Systematic Planning Process Statements

Who will use the data?

DOE and its contractors (e.g., LATA Kentucky, Pro-2-Serv, KDEP, and EPA).

What will the data be used for?

To evaluate the effectiveness of the soil mixing with steam treatment at removing VOC contamination in the SWMU 1 UCRS soils and effectiveness at placing ZVI in the subsurface soils consistent with design document requirements.

What types of data are needed? (target analytes, analytical groups, field screening, on-site analytical or off-site laboratory techniques, sampling techniques)

Qualitative field instrumentation results will be used to determine the depth interval to sample the soil core with an Encore sampler and analyze for VOCs by an off-site Sample Management Office laboratory, along with associated QC samples. The soil samples will be analyzed for VOC and ZVI concentration. The VOC analysis is necessary since the baseline samples from earlier investigations and the RDSI sampled for VOCs and that VOCs are the target of the remedial action for this unit. The VOC analyses collected from the posttreatment sampling will be utilized to provide a comparison of VOC contaminant concentrations before and after the soil mixing process. The collection of ZVI samples will allow an assessment of the soil mixing treatment to be performed. Groundwater samples will be obtained from the monitoring wells that will be installed following the soil mixing and from existing wells. The monitoring wells will provide a means for determining the effect of the removal of UCRS soil VOC contaminant source will have on the RGA groundwater in the area of the SWMU 1.

Real-time data will be collected to determine the relative level of contamination being extracted during mixing and steam using field gas chromatographs. Temperature of extracted gas will be collected real time to estimate the temperature of the subsurface reached by injection of steam.

How "good" do the data need to be in order to support the environmental decision?

The posttreatment sampling and evaluation will not result in an environmental decision being made as part of this project but will provide only a comparison of pre- and post-active treatment VOC contaminant concentrations. Environmental decisions, if they are required, will be made as part of the GWOU Project at a later time; however, the data collected in the posttreatment sampling and evaluation will need to be at a level consistent to that obtained in the RDSI portion of the Remedial Design Report to allow data comparison. Therefore, the data needs will be consistent with the measurement quality objective and data quality indicators established by the systematic planning process for the RDSI. To that end, all posttreatment sampling and evaluation fixed-laboratory data will be verified and assessed with 10% validated at Level IV, which is consistent with the level of effort performed in the RDSI data collection.

The real-time data collected will be qualitative in nature relative to the soil cleanup levels documented in the ROD.

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

The numbers of samples to be submitted to the fixed-laboratories are identified in Section 8 of this RAWP and Worksheet #18.

QAPP Worksheet #11
Project Quality Objectives/Systematic Planning Process Statements (Continued)

Where, when, and how should the data be collected/generated?

See Section 8, Posttreatment Sampling and Analysis, of this RAWP.

Who will collect and generate the data?

A sample team of individuals who are properly trained and skilled in the execution of screening and sampling procedures will perform the field screening measurements and then collect the encore samples, prepare samples for shipment and ship the samples. The sampling team will utilize the same general steps for determining soil sample locations as utilized in the RDSI. Consistency with the RDSI approach is necessary to provide a posttreatment data set that is, to the degree possible, consistent with the pre-treatment RDSI data set. The details of this screening process is included in Section 8.1 of this RAWP.

How will the data be reported?

Field data will be recorded on chain-of-custody forms, in field logbooks, and field data sheets. The field and fixed-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 Oak Ridge Environmental Information System (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.

QAPP Worksheet #12-A---Measurement Performance Criteria Table[1]

Sampling of soils will follow the standard operating procedures included in Sections 2 and 8 of this RAWP. The following table provides the measurement performance criteria.

Matrix: Soil/Sediment						
Analytical Group: Volatile Organic Compounds[1,2]						
Concentration Level: Low						
Analyte	**CAS Number**	**EPA Method**	**Soil/Sediment Accuracy % Recovery**	**Soil/ Sediment Precision RPD Lab/Field**	**Soil/ Sediment PQL (µg/Kg)**	**Soil/ Sediment MDL*(µg /Kg)**
1,1-Dichloroethene	75-35-4	SW-846, 8260B	50-150	< 22/< 50	10	5
cis-1,2-Dichloroethene	156-59-2	SW-846, 8260B	50-150	< 22/< 50	10	5
trans-1,2-Dichloroethene	156-60-5	SW-846, 8260B	50-150	< 22/< 50	10	5
Trichloroethene	79-01-6	SW-846, 8260B	50-150	< 22/< 50	10	5
Vinyl Chloride	75-01-4	SW-846, 8260B	50-150	< 22/< 50	10	5

[1] Additional information about quality control samples is found in Worksheet #28.
[2] Identifies routinely available analytical limits expected to be achieved in the groundwater monitoring; these values will be used to procure laboratory services. If the laboratory services cannot meet the limits specified in the QAPP, the QAPP will be amended and resubmitted.
*The analytical laboratory may not be able to meet the project action limits established by contaminant transport modeling in Appendix C of *Revised Focus Feasibility Study for Solid Waste Management Units 1, 211A, and 211B Volatile Organic Compound Sources for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, [Revised Focused Feasibility Study (Revised FFS)]. In those cases, LATA Kentucky will have the laboratory report to the method detection limit qualifying the result as estimated. Standard practices for qualifying data will apply for any result reported below the laboratory practical quantitation limit.

QAPP Worksheet #12-K
Measurement Performance Criteria Table[1]

Sampling of groundwater will follow the standard operating procedures included in Sections 2 and 8 of this RAWP. The following table provides the measurement performance criteria.

Matrix: Water/Groundwater						
Analytical Group: Volatile Organic Compounds[1,2]						
Concentration Level: Low						
Analyte	**CAS Number**	**EPA Method**	**Aqueous Accuracy % Recovery**	**Aqueous Precision RPD**	**Water PQL (µg/L)**	**Water MDL*(µg/L)**
1,1-Dichloroethene	75-35-4	SW-846, 8260B	80-120	< 25	5	2.5
cis-1,2-Dichloroethene	156-59-2	SW-846, 8260B	70-125	< 25	1	0.5
trans-1,2-Dichloroethene	156-60-5	SW-846, 8260B	70-125	< 25	1	0.5
Trichloroethene	79-01-6	SW-846, 8260B	70-125	≤ 25	1	0.5
Vinyl Chloride	75-01-4	SW-846, 8260B	50-145	≤ 25	2	1

[1] Additional information about QC samples is found in Worksheet #28.
[2] Identifies routinely available analytical limits expected to be achieved in the groundwater monitoring; these values will be used to procure laboratory services. If the laboratory services cannot meet the limits specified in the QAPP, the QAPP will be amended and resubmitted.
*The analytical laboratory may not be able to meet the project action limits established by contaminant transport modeling in Appendix C of *Revised Focus Feasibility Study for Solid Waste Management Units 1, 211A, and 211B Volatile Organic Compound Sources for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, [Revised Focused Feasibility Study (Revised FFS)]. In those cases, LATA Kentucky will have the laboratory report to the method detection limit qualifying the result as estimated. Standard practices for qualifying data will apply for any result reported below the laboratory practical quantitation limit.

