Department of Energy

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DEC 20 2017

Mr. Allen Schubert
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PPPO-02-4423478-18B

Dear Mr. Schubert:

CONTRACT NO. DE-EM0004895: APPROVAL OF THE ENVIRONMENTAL MONITORING PLAN FOR FISCAL YEAR 2018, CP2-ES-0006/FR1

Reference: Letter from W. Kirby to M. Fultz, "Four Rivers Nuclear Partnership, LLC, Deliverable No. 42—FINAL *Environmental Monitoring Plan Fiscal Year 2018, Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, CP2-ES-0006/FR1," (FRNP-18-0263), dated November 30, 2017

The U.S. Department of Energy (DOE) has reviewed the referenced document for compliance with DOE requirements. DOE hereby approves the plan as submitted. If you have any questions or require additional information, please contact David Dollins at (270) 441-6819.

Sincerely,

Marcia D. Fultz
Contracting Officer
Portsmouth/Paducah Project Office

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CP2-ES-0006/FR1

Environmental Monitoring Plan
Fiscal Year 2018
Paducah Gaseous Diffusion Plant,
Paducah, Kentucky

This document is approved for public release per review by:

David Hayden
FRNP Classification Support

11-29-17
Date

Environmental Monitoring Plan
Fiscal Year 2018
Paducah Gaseous Diffusion Plant,
Paducah, Kentucky

Date Issued—January 2018

U.S. DEPARTMENT OF ENERGY
Office of Environmental Management

Prepared by
FOUR RIVERS NUCLEAR PARTNERSHIP, LLC,
managing the
Deactivation and Remediation Project at the
Paducah Gaseous Diffusion Plant
under Contract DE-EM0004895

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FIGURES

TABLES

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ACRONYMS

AEC	Atomic Energy Commission
AIP	Agreement in Principle
ASER	Annual Site Environmental Report
CAP-88	Clean Air Act Assessment Package-88
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
CY	calendar year
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DQO	data quality objective
ED	effective dose
EDE	effective dose equivalent
EM	environmental monitoring
EMP	Environmental Monitoring Plan
EMS	Environmental Management System
EPA	U.S. Environmental Protection Agency
ERPP	Environmental Radiation Protection Program
FFA	Federal Facility Agreement
FPDP	Fluor Federal Services, Inc., Paducah Deactivation Project
FRNP	Four Rivers Nuclear Partnership, LLC
FY	fiscal year
GDP	gaseous diffusion plant
GSA	General Services Administration
ISMS	Integrated Safety Management System
KAR	*Kentucky Administrative Regulation*
KDOW	Kentucky Division of Water
KDWM	Kentucky Division of Waste Management
KPDES	Kentucky Pollutant Discharge Elimination System
LATA Kentucky	LATA Environmental Services of Kentucky, LLC
MCS	Mid-America Conversion Services, LLC
MDA	minimum detectable activity
MEI	maximally exposed individual
MDL	method detection limit
MW	monitoring well
NESHAP	National Emission Standards for Hazardous Air Pollutants
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
O	Order
O&M	operation and maintenance
OREIS	Paducah Oak Ridge Environmental Information System
OU	operable unit
PEGASIS	PPPO Environmental Geographic Analytical Spatial Information System
PGDP	Paducah Gaseous Diffusion Plant
PQL	practical quantification limit
QA	quality assurance
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
ROD	record of decision

RI	remedial investigation
SARA	Superfund Amendments Reauthorization Act
SDWA	Safe Drinking Water Act
SPCC	spill prevention control and countermeasure
SSPP	Strategic Sustainability Performance Plan
SWMU	solid waste management unit
TED	total effective dose
USEC	United States Enrichment Corporation
WKWMA	West Kentucky Wildlife Management Area
WMP	Watershed Monitoring Plan

EXECUTIVE SUMMARY

This Paducah Site Environmental Monitoring Plan (EMP) for fiscal year (FY) 2018 is intended to document the rationale, sampling frequency, parameters, and analytical methods for environmental monitoring (EM) activities at the Paducah Site and provide information on site characteristics, environmental pathways, dose assessment methodologies, and quality assurance management.

EM at the Paducah Site consists of effluent monitoring and environmental surveillance activities and supports the evaluation and assessment of unplanned releases. Monitoring is conducted for a variety of media including air, surface water, groundwater, and sediment.

This EMP is comprised of the main text that details rationale and objectives, as well as four appendices. Appendix A is a summary of the Paducah Site permits and agreements; Appendix B is a well inventory; Appendix C lists all individual sampling programs, along with their sampling frequencies, methods, action limits, and parameter lists; and Appendix D contains the quality assurance project plan for executing the work described in this EMP.

Sampling frequencies and sampling parameters that were modified for a sampling program that was permit-driven or collected as a result of a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) or Resource Conservation and Recovery Act (RCRA) decision document were changed only if the permit allowed the change. Data collected under existing permits and under CERCLA or RCRA decision documents will continue to be evaluated in FY 2018. If changes are deemed appropriate based on trending analyses, they will be proposed via a permit modification or decision document change (as applicable) and implemented immediately after approval by the regulatory agencies. These changes will be incorporated in the FY 2019 EMP. If sampling is modified due to a change in a sampling approach or by physical limitations, such as a dry well, then those conditions will be documented in the assessment file for that given project.

Until 2013, the United States Enrichment Corporation (USEC) enriched uranium at the Paducah Site to supply nuclear fuel to electric utilities worldwide. In October 2014, USEC terminated its lease with DOE. DOE retains ownership of all facilities and retains responsibility for managing the disposition of legacy waste material and environmental cleanup. Changes to the sampling programs reflected in the FY 2018 EMP include, but are not limited to, the following actions, which are described later in more detail.

- **Northwest Plume.** The sampling frequency for MW460 within the Operations and Maintenance plan is semiannual; however, the frequency of sampling has been increased to quarterly in order to evaluate trends in trichloroethene (TCE) concentrations along the Northwest Plume.

- **Solid Waste Management Unit (SWMU) 1.** The sampling frequency for MWs associated with SWMU 1 has been modified to semiannually, as required by 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, December 2013.

- **Environmental Surveillance Groundwater Monitoring Program.** The sampling frequencies for MW354, MW403, and MW431 have been increased to quarterly and MW453 and MW454 to annually in order to evaluate trends in TCE concentrations along the Northwest Plume. The sampling frequencies for MW98, MW135, and MW197 have been increased to semiannually in order to evaluate trends in TCE along the eastern edge of the Northwest Plume. The background location for

the biennial sampling has been changed from MW194 to MW103. Recent detections of TCE in MW194 suggest the groundwater quality in that area may be influenced by dissolved contamination originating at the Paducah Site. In order to represent background water quality better, MW103, located upgradient of the industrial area at the Paducah Site, will be used for a background well in place of MW194. All of these changes within the Environmental Surveillance Groundwater Monitoring program are being made as a result of data evaluations conducted by the EM and groundwater remediation organizations.

- **Kentucky Pollutant Discharge Elimination System (KPDES) Outfall Sampling.** The sampling frequencies and parameters have been modified to reflect requirements included in the new KPDES permit, permit number KY0004049. This new permit combines KPDES permits KY0004049 and KY0102083.

- **Environmental Surveillance Watershed Monitoring Program.** The previous KPDES permit required that 19 in-stream surface water locations be sampled quarterly for polychlorinated biphenyls and TCE. The new KPDES permit does not require this sampling; therefore, this sampling program has been modified to include only locations near the C-746-K Landfill (C746K-5 and K746KTB1A) and a seep location (LBCSP5) in Little Bayou Creek. The sampling of surface water near the C-746-K Landfill meets the requirements of the *Record of Decision for Waste Area Groups 1 and 7 for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/06-1470&D2, September 1997, and will be analyzed for volatiles and metals. The seep location will be monitored for TCE, and it is being sampled for continued evaluation of trends in groundwater upwelling at this location. Surface water location, L14, has been added to the quarterly Environmental Radiation Protection Program to include monitoring upstream of the C-746-S&T and C-746-U landfills.

1. INTRODUCTION

1.1 PURPOSE

This Paducah Site Environmental Monitoring Plan (EMP) for fiscal year (FY) 2018 is intended to document the rationale, sampling frequency, parameters, and analytical methods for environmental monitoring (EM) activities at the Paducah Site and provide information on site characteristics, environmental pathways, dose assessment methodologies, and quality assurance (QA) management. Guidance for EM is included in U.S. Department of Energy (DOE) Order (O) 436.1, *Departmental Sustainability*; DOE O 458.1, *Radiation Protection of the Public and the Environment*; DOE/HDBK-1216-2015, *Environmental Radiological Effluent Monitoring and Environmental Surveillance* (DOE 2015a), hereinafter identified as the Radiological Guide; and Commonwealth of Kentucky and federal regulations that implement federal environmental laws. The purpose of the Radiological Guide is to identify procedures, systems, methods, instruments, and practices that may be used to plan and implement radiological effluent monitoring and environmental surveillance that meet the requirements in DOE O 458.1.

This FY 2018 EMP supports meeting requirements in DOE O 436.1 and DOE O 458.1 at the site. DOE O 436.1, Departmental Sustainability, requires that sites incorporate activities and programs to meet the goals of the Strategic Sustainability Performance Plan (SSPP), which are specified in Executive Order 13693. These environmental stewardship goals of the SSPP require sites to prevent pollution and eliminate waste; follow sustainable acquisition practices; encourage agency innovation; reduce greenhouse gas emissions; perform regional and local planning; execute and integrate high-performance sustainable design and green building best practices; and usher in electronic stewardship and data center energy efficiency. DOE O 458.1 establishes standards and requirements for DOE operations with respect to protection of the public and the environment against undue risk from radiation.

This EMP also supports permit requirements and supplements the ongoing Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) remedial investigations (RIs) being conducted at the Paducah Site. In accordance with the Paducah Site Management Plan, currently there are five defined CERCLA pre-gaseous diffusion plant (GDP) operable units (OUs)—surface water, groundwater, soils, burial grounds, and decontamination and decommissioning—and five defined CERCLA post-GDP OUs—GDP groundwater sources, additional burial ground sources, GDP decontamination and decommissioning, soils and slabs, and GDP lagoons and ditches—that require investigation (DOE 2015b). This EMP is integrated with OU investigations and/or remedial actions to help provide collection of optimal data sets.

1.2 SCOPE

EM at the Paducah Site consists of effluent monitoring and environmental surveillance activities and supports the evaluation and assessment of unplanned releases. Monitoring is conducted routinely for a variety of media including air, surface water, groundwater, and sediment. Effluent monitoring is the direct measurement or the collection and analysis of liquid discharges and gaseous emissions to the environment. Environmental surveillance is the direct measurement or the collection and analysis of ambient air, surface water, groundwater, sediment, and other media.

Until 2013, the United States Enrichment Corporation (USEC) enriched uranium at the Paducah Site to supply nuclear fuel to electric utilities worldwide. In October 2014, USEC returned Paducah leased facilities to DOE. These returned facilities are undergoing deactivation in preparation for

decommissioning. Deactivation and decommissioning work continues for some Paducah facilities that already were under DOE control.

The new deactivation and remediation contractor, Four Rivers Nuclear Partnership, LLC, (FRNP) will implement the FY 2018 EMP.

In order for DOE and FRNP to meet compliance with applicable environmental, public health, and resource protection requirements cost-effectively, the EMP is evaluated and modified, as appropriate. These modifications may include adjusting the number of monitoring wells (MWs) that are sampled, changing sampling frequency of certain activities, or eliminating parameters to avoid duplication of data. As a contractor for DOE at the Paducah Site, FRNP evaluates optimization of sampling efforts in order to provide a comprehensive data set to the affected projects. Changes to the EMP, as a result of these evaluations, will be documented in the EMP rationale section and in each specific project section in Appendix C of the EMP. Changes that occur and are implemented during the FY will be documented in the following year's EMP. Optimization of permit-required sampling also is performed, but will be implemented only when approved by the regulatory agencies.

The Paducah Site EMP is evaluated and modified, as appropriate, using the data quality objective (DQO) methodology on an FY basis (i.e., October 1 through September 30) (EPA 2006). Measurement quality objectives are addressed in Appendix D, the Environmental Monitoring Quality Assurance Project Plan (QAPP), which is consistent with the Programmatic QAPP (DOE 2017a). Project data, following data verification, data assessment, and data validation, are placed into and reported from the Paducah Oak Ridge Environmental Information System (OREIS). Data loaded into Paducah OREIS then is available to public stakeholders via the PPPO Environmental Geographic Analytical Spatial Information System (PEGASIS). Results are published and made available to the public in the form of the Annual Site Environmental Report (ASER) produced by the site deactivation and remediation contractor. A summary of the ASER also is produced by high school students through a grant with Kentucky Research Consortium for Energy and Environment.

QA is assured through assessments and management-by-walking-around. At a minimum, a management assessment of a sampling activity mandated by a permit will be conducted on a quarterly basis.

Operational sampling included in the Title V air permit is considered outside the scope of the EMP. FRNP will implement the appropriate operational sampling. While this EMP addresses liquid effluent monitoring from the depleted uranium hexafluoride conversion facility (DUF_6), which is operated by Mid-America Conversion Services, LLC, (MCS) this EMP does not address gaseous emissions monitoring that is conducted by MCS in support of their air permit.

1.3 RATIONALE

The rationale for EM activities at the Paducah Site for FY 2018 is premised by the understanding that sampling frequency, sampling parameters, and analytical methods must be sufficient to meet regulatory and contractual requirements and support appropriate DOE orders and guidance cost-effectively.

Data collected under existing permits, National Emission Standards for Hazardous Air Pollutants (NESHAP) Management Plan (LATA Kentucky 2013), and under CERCLA or Resource Conservation and Recovery Act (RCRA) decision documents will continue to be evaluated in FY 2018. Sampling frequencies and sampling parameters that were modified for a sampling program that was permit-driven or collected as a result of a CERCLA or RCRA decision document were changed only if the permit or decision document allowed the change. If, during FY 2018, changes are deemed appropriate based on

trending analyses, changes will be proposed via a permit modification or decision document change and implemented immediately after approval by the regulatory agencies. These changes will be incorporated in the FY 2019 Paducah Site EMP. If sampling is modified due to a change in a sampling approach or by physical limitations, such as a dry well, then those conditions will be documented in the assessment file for that given project.

Changes to the sampling programs reflected in the FY 2018 EMP include, but are not limited to, the following actions, which are described in more detail in Appendix B and Appendix C.