QAPP 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	OREIS data will be used to provide a baseline data point(s) from which to measure the success of the soil mixing treatment through comparison to sample analyses results obtained from the Posttreatment sampling and analysis.	Data have been verified, assessed, and validated (if validation required). Rejected data will not be used.
Historical Documentation	WAG 27 RI Report (DOE/OR/07-1777&D2)[1]	DOE contractors, soil and water, 1998	Data will be used to provide a baseline data point(s) from which to measure the success of the soil mixing treatment through comparison to sample analyses results obtained from the Posttreatment sampling and analysis.	Data have been verified, assessed, and validated (if validation required). Rejected data will not be used. Subsequent excavation has removed some high-PCB areas at SWMU 1.
Historical Documentation	SW Plume SI Report (DOE/OR/07-2180&D2/R1)[2]	DOE contractors, soil and water, 1997	Data will be used to provide a baseline data point(s) from which to measure the success of the soil mixing treatment through comparison to sample analyses results obtained from the Posttreatment sampling and analysis.	Data have been verified, assessed, and validated (if validation required). Rejected data will not be used.

QAPP Worksheet #13 (Continued)
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
Historical Documentation	*Remedial Design Report In Situ Source Treatment Using Deep Soil Mixing for Southwest Plume Volatile Organic Source at the C-747-C Oil Landfarm (Solid Waste Management Unit 1) at the Paducah Gaseous Diffusion Plant*, DOE/LX/07-1276&D1	DOE contractors, soil, 2012	Data will be used to provide a baseline data point(s) from which to measure the success of the soil mixing treatment through comparison to sample analyses results obtained from the Posttreatment sampling and analysis.	Data have been verified, assessed, and validated (if validation required). Rejected data will not be used.

[1] The data were generated with sufficient sensitivities (detection limits), analyte suites, and analytical methods for use in making decisions in the current characterization plan.
[2] See note 1.

QAPP 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 samples—Worksheets #20 and #28
- Equipment calibration—Worksheets #22 and #24
- Data review/validation—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 this Remedial Action Work Plan, Section 9.

Documentation and Records:

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

QAPP Worksheet #14 (Continued)
Summary of Project Tasks*

Assessment/Audit Tasks:

Assessments and audits will be per procedure PAD-QA-1420, *Conduct of Management 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 direct push technology (DPT) sampling at the SWMU 1 area of field implementation to verify work is being performed consistent with the SAP contained in Section 8 of this RAWP.

Data Review Tasks:

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

*It is understood that SOPs are contractor specific.

QAPP Worksheet #15-A
Reference Limits and Evaluation Table

Matrix: Soil
Analyte Group: VOCs

VOCs	CAS Number	Project Action Limit/NAL (μg/kg)	Project Action Limit Reference*	Site COPC?	Laboratory-Specific***	
					PQLs (μg/kg)	MDLs (μg/kg)
1,1-Dichloroethene	75-35-4	62.6	Worker Protection RGs	Yes	10	5
cis-1,2-Dichloroethene	156-59-2	600	Groundwater Protection RGs	Yes	10	5
trans-1,2-Dichloroethene	156-60-5	1,080	Groundwater Protection RGs	Yes	10	5
Trichloroethene	79-01-6	58.5	Worker Protection RGs	Yes	10	5
Vinyl chloride	75-01-4	34	Groundwater Protection RGs	Yes	10	5

*Project Action Limits shown are remedial goals from the lesser value of Table 2.1 and Table 2.2 of Revised FFS. Table 2.1 provides worker protection RGs. Table 2.2 provides groundwater protection RGs.
**The analytical laboratory may not be able to meet the project action limits established by contaminant transport modeling in Appendix C of Revised FFS. In those cases, LATA Kentucky will have the laboratory report to the method detection limit qualifying the result as estimated. Standard practices for qualifying data will apply for any result reported below the laboratory practical quantitation limit.
***Identifies routinely available analytical limits expected to be achieved in the groundwater monitoring; these values will be used to procure laboratory services. If the laboratory services cannot meet the limits specified in the QAPP, the QAPP will be amended and resubmitted.

QAPP Worksheet #15-B
Reference Limits and Evaluation Table

Matrix: Groundwater
Analytical Group: Volatile Organic Compounds

VOCs	CAS Number	Project Action Limit/NAL (µg/L)*	Project Action Limit Reference*	Site COPC?	Laboratory-Specific**	
					PQLs (µg/L)	MDLs (µg/L)
1,1-Dichloroethene	75-35-4	7	MCL	Yes	5	2.5
cis-1,2-Dichloroethene	156-59-2	70	MCL	Yes	1	0.5
trans-1,2-Dichloroethene	156-60-5	100	MCL	Yes	1	0.5
Trichloroethene	79-01-6	5	MCL	Yes	1	0.5
Vinyl Chloride	75-01-4	2	MCL	Yes	2	1

*This project does not have applicable groundwater cleanup levels, The Project Action Limits shown are groundwater protection remediation goals from Table 2.2 of Revised FFS. These groundwater protection remediation goals provided the basis for determining the UCRS soil cleanup levels applicable for this remedial action.
**The analytical laboratory may not be able to meet the no action levels (NALs) established by Methods for Conducting Risk Assessments and Risk Evaluation at PGDP (Risk Methods Document). In those cases, LATA Kentucky will have the laboratory report to the method detection limit qualifying the result as estimated. Standard practices for qualifying data will apply for any result reported below the laboratory practical quantitation limit. Identifies routinely available analytical limits expected to be achieved in the groundwater monitoring; these values will be used to procure laboratory services. If the laboratory services cannot meet the limits specified in the QAPP, the QAPP will be amended and resubmitted.

QAPP Worksheet #16
Project Schedule/Timeline Table

Section 6 of this RAWP provides the project-specific schedule of activities for this remedial action.

QAPP 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 posttreatment nature and extent investigation will be implemented utilizing boring locations co-located adjacent to the RDSI soil borings as described in Section 8.1 of the RAWP. The posttreatment investigation will be based primarily on sampling from soil borings completed with DPT. In each soil boring, the investigation will characterize VOC trends using field PID readings at 0.5 ft depth intervals from surface to the base of the UCRS at a depth of approximately 60 ft. At least one soil sample will be collected for fixed laboratory analysis from each 5-ft depth interval. The sample location will be based on the portion of the core exhibiting the highest PID readings. The sample results will provide an indication of posttreatment VOC source material remaining in the UCRS. The posttreatment investigation also will collect samples for laboratory analysis of the percent of ZVI present in the UCRS soils.

Monitoring wells will be drilled and completed at six locations around SWMU 1 and when combined with the existing monitoring well—MW161 will—provide ongoing groundwater samples to determine the reduction of VOC contamination in the RGA from the SWMU 1 area. The wells also will provide groundwater levels.

Real-time data will be collected to determine the relative level of contamination being extracted during mixing and steam using field gas chromatographs. Temperature of extracted gas will be collected real time to estimate the temperature of the subsurface reached by injection of steam. The real-time data is qualitative in nature to allow operators to assess the effectiveness of the remedy in a real-time approach. The real-time data collected will be qualitative in nature relative to the soil cleanup levels documented in the ROD.

Describe the sampling design and rationale in terms of which matrices will be sampled:

Soil borings will be sampled at predetermined locations to compare TCE levels with SWMU-specific cleanup levels and also to baseline TCE levels present during the RDSI. The change in the level of contamination present in the posttreatment sampling will provide data for determining the effect the soil mixing with steam/hot air and placement of ZVI has had on the treated area.

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

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

  Standard Environmental Sampling:

  Volatile organic compounds (VOCs) by SW-846, 8260B. **See Worksheet #12A and #12K for method detection limit.**

  Engineering & Design Sampling:

  For soils: zero-valent iron presence and quantity will be performed in the laboratory. The test is an experimental procedure utilized to check the weight of magnetic iron against weight of soil sample to determine the presence of ZVI in the mixed zone sampled. The process analysis is described in Section 8.1.1, Soil Sampling, and 8.1.2, Groundwater Sampling, of this RAWP.

- **Where are the sampling locations (including QC, critical, and background samples)?**

  See Worksheet #18.

- **How many samples to be taken?**

  See Worksheet #18.

- **What is the sampling frequency (including seasonal considerations)?**

  This is a one-time sampling event except for the monitoring wells. The monitoring wells will be sampled initially over a two-year period. The first-year will be on a quarterly basis; while the second year will be on a semiannual basis. Sampling beyond the initial two-year period will be performed as part of and consistent with the PGDP Environmental Monitoring Plan and will support the required CERCLA five-year reviews of remedial actions.

QAPP Worksheet #17-B
Engineering and Design Sampling

	Media Type	Sample Location	Number of Samples	Test/Analytical Method	Project Action Limit	PQL
Geotechnical Analysis						
ZVI (magnetic) Weight Content Analysis	Soil	Adjacent to VOC soil samples	180	N/A*	N/A	N/A

*These qualitative tests will be performed by a geotechnical fixed-base laboratory.
N/A = not applicable

QAPP Worksheet #18-A
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)	Sampling SOP Reference	Rationale for Sampling Location
SWMU 1	Soil	Subsurface	VOCs	Up to 439 mg/kg TCE	180[1]+9 field duplicates +9 confirmation samples	See Worksheet #21	See Worksheet #17-A[3]
	Groundwater	Subsurface	VOCs	TCE assumed 11,000 µg/L	36[2]+2 field duplicates		

[1] Fifteen soil borings with 12 samples per boring. Soil sample depth is field determined. Soil sample selection will be made by obtaining sample from the portion of the 5 ft core having the highest PID readings obtained from PID scan.
[2] Six wells sampled quarterly first year and semiannually second year for 36 samples.
[3] Sample analytical results beyond the initial two-year period will be performed as part of and consistent with the PGDP Environmental Monitoring Plan and will support the required CERCLA five-year reviews of remedial actions.

QAPP 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)
Soil	Volatile Organic Compounds	See Worksheet #18	8260B	250 g	9 oz. Glass*	Cool to 4°C	14 days

*Alternate containers for the soil samples will utilize three 5 g Encore samplers.

QAPP Worksheet #19 (Continued)
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)
Groundwater	Volatile Organic Compounds	See Worksheet #18	8260B	120 mL	3 x 40 mL Glass volatile organic analyte (VOA) vial	Cool < 4°C, HCl	14 days for preserved

NOTE: Sample volume container requirements will be specified by the laboratory. Sample bottle requirements will be documented and relayed to the field sampling team via labels and chain-of-custody forms generated by PEMS (Project Environmental Measurements System).

QAPP 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[1]	Total No. of Samples to Lab[2]
Soil	VOCs	Moderate	See Worksheet #12	See Worksheet #17	5%	N/A	5%	5%	N/A	See Worksheet #18-A
Groundwater	VOCs	High	See Worksheet #12	See Worksheet #17	5%	N/A	5%	5%	N/A	See Worksheet #18-A

[1] Proficiency testing (PT) sample will be collected only when required by a specific project.
[2] A fixed laboratory will perform groundwater and soil VOC analyses. Confirmation samples for VOCs will be sent to a fixed-laboratory at a rate of 10% along with VOCs needed for field QC samples. All other analyses will be performed by a fixed or fixed-based laboratory.

QAPP 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	None
2	PAD-ENM-0026, *Wet Chemistry and Misc. Analyses Data Verification and Validation*	Contractor	N/A	N	None
3	PAD-ENM-1001, *Transmitting Data to the Paducah Oak Ridge Environmental Information System (OREIS)*	Contractor	N/A	N	None
4	PAD-ENM-1003, *Developing, Implementing, and Maintaining Data Management Implementation Plans*	Contractor	N/A	N	None
5	PAD-ENM-2100, *Groundwater Level Measurement*	Contractor	Sampling	N	None
6	PAD-ENM-2101, *Groundwater Sampling*	Contractor	Sampling	Y[c]	None
7	PAD-ENM-2300 *Collection of Soil Samples*	Contractor	Sampling	N	None
8	PAD-ENM-2303, *Borehole Logging*	Contractor	Sampling	N	None
9	PAD-ENM-2700, *Logbooks and Data Forms*	Contractor	N/A	N	None
10	PAD-ENM-2702, *Decontamination of Sampling Equipment and Devices*	Contractor	Sampling	N	None
11	PAD-ENM-2704, *Trip, Equipment, and Field Blank Preparation*	Contractor	Sampling	N	None
12	PAD-ENM-2708, *Chain-of-Custody Forms, Field Sample Logs, Sample Labels, and Custody Seals*	Contractor	Sampling	N	None
13	PAD-ENM-5003, *Quality Assured Data*	Contractor	N/A	N	None
14	PAD-ENM-5004, *Sample Tracking, Lab Coordination, and Sample Handling*	Contractor	N/A	N	None
15	PAD-ENM-5007, *Data Management Coordination*	Contractor	N/A	N	None
16	PAD-ENR-0020, Collection of Soil Samples with *Direct Push Technology Sampling*	Contractor	Sampling	N	None
17	PAD-ENM-5105, *ROAC1 Volatile and Semivolatile Data Verification and Validation*	Contractor	N/A	N	None

QAPP Worksheet #21 (Continued)
Project Sampling SOP References Table

Reference Number	Title, Revision Date, and/or Number[a]	Originating Organization[b]	Equipment Type	Modified for Project Work? (Y/N)	Comments
18	PAD-ENM-5107, *Inorganic Data Validation and Verification*	Contractor	N/A	N	None

[a] SOPs are posted to the LATA Kentucky intranet Web site. External FFA parties can access this site using remote access with privileges upon approval.
[b] The work will be conducted by LATA Kentucky staff or a subcontractor. In either case, SOPs listed will be followed.
[C] Work instructions for groundwater sampling will include a modification to the steps of PAD-ENM-2101 to incorporate sampling in wells with non-dedicated pumps.
N/A = not applicable

QAPP 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	Manufacturers specifications
Water Quality Meter	Calibrate at the beginning of the day	Performed monthly and as needed	Measure solutions with known values [National Institute for Standards and Technology 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	Manufacturers specifications

QAPP 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	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

*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*.

QAPP 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)
SW-846-8260B	Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS)	Definitive	VOAs	GC/MS	TBD	TBD*

*Information will be based on laboratory used. Laboratory will be chosen from available Sample Management Office laboratories prior to initiation of fieldwork. Analysis will be by the most recent revision.
TBD = to be determined.

QAPP 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. 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. No field test kits are planned to be used. Real-time data collection during soil mixing will be performed utilizing gas chromatographs to assess the relative contamination level in the extracted vapor. These instruments will follow the manufacturer's recommended calibration information.

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
No test kits are planned to be used.						