- **Northwest Plume.** The sampling frequency for MW460 within the Operations and Maintenance (O&M) Plan is semiannual; however, the frequency of sampling has been increased to quarterly in order to evaluate trends in TCE concentrations along the Northwest Plume.

- **Solid Waste Management Unit (SWMU) 1.** The sampling frequency for MWs associated with SWMU 1 has been modified to semiannually as required by 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, December 2013.

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1.4 GENERAL CONSIDERATIONS

1.4.1 Site Description

The Paducah Site is located in a generally rural area of McCracken County, Kentucky [population approximately 65,000 (DOC 2016)]. Uranium enrichment ceased in May 2013. The uranium enrichment process facility consisted of a diffusion cascade and extensive support facilities. The cascade, including product and tails withdrawal, is housed in six large process buildings. The plant is located on a reservation consisting of approximately 3,556 acres in western McCracken County, 10 miles west of Paducah, Kentucky, [population approximately 25,000 (DOC 2016)] and 3.5 miles south of the Ohio River (Figure 1). The facility is on approximately 1,350 acres with controlled access. Roughly 628 acres of the reservation are enclosed within a fenced security area. An uninhabited buffer zone of at least 400 yd surrounds the entire fenced area. During World War II, the Kentucky Ordnance Works was operated in an area southwest of the plant on what is now a wildlife management area. Three small communities are located within 3 miles of the DOE property boundary at Paducah Gaseous Diffusion Plant (PGDP): Heath and Grahamville to the east and Kevil to the southwest. The closest commercial airport is Barkley Regional Airport, approximately 5 miles to the southeast. The population within a 50-mile radius of PGDP is about 534,000. Within a 10-mile radius of PGDP, the population is about 89,000 (ESRI 2012).

1.4.2 Site Background Information

Before World War II, the area now occupied by PGDP was used for agricultural purposes. Numerous small farms produced various grain crops, provided pasture for livestock, and included large fruit orchards.

During World War II, a 16,126-acre tract was assembled for construction of Kentucky Ordnance Works, which subsequently was operated by the Atlas Powder Company until the end of the war. At that time, it was turned over to the Federal Farm Mortgage Corporation and then to the General Services Administration (GSA).

In 1950, the U.S. Department of Defense (DOD) and DOE's predecessor, the Atomic Energy Commission (AEC), began efforts to expand fissionable material production capacity. As part of this effort, the National Security Resources Board was instructed to designate power areas within a strategically safe area of the United States. Eight government-owned sites initially were selected as candidate areas. In October 1950, as a result of joint recommendations from DOD, U.S. Department of State, and AEC, President Harry S. Truman directed AEC to expand further production of atomic weapons. One of the principal facets of this expansion program was the provision for a new gaseous diffusion plant. On October 18, 1950, AEC approved the Paducah Site for uranium enrichment operations and formally requested the Department of the Army to transfer the site from GSA to AEC. Of the 7,566 acres acquired by the AEC, 1,361 acres subsequently were transferred to the Tennessee Valley Authority (Shawnee Fossil Plant Site), and approximately 2,700 acres were conveyed to the Commonwealth of Kentucky for wildlife conservation and for recreational purposes [West Kentucky Wildlife Management Area (WKWMA)].

Although construction of PGDP was not complete until 1954, production of enriched uranium began in 1952. Recycled uranium from nuclear reactors was introduced into the PGDP enrichment cascades in 1953 and continued through 1964. In 1964, cascade feed material was switched solely to virgin-mined uranium. Use of recycled uranium resumed in 1969 and continued through 1976. In 1976, the practice of recycling uranium feed material from nuclear reactors was halted and never resumed. During the recycling time periods, Paducah received approximately 100,000 metric tons of recycled uranium

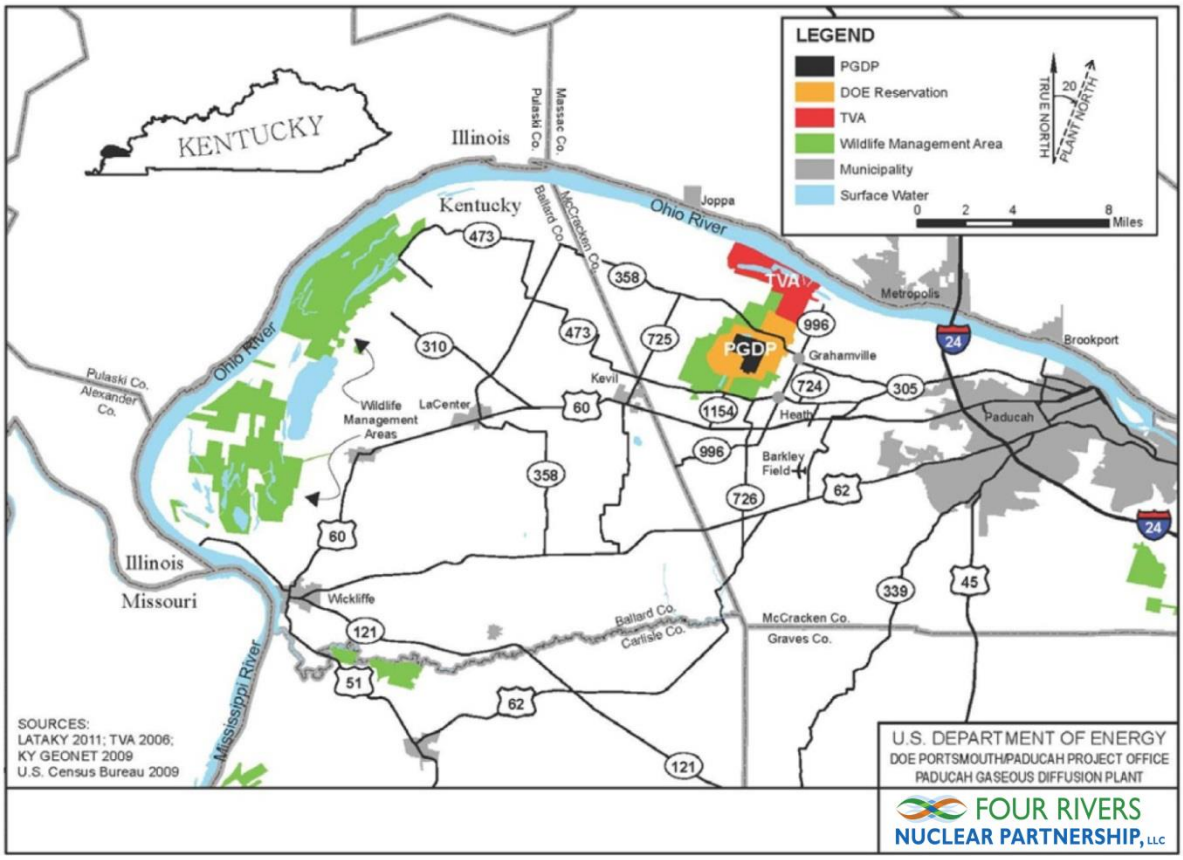

Figure 1. Location of the Paducah Site

containing an estimated 328 grams of plutonium-239 (Pu-239), 18,400 grams of neptunium-237 (Np-237), and 661,000 grams of technetium-99 (Tc-99). The majority of the Pu-239 and Np-237 was separated out during the initial chemical conversion to uranium hexafluoride (UF_6). Concentrations of transuranics (e.g., Pu-239 and Np-237) and Tc-99 are believed to have been deposited on internal surfaces of process equipment and in waste products.

In October 1992, congressional passage of the 1992 National Energy Policy Act established USEC. USEC operated the uranium enrichment process until 2013, at which time USEC began transition of the facilities to DOE, as specified by the terms and conditions of the Lease Agreement.

PGDP was placed on the U.S. Environmental Protection Agency (EPA) National Priorities List on May 3, 1994, with an effective date of June 30, 1994. Environmental restoration is being addressed under a Federal Facility Agreement (FFA) with EPA and the Commonwealth of Kentucky. The FFA became effective February 13, 1998.

1.5 PLAN OBJECTIVES

The main objectives of this EMP are as follows:

- Ensure the early identification of potential adverse environmental impacts associated with DOE operations through effluent monitoring and environmental surveillance.

- Ensure that analytical work supporting EM is implemented using the following:
  - A consistent system for collecting, assessing, and documenting environmental data of known and documented quality;
  - A validated and consistent approach for sampling and analysis of samples to ensure laboratory data meet program-specific needs and requirements; and
  - An integrated sampling approach to avoid duplicative data collection.
- Support the "fully implemented status" of the Paducah Site Environmental Management System (EMS).
- Support the implementation of the Paducah Site Integrated Safety Management System (ISMS).
- Ensure integration of EMS into the site's ISMS.

Outputs from implementation of the EMP may be used to do the following:

- Provide data for use in the ASER and ASER Summary, which informs the public about releases and potential impacts from DOE operations to human health and the environment;
- Identify DOE operations pollutant contributions;
- Provide ancillary data that may be required to assess the consequences of a spill or release;
- Identify significant changes in sample analytical results;
- Support or supplement data needs for CERCLA actions; and
- Provide a mechanism for long-term data collection needs under the FFA, when applicable.

1.6 PLAN OVERVIEW

Section 1 is used to describe the program's relevant historical and current information. Section 2 of this document describes effluent monitoring for liquid and airborne radiological constituents. Section 3 discusses meteorological monitoring, which is collected from the National Weather Service. Section 4 addresses, by media, environmental surveillance activities undertaken to monitor the radiological impacts of DOE operations. Section 5 describes the dose calculation methods used for the site. Section 6 provides various reporting requirements. Section 7 lists references utilized in the preparation of this plan.

The appendices provide detailed information regarding site permits, groundwater well information, sampling program details, QA, and data management.

1.7 MEASURING FACILITY IMPACT

The Radiological Guide requires comparisons of the measured concentrations against measured concentrations at "background" locations. For the purposes of this EMP, a "background" location also is called a reference location and is defined as an area unaffected by releases from PGDP. The area could,

however, be impacted by the operation of other industrial or commercial facilities. When no standards or criteria exist for contaminants that may have an impact on human health or the environment, comparisons to concentrations at reference locations can be made to determine if concentrations are significantly higher near the Paducah Site boundary.

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2. EFFLUENT MONITORING

Effluent monitoring is the collection and analysis of samples or measurements of liquid and gaseous effluents to quantify and officially report chemical and radiological contaminants, assess radiation exposures of the public, provide a means to control effluents at or near the point of discharge, and demonstrate compliance with applicable standards and permit requirements. Effluent monitoring is initiated to demonstrate compliance with one or more federal or Commonwealth of Kentucky regulations, permit conditions, or environmental commitments made in environmental impact statements, environmental assessments, DOE Orders and guides, or other official documents. Table 1 lists the various routine effluent monitoring activities performed at the Paducah Site. This table includes monitoring of liquid effluents, but it does not include gaseous effluents by MCS operations or FRNP. MCS and FRNP conduct gaseous emissions monitoring on their systems, as described in Section 1 of this EMP. Ambient air monitoring, which is required by NESHAP, is included within this EMP. A summary of permits and compliance agreements is included in Appendix A.

Table 1. Routine Liquid Effluent Monitoring

Program	Number of Locations	Sampling Frequency
Surface Water		
C-746-S&T Landfills	3[a]	Quarterly
C-746-U Landfill	3[a]	Quarterly
Environmental Radiation Protection Program (ERPP) near Kentucky Pollutant Discharge Elimination System (KPDES) Outfalls	14	Monthly
KPDES[b]		
Outfall (K001)	1	Weekly
Outfall (K002, K004[c], K006, K008, K009, K010, K011, K012, K013, K015, K016, K017, K019, K020)	14	Monthly
Outfall Toxicity[d] (K001, K010, K011[e], K017)	4	Quarterly
CERCLA Outfall		
C001	1	Weekly and quarterly
Leachate		
C-746-S&T Landfills	1	As required and annually
C-746-U Landfill	1	As required and annually
C-404 Landfill	1	As required

[a] One location, L154, is permitted for both the C-746-S&T Landfills and for the C-746-U Landfill. L154 is included in the totals for both landfills. Total number of locations sampled equals five.
[b] Sampling frequency reflects most frequent analyses required by the permit and does not reflect field measurement analyses.
[c] K004 is sampled twice per month.
[d] K001, K010, and K011 are monitored for chronic toxicity. K017 is monitored for acute toxicity.
[e] Chronic toxicity is required only when the effluent from the C-617 Lagoon is discharged through the outfall.
NOTE: Sampling locations and frequencies are detailed in Appendix C.

The primary statute governing the monitoring of effluents to surface water is the Clean Water Act (with the exception of radionuclides), which requires the issuance of a National Pollutant Discharge Elimination

System (NPDES) permit.[1] EPA has delegated the administration of the NPDES Program to the Kentucky Division of Water (KDOW) KPDES Program. The KPDES permit requires radiological monitoring at some of the permitted outfalls for reporting purposes only.

Sampling and analytical methods meet the requirements described in 40 *CFR* § 136 or the KPDES permit. In addition, DOE O 458.1, *Radiation Protection of the Public and the Environment*, and the Radiological Guide provide general and detailed guidance regarding the establishment of effluent monitoring programs for radiological parameters.

Rationale and Design Objectives. To ensure the protection of public health and the environment, the technical/regulatory objectives identified as part of DQOs for the Effluent Monitoring Program include the following:

- Verifying compliance with applicable federal, Commonwealth of Kentucky, and local effluent regulations and DOE Orders;
- Determining compliance with commitments made in environmental impact statements, environmental assessments, or other official documents;
- Evaluating the effectiveness of treatment processes and pollution control;
- Identifying potential environmental problems and evaluating the need for remedial actions or mitigating measures;
- Supporting permit revision and/or reissuance;
- Detecting, characterizing, and reporting unplanned releases; and
- Measuring changes in monitored concentrations of constituents in effluent over time.

In addition, Section 2.0 of the Radiological Guide recommends that this plan document the following:

- Effluent monitoring (sampling or *in situ* measurement) extraction locations used for providing quantitative effluent release data for each outfall;
- Procedures and equipment used to perform the extraction and measurement;
- Frequency and analyses required for each extraction (continuous monitoring and/or sampling) location;
- Method detection level (MDL)/minimum detectable activity (MDA) and accuracy by analyte;
- QA components; and
- Effluent outfall alarms (not required at PGDP).

The preceding requirements are addressed as follows.

[1] Radioactive materials that are regulated under the Atomic Energy Act of 1954 are excluded from the Clean Water Act.