TBD = to be determined
N/A = not applicable

QAPP 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
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

*The laboratory is responsible for maintaining instrument and equipment maintenance, testing, and inspection information per their QA Plan. This information is audited annually by a DOE Consolidated Audit Program (DOECAP). Laboratory(s) contracted will be DOECAP-audited. Field survey/sampling instrumentation will be maintained, tested, and inspected according to manufacturer's instructions.
ECD = electron capture device
FID = flame ionization detector

QAPP 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):	No field laboratory will be utilized. The fixed-laboratory archives samples after 6 months.
Sample Extract/Digestate Storage (No. of days from extraction/digestion):	120 days
Biological Sample Storage (No. of days from sample collection):	N/A
SAMPLE DISPOSAL	
Personnel/Organization:	Waste Disposition/DOE Prime Contractor and Subcontractors
Number of Days from Analysis:	6 months

QAPP 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.*

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 Sections 4 and 8.1 of this RAWP.

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.*

*It is understood that SOPs are contractor specific.

QAPP Worksheet #28
QC Samples Table

Matrix:	Aqueous/Soils
Analytical Group/Concentration Level:	VOCs
Sampling SOP:	See Worksheet #21
Analytical Method/SOP Reference:	8260B
Sampler's Name/Field Sampling Organization:	TBD
Analytical Organization:	TBD
No. of Sample Locations	See Section 8 of RAWP

QC Sample:	**Frequency**	**Number**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator**	**Measurement Performance Criteria**
Split Samples	As requested by regulatory agency	TBD	N/A	N/A	N/A	N/A	N/A
Field Blank	Minimum 5%	18	≤ CRQL	Verify results; reanalyze	Laboratory should alert project	Contamination–Accuracy/bias	See procedure PAD-ENM-5003, *Quality Assured Data*
Trip Blank	1 per cooler containing VOC samples	~30	≤ CRQL	Verify results; reanalyze		Contamination–Accuracy/bias	See procedure PAD-ENM-5003, *Quality Assured Data*
Equipment Blank	Minimum 5%	18	≤ CRQL	Verify results; reanalyze		Contamination–Accuracy/bias	See procedure PAD-ENM-5003, *Quality Assured Data*

QAPP Worksheet #28 (Continued)
QC Samples Table

QC Sample	Frequency	Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective	Data Quality Indicator	Measurement Performance Criteria
Method Blank	1 per SDG[1]	30	See data validation procedure PAD-ENM-5105	Verify results; reanalyze	Data reviewer/Data validator	Contamination–Accuracy/bias	See data validation procedure PAD-ENM-5105
Surrogate Samples	All samples[2]	Total number of samples	See data validation procedure PAD-ENM-5105	Verify results; reanalyze	Data reviewer/Data validator	Accuracy	See data validation procedure PAD-ENM-5105
Internal standards, laboratory spiked blanks or spiked field samples (matrix spike samples[3])	Minimum 5%	12	See data validation procedures PAD-ENM-5105, 5107, 5103, 5102	Check calculations and instrument; reanalyze affected samples	Laboratory should alert project	Accuracy	See procedure PAD-ENM-5003, *Quality Assured Data*
Field duplicate	Minimum 5%	11	None	Data reviewer will place qualifiers on samples affected	Data reviewer/ Project manager	Homogeneity/ Precision	RPD ≤ 50% soils, RPD < 25% aqueous
Laboratory duplicate	Per laboratory procedure	TBD	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*

[1] 1 per Sample Delivery Group (SDG) or 1 per 20 samples, whichever is most frequent. Sampling project length expected at 30 days maximum. See Worksheet 18 for total sample numbers.
[2] Surrogate standards are added to all analytical samples, blanks and QC samples.
[3] Both matrix spike samples and matrix spike duplicate samples are analyzed at a minimum frequency of 5%.

QAPP 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	None

*It is understood that SOPs are contractor specific.

QAPP 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) [1]	Backup Laboratory/Organization (Name and Address, Contact Person and Telephone Number) [1]
Soil/ Groundwater	VOCs	Moderate/High	SWMU 1	See Worksheet #23	28-day	TBD	TBD
Soil	Geotechnical/ ZVI	N/A	SWMU 1	N/A	28-day	TBD	TBD

TBD = to be determined
[1] Laboratory contracting will be subsequent to the completion of the RAWP.

QAPP 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 CAs (Title and Organizational Affiliation)	Person(s) Responsible for Monitoring Effectiveness of CA (Title and Organizational Affiliation)
Audit/ Surveillance	A	Internal	Prime Contractor QA	QA Specialists or Contractor	Project Management, Contractor	Project Management, Contractor	QA Specialist, Contractor
Laboratory Audit	Annual	External	DOECAP	Laboratory Assessor	Laboratory	Laboratory	DOECAP
Management Assessments	B	Internal	Prime Contractor Project Management	Regulatory Management, Contractor	Regulatory Management, Contractor	Regulatory Management, Contractor	QA Specialist, Contractor
Management by Walking Around (MBWA)*	Quarterly	Internal	Project Management	Project Management	Project Management	Project Management	Project Management
MBWA Follow-up surveillances	Quarterly	Internal	Project Management	Project Management or designee, Contractor	Project Management/Designee, Contractor	Project Management, Contractor	Project Management

A = frequency determined by QA Manager and conducted per PAD-QA-1003, *Surveillance* or PAD-QA-1502, *Audits*.
B = assessment frequency determined by regulatory manager and conducted per PAD-QA-1420, *Conduct of Management Assessments*.
*Reference: PAD-QA-1033 *Management by Walking Around (MBWA) Program*.

QAPP 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	Form QA-F-0074, Management Assessment Report and Checklist and QA-F-0710, Issue Identification Form	Project management, issue owner, contractor	Upon issuance of Form QA-F-0074, Management Assessment Report and Checklist, the 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.

QAPP Worksheet #32 (Continued)
Assessment Findings and Corrective Action Responses*

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
Audit and Surveillances	QA-F-0069, Audit Checklist, or QA-F-0072, Surveillance Report, and QA-F-0075, Nonconformance Report (NCR) Form or QA-F-0068, Condition Report (CF) Form	Project management, issue owner, contractor	Upon issuance of QA-F-0069, Audit Checklist, or QA-F-0072, Surveillance Report, the QA-F-0075, NCR Form or QA-F-0068, CF Form, will be completed and attached to the report	QA-F-0075, NCR Form or QA-F-0068, CF 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.

QAPP 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
Audit/Surveillances	TBD as determined by QA Manager	30 days after completion of audit/surveillance	QA Manager	LATA Kentucky Project Manager QA Manager
Corrective Action Plan	As needed	Varies per PAD-QA-1210, *Issues Management*	Project Manager	QA Manager

QAPP 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 LATA Kentucky 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 LATA Kentucky procedure, PAD-ENM-5004, *Sample Tracking, Lab Coordination and Sample Handling*. 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 LATA Kentucky 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
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.

QAPP 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 LATA Kentucky 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 LATA Kentucky 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 LATA Kentucky 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 LATA Kentucky 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.