- Appendix C of this document lists all effluent monitoring locations. Appendix C specifies sampling and field measurements, as well as analytical method information. Appendix C also lists the sampling frequency at each location and the required analytical parameters, analytical method, and required reporting limits (as applicable). Additionally, Appendix C specifies the sampling driver for each sampling program (e.g., permit, CERCLA decision document). Generally, data collected as part of this document not only meets permit and CERCLA decision requirements, it also provides data sets that may be used in future CERCLA decision documents.

- Appendix D of this document provides the QAPP. All QA components are outlined within this plan. The QAPP identifies reporting limits [or practical quantification limits (PQLs)] and MDLs/MDAs. In cases where reporting limits (or PQLs) are specified under a given regulatory driver, those requirements are denoted as such within the QAPP.

- Each laboratory receives a statement of work for all sampling activities. The reporting limits (or PQLs) found in the QAPP are specified in the statement of work as a condition of work. If a laboratory cannot meet these limits, and if the limits are not a matter of regulatory compliance, the contractor project manager may approve the increased reporting limits (or PQL) and/or MDLs/MDAs.

- Monitoring results from the KPDES outfalls are summarized in the discharge monitoring reports, which are submitted on a monthly basis to the KDOW as required by the KPDES permit. Notifications of exceedances to the permit are submitted per the specifications within the permit. Surface water monitoring results at the landfills are summarized in quarterly reports and submitted to Kentucky Division of Waste Management (KDWM) on a quarterly basis.

Evaluation of Effluents. Effluents, regardless of whether they contain radiological contaminants from new or modified facilities, are to be evaluated against permit conditions (as applicable) by the Environmental Compliance support personnel. Additionally, data are reviewed by the ERPP organization for evaluation and trending purposes and to determine any required response.

Physical/Chemical/KPDES. KPDES is the regulatory program administered by KDOW for discharge of wastewaters to the waters of the Commonwealth of Kentucky. The DOE Paducah Site KPDES permit, KY0004049, was renewed in July 2017. The permit number for this new permit is KY0004049, which is the same number as the previous KPDES permit. The new permit has an effective date of September 1, 2017, and combines the previous KY0004049 permit with KY0102083. The KPDES permit establishes monitoring requirements for the discharge of effluent and surface water runoff.

The permit defines limits on the concentration and amounts of specific chemicals that can be discharged and on the physical impact of those discharges (e.g., temperature or biological harm) to surface waters.

Processes for DOE operations have been evaluated to determine the chemicals, radiological components, and physical parameters (e.g., temperature) likely to affect the KPDES-permitted effluents. Effluents from permitted landfills are evaluated during the reporting and permit renewal processes.

Radiological. Based on the evaluation of emissions and the results of radiological monitoring from historical data sets, neither continuous monitoring nor continuous sampling with frequent analyses is required by DOE O 458.1. The KPDES permit requires radiological analyses at some of the outfall locations (Figure C.12).

Effluent sampling is required by the ERPP. Radiological data sets of effluent water near the KPDES outfalls (Figure C.13), along with surveillance data of surface water and sediments slightly downstream (Figures C.15 and C.16), are evaluated as part of the ERPP.

Program Implementation Procedures. The FRNP EM manager (or designee) is responsible for implementing all relevant aspects of the EMP. In that role, the FRNP EM manager reports through a line organization to the Environmental Services Project Director and provides centralized coordination responsibilities.

2.1 LIQUID

2.1.1 Surface Water

Surface water leaving KPDES outfalls/the CERCLA outfall includes rainfall runoff from cylinder yards and landfills and effluent from site processes. The intent of monitoring is to assess compliance with Commonwealth of Kentucky and federal regulations, permits, and DOE Orders and to assess the impact of DOE operations on the local environment.

C-746-S&T and C-746-U Landfills Surface Water. Rainfall runoff from three locations at C-746-U Landfill and three locations at C-746-S&T Landfills (Figure C.11) are sampled quarterly for parameters listed in Appendix C. Although three locations are cited for each, there are only five unique locations.

KPDES Monitoring. Fifteen effluent sampling points covered by the KPDES permit are illustrated in Appendix C (Figure C.12).

2.1.2 Leachate

C-746-S and C-746-U Landfills Leachate. Leachate from the solid waste landfills is sampled annually and is analyzed for the parameters listed in Appendix C in accordance with permit requirements.

C-404 Landfill Leachate. Leachate samples are collected from the C-404 Landfill Leachate Collection System and analyzed for the parameters listed in Appendix C in accordance with permit requirements.

2.2 AIRBORNE

Airborne emissions are regulated by the Kentucky Division for Air Quality. For emissions that may be harmful to the public or the environment, permits are required from the Division for Air Quality. Operations at the Paducah Site require air permits. Ambient air monitoring, which monitors fugitive emissions from all Paducah Site operations, is conducted by eight continuous air monitors, as described in the approved Paducah Site NESHAP Management Plan, PAD-REG-1017 (LATA Kentucky 2013). Data from a background location also is collected.

Operational sampling included in the Title V air permit (V-14-012R1) is considered outside the scope of the EMP. FRNP will implement the appropriate operational sampling. This data will be available in the event it is needed to evaluate site conditions. Additionally, the DUF_6 facility maintains an air permit (F-10-035), which also is considered outside the scope of the EMP.

3. METEOROLOGICAL MONITORING

DOE operations may have airborne radionuclide and chemical emissions from various sources, such as CERCLA remedial actions, as well as fugitive emissions and stack emissions from deactivation of the gaseous diffusion buildings. The Paducah Site requires meteorological monitoring data to support both chemical and radiological evaluations. The Radiological Guide recommends that a meteorological monitoring program appropriate to site activities be established. In general, sites should have on-site measurements of basic meteorological data. The Paducah Site no longer operates the on-site meteorological tower to collect meteorological data. Meteorological data sets purchased from other sources and historical data collected at the site may be used to model the radiological and chemical emissions. Purchased meteorological data is procured from accredited meteorological measuring stations that are in close proximity to the site.

3.1 CHEMICAL EMISSIONS

DOE operations may have airborne chemical emissions from various sources, such as CERCLA remedial actions, as well as fugitive emissions.

3.2 RADIOLOGICAL EMISSIONS

Operations at the Paducah Site may have airborne radiological emissions from various sources, such as CERCLA remedial actions, deactivation activities, DUF_6 conversion activities, as well as fugitive emissions. Modeling to demonstrate compliance with NESHAP regulations is conducted using the Clean Air Act Assessment Package-88 (CAP-88). In accordance with the NESHAP Management Plan (LATA Kentucky 2013), meteorological data utilized for CAP-88 are compiled from the National Weather Service at Paducah and the National Climatic Data Center's "Climate at a Glance" database.. Other dose modeling software such as RESRAD-OFFSITE or RESRAD-BIOTA may be used with appropriate meteorological data sets.

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4. ENVIRONMENTAL SURVEILLANCE

Supporting the goal of DOE O 436.1, *Departmental Sustainability*, for planning environmental activities, the Paducah Site performs environmental surveillance. Environmental surveillance is the collection and analysis of samples or direct measurements of air, water, sediment, and other media from DOE sites and their environment for the purpose of determining compliance with applicable standards and permit requirements, assessing radiation exposures of members of the public, and assessing the effects, if any, on the local environment; therefore, the environmental surveillance program is a comprehensive environmental program addressing radiological and nonradiological parameters.

In support of DOE O 458.1, *Radiation Protection of the Public and the Environment*, the Paducah Site performs monitoring of remedial actions and activities to monitor that members of the public are not exposed to ionizing radiation at a total effective dose (TED) exceeding 100 mrem (1 mSv) in a year from all site-related sources of ionizing radiation and exposure pathways. Air emissions are covered under 40 *CFR* § 61, NESHAP. Because 40 *CFR* § 61 still operates under previous dosimetric terminology, dose calculated and reported to comply with 40 *CFR* § 61 will continue to be reported under the old terminology. Air emissions are required to be part of the total when calculating TED under the new 10 *CFR* § 835 dosimetric terminology; however, until 40 *CFR* § 61 is revised to incorporate new dosimetric terminology, the effective dose equivalent (EDE) calculated from the old terminology under NESHAP will be assumed to be approximately equivalent to effective dose (ED) defined under the new terminology for the purpose of incorporating it into the TED calculated. Any one air emission source is limited to 10 mrem per year EDE to the maximally exposed individual (MEI) of the public per 40 *CFR* § 61, Subpart H.

DOE activities must be conducted to ensure that radionuclides contained in liquid effluents do not cause private or public drinking water systems to exceed an annual dose of 4 mrem per year per 40 *CFR* § 141, which is more limiting than DOE O 458.1 limit of 10 mrem per year. For monitoring of public drinking water systems, 40 *CFR* § 141 allows for environmental surveillance data to be used in the vicinity of nuclear facilities. The nearest downstream public water withdrawal location is Cairo, Illinois, located on the Ohio River. For comparison purposes, a background sample of the Ohio River water is collected upstream of the site. The plant effluent sampling results are evaluated against both the Cairo, Illinois, sampling results and the background location sampling results. This evaluation is to demonstrate that plant effluent concentrations are below a 4 mrem per year standard at the public drinking water system. Plant environmental surveillance sampling locations are within the Bayou and Little Bayou Creek systems prior to confluence with the Ohio River.

DOE O 458.1 defines “public dose” as the dose received by member(s) of the public from exposure to radiation and to radioactive material released by a DOE radiological activity whether the exposure is within a DOE site boundary or off-site. It does not include doses received from radon and its decay products in air (regulated separately under DOE O 458.1), occupational exposures, doses received from naturally occurring “reference” radiation, or doses received by a patient from medical procedures. The determination of the public dose, as established by EPA regulation 40 *CFR* § 61, differs in that the 10 mrem EDE per year limit applies to dose received where the members of the public reside.

The Radiological Guide recommends that DOE facilities perform routine surveillance if an annual dose of site origin at the site boundary exceeds either 5 mrem per year ED to an individual or 100 person-rem collective ED within a radius of 80 km (about 50 miles) of a central point on the site. Historically, as reported in previous ASERs, the annual dose due to DOE operations at the Paducah Site has been less than 5 mrem per year ED (individual) or 100 person-rem collective ED.

An overview of routine environmental surveillance is provided in Table 2, which lists for each program the number of sampling locations, sampling frequency, sample type, and parameters for the analysis performed.

Table 2. Routine Environmental Surveillance

Program	Number of Locations	Sampling Frequency	Sample Type	Parameters
Groundwater				
Surveillance	31	Annually	Grab	See Appendix C
Surveillance	85	Biennially (Sampled FY 2017—will be sampled in FY 2019)	Grab	See Appendix C
Surveillance	3	Semiannually	Grab	See Appendix C
Surveillance	3	Quarterly	Grab	See Appendix C
Surveillance Geochemical	38	Every 3 years (Sampled FY 2016—will be sampled in FY 2019)	Grab	See Appendix C
C-746-S&T Landfills	25[a]	Quarterly	Grab	See Appendix C
C-746-U Landfill	21[a]	Quarterly	Grab	See Appendix C
C-404 Landfill	9	Semiannually	Grab	See Appendix C
C-746-K Landfill	3	Semiannually	Grab	See Appendix C
Northeast Plume	14	Semiannually	Grab	See Appendix C
Northeast Plume	34	Quarterly	Grab	See Appendix C
Northwest Plume	32	Semiannually	Grab	See Appendix C
Northwest Plume	1	Quarterly	Grab	See Appendix C
C-400	9	Quarterly	Grab	See Appendix C
C-400	8	Semiannually	Grab	See Appendix C
SWMU 1	7	Semiannually	Grab	See Appendix C
Water Policy Boundary—NW	20	Quarterly	Grab	See Appendix C
Water Policy Boundary—NE	7	Annually	Grab	See Appendix C
Residential Carbon Filter System	1	Semiannually	Grab	See Appendix C
Surface Water and Seeps				
Surface Water and Seeps	3	Quarterly	Grab	See Appendix C
Surface Water—ERPP	7/2	Quarterly/Annually	Grab	See Appendix C
C-613 Sediment Basin	1	Quarterly	Grab	See Appendix C
Sediment				
Sediment	14	Semiannually	Grab	See Appendix C
Sediment—ERPP	6	Annually	Grab	See Appendix C
Ambient Air	9	Weekly/Quarterly	N/A	See Appendix C
Meteorologic[b]	N/A	N/A	N/A	N/A
Environmental Dosimeters	64/7	Quarterly	Continuous	External Gamma/Neutron

[a] Four of the same wells are cited in both C-746-U and C-746-S&T Landfills permits. For these totals, the wells are counted for both programs. Also, for the C-746-S&T Landfills locations, the count of 25 wells includes 2 wells that are measured only for water level. Twenty-three locations are sampled for analytical laboratory parameters.

[b] Information is taken from the National Weather Service and historic data sets.

4.1 GROUNDWATER

4.1.1 Introduction

The Paducah Site, located in the Jackson Purchase region of western Kentucky, lies within the northern tip of the Mississippi Embayment portion of the Gulf Coastal Plain Province. The stratigraphic sequence in the region consists of Cretaceous, Tertiary, and Quaternary sediment unconformably overlying Paleozoic bedrock. The *Report of the Paducah Gaseous Diffusion Plant Groundwater Investigation Phase III* (Clausen et al. 1992) discusses geology and hydrogeology of the Paducah Site in detail. Additional information regarding the geology and hydrogeology at the Paducah Site is covered in the *Update of the Paducah Gaseous Diffusion Plant Sitewide Groundwater Flow Model* (DOE 2017b) for PGDP. The most recent groundwater contaminant plume maps were developed in 2017 and are contained in *Trichloroethene and Technetium-99 Groundwater Contamination in the Regional Gravel Aquifer for Calendar Year 2016 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (FPDP 2017).

4.1.2 Rationale and Design Criteria

The groundwater monitoring program consists of routine compliance monitoring designed to ensure the protection of public health and the environment. The technical criteria identified as part of DQOs for the groundwater monitoring program include the following:

- Obtain data to determine baseline conditions of groundwater quality and quantity;
- Demonstrate compliance with and implementation of all applicable regulations and DOE Orders;
- Provide data to allow early detection of groundwater pollution or contamination;
- Identify existing and potential groundwater contamination sources and maintain surveillance of these sources; and
- Provide data for making decisions about waste disposal on land-based units and the management and protection of groundwater resources.

The following addresses specific laws, regulations, and orders.