QAPP 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	Soil/Groundwater	VOCs	Moderate/High	National Functional Guidelines; Worksheets #12, #15, and #28; and PAD-ENM-5105, *Volatile and Semivolatile Data Verification and Validation*	Data Validator, LATA Kentucky

QAPP 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 and 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 C

ADDENDUM TO THE RAWP

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ADDENDUM

***Remedial Action Work Plan for In Situ Source Treatment by Deep Soil Mixing of the Southwest Groundwater Plume Volatile Organic Source at the C-747-C Oil Landfarm (Solid Waste Management Unit 1) at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/LX/07-1287&D2/A1/R1**

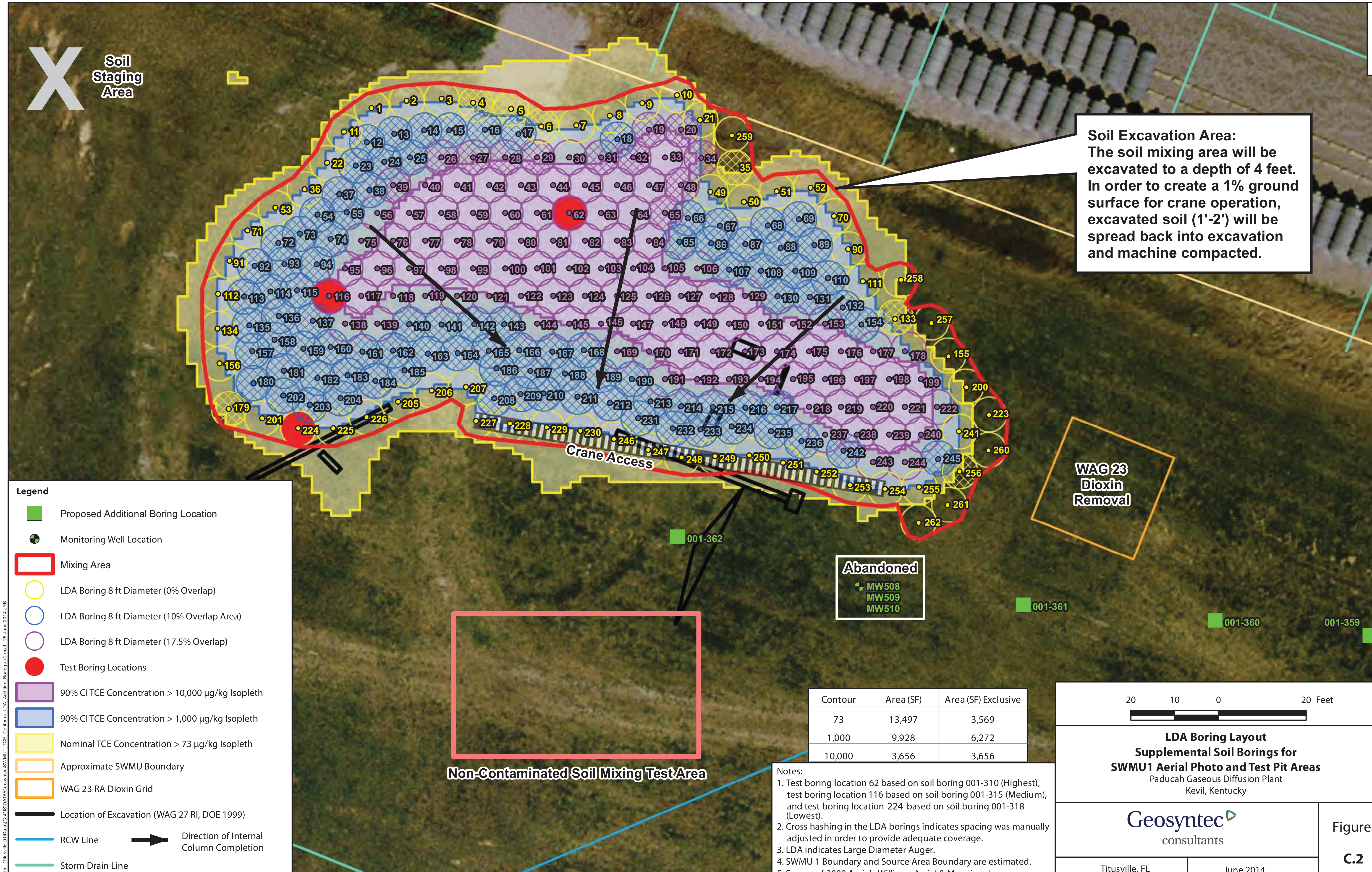
Introduction: This addendum documents information developed by the Federal Facility Agreement (FFA) parties for the purposes of implementing additional investigation activities and reducing the uncertainties described in the 2013 *Remedial Design Report In Situ Source Treatment Using Deep Soil Mixing for the Southwest Groundwater Plume Volatile Organic Compound Source at the C-747-C Oil Landfarm (Solid Waste Management Unit 1) at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-1276&D2/R1 (RDR). The RDR indicates the following in Section 1.5, Sequencing with Other Remedies:

> Historical photographic documentation analysis performed by the FFA parties of SWMU 1 and information gathered from interviews of past workers at the SWMU 1 Landfarm have identified that activities (captured as images/shadows on air photographs) occurred at SWMU 1 east of the area planned for soil mixing operations. These activities, although unidentified, are not expected to have been actual landfarming of contaminated oil. Information collected to date, including WAG 27 RI test pit descriptions, place two oil landfarm plots in the western one-half of the SWMU 1 area. These activities, however, result in a level of uncertainty in landfarming plot location that cannot be addressed with the available current soil contaminant analytical data. To address this uncertainty, additional investigation activities will be performed in the southern and eastern areas of SWMU 1.

An undated historical photograph picturing the landfarm plots/trenches containing liquids and presumably associated drums of materials staged for landfarming is provided as Figure C.1. The exact location of the area shown in the photograph is not known. No aerial photographs during the oil landfarm operational years (1973–1979) have been identified that show visible activities in the planned soil mixing area. The level of uncertainty in landfarming plot location supports collection of additional samples. Aerial photographs of the Solid Waste Management Unit (SWMU) 1 area obtained in December 1974 and March 1975 captured images/shadows to the east of the planned soil mixing area and provide the target locations for three of the planned additional soil borings.

A soil removal action was performed to an area east of the planned soil mixing zone and north of the area of the locations for the additional soil borings and is shown on Figure C.2. The removal action excavated and removed 23 yd^3 of dioxin-contaminated soil. The remedial action work plan (RAWP) (Section 11.4.7) references the *Soils Operable Unit Remedial Investigation Report at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-1276&D2, Section 5.1, that identified PCB surface soil (0–1 ft) contamination exceeding Industrial Worker action levels in the area of the additional soil boring activity. The FFA parties discussed the scope of the additional sampling activities to investigate this uncertainty during a conference call on March 24, 2014, and the decision rules and sampling strategy contained herein are the result of these discussions.

Figure C.1. Undated Historical Photograph of C-746-C Oil Landfarm



Contour	Area (SF)	Area (SF) Exclusive
73	13,497	3,569
1,000	9,928	6,272
10,000	3,656	3,656

Notes:
1. Test boring location 62 based on soil boring 001-310 (Highest), test boring location 116 based on soil boring 001-315 (Medium), and test boring location 224 based on soil boring 001-318 (Lowest).
2. Cross hashing in the LDA borings indicates spacing was manually adjusted in order to provide adequate coverage.
3. LDA indicates Large Diameter Auger.
4. SWMU 1 Boundary and Source Area Boundary are estimated.
5. Source of 2009 Aerial: Williams Aerial & Mapping, Inc.

LDA Boring Layout
Supplemental Soil Borings for
SWMU1 Aerial Photo and Test Pit Areas
Paducah Gaseous Diffusion Plant
Kevil, Kentucky

Geosyntec consultants

Titusville, FL | June 2014

Figure C.2

Figure C.2. LDA Boring Layout Supplemental Soil Borings for SWMU 1 Aerial Photo and Test Pit Areas

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Purpose: Reduce the uncertainty of the presence of trichloroethene (TCE) and specific degradation products in two areas (to the east and south of the soil mixing area defined in the RDR) where oil landfarm activities may have occurred and that are not part of the currently planned soil mixing area. The FFA parties have agreed that the following sampling approach will provide a sufficient basis to evaluate the two areas for the presence of TCE and specific degradation products and will reduce the number of questions concerning uncertainty:

- Drill and sample 3 soil borings in the SWMU 1 area identified by dark areas in the 1970s Paducah Gaseous Diffusion Plant (PGDP) air photos; and

- Drill and sample 1 soil boring in SWMU 1 in an area adjacent to Test Pit TB3, Waste Area Grouping (WAG) 27 Remedial Investigation Report, Geophysical Survey and Excavation Report, Volume 2, DOE/OR/07-1777&D2.

Boundary: Areas identified on map to 60 ft below ground surface [see Figure C.2 (based on Figure 5 from the RDR)]. Areas correspond to (1) aerial photo depiction of *possible* drum storage location and (2) trenching performed during WAG 27 Remedial Investigation.

Number of Soil Borings: 4 [see Figure C.2 (based on Figure 5 from the RDR)]—The approximate coordinates for planned soil borings are shown in Table C.1.

Table C.1. SWMU 1 Soil Borings

Soil Boring Number	Approximate Plant Coordinates	
	East	North
001-359	-6,672	-1,741
001-360	-6,706	-1,751
001-361	-6,748	-1,764
001-362	-6,827	-1,779

Drilling Technology: Direct push

Sampling Method: The sampling approach previously was approved in Section 8 of the *Remedial Action Work Plan for In Situ Source Treatment by Deep Soil Mixing of the Southwest Groundwater Plume Volatile Organic Source at the C-747-C Oil Landfarm (Solid Waste Management Unit 1) at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-1287&D2.

1. Continuous soil core in 5-ft increments to the top of the Regional Gravel Aquifer (~ 60 ft to 62 ft).

2. Scan the soil core with the field photoionization detector (PID) by inserting a clean awl through the polyvinyl chloride core liner into the soil creating a small void in the soil core at each 0.5-ft depth increment and immediately scanning the soil core with a PID (using a water separator on the PID sample tube) at each 0.5-ft point of access. Record each PID reading in a field logbook. The field PID measurements will be used to identify sections of the soil core containing higher

volatile organic compound (VOC) levels (if present) for subsampling with an En Core® sampler.

3. Cut open the soil core liner. Perform a radiological scan of the soil core if required by the field radiological technician to ensure the safety of the field sample crew.

4. Where the highest PID response is detected, collect a soil subsample for VOC analysis using an En Core® sampler (12 subsamples per soil boring).

5. If no elevated PID response is measured, collect the soil subsample based on observations of greater sand content, if present and apparent. If no sandy zones are obvious, collect the soil subsample for (VOC) analysis from the middle point of the length of the soil core.

6. Submit soil subsample to an existing DOE Sample Management Office Laboratory for analysis of the following VOCs, with standard 7-day turnaround:

   - TCE
   - *cis*-1,2-Dichloroethene
   - *trans*-1,2-Dichloroethene
   - Vinyl chloride

Quality assurance and health and safety requirements will be as included in the approved RAWP, DOE/LX/07-1287&D2.

Project Documentation:

The results of this additional sampling will be documented by technical memorandum to the FFA parties and for inclusion in the post-*Record of Decision for Solid Waste Management Units 1, 211-A, 211-B, and Part of 102 Volatile Organic Compound Sources for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plan, Paducah, Kentucky*, DOE/LX/07-0365&D2/R1, (ROD) post-ROD Administrative Record project file.

Decision Rules:

- IF an analysis of soil samples finds average TCE ≥ 1,000 ppb in any single boring, THEN the FFA parties will reconvene to discuss the results and path forward [e.g., long-term monitoring (LTM), active remediation, added to the Post-GDP Groundwater Sources Operable Unit project, development of necessary documentation, etc.].

- IF an analysis of soil samples finds average TCE < 1,000 ppb and ≥ 75 ppb in any single boring AND any individual result from that boring finds TCE ≥ 1,000 ppb, THEN the FFA parties will reconvene to discuss the results and path forward (e.g., LTM, active remediation, added to the Post-GDP Groundwater Sources Operable Unit project, development of necessary documentation, etc.).

- IF an analysis of soil samples finds an individual result of TCE ≥ 1,000 ppb in any single boring, THEN the FFA parties will reconvene to discuss the results and path forward (e.g., LTM, active remediation, added to the Post-GDP Groundwater Sources Operable Unit project, development of necessary documentation, etc.).

- IF an analysis of soil samples finds average TCE < 1,000 ppb and ≥ 75 ppb in any single boring and all individual results TCE < 1,000 ppb, THEN those areas will be addressed by the action through long-term monitoring consistent with the ROD.

- IF an analysis of soil samples finds average TCE < 75 ppb in any single boring, THEN uncertainty for that boring will be considered addressed and the final remedial action completion report will document that no further CERCLA remedial action is necessary for that boring.

Additional RAWP Modifications:

Note: Items A through H are shown on associated Figures C.3 and C.4.

A. <u>Reselection of Soil Mix Test Cells–Column 224 in Place of Column 5</u>

RDR Section 4.4.2, Implementation Sequence, indicates, "Prior to full active remedial implementation, at least two test cells will be performed during implementation in the SWMU 1 treatment area to simulate active remediation, to ensure the system is functioning efficiently as designed, and to troubleshoot problems or issues that developed prior to active remediation. The test treatment cells will be conducted in an area of highest detected concentration and in an exterior cell of anticipated lowest concentrations at the site."

The implementation of test cells is intended to evaluate the mixing and treatment equipment, including the stability of the crane, Kelly bar, and drilling table, while each is in operation in the contamination area prior to full implementation of the remedial action. As indicated on Figure 5 of the RDR, the three test cells are columns 5, 62, and 116. The test cells were selected on the basis of whether the cell is located in an area of high, medium, and low contamination in the mixing area. Soil column 5 is in a low contamination area and would be one of the first columns mixed. Column 5, however, is relatively close (~ 35 ft) to the cylinder yard to the north of the mixing area. Because of the close proximity of soil column 5 to the cylinder yard and the potential for damage to the cylinders from falling items from the crane, it is recommended that the low contamination test cell be selected from a column that is farther from the cylinder yard. Instead of selecting column 5, it would be better to select soil column 224; therefore, it is recommended that the first contaminated column to be mixed be column 224, which will be followed by the two remaining test columns, 116 and then 62. After the three test cells are completed successfully, the outermost ring of columns will be mixed in parallel with posttreatment soil sampling of the three test cells.