DOE Orders. Neither DOE Orders nor the Radiological Guide requires specific groundwater sampling frequencies or parameters. Instead, DOE Orders require that sample collection programs reflect specific facility needs. Type and frequency of sampling shall be adequate to characterize effluent streams and to identify existing and potential groundwater contamination sources. Monitoring verifies that releases are sustainable without causing environmental harm. This EMP was written to include effluent monitoring and environmental surveillance at the Paducah Site. In order to provide a data set that is assessed for potential environmental impacts, a comparison data set from samples collected from areas that are not impacted by site operations also is required. Such sample locations are called “background” locations.

Commonwealth of Kentucky Regulation. Preparation of a Groundwater Protection Plan that addresses requirements to ensure protection for all current and future uses of groundwater and to prevent groundwater pollution is required by 401 *KAR* 5:037. This requirement was addressed by DOE, by writing and implementing the Groundwater Protection Plan, according to 401 *KAR* 5:037, prior to the deadline of August 24, 1995. The current Groundwater Protection Plan is *Groundwater Protection Plan for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* PAD-PROJ-0018/R2

(LATA Kentucky 2015). This document is reviewed and revised, as needed, to reflect current site operations.

Agreement in Principle Sampling. The Agreement in Principle (AIP) provides sampling and inspection of the differing monitoring programs. The oversight includes inspections (including MW inspections and surface water area inspections), sample analysis, statistical analysis of sample results, and data quality. KDWM AIP personnel conduct independent groundwater and surface water sampling and obtain DOE sample splits.

AIP personnel also respond to questions and concerns from the public, including sampling of residential wells. The AIP personnel participate in public meetings to provide an independent view of the effect of the Paducah Site on the local environment and health of the public.

CERCLA Actions. A requirement of the FFA is to determine the nature and extent of off-site contamination (attributed to historical releases from Paducah facilities). This requirement is addressed through the RI process and ongoing remedial actions for OUs at the Paducah Site, as well as for the sampling under this EMP.

The *Action Memorandum for the Water Policy at Paducah Gaseous Diffusion Plant* (Water Policy) (DOE 1994) stipulated the need to ensure that residential landowners whose well water was contaminated by PGDP sources were provided with water (DOE 1995; DOE 1993). The Water Policy was established in accordance with the Administrative Consent Order, following an Engineering Evaluation/Cost Analysis, and was written to document the preferred alternative addressing the need for protection of human health due to the presence of groundwater contamination originating from the Paducah Site. As soon as possible after contamination was found in local residential water supply wells, the affected households were supplied with bottled water. Construction of water mains allowed access to water lines for homes in the affected area. This was accomplished as a non-time-critical removal action under CERCLA. The Action Memorandum provided the sampling strategy only at the time the document was prepared and referred future sampling to the Sampling and Analysis Plan Addendum, which was superseded by the EMP. Currently, 27 wells are sampled in support of action (Figures C.8 and C.9).

The EMP also supplements the Paducah CERCLA RIs and ongoing remedial actions, as described in Section 1 of this EMP. The EMP is integrated with each OU investigation to provide collection of optimal data sets.

C-400 Program. Sampling of MWs provides a meaningful tool for evaluating the downgradient dissolved-phase contamination in the Northwest Plume and the efficacy of the C-400 Interim Remedial Action (Figure C.6). MWs are required to be sampled by the *Record of Decision for Interim Remedial Action for the Groundwater Operable Unit for the Volatile Organic Compound Contamination at the C-400 Cleaning Building* (DOE 2005). Additional sampling requirements are documented in PPPO-02-452-09, "Response to Letter from Kentucky Division of Waste Management Regarding Baseline Groundwater Sample Collection at the Northwest Corner of the C-400 Building," July 8, 2009.

FFA Requirement and O&M Plan for the Northwest and Northeast Plume Programs. In order to monitor the nature and extent of groundwater contamination and to evaluate any cyclic trends in water quality that may affect contaminant migration, 32 wells are required to be sampled semiannually for the Northwest Plume (Figure C.5) according to the O&M Plan. In addition, one well will be sampled quarterly in order to evaluate trends in TCE concentrations along the Northwest Plume. Thirty-four wells will be sampled quarterly, and fourteen wells will be sampled semiannually for the Northeast Plume (Figure C.4), according to the O&M Plan and the Remedial Action Work Plan for Optimization of the Northeast Plume Interim Remedial Action (DOE 2016).

O&M Plans also specify production sampling. Sampling and monitoring of treatment systems are not captured within this EMP. The Northeast Plume O&M plan requires sampling of a CERCLA outfall in order to monitor effluent from the Northeast Plume Containment System. The sampling requirements for the CERCLA outfall are included in this EMP.

SWMU 1 Program. Sampling of MWs in order to monitor the progress of contaminant reduction in the Regional Gravel Aquifer groundwater following soil mixing is required by 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)* (DOE 2013). Seven wells will be sampled semiannually in FY 2018 (Figure C.7).

4.1.2.1 Landfill groundwater monitoring program

C-746-S and C-746-T Landfills. C-746-S and C-746-T Solid Waste Landfills are closed landfills owned by DOE. These landfills currently are in postclosure status under the landfill permit. The groundwater is monitored utilizing a total of 25 MWs near the two landfills (Figure C.1). Of these 25, 23 are used for collection of samples to analyze organic, inorganic, and radiological parameters. The remaining two are used for water level measurements. Additional analytical information is found in Appendix C.

C-746-U Landfill. The C-746-U Solid Waste Landfill is an operating landfill owned and managed by DOE. This landfill currently is being operated as a contained landfill under the landfill permit; 21 MWs (Figure C.1) are monitored quarterly for organic, inorganic, and radiological parameters. Additional analytical information is found in Appendix C. Sampling and monitoring of treatment systems are not captured within this document because they are part of the daily operations of the landfill.

Technical Attachment 25, Appendix G, to the permit for C-746-S, C-746-T, and C-746-U Landfills specifies a sample collection order. The order is as follows: volatiles (including total organic halides), dissolved gases and total organic carbon, semivolatile organics, metals and cyanide, water quality cations and anions, and radionuclides. If samples are being collected at a location where it is anticipated that sample volume is not adequate, then the order of collection will be volatiles followed by radionuclides.

C-404 Landfill. The C-404 Hazardous Waste Landfill is currently subject to post-closure monitoring under EPA Hazardous Waste Permit KY8-890-008-982. The C-404 Hazardous Waste Landfill currently is being monitored under detection monitoring (semiannual sampling) according to permit requirements, including Attachment E of the permit, "Groundwater Monitoring." The groundwater is monitored utilizing nine MWs (Figure C.2). There are six downgradient and three upgradient compliance point wells. Per the permit, sample aliquots shall be withdrawn in the following order: volatiles, total metals, and radionuclides. Remaining permit requirements may follow the radionuclide sample collection. Samples are to be collected twice a year: January through March as one sampling event and July through September as the second event. Results from the January through March event are reported to KDWM by May 30 and results from the July through September event are reported to KDWM by November 30.

Prior to sample collection, KDWM shall be notified one week in advance. Notification may be made in writing or electronic format. Electronic mail shall be submitted to pertinent KDWM field personnel.

All groundwater wells (MWs, piezometers, etc.) will be inspected annually during the third quarter of the calendar year (CY). The wells will be inspected for the condition of the Kentucky Groundwater Data Repository identification, the outer casing, the concrete pad, the bumper posts, painting, the well cap, the lettering and numbers, lock and hasp, well access, vegetation control, and well fittings and tubing. Items will be repaired, as necessary. The wells will be inspected annually for excessive sedimentation by performing a depth sounding at each MW. If a well is found no longer to meet the requirements of

401 *KAR* 34:060, the well will be abandoned in accordance with 401 *KAR* 6:350 and the Hazardous Waste Permit. If a replacement well is needed, it will be installed in accordance with 401 *KAR* 6:350 and the requirements of the Hazardous Waste Permit.

C-746-K Landfill. Sampling of three MWs (Figure C.3) is conducted to evaluate the potential impact of historical waste disposal activities at the C-746-K Landfill on the groundwater quality parameters, which are analyzed semiannually, as identified in Appendix C. The Record of Decision (ROD) for Waste Area Groups 1 and 7 (DOE 1997) discussed sampling that was being conducted at the time of the ROD development; however, the ROD allowed for modifications to the sampling strategy with documentation of the strategy in a Sampling and Analysis Plan addendum, which was replaced by the EMP. Sampling of these wells is not required by a permit, but is conducted in support of the FFA CERCLA investigation and RCRA facility investigations according to the FFA. Additional analytical information is found in Appendix C.

4.1.2.2 Surveillance monitoring program

Environmental Surveillance Program. In order to monitor the nature and extent of groundwater contamination and to monitor groundwater quality, 84 nonbackground MWs and 1 background are sampled biennially, 30 nonbackground MWs and 1 background are monitored annually, 3 MWs are sampled semiannually, and 3 MWs are sampled quarterly, as shown in (Figure C.10). Sampling of these MWs is not driven by a permitted process, but is conducted in support of the FFA CERCLA investigations, as well as DOE O 436.1. The inclusion of these MWs in this program does not exclude them from other sampling programs. For ease of review, Appendix B of this document contains a well inventory list, which acts as a crosswalk for each MW and sampling program.

The sampling frequency for this program was modified in the FY 2011 EMP. The sampling frequency was modified from a quarter/semiannual basis to an annual/biennial basis. This modification was justified by an evaluation of the data collected over 10 years, which showed that there had not been significant changes that merited the need for sampling as frequently. The MWs that were selected to be monitored annually were selected based on their location within the plumes. The sampling frequency for 3 MWs has been increased to quarterly, and the sampling frequency for 3 MWs has been increased to semiannually in FY 2018 in order to evaluate TCE concentrations along the Northwest Plume. The 85 MWs that were selected to be monitored biennially were sampled in FY 2017; therefore, these wells will be sampled in FY 2019.

One background well is sampled biennially and one annually to monitor the background water chemistry of wells located upgradient of the plant to compare with MWs potentially impacted from plant activities.

Environmental Surveillance (Geochemical Monitoring) Program. In order to monitor the effects of natural attenuation of groundwater contamination and to monitor groundwater quality, 38 MWs are to be sampled every 3 years (Table C.24). Sampling of these wells is not driven by a permitted process, but is conducted in support of the FFA CERCLA investigations, as well as DOE O 436.1. The sampling frequency for this program was modified in the FY 2011 EMP. The sampling frequency was modified from an annual basis to a triennial basis. These MWs were sampled in FY 2016 as part of the triennial basis sampling strategy; therefore, these wells will not be sampled in FY 2018.

4.1.3 Extent and Frequency of Monitoring

Appendix B provides information for all wells used at the Paducah Site, as well as residential wells located off-site. The groundwater sampling frequency and parameters, which are identified in Appendix C, are reviewed annually. The information detailed in Appendix C is the planning document for all

monitoring and lists sites to be monitored, the governing program(s), MWs, parameters, analytical methods, required reporting limits (as applicable), and the sampling frequency.

4.1.4 Program Implementation Procedures

Organization. The FRNP EM manager (or designee) is responsible for implementing all relevant aspects of the EMP.

Plans. The *Groundwater Protection Plan for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, PAD-PROJ-0018/R2, (LATA Kentucky 2015) addresses the following specific requirements listed in Section 3(3) of 401 *KAR* 5:037:

(a) General information regarding the facility and its operation;

(b) Identification of activities associated with the facility, as identified in Section 2 of the regulation;

(c) Identification of all practices chosen for the plan to protect groundwater from pollution;

(d) Implementation schedules for the protection practices;

(e) Description of and implementation schedule for employee training necessary to ensure implementation of the plan;

(f) Schedule of required inspections, as applicable; and

(g) Certification of the plan by the appropriate PGDP representative.

These plans and the EMP provide the framework of the Groundwater Monitoring Program.

4.2 SURFACE WATER/SEDIMENT ENVIRONMENT

Surface Water. Measurement of water quality parameters in surface water samples provides a general guide to the environmental health of the system. Certain contaminants (e.g., volatile organic compounds) that are not particularly concentrated in other media are more efficiently analyzed in water samples.

Sediment. A single sediment sample can represent information that would require a large number of water samples, spaced over a period of time, to reconstruct. Sediment acts to collect, concentrate, and store specific kinds of contaminants at specific locations. Concentrations of contaminants in sediments represent integrated measures of aqueous contaminant concentrations over some preceding period of time.

The Environmental Surveillance Program at the Paducah Site for surface water and sediment evolved over a number of years in response to regulatory and community concerns. Initially, the prudent action was to sample surface water at the permitted outfalls and upstream and downstream within the receiving streams to assess potential impacts. Since that time, DOE has conducted remediation/removal efforts at the site, which has decreased the potential for surface water and sediment contamination. Additionally, the effluent and surface water runoff from outfalls leaving the plant site is monitored to confirm no current impacts from ongoing operations. Monitoring at the outfalls is permitted by KDOW through the KPDES permit and radiological parameters are monitored under DOE O 458.1 requirements. Limited radiological samples for surface water and sediment are collected in the environment to verify the effectiveness of the outfall sampling and to evaluate the accumulation of radionuclides in the environment.

4.2.1 Rationale and Design Criteria

The surface water and sediment sampling sites included in this EMP are located on selected receiving streams downstream from primary contaminant sources and reference streams. The reference streams are located either off-site or on-site, but upstream of contaminant sources. Sample sites were selected to prioritize areas where the public had access and to capture any and all emissions from the plant site. Contaminant sources include both point sources (e.g., effluent outfalls) and nonpoint sources, such as waste disposal areas or burial grounds.

4.2.2 Extent and Frequency of Monitoring

4.2.2.1 Surface water program

Previously, the KPDES permit required sampling for PCBs and TCE at 19 locations upstream and downstream from Paducah Site operations. The new KPDES permit (KY0004049) does not require this sampling; therefore, these locations have been removed from this program for FY 2018, with the exception of the C-746-K Landfill locations. The C-746-K Landfill locations will be sampled per the ROD for Waste Area Groups 1 and 7 (DOE 1997). One seep location in Little Bayou Creek is sampled quarterly for TCE (Figure C.15).

For radiological parameters, surface water is sampled quarterly at seven locations and annually at two locations. Two locations, L1 (background) and L30 (a location just downstream of the Paducah Site), are sampled annually. L29A (background) and a location near the nearest public water withdrawal location, Cairo, Illinois, (L306) are sampled quarterly. This sampling is performed to evaluate all potential radiological effluents leaving the site and to evaluate the effectiveness of the outfall sampling program. This supports the implementation of DOE O 458.1 through the ERPP, CP2-ES-0103 (FPDP 2014). Additional analytical information is found in Appendix C.

4.2.2.2 Sediment program

Sediment samples are collected semiannually from 14 locations, 2 of which are considered background locations (Figure C.16). Five locations and a background are sampled for radiological parameters to evaluate the effectiveness of the plant effluent monitoring and to monitor the accumulation of contaminants in the environment. Sediment is sampled near the surface water and biological stations at locations downstream from plant operations and in background (reference) streams. Station locations coincide with those for surface water in Bayou Creek and Little Bayou Creek. Of note: Analytical laboratory results will be reported on a dry weight basis, as applicable, unless specified otherwise. Additional analytical information is found in Appendix C. An assessment code of "DRY" has been added in OREIS with the description of "Result reported on a dry weight basis," for data generated starting in FY 2014, as applicable.

4.2.3 Program Implementation Procedures

The FRNP EM manager (or designee) is responsible for implementing all relevant aspects of the EMP. In that role, the FRNP EM manager reports through a line organization to the Environmental Services Project Director and provides centralized coordination responsibilities.

4.3 TERRESTRIAL ENVIRONMENT

Woodlands, meadows, and cultivated fields dominate the rural landscape around the DOE Reservation. Immediately adjacent to the DOE Reservation is WKWMA, which is used by a considerable number of hunters, trappers, and anglers each year. Hunting and trapping activities may include such wildlife as rabbit, deer, quail, raccoon, squirrel, dove, turkey, waterfowl, and beaver. Additionally, the Kentucky Department of Fish and Wildlife Resources sponsors field hunting trials for dogs within the WKWMA.

This section discusses the terrestrial environment near the Paducah Site that could become radiologically contaminated as a result of releases of materials from current or past DOE operations. Farm-raised animal products, as well as local wildlife in the area, may be contaminated through water releases. Wildlife and animal products, including meat, eggs, and milk, may become contaminated through animal ingestion of contaminated water, sediment, other animals, or through direct contact with contaminated areas. The subsequent ingestion of these products can lead to a dose to man and is discussed in subsequent sections. Concentrations of both radionuclide and chemical contaminants are evaluated in the terrestrial environment. The Radiological Guide suggests that if wild game, such as deer or game birds, is available locally, these species should be considered for radiological sampling purposes. Due to downward trends and continued lack of detection results, this sampling is not performed. Additional details of these evaluations are discussed below.

4.3.1 Rationale and Design Criteria

AIRDOS-EPA computer code contained in the latest version of the CAP-88, which implements a steady-state, Gaussian plume, atmospheric dispersion model, is used to calculate environmental concentrations of the estimated released airborne radionuclides and then uses U.S. Nuclear Regulatory Commission (NRC) Regulatory Guide 1.109 food chain models to calculate human exposures, both internal and external, to receptors. The human exposure values then are used by EPA's version of the DARTAB computer code to calculate radiation doses to the public from radionuclides released during the year.

4.3.1.1 Soils

Very low amounts of airborne radionuclides are emitted at the Paducah Site. A portion of the airborne radionuclides is estimated to be deposited in soil. Irrigation and deposition through waterborne radionuclides is an incomplete pathway because municipal water is used at nearby residences for household purposes (including activities such as watering plants and lawns). See Section 4.3.1 for air modeling information.

4.3.1.2 Animal products

Very low amounts of airborne radionuclides are emitted at the Paducah Site. A portion of the airborne radionuclides is estimated to be deposited in soil and on food crops where they may be absorbed into plants and then may be ingested by animals. Animal products then may be ingested by the public. Irrigation and deposition through waterborne radionuclides is an incomplete pathway because municipal water is used at nearby residences for household purposes (including activities such as watering plants and lawns). The Paducah Site estimates doses from animal products to the receptors based on these estimated airborne emissions. See Section 4.3.1 for air modeling information.

4.3.1.3 Food crops and vegetation

Very low amounts of airborne radionuclides are emitted at the Paducah Site. A portion of the airborne radionuclides is estimated to be deposited in soil and on food crops and vegetation where they may be absorbed into food crops and vegetation. These food crops then may be ingested by the public. Irrigation and deposition through waterborne radionuclides is an incomplete pathway because municipal water is used at nearby residences for household purposes (including activities such as watering plants and lawns). The Paducah Site estimates doses from food crops to the receptors based on these estimated airborne emissions. See Section 4.3.1 for air modeling information.

4.3.1.4 Wildlife

Wildlife monitoring (i.e., deer) historically was conducted near the Paducah Site. In 2011, an extensive review was conducted of data sets from 20 years of deer harvesting events. As a result of this review, the deer monitoring was eliminated because of a downward trend and a continued lack of detection in the results, as well as an overall downward trend in the concentration of contaminants found at the Paducah Site due to remediation efforts.

4.4 EXTERNAL RADIATION

The Paducah Site conducts routine surveillance of external gamma and neutron radiation exposure to monitor any effects due to past releases of radionuclides and current operations involving radioactive sources (e.g., depleted uranium hexafluoride cylinder management). Historical monitoring has shown that the external gamma and neutron radiation dose from routine DOE operations at the Paducah Site boundary is under 10 mrem per year ED (individual) and 100 person-rem per year ED (collective dose for exposed population). Routine surveillance of external gamma radiation with dosimeters is conducted to provide data to model direct external radiation from sources located on-site consistent with DOE O 458.1. Area gamma and neutron dosimetry monitoring near cylinder yards has been in place in previous years to meet 10 *CFR* § 835 requirements.

4.4.1 Objectives

A primary objective is to calculate the ED of the MEI member of the public.

A second objective is to calculate ED to a member of the public in areas freely accessible to members of the public. The Paducah Site licenses a portion of the Paducah Site to the Kentucky Department of Fish and Wildlife for recreational uses. These areas are open to the public for use but do not have any residences within the Paducah Site boundary. Public traffic is allowed on the main reservation roads outside of the active plant area as a courtesy to the public, and some members of the public visit the DOE Reservation for various reasons, including hunting. It is anticipated that any use would be limited to recreational purposes and durations of time spent in the area by the public would be less than full time.

A third objective is to calculate the ED to a member of the public at the Paducah Site boundary. No residences are on-site and any residential receptor would be beyond the Paducah Site boundary.

A fourth objective is to establish the potential dose that a member of the public may receive while visiting or passing through the Paducah Site. This would be for visitors accessing the Paducah Site in the area closed for public access but outside DOE-controlled areas, as defined by DOE O 458.1.

A fifth objective of external exposure monitoring is to establish the potential radiation dose from direct exposure to DOE operations at the boundary of the DOE perimeter fence.

4.4.2 Rationale and Design Criteria

The External Radiation Monitoring Program is designed to provide exposure data on direct radiation from DOE operations to members of the public. The primary factor in selecting the monitoring locations is the potential for a member of the public to be exposed to direct radiation. The highest potential radiation exposure to the public is at the plant perimeter.

The monitoring program conducts area external radiation dose monitoring using dosimeters. Devices of this type are capable of measuring exposure resulting from gamma and neutron radiation and are used throughout the industry to perform EM.

The primary sources for radiation exposure to areas outside the PGDP security fence are the UF_6 cylinder storage yards, which are located within the secured area, but in close proximity to the perimeter fence. Studies conducted within the cylinder storage yards have shown that the cylinders are sources of both gamma and neutron radiation. The neutrons are produced at moderate energy levels by the alpha-fluorine reaction taking place within the residual UF_6 material. Further studies have indicated that the range of the neutrons is such that the neutron dose rate falls off rapidly with distance.

4.4.3 Extent and Frequency of Monitoring

The extent and frequency of monitoring for external gamma radiation are determined based on the principle that the exposure levels decrease with distance from the sources and that the levels are relatively constant over time.

Public access assumptions are that (1) the security fence for the secured area provides a physical boundary beyond which the public has no access; (2) the locations of residences and communities outside the reservation are known; and (3) individual exposure scenarios may vary.

Environmental gamma detection dosimeters are located at 64 locations and neutron dosimeters are located at 7 locations, including inside the PGDP security fence, PGDP perimeter, outfalls, ditches, and background locations (Figure C.18). Dosimeters also have been placed in areas that historically have received the highest radiation exposure.

Data comparisons are made yearly between the current year and the prior year's radiation monitoring and the results are presented in the Annual Report on External Radiation Monitoring, as well as in the ASER.

4.5 AMBIENT AIR

DOE complies with 40 *CFR* Part 61, Subpart H, to control airborne emissions of radionuclides. This compliance includes evaluation of activities that have potential radionuclide emissions. The EDE from point sources is calculated based on monitoring information for each source.

In addition to point sources, DOE has identified potential fugitive and diffuse sources of radionuclides. In accordance with the Paducah Site NESHAP Management Plan, PAD-REG-1017, ambient air is monitored to measure concentrations of radionuclides from all sources, including fugitive and diffuse. The ambient air monitoring network is comprised of nine air monitoring stations surrounding the site,

including one background station (Figure C.18). Additional analytical information is found in Appendix C.

Because the public dose has been below 10 mrem per year consistently, additional sampling beyond the ambient air monitoring is not warranted for the FY 2018 EMP.

4.6 VEGETATION/SOIL

Very low amounts of airborne radionuclides are emitted at the Paducah Site from DOE sources. A portion of the airborne radionuclides is estimated to be deposited in soil and on vegetation. The Paducah Site estimates doses through the food chain to the receptors based on these estimated airborne emissions. See Section 4.3.1 for air modeling information.

4.7 ANIMAL PRODUCTS

Very low amounts of airborne radionuclides are emitted at the Paducah Site from DOE sources. A portion of the airborne radionuclides are estimated to be deposited in soil and on food crops where they may be absorbed into plants and then may be ingested by animals. Animal products then may be ingested by the public. Irrigation and deposition through waterborne radionuclides is an incomplete pathway because municipal water is used at nearby residences for household purposes (including activities such as watering plants and lawns). The Paducah Site estimates doses from animal products to the receptors based on these estimated airborne emissions. See Section 4.3.1 for air modeling information.

4.8 WATERSHED BIOLOGICAL MONITORING

Historically, a Watershed Monitoring Plan (WMP) was required to meet KPDES permit requirements. The WMP detailed the Paducah Site's biological monitoring program.

In 2011, the WMP was modified to eliminate the requirement for biological monitoring in the creeks surrounding the site. The justification for elimination of biological monitoring in creeks presented by the KDOW in a revised KPDES permit (KY0004049) was that, over the years, the watersheds had been sampled extensively to the point that further collection of aquatic organisms could result in a deleterious effect on the aquatic community; therefore, biological sampling no longer was required. Elimination of the program also was supported by the fact that measured concentrations associated with radionuclides of concern at the Paducah Site in fish were low and there was an overall downward trend in the concentration of contaminants due to remediation efforts.

4.9 KENTUCKY NON-TRANSIENT NON-COMMUNITY WATER SYSTEM

The Paducah Site operates a non-transient non-community water system required in accordance with 401 *KAR* 8:150 through 401 *KA*R 8:600 and under the Safe Drinking Water Act (SDWA). Drinking water monitoring requirements are promulgated under authority of the SDWA by KDOW.

5. DOSE CALCULATIONS

Effluent releases due to operations at the Paducah Site from DOE sources may contain radionuclides. After release, these substances disperse through the environment by transport mechanisms by which they eventually may reach and affect humans. This section describes the methodologies used to model the dispersion of radionuclides and to estimate human exposure resulting from the intake of the dispersed radionuclides. Human exposures to radionuclides are characterized in terms of TED to the public MEI and to the entire population residing within 50 miles of the site. Site-specific pathways may be used that have current or potential future pathways that are not listed in the Risk Methods Document (DOE 2017c). The Risk Methods Document states that during the DQO process for a specific project, risk analyses will be used to identify qualitatively the preliminary chemicals of potential concern, receptors that may be exposed to contaminants, locations at which exposure may occur, and pathways by which contaminants may reach these locations. This information will be used to develop the conceptual site model against which the new data collected can be compared. Exposure factors will be based on information contained in the Risk Methods Document or in consultation with project teams for site-specific parameters. In addition to the dose assessments in support of the ASER, individual projects also may perform dose assessments to establish bounding scenarios to ensure that any future public radiological exposures are maintained within the limits established in DOE Orders. The assumptions and parameters used in these project-specific assessments are found within the individual project technical derivations.

5.1 CONFORMANCE WITH STANDARDS FOR PUBLIC DOSE CALCULATIONS

Models selected to assess environmental transport of and human exposures to substances released from DOE operations are codified or approved for use by DOE. The models are appropriate for the physical and environmental situation encountered and for the data available to characterize the situation. Input data, including default values, are documented and evaluated for applicability to the situation being modeled.

A complete set of potential human exposure pathways is considered in the assessments of radiological exposures. Those pathways that represent the potential exposures to the most exposed individual and to the entire population residing within 49.7 miles of the site are evaluated as appropriate. The pathways that are evaluated are discussed in Sections 5.3 and 5.4.

Descriptions of the models and computer codes may consist of references to published descriptions or of actual mathematical formulations developed for special calculations. Surface water and groundwater modeling are conducted, as necessary, to conform to applicable requirements of the Commonwealth of Kentucky and of the regional EPA office.

5.2 MAJOR CONSIDERATIONS

Members of the public may receive radiation doses from the Paducah Site from DOE sources from materials released to the air and waters. In addition, some members of the public may receive minor radiation doses through direct external irradiation by radiation emanating from the cylinder yards located within the secured area of the plant. Doses are estimated for all potentially important exposure pathways relevant to the above exposure media. Table 3 lists environmental release and transport mechanisms that apply to emissions from DOE operations. Estimation of the consequences of radionuclide or chemical

Table 3. Environmental Transport Mechanisms Applicable to Releases from DOE Operations

Releases to water	Remain dissolved or suspended in water Deposit on ground via irrigation* Deposit on vegetation via irrigation* Deposit in sediment Uptake to biota
Releases to air	Remain suspended in air Deposit on ground Deposit on vegetation Uptake to biota

*The protective measures taken in support of the Water Policy preclude the use of potentially contaminated water for irrigation. The inclusion of irrigation as a potentially completed exposure pathway is for informational purposes only, and the doses are not modeled.

releases from DOE operations must consider all potential pathways by which these materials may reach the surrounding population. To aid in selecting potentially important pathways, a land use survey was performed. This survey recorded and mapped the locations of all residences, farms for animal products, and vegetable gardens within a 3-mile radius of the site. All identified locations were plotted on a map divided into 16 equal sectors corresponding to the 16 cardinal compass points. This land use survey and other potential pathways are summarized in the Risk Methods Document (DOE 2017c).

This information was compared to modeling results to identify the MEI. Demographic data were obtained from the Bureau of the Census to document characteristics of the people who live near the site. As part of the management of the Water Policy, property surrounding the Paducah Site is evaluated annually to ensure that there have been no changes to property ownership.

As part of a CERCLA site investigation, a survey was taken of users of surface and groundwater in the vicinity of the Paducah Site to determine the number of residents using water wells within a 4-mile radius and to determine the number of surface water intakes on the Ohio River up to 15 miles downstream from the Paducah Site.

No resident or business responding to the survey reported using a private intake on the Ohio River or on Bayou Creek or Little Bayou Creek for any part of their water supply. On the Ohio River, the nearest downstream water-intake point used for drinking water is at Cairo, Illinois. Cairo is within 50 miles of the Paducah Site, and drinking water concentrations to the population at that location are considered in the dose assessment.

Figures 2 and 3 list potential environmental pathways to humans and associated media for the transport mechanisms given in Table 3. Sections 5.3, 5.4, and 5.5 discuss the environmental transport, food chain, and dosimetric models used to evaluate human exposures due to current or past DOE operations. Input data to the models are evaluated using site-specific (collected under the EM and surveillance activities described earlier in this plan), historical data, and generic (default) values.

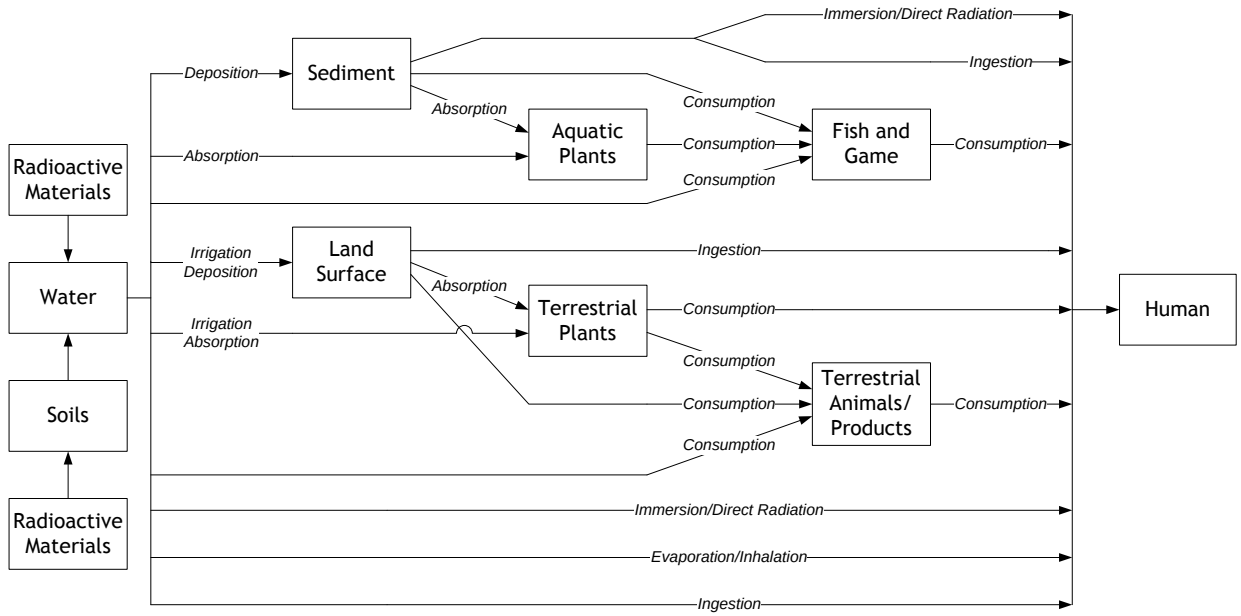

Figure 2. Possible Pathways between Radioactive Material Released to the Water and Humans

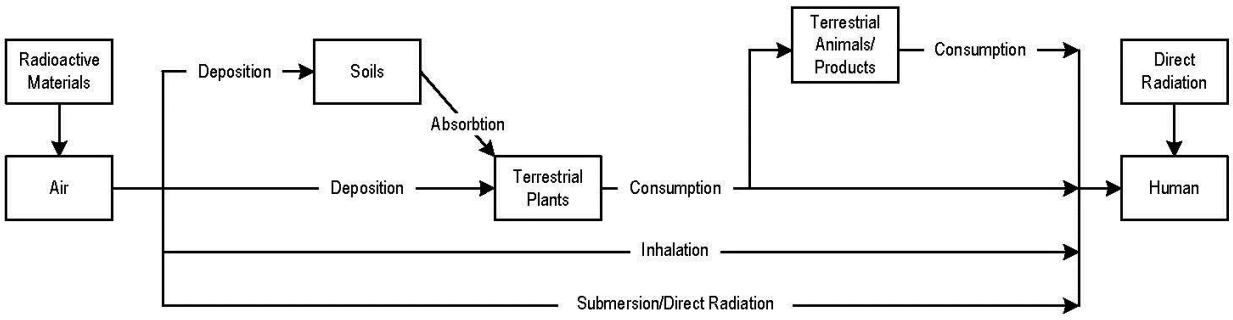

Figure 3. Possible Pathways between Radioactive Materials Released to the Air and Humans

5.3 TRANSPORT MODELS

This section describes the methodologies used to characterize environmental concentrations of radiological materials released from current or past DOE operations. In some cases, transport models are used to predict concentrations; in other cases, measured concentrations are available. When both predicted and measured concentrations are available, the measured concentrations are used to verify modeling predictions.

5.3.1 Atmospheric Transport

Contaminants released to air may be inhaled by individuals, cause direct radiation by submersion, or deposit on vegetation that may be consumed by farm animals or humans.

Dose calculations on atmospheric releases are described in Section 5.4.1.

5.3.2 Water Transport

Contaminants released to water may remain dissolved or suspended in water (groundwater or surface water), deposited in sediment, deposited on ground or vegetation by irrigation,[2] absorbed into plants and animals, or may infiltrate to the groundwater. Quantities of radionuclides released to surface waters are determined by sampling permitted outfalls in each of the local receiving streams. Contamination of private wells with both Tc-99 and TCE due to releases from historical DOE operations led to a response action in 1988. DOE supplied potable water to affected residents and installed an interim water supply for each resident whose water had TCE above the laboratory reporting limit of 1 ppb. For a long-term water supply, a community water line was extended to the residents with contaminated wells. Irrigation of gardens and watering of livestock using contaminated well water has ceased. Presently, groundwater transport is not modeled, but such modeling would be initiated if off-site samples indicate a need for risk assessment purposes.

5.4 ENVIRONMENTAL PATHWAY MODELS

This section describes the methodologies that are used to characterize mechanisms for human uptake and exposure to the radiological contaminant concentrations described in Section 5.3. As in Section 5.3, both modeling and sampling are used to obtain contaminant concentrations in media and foods to which humans may be exposed. In addition, environmental gamma radiation exposure is measured through a dosimetry program.

5.4.1 Contaminants in Air

The ambient air surrounding the Paducah Site is monitored to evaluate public exposure to airborne radionuclides. The results of this ambient air monitoring are used by DOE to demonstrate compliance with Commonwealth of Kentucky and federal regulations as well as with DOE Orders. The DOE contribution to airborne radioactivity from DOE operations at the Paducah Site normally is too low to be detected in the presence of natural background radiation in the environment; therefore, as required under 40 *CFR* § 61, Subpart H, potential doses to the public from point sources also are calculated with a dispersion model. This model calculates how measured quantities of released radionuclides mix with the atmosphere, where they travel, and where they could deposit. Once the dispersion is calculated, population data and concentration/dose conversion factors are used to calculate individual and population doses. These doses include exposure from all the pathways represented in Figure 3, although the primary route of exposure is inhalation. The ambient air monitoring data collected from the ambient air monitoring network are used to assess the impact of emissions of all point and fugitive sources.

The radiation dose calculations are performed using the latest version of CAP-88 computer codes. This package contains EPA's most recent version of the AIRDOS-EPA computer code. The code uses a steady-state, Gaussian plume, atmospheric dispersion model to calculate environmental concentrations of released radionuclides. The code also uses NRC Regulatory Guide 1.109 for food chain models to calculate human exposures, both internal and external, to radionuclides deposited in the environment. DOE uses EPA's latest version of the DARTAB computer code that uses the human exposure values to calculate radiation doses to the public from radionuclides released during the year. The dose calculations use dose conversion factors from the latest version of the RADRISK data file, which EPA provides with CAP-88.

[2] The protective measures taken in support of the Water Policy preclude the use of potentially contaminated water for irrigation. The inclusion of irrigation as a potentially completed exposure pathway is for informational purposes only, and the doses are not modeled.

5.4.2 Contaminants in Water

Potential direct routes of human exposure to contaminants in waters include ingestion (drinking water, incidental ingestion while swimming), immersion (swimming, wading, showering), direct irradiation (boating, skiing, shoreline use), and inhalation (e.g., release of contaminants during household use of water). Indirect pathways involve deposition on soil and crops by deposition in sediment (Section 5.4.3), contaminants in soil (Section 5.4.4), contaminants in or on food crops (Section 5.4.5), and contaminants in terrestrial animals and fish (Section 5.4.6).

DOE O 458.1 requires conducting radiological activities to ensure that radionuclides from DOE activities contained in liquid effluents do not cause private or public drinking water systems to exceed the drinking water maximum contaminant levels in 40 *CFR* § 141. Per 40 *CFR* § 141, environmental surveillance data may be used in the vicinity of a nuclear facility to verify compliance with 40 *CFR* § 141 radiological limits for drinking water. Surveillance data from Bayou and Little Bayou Creeks also may be used to verify compliance with 40 *CFR* § 141 prior to their entrance into the Ohio River.

If the surveillance data from Bayou and Little Bayou Creeks exceed the limits for drinking water, samples may be taken at the Cairo, Illinois, intake and compared to the Ohio River background upstream of the PGDP to demonstrate DOE compliance.

Surface water is not used for drinking or irrigation near the plant. In 1990, a survey of surface water and groundwater users in the vicinity of the Paducah Site was conducted to determine the number of residents using water wells within a 4-mile radius and to determine the number of surface water intakes on the Ohio River within 15 miles downstream of the plant. No residents or businesses that responded to the survey questionnaire reported using a private surface water intake on the Ohio River, Bayou Creek, or Little Bayou Creek for any part of their water supply. Private groundwater wells were the major water supply for residents surrounding the Paducah Site. Most residents reported using water from their residential wells for drinking, irrigation, and domestic uses. As part of the management of the Water Policy, property surrounding the Paducah Site is evaluated annually to ensure there have been no changes to property ownership. Collective dose is not calculated for the incidental ingestion of surface water pathway due to the lack of a plausible exposure scenario. This pathway is more likely to involve individuals; therefore, it is more suited for MEI dose calculation.

In September 1988, following the discovery of contamination in residential drinking water wells, water was supplied to all residents with contamination. In 1992, a Water Policy was developed, which specified that residents in the Water Policy box were to receive supplied water either through bottled water or municipal water. That effort was completed May 31, 1994.

Dose calculations are made for the drinking water pathway if measurable concentrations of radionuclides are found in water samples collected from drinking water systems. Cairo, Illinois, about 36 miles downstream on the Ohio River, has the nearest drinking water intake to the plant. The dose to a resident from drinking water ingestion is evaluated based on environmental surveillance data, which includes a sample taken at Cairo, Illinois. If site environmental surveillance data is insufficient to meet the requirements of 40 *CFR* § 141 and DOE Order 458.1, additional samples may be taken at the water intake of the drinking water system. Members of the public (adult) are assumed to ingest 2.5 liters per day of drinking water per the Risk Methods Document (DOE 2017c). Collective doses for the drinking water pathway are calculated based on the population of Cairo, Illinois.

Measured concentrations are compared with federal and Commonwealth of Kentucky standards and with historical concentrations for each contaminant found.

5.4.3 Contaminants in Sediment

Discharges from DOE operations to surface waters may result in accumulations in sediment of radionuclides. Potential routes of human exposure from sediment are direct irradiation, indirect pathways, and incidental ingestion. An example of an indirect pathway is a fish ingesting contaminated sediment and subsequent human ingestion of the fish.

External irradiation from contaminated sediment in Little Bayou Creek is a pathway of potential importance. Sediment is known to contain uranium isotopes, Np-237 and Pu-239. Radionuclides deposited on the shores of rivers or creeks may accumulate over a period of time, leading to external irradiation of persons standing on contaminated surfaces. The amount of the nuclides built up on the shoreline depends on the concentration in the water, the depth of deposit, and the length of the period of buildup. The dose to persons depends on the time spent near the contaminants. This exposure time is expected to be minimal because warning signs are posted in this area that indicate the possible presence of contamination. Collective dose is not calculated for the incidental ingestion of sediment within plant creeks and ditches pathway due to the lack of a plausible exposure scenario. This pathway is more likely to involve individuals; therefore, it is more suited for MEI dose calculation.

Incidental ingestion of contaminated sediment may result from exposure during fishing, hunting, or other recreational activities.

5.5 CONTAMINANTS IN SOIL

A portion of the airborne radionuclides is estimated to be deposited in soil and on food crops where they may be absorbed into plants and then may be ingested by animals. Animal products then may be ingested by the public. The Paducah Site estimates doses from animal products to the receptors based on these estimated airborne emissions. AIRDOS-EPA computer code contained in the latest version of CAP-88, which implements a steady-state, Gaussian plume, atmospheric dispersion model, is used to calculate environmental concentrations of the estimated released airborne radionuclides and then uses NRC Regulatory Guide 1.109 food chain models to calculate human exposures, both internal and external, to receptors. The human exposure values then are used by the EPA's version of the DARTAB computer code contained in the latest version of CAP-88 to calculate radiation doses to the public from radionuclides released during the year.

Contaminants also may be deposited in soil due to irrigation of crops from groundwater and/or surface water. As part of a CERCLA site investigation, a survey was taken of users of surface and groundwater in the vicinity of the Paducah Site to determine the number of residents using water wells within a 4-mile radius, as specified in the 1990 land use survey, and to determine the number of surface water intakes on the Ohio River up to 15 miles downstream from the site.

No resident or business responding to the survey reported using a private intake on the Ohio River, Bayou Creek, or Little Bayou Creek for any part of their water supply. Because irrigation of gardens and watering of livestock using contaminated well water has ceased, this form of exposure is not modeled.

5.6 CONTAMINANTS IN OR ON FOOD CROPS

A portion of the airborne radionuclides is estimated to be deposited in soil and on food crops where they may be absorbed into food crops. These food crops then may be ingested by the public. The Paducah Site estimates doses from food crops to the receptors based on these estimated airborne emissions.

AIRDOS-EPA computer code contained in the latest version of CAP-88, which implements a steady-state, Gaussian plume, atmospheric dispersion model, is used to calculate environmental concentrations of the estimated released airborne radionuclides and then uses NRC Regulatory Guide 1.109 food chain models to calculate human exposures, both internal and external, to receptors. The human exposure values then are used by the EPA's version of the DARTAB computer code contained in the latest version of CAP-88 to calculate radiation doses to the public from radionuclides released during the year.

Contaminants also may be deposited on vegetation due to irrigation of crops from groundwater and/or surface water. As part of a CERCLA site investigation, a survey was taken of users of surface and groundwater in the vicinity of the Paducah Site to determine the number of residents using water wells within a 4-mile radius and to determine the number of surface water intakes on the Ohio River up to 15 miles downstream from the site.

No resident or business responding to the survey reported using a private intake on the Ohio River, Bayou Creek, or Little Bayou Creek for any part of their water supply. As part of the management of the Water Policy, property surrounding the Paducah Site is evaluated annually to ensure that there have been no changes to property ownership. Because irrigation of gardens and watering of livestock using contaminated well water has ceased this form of exposure is not modeled.

5.7 CONTAMINANTS IN TERRESTRIAL ANIMALS AND FISH

Contaminants may accumulate in animals from eating contaminated feed, drinking contaminated water, and breathing contaminated air. Contaminants may accumulate in fish when they eat contaminated foods and equilibrate with surrounding waters. Indirect pathways for human exposure to contaminants in animals and fish are eating meat and fish. Because both measured concentrations and bioconcentration factors associated with radionuclides of concern at the Paducah Site in animals and fish are low, assessments of these pathways are not performed for the EMP; however, radionuclide impact to animals and fish is evaluated per project based on the expected concentration of radionuclides discharged.

Biota in the watersheds has been sampled extensively, to the point that further collection of aquatic organisms could result in a deleterious effect on the aquatic community.

A portion of the airborne radionuclides are estimated to be deposited in soil and on food crops where they may be absorbed into plants and then may be ingested by domestic animals. Domestic animal products then may be ingested by the public. The Paducah Site estimates doses from animal products to the receptors based on these estimated airborne emissions. AIRDOS-EPA computer code contained in the latest version of CAP-88, which implements a steady-state, Gaussian plume, atmospheric dispersion model, is used to calculate environmental concentrations of the estimated released airborne radionuclides and then uses NRC Regulatory Guide 1.109 food chain models to calculate human exposures, both internal and external, to receptors. The human exposure values then are used by the EPA's version of the DARTAB computer code contained in the latest version of CAP-88 to calculate radiation doses to the public from radionuclides released during the year.

During the 20-year period of deer harvesting at the site, dose assessments from the ingestion of deer meat were performed using measured concentrations of contaminants. In 2011, an evaluation was conducted of the data sets from the years of deer harvesting events (LATA Kentucky 2011b). As a result of this review, the deer harvest was eliminated because of a downward trend and a continued lack of detection in the results, as well as an overall downward trend in the concentration of contaminants found at the Paducah

Site due to remediation efforts. The elimination of the deer harvest program was documented in the FY 2012 EMP and is not referenced in Appendix C.

5.8 DIRECT RADIATION

The only identified source of potential exposure to the public from radiation emanating from radionuclides contained in structures and other objects is gamma radiation from the uranium cylinder storage yards. It is very improbable that members of the public would be exposed to gamma radiation from these uranium cylinders found in the storage yards due to limited exposure time, distance from the access points of the public to the cylinder yards, and shielding. Collective doses for direct radiation are calculated, based on the total estimated number of visitors hiking within WKWMA annually.

5.9 INTERNAL DOSIMETRY MODELS

The results of all dose calculations are reported in terms of TED, the sum of ED received during the year from external exposures, plus the 50-year committed equivalent dose from intake of radionuclides during the year. Appropriate dose conversion factors based on site-specific factors and uses that are used in the calculations are obtained from DOE O 458.1 reference documents such as these: International Commission on Radiological Protection Publication 60 and 40 *CFR* Part 141, *National Primary Drinking Water Regulations.* Although not used in specific dose calculations, the derived concentration standards given in DOE-STD-1196-2011 given in DOE O 458.1 may be used to infer the acceptability or magnitude of doses associated with measured concentrations of radionuclides in environmental media.

5.10 RADIATION DOSE TO AQUATIC AND TERRESTRIAL BIOTA

Compliance with DOE-STD-1153-2002, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota*, regarding the absorbed dose rate limit to native organisms (e.g., invertebrates, fish, raccoons, and muskrats) is demonstrated using generally accepted methods of dose calculation. Current practice estimates absorbed doses by multiplying measured radionuclide concentrations in surface waters by internationally recognized, organism-specific dose rate factors for external and internal exposures and summing the external and internal contributions.

5.11 REPORTS AND RECORDS

Doses to the maximally exposed member of the public and to the population are published in the ASER. In addition, if a radiological release that exceeds any limit contained in paragraphs 4.f.(2), 4.f.(5), 4.g.(4), 4.g.(5)(a), 4.g.(7), 4.g.(8)(a)4 or 4.i.(1) of DOE O 458.1 Chg 3, *Radiation Protection of the Public and the Environment*, dated January 15, 2013, or exceeds the 40 *CFR* § 61.92 requirements, then the Paducah Site notifies DOE Headquarters.

All input data used in dose calculations are considered as records requiring “permanent retention.”

6. REPORTS

6.1 INTRODUCTION

This section provides an overview of the reporting requirements that are followed by DOE utilizing data generated under the EMP. These requirements have been established in regulations, statutes, and orders issued by regulatory agencies and by DOE and are addressed specifically in the individual sections of this plan. In addition to the reporting requirements listed, data generated under the EMP also is used in preparing regulatory documents completed under the FFA, as appropriate. Revisions to the groundwater conceptual model use data generated under this EMP.

It is the policy of DOE to comply with all applicable environmental requirements, and those listed here are subject to supersession and/or amendment as well as being variable in applicability to individual DOE facilities.

6.2 REPORTING REQUIREMENTS

The preparation and disposition of reports relevant to EM are shown in Table 4, Applicable Reporting Requirements. The ASER contains a summary for the effluent monitoring and environmental surveillance data for each CY. Data that are collected less frequently than annually are contained in each year's reports until new data are available. The ASER includes comparisons of values of contaminants at sampling locations to average reference values or to environmental standards, criteria, or permit limits. All permit activities, such as mitigation action plans, new requirements, or emission sources are described.

The ASER also includes the information from the Superfund Amendments Reauthorization Act (SARA) 6.3 Title III, Section 313, *Toxic Chemical Release Inventory Report*, on quantities of nonradiological chemical emissions to the environment from unplanned releases. The ASER also includes the chemicals reported in the Emergency Planning and Right-to-Know Act, Section 312, Hazardous Chemical Inventory.

Table 4. Applicable Reporting Requirements

Reporting	Due Date	Source of Requirement	Requirement
ASER	October 1	DOE O 231.1B and DOE O 458.1 (and ERPP)	All DOE facilities that conduct significant environmental protection programs shall prepare an ASER for DOE. The report must provide a comprehensive review of the environmental surveillance programs, status of environmental compliance, and effluent data for nonradioactive pollutants.
Annual NESHAP Compliance Report	June 30	NESHAP 40 *CFR* § 61 Subpart H	Reporting shall include results from monitoring of radionuclide emissions to the ambient air, as well as, required dose calculations. Ambient air monitoring data are included in the NESHAP reports for assessment of fugitive and diffuse emission sources.
Discharge Monitoring Report	Monthly and Quarterly	Clean Water Act	Discharge Monitoring Reports are required for compliance with KPDES permit KY0004049.

Table 4. Applicable Reporting Requirements (Continued)

Reporting	Due Date	Source of Requirement	Requirement
Toxicity Report	Quarterly	Clean Water Act	Toxicity reports are required for compliance with KPDES permit KY0004049.
Annual PCB Document	July 1	40 *CFR* § 761.180	The Annual PCB Document is required for PCBs in use and PCB wastes.
SARA Section 313	June 1	SARA Title III	Covered facilities (see above) shall report to EPA and the Commonwealth of Kentucky, all environmental releases of specified toxic chemicals that are manufactured, processed, or otherwise used in excess of specified thresholds.
SARA Section 312	March 1	SARA Title III	Annual Hazardous Chemical Inventory Report.
C-746-U Landfill Compliance Monitoring Report	Quarterly	401 *KAR* 47:130	This report is required in accordance with the landfill solid waste permit.
Landfill Quarterly Operating Report	Quarterly	401 *KAR* 47:130	This report is required in accordance with the landfill solid waste permit.
C-746-S&T Landfills Compliance Monitoring Report	Quarterly	401 *KAR* 47:130	This report is required in accordance with the landfill solid waste permit.
Semiannual C-404 Landfill Groundwater Monitoring Report	May, November	401 *KAR* 34:060	This report is required in accordance with Paducah hazardous waste permit KY8-890-008-982.
Environmental Monitoring Plan	October 1 Annually	DOE O 436.1 DOE O 458.1 (and ERPP)	Requires a plan to ensure the site's sustainability; characterize the exposures and doses to individuals and to the population; and evaluate the potential impacts to the biota in the vicinity of DOE activity.
Groundwater Protection Plan	Three Years; Last Updated May 2015	401 *KAR* 5:037	Requires a plan to ensure protection for all current and future uses of groundwater and to prevent groundwater pollution.
Best Management Practices Plan	Five Years; Last Updated March 2015 (Draft submitted to DOE for review on August 14, 2017)	KPDES permit (KPDES permit is required by the Clean Water Act)	This plan is required by KPDES permit KY0004049.
Spill Prevention Control and Countermeasure (SPCC) Plan	Reviewed Every Three Years; Last Updated January 2016 (Revised SPCC Plan projected in fall 2017)	40 *CFR* § 112	Requires regulated facilities to prepare and implement a SPCC. The purpose of a SPCC Plan is to form a comprehensive spill prevention program that minimizes the potential for discharges.
Annual External Monitoring Report	March 1	DOE O 458.1 (and ERPP)	This report estimates the external dose on an annual basis; summary info also is included in the ASER.
FFA Semiannual Report	April 30 October 30	FFA	This report is required by the FFA. Data generated in many of the sampling programs referenced in Appendix C are reported in this report.

7. REFERENCES

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APPENDIX A

PADUCAH PERMIT SUMMARY

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U.S. DEPARTMENT OF ENERGY PERMIT SUMMARY
FOR THE
PADUCAH GASEOUS DIFFUSION PLANT

Permit Type	Issuer	Expiration Date	Permit Number	Permittee
AIR				
Title V Air Permit	Kentucky Division of Air Quality	2/25/2020	V-14-012	Four Rivers Nuclear Partnership, LLC (FRNP)
WATER				
Kentucky Pollutant Discharge Elimination System (KPDES)	Kentucky Division of Water (KDOW)	8/30/2022[a]	KY0004049	U.S. Department of Energy (DOE), FRNP and Mid-America Conversion Services, LLC
Permit to Withdraw Public Water	KDOW	N/A	0900	FRNP
Water Treatment Registration (Public Water System)	KDOW	N/A	PWS No. 0732457	FRNP
SOLID WASTE				
C-746-S Residential Landfill (Closed) C-746-T Inert Landfill (Closed) C-746-U Solid Waste Landfill	Kentucky Division of Waste Management (KDWM)	11/04/2026	SW07300014 SW07300015 SW07300045	DOE/FRNP
RCRA				
Hazardous Waste Facility Operating Permit	KDWM	8/22/2025	KY8-890-008-982	DOE/FRNP
Hazardous and Solid Waste Amendments (HSWA) Portion of the RCRA Permit[b]	EPA	04/23/2016	KY8-890-008-982	DOE/FRNP

[a] KPDES permit KY0004049 was renewed in July 2017 with an effective data of September 1, 2017, and combines the previous KY0004049 permit with the KY0102083 permit.
[b] The renewal application has been submitted, but has not been finalized yet.

U.S. DEPARTMENT OF ENERGY COMPLIANCE AGREEMENTS SUMMARY FOR THE PADUCAH GASEOUS DIFFUSION PLANT

Agreement	Effective Date	Expiration Date	Entities
TSCA FFCA (Toxic Substances Control Act Federal Facility Compliance Agreement)	05/2017 (Modification)	N/A	EPA and DOE
FFCA Agreed Order/Site Treatment Plan	09/1997	N/A	KDWM and DOE
Federal Facility Agreement	02/1998	Ongoing	Commonwealth of Kentucky, EPA, and DOE
Agreed Order for Waste, Air, and Water Violations	10/2003	Ongoing	Commonwealth of Kentucky and DOE
Agreed Order for DUF_6 Management	10/2003	Ongoing	KDWM and DOE

APPENDIX B

WELL PROGRAM INVENTORY

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ACRONYMS

400GQ	C-400 groundwater well quarterly
400GSA	C-400 groundwater well semiannually
404G	C-404 Landfill groundwater well
A	annual inspection
AB	abandoned
AB-IP	abandoned in place
A-TS	inspect only, transducer in well
CARB	residential well sampled under the Carbon Filter Treatment System
CM	construction monitoring well
DOE	U.S. Department of Energy
FY	fiscal year
FYR	inspection coordinated with the submittal of the Comprehensive Environmental Response, Compensation, and Liability Act Five-Year Review
GC	geochemical surveillance triennial sampling
GWESA	environmental surveillance annual sampling
GWESBA	environmental surveillance biennial sampling
GWESQ	environmental surveillance quarterly sampling
GWESSA	environmental surveillance semiannual sampling
GWNEQ	groundwater Northeast Plume quarterly sampling
GWNESA	groundwater Northeast Plume semiannual sampling
GWNWSA	groundwater Northwest Plume operation and maintenance semiannual sampling
GWNWQ	groundwater Northwest Plume operation and maintenance quarterly sampling
GWSWMU1	groundwater Solid Waste Management Unit 1
GWSWMU4	groundwater Solid Waste Management Unit 4
GWSWP	groundwater Southwest Plume
KDFWR	Kentucky Department of Fish and Wildlife Resources
KG	C-746-K Landfill groundwater well
LRGA	Lower Regional Gravel Aquifer
MW	monitoring well
NA	not applicable; monitoring well or piezometer abandoned
NI	not inspected
NR	not required
NS	not sampled
PZ	piezometer
Q	In the Water Level column, “Q” indicates water levels are collected quarterly
R	residential
RGA	Regional Gravel Aquifer
SG	C-746-S&T Landfills groundwater well
TVA	Tennessee Valley Authority
UCRS	Upper Continental Recharge System
UG	C-746-U Landfill groundwater well
Unknown	information is unknown, cannot be confirmed, or is unavailable
URGA	Upper Regional Gravel Aquifer
W	A well with physical characteristics not considered typical of a monitoring well
WPB-NE	Water Policy Boundary Monitoring Program—Northeast annual sampling
WPB-NW	Water Policy Boundary Monitoring Program—Northwest quarterly sampling

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Table B.1 includes 399 current monitoring wells (MWs) and piezometers (PZs) and a listing of the sampled residential wells.

Table B.1. Well Program Inventory

Well Number	Screened Zone	Status	Property Where Located	Sampled	Water Level	Inspection
MW1	RGA	AB 94	NA	NA	NA	NA
MW2	Unknown	AB 88	NA	NA	NA	NA
MW3	Unknown	AB 88	NA	NA	NA	NA
MW4	Unknown	AB 88	NA	NA	NA	NA
MW5	Unknown	AB 88	NA	NA	NA	NA
PZ5G	Unknown	Current	DOE	NS	A	A
PZ5S	Unknown	Current	DOE	NS	A	A
MW6	Unknown	AB 88	NA	NA	NA	NA
MW7	UCRS	AB 94	NA	NA	NA	NA
MW8	RGA	AB 94	NA	NA	NA	NA
MW9	RGA	AB 94	NA	NA	NA	NA
MW10	RGA	AB	NA	NA	NA	NA
MW11	UCRS	AB 94	NA	NA	NA	NA
MW12	RGA	AB 94	NA	NA	NA	NA
MW13	UCRS	AB 94	NA	NA	NA	NA
MW14	UCRS	AB 94	NA	NA	NA	NA
MW15	RGA	AB 94	NA	NA	NA	NA
MW16	UCRS	AB 94	NA	NA	NA	NA
MW17	RGA	AB 94	NA	NA	NA	NA
MW18	UCRS	AB 94	NA	NA	NA	NA
MW19	RGA	AB 94	NA	NA	NA	NA
MW20 (also R4)	RGA	Current	KDFWR	NS	A	A
MW21	RGA	AB 94	NA	NA	NA	NA
MW22	RGA	AB 94	NA	NA	NA	NA
MW23	Porters Creek Clay Well	AB 94	NA	NA	NA	NA
MW24	Porters Creek Clay Well	AB 94	NA	NA	NA	NA
MW25	Porters Creek Clay Well	AB 94	NA	NA	NA	NA
MW26	Porters Creek Clay Well	AB 94	NA	NA	NA	NA
MW27	Porters Creek Clay Well	AB 94	NA	NA	NA	NA
MW28	UCRS	AB 94	NA	NA	NA	NA
MW29	UCRS	AB 94	NA	NA	NA	NA
MW30	UCRS	AB 94	NA	NA	NA	NA
MW31	UCRS	AB 94	NA	NA	NA	NA
MW32	UCRS	AB 94	NA	NA	NA	NA
MW33	UCRS	AB	NA	NA	NA	NA
MW34	UCRS	AB 94	NA	NA	NA	NA
MW35	UCRS	AB 94	NA	NA	NA	NA
MW36	UCRS	AB 94	NA	NA	NA	NA
MW37	UCRS	AB 94	NA	NA	NA	NA

Table B.1. Well Program Inventory (Continued)

Well Number	Screened Zone	Status	Property Where Located	Sampled	Water Level	Inspection
MW38	RGA	AB 94	NA	NA	NA	NA
MW39	RGA	AB 94	NA	NA	NA	NA
MW40	RGA	AB 94	NA	NA	NA	NA
MW41	RGA	AB 94	NA	NA	NA	NA
MW42	RGA	AB 94	NA	NA	NA	NA
MW43	RGA	AB 94	NA	NA	NA	NA
MW44	RGA	AB 94	NA	NA	NA	NA
MW45	RGA	AB 87	NA	NA	NA	NA
MW46	RGA	AB 94	NA	NA	NA	NA
MW47	UCRS	AB 94	NA	NA	NA	NA
MW48	RGA	AB 94	NA	NA	NA	NA
MW49	UCRS	AB 94	NA	NA	NA	NA
MW50	RGA	AB 94	NA	NA	NA	NA
MW51	RGA	AB 94	NA	NA	NA	NA
MW52	RGA	AB 94	NA	NA	NA	NA
MW53	RGA	AB 94	NA	NA	NA	NA
MW54	RGA	AB 94	NA	NA	NA	NA
MW55	RGA	AB 87	NA	NA	NA	NA
MW56	UCRS	AB 87	NA	NA	NA	NA
MW57	UCRS	AB 94	NA	NA	NA	NA
MW58	UCRS	AB 90	NA	NA	NA	NA
MW59	RGA	AB	NA	NA	NA	NA
MW60	UCRS	AB	NA	NA	NA	NA
MW61	RGA	AB	NA	NA	NA	NA
MW62	RGA	AB	NA	NA	NA	NA
MW63	RGA	Current	DOE	GWNWSA	A	A
MW64	UCRS	Current	DOE	NS	A	A
MW65	RGA	Current	DOE	GWNWSA	A	A
MW66	RGA	Current	DOE	GWNWSA	A	A
MW67	RGA	Current	DOE	GWESBA, 404G	A, Q	A
MW68	RGA	Current	DOE	GWESA	A	A
MW69	UCRS	Current	DOE	NS	A	A
MW70	RGA	AB 94	NA	NA	NA	NA
MW71	RGA	Current	DOE	GWESA	A	A
MW72	RGA	Current	DOE	NS	A	A
MW73	RGA	Current	DOE	NS	A	A
PZ74	UCRS	Current	DOE	NS	A	A
MW75	UCRS	Current	DOE	NS	A	A
MW76	RGA	Current	DOE	GWESBA, 404G	A, Q	A
MW77 (PZ)	RGA	Current	DOE	NS	A	A
MW78	RGA	Current	DOE	NS	A	A
MW79	RGA	Current	DOE	NS	A	A
MW80	RGA	Current	DOE	NS	A	A
MW81	RGA	Current	DOE	NS	A	A
MW82	UCRS	Current	DOE	NS	A	A
MW83	UCRS	Current	DOE	NS	A	A
MW84	RGA	Current	DOE	404G	A, Q	A

Table B.1. Well Program Inventory (Continued)

Well Number	Screened Zone	Status	Property Where Located	Sampled	Water Level	Inspection
MW85	UCRS	Current	DOE	404G	A, Q	A
MW86	RGA	Current	DOE	GWESBA, 404G	A, Q	A
MW87	RGA	Current	DOE	404G	A, Q	A
MW88	UCRS	Current	DOE	404G	A, Q	A
MW89	RGA	Current	DOE	GWESBA, 404G	A, Q	A
MW90	RGA	AB 2001	NA	NA	NA	NA
MW90A	RGA	Current	DOE	404G	A, Q	A
MW91[a]	UCRS	AB 2017	NA	NA	NA	NA
MW91A	UCRS	Current	DOE	404G	A, Q	A
MW92	RGA	Current	DOE	GWESBA, 404G	A, Q	A
MW93	RGA	Current	DOE	404G	A, Q	A
MW94	UCRS	Current	DOE	404G	A, Q	A
MW95	RGA	AB 2001	NA	NA	NA	NA
MW95A	RGA	Current	DOE	GWESBA, 404G	A, Q	A
MW96	UCRS	Current	DOE	NS	A	A
MW97	RGA	AB 97	NA	NA	NA	NA
MW98	RGA	Current	DOE	GWESSA	A, Q	A
MW99	RGA	Current	TVA	GWESA, GC	A	A
MW100	RGA	Current	TVA	GWESA, GC	A, Q	A
PZ101	Terrace Gravel	Current	DOE	NS	A	A
MW102	McNairy	Current	DOE	NS	A	A
MW103	RGA	Current	DOE	GWESBA	A	A
MW104	UCRS	AB 96	NA	NA	NA	NA
MW105	RGA	AB	NA	NA	NA	NA
MW106	RGA	AB 2014	NA	NA	NA	NA
MW106A	RGA	Current	DOE	GWESBA, WPB-NW	A	A
PZ107	RGA	Current	DOE	NS	A	A
MW108	RGA	Current	DOE	NS	A	A
PZ109	RGA	Current	DOE	NS	A	A
PZ110	RGA	Current	DOE	NS	A	A
PZ111	UCRS	Current	DOE	NS	A	A
PZ112	UCRS	AB 2017	NA	NA	NA	NA
PZ113	RGA	AB 2017	NA	NA	NA	NA
PZ114	McNairy	Current	DOE	NS	A	A
PZ115	McNairy	Current	DOE	NS	A	A
PZ116	RGA	AB 2017	NA	NA	NA	NA
PZ117	RGA	Current	DOE	NS	A	A
PZ118	RGA	Current	DOE	NS	A	A
MW119	RGA	AB	NA	NA	NA	NA
MW120	McNairy	Current	DOE	NS	A	A
MW121	McNairy	Current	KDFWR	NS	A	A
MW122	McNairy	Current	DOE	NS	A	A
MW123	RGA	Current	KDFWR	NS	A	A
MW124	RGA	Current	DOE	GWNEQ, GWNESA	A	A
MW125	RGA	Current	KDFWR	GWESA, GC	A, Q	A
MW126	RGA	Current	DOE	GWNEQ, GWNESA	A	A
MW127	UCRS	AB-IP	NA	NA	NA	NA

Table B.1. Well Program Inventory (Continued)

Well Number	Screened Zone	Status	Property Where Located	Sampled	Water Level	Inspection
MW128	UCRS	AB-IP	NA	NA	NA	NA
MW129	Terrace Gravels	AB-IP	NA	NA	NA	NA
MW130	Terrace Gravels	AB-IP	NA	NA	NA	NA
MW131	Terrace Gravels	AB-IP	NA	NA	NA	NA
MW132	RGA	Current	DOE	NS	A	A
MW133	McNairy	Current	TVA	NS	A	A
MW134	RGA	Current	KDFWR	GC, WPB-NW	A	A
MW135	RGA	Current	TVA	GWESSA	A	A
MW136	UCRS	AB	NA	NA	NA	NA
MW137	RGA	Current	TVA	NS	A	A
MW138	UCRS	Current	TVA	NS	A	A
MW139	RGA	Current	DOE	GWESA	A, Q	A
MW140	McNairy	AB	NA	NA	NA	NA
MW141	RGA	AB 98	NA	NA	NA	NA
MW142	RGA	AB 98	NA	NA	NA	NA
MW143	UCRS	AB 98	NA	NA	NA	NA
MW144	RGA	Current	DOE	GWNEQ	A	A
MW145	RGA	Current	DOE	GWNEQ, GWNESA, GC	A	A
MW146	RGA	Current	TVA	GWESBA, WPB-NW	A	A
MW147	RGA	Current	TVA	NS	A	A
MW148	RGA	Current	Private—Residential	GWESBA	A	A
MW149	UCRS	Current	Private—Residential	GWESBA	A	A
MW150	RGA	Current	Private—Residential	GWESA	A	A
MW151	Terrace Gravels	Current	Private—Residential	NS	A	A
MW152	RGA	Current	TVA	GWESA, GC	A	A
MW153	UCRS	Current	TVA	NS	A	A
MW154	UCRS	Current	DOE	NS	A	A
MW155	RGA	Current	DOE	400GQ, GWNEQ	A	A
MW156	RGA	Current	DOE	400GQ, GWNEQ	A	A
MW157	UCRS	Current	DOE	NS	A	A
MW158	RGA	AB 99	NA	NA	NA	NA
MW159	RGA	AB 99	NA	NA	NA	NA
MW160	UCRS	AB 99	NA	NA	NA	NA
MW161	RGA	Current	DOE	GWSWMU1, GWESA, GC	A	A
MW162	UCRS	Current	DOE	NS	A	A
MW163	RGA	Current	DOE	GWESBA, GC	A	A
MW164	UCRS	Current	DOE	NS	A	A
MW165	RGA	AB 2014	NA	NA	NA	NA
MW165A	RGA	Current	DOE	GWNWSA	A, Q	A
MW166	UCRS	Current	DOE	NS	A	A
MW167	UCRS	Current	DOE	NS	A	A
MW168	RGA	Current	DOE	GWESBA	A	A
MW169	RGA	Current	DOE	GWESBA	A	A
MW170	UCRS	Current	DOE	NS	A	A
MW171	UCRS	Current	DOE	NS	A	A
MW172	UCRS	Current	DOE	NS	A	A

Table B.1. Well Program Inventory (Continued)

Well Number	Screened Zone	Status	Property Where Located	Sampled	Water Level	Inspection
MW173	RGA	Current	DOE	GWNWSA	A, Q	A
MW174	UCRS	Current	DOE	GWESBA	A	A
MW175	RGA	Current	DOE	400GSA	A	A
MW176	UCRS	Current	DOE	NS	A	A
MW177	UCRS	Current	DOE	NS	A	A
MW178	RGA	Current	DOE	NS	A	A
MW179	RGA	AB 2003	NA	NA	NA	NA
MW180	UCRS	Current	DOE	NS	A	A
MW181	RGA	AB 2000	NA	NA	NA	NA
MW182	UCRS	Current	DOE	GWESA	A	A
183, Not Installed	NA	NA	NA	NA	NA	NA
MW184	UCRS	AB 98	NA	NA	NA	NA
MW185	RGA	Current	DOE	NS	A	A
MW186	UCRS	Current	DOE	GWESBA	A	A
MW187	UCRS	Current	DOE	GWESBA	A	A
MW188	RGA	Current	DOE	GC	A	A
MW189	UCRS	Current	DOE	NS	A	A
MW190	UCRS	Current	DOE	NS	A	A
MW191	RGA	Current	DOE	GWESA	A	A
MW192	UCRS	Current	DOE	NS	A	A
MW193	RGA	Current	DOE	GWESBA, GC	A, Q	A
MW194	RGA	Current	KDFWR	WPB-NW	A	A
MW195	UCRS	AB 94	NA	NA	NA	NA
MW196	Terrace Gravels	Current	DOE	NS	A	A
MW197	RGA	Current	DOE	GWESSA	A, Q	A
MW198	UCRS	Current	DOE	NS	A	A
MW199	RGA	Current	Private—Residential	WPB-NW	A	A
MW200	RGA	Current	KDFWR	GWESBA	A, Q	A
MW201	RGA	Current	KDFWR	GWESBA, GC, WPB-NW	A	A
MW202	RGA	Current	KDFWR