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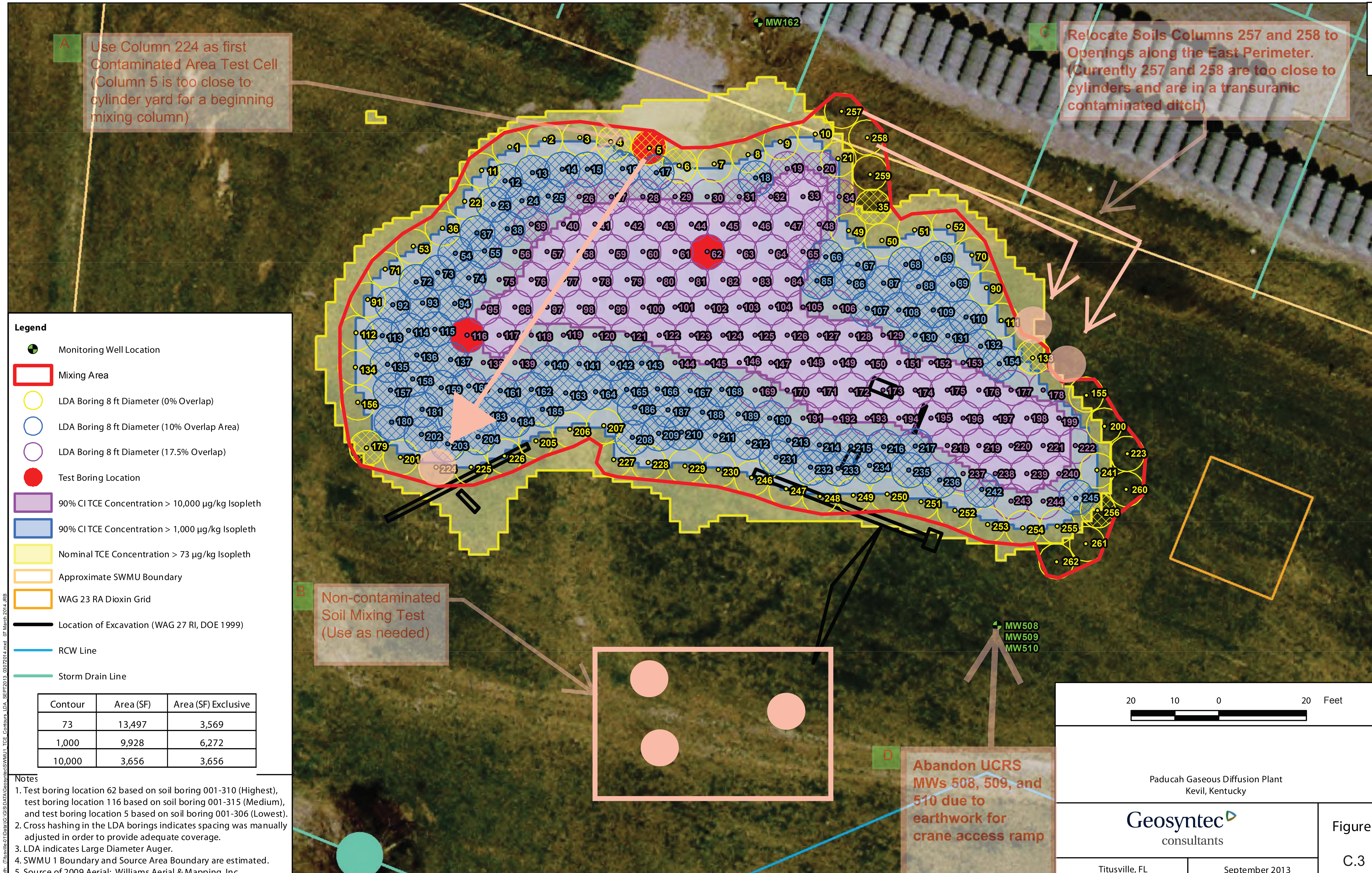
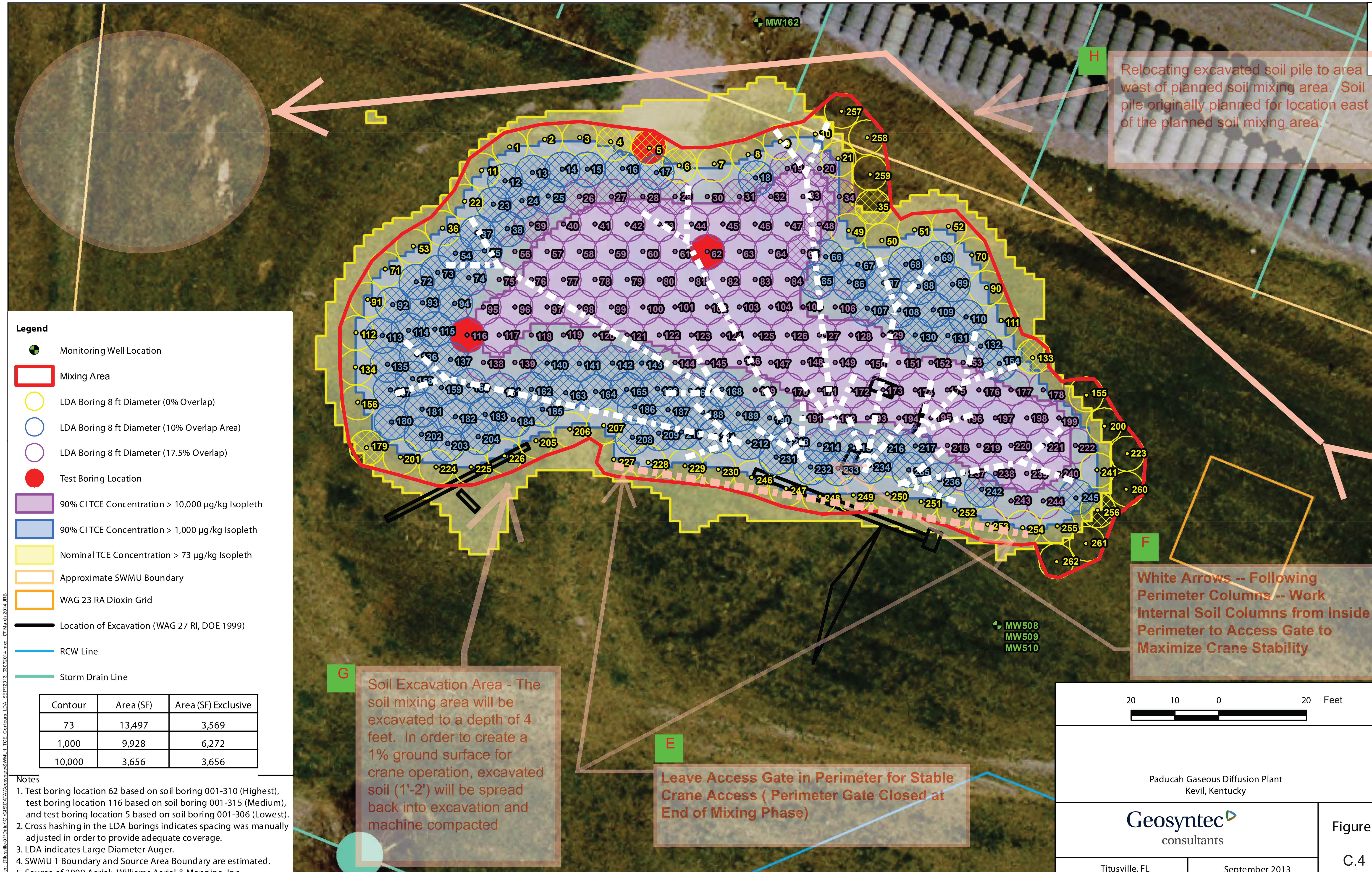


Figure C.3 Additional RAWP Modifications A-D



Contour	Area (SF)	Area (SF) Exclusive
73	13,497	3,569
1,000	9,928	6,272
10,000	3,656	3,656

Notes
1. Test boring location 62 based on soil boring 001-310 (Highest), test boring location 116 based on soil boring 001-315 (Medium), and test boring location 5 based on soil boring 001-306 (Lowest).
2. Cross hashing in the LDA borings indicates spacing was manually adjusted in order to provide adequate coverage.
3. LDA indicates Large Diameter Auger.
4. SWMU 1 Boundary and Source Area Boundary are estimated.
5. Source of 2009 Aerial: Williams Aerial & Mapping, Inc.

Figure C.4. Additional RAWP Modifications E-H

B. Noncontaminated Soil Mix Equipment Test Area

The project will be setting up a test area in a noncontaminated area outside the planned soil mixing area. The purpose of this noncontaminated test area is to provide a location that can be used to test the mechanical integrity of the soil mixing equipment without mixing in a contaminated area. This area also will be used to perform testing of the mixing equipment following mechanical repairs. The location chosen is about 30 ft due south of the planned soil mixing area. The chosen area will lie adjacent to the ramp required for the crane to access the planned soil mixing area. It is expected that the subcontractor will use this area to shakedown the soil mixing equipment prior to initiating actual soil mixing of contaminated soils. It also provides a test area away from the uranium hexafluoride cylinders located north of the planned mixing area.

C. Relocation of Extra/Additional Perimeter Soil Columns—Soil Columns 257 and 258

Soil columns 257 and 258 are adjacent to the extreme north portion of the SWMU 1 planned soil mixing area and actually are located outside the planned mixing area. Columns 257 and 258 were two of several extra or additional columns added to the eastern side of the mixing area where high contaminant concentration gradients are present. Columns 257 and 258 are located approximately 12 ft from the cylinders located north of SWMU 1. Columns 257 and 258 also are located in the ditch that is a transuranic radiological control area adjacent to SWMU 1. Because of the close proximity of columns 257 and 258 to the cylinders, the potential for damage to the cylinders from falling items from the crane and the radiological concern, it is recommended that the 257 and 258 soil columns be relocated farther south, adjacent to soil column 133. The alternate locations continue to meet the original intent of the additional columns being located in areas where the TCE concentration gradients are high, while providing increased health and safety protection by moving the equipment away from close proximity of the cylinders and the transuranic soil contamination.

D. Abandon Upper Continental Recharge System Monitoring Wells 508/509/510

Monitoring wells 508/509/510 were installed during the remedial design support investigation (RDSI) to provide information to support the remedial action. The wells are completed variably in the Upper Continental Recharge System (UCRS) down to approximately 32 ft. As a result of the need to provide an access ramp with a 1% slope for the soil mixing crane, the presence of these UCRS monitoring wells will impede construction. The abandonment of the wells will afford more open access for providing slope-critical facilities for crane access to the planned mixing area. The FFA parties will determine the locations of posttreatment monitoring wells following the soil mixing operations.

E/F. Modified Concentric Soil Mixing Implementation Sequence and Crane Access Gate

RDR Section 4.4.2, Implementation Sequence, indicates the following: "The sequencing of soil mixing and treatment locations will be conducted such that the perimeter cells are treated first and subsequent locations will be performed inward in concentric circles, generally targeting lower contaminant concentration areas prior to targeting higher concentration areas and creating a perimeter zero-valent iron slurry enhanced ring, which would provide treatment as a best management practice to potential groundwater displaced outward during implementation."

The commercial organizations bidding for the contract to implement this soil mixing remedial action have identified that placing heavy equipment on previously mixed soils can cause crane stability issues, even when crane mats are used properly. These potential stability issues result from decreased soil strength and higher water saturation levels in the mixed soil columns. The weight of the crane, in excess of 200,000 lb, could cause failure of the mixed soil foundation and result in the crane falling over or the boom buckling. The currently approved sequence includes working in concentric rings from the outside columns toward the inside columns with the higher contaminant concentrations. This requires that the soil mixing equipment sit on previously mixed soil (see Figure 5, RDR). To reduce the need of the soil mixing equipment being positioned on previously mixed soil columns, a modified mixing sequence is recommended.

The modified mixing sequence starts with soil mixing on the perimeter ring of soil columns, but leaves an unmixed open section in the perimeter ring to provide stable soil for the equipment to access the soil mixing area. This open section will include up to 8 soil mixing columns of the 13 soil columns between columns 227 to 254, directly adjacent to the crane and equipment access ramp. The mixed perimeter ring will provide the exterior treatment zone through which potentially migrating subsurface contaminants should appear, if they are forced to the exterior of the soil mixing area. The internal soil mix columns then will be mixed working backward from the perimeter to the open section, similar to the approach a painter might take when painting the floor of a room from the far reaches and working toward the room's access door. The open section of the perimeter ring from soil columns 227 to 254 will be closed (soil mixed) as the equipment exits the mixing area.

G. <u>Leveling of Excavation Bottom for Soil Mixing</u>

The ground surface of SWMU 1 is variable and, as such, even after the 4 ft of soil excavation described in Section 1.5 of the RDR, the surface will remain variable. The soil mixing crane when loaded is required to work from a surface that has a 1% or less slope. To provide this flat surface, it is necessary for the 4-ft depth excavation area to be one of the following:

- Excavated deeper in some locations and filled-in in others,
- Over excavated by a variable amount, or
- Filled-in by a variable amount.

Although it was not indicated in the RDR or the RAWP, prior to initiating any soil mixing effort, soil from the 4-ft excavation stockpile will be respread in lifts and machine-compacted to provide a more stable soil surface from which the crane can work and to promote storm water drainage from the soil mixing area. The soil work surface following the respreading and machine compacting of a portion of the previously excavated soil will place the soil work surface at approximately 2 ft below the original ground surface and will allow the mixing tool to reach the targeted HU4/HU5 interface, while meeting the machine-required 1% ground slope.

The locations of some of the northern soil mixing columns (9, 10, 21, 259, Figure 5) are adjacent to and in the drainage ditch located between the C-747-C Oil Landfarm and C-745-A Cylinder Yard. If a portion of the soil is not placed back into the excavated area, ground elevations following the 4-ft soil excavation will be below the grade of the ditches, storm water would flow into the soil mixing area instead of continuing to flow west. Additionally, the elevation of the west drainage ditch would be approximately the same as the land surface following excavation, resulting in ponding of storm water in the mixing area. By placing a portion of the soil back into the excavated area, the grade of the soil mixing area will be raised above the grade of the ditches and provide for storm water drainage from the mixing area.

H. <u>Excavated Soil Staging Area</u>

Figure 9 from the RDR indicated the overburden soil staging pile would be located east of the planned soil mixing area. Due to the increased volume of soil from the 4 ft soil excavation, the need for a 1% sloped access road from 4th Street for the soil mixing crane, and limiting the loading on buried utilities in the SWMU area, it has become necessary to relocate the soil staging area to the west side of the planned soil mixing area. The soil staging area still will be constructed adjacent to the planned mixing area, underlaid with a synthetic liner, and covered with a liner (thatch mat) to prevent erosion, as indicated in the RDR. The soil pile will remain in place until soil mixing is complete, at which time the soil will be spread to the original excavated area and graded to natural contours.

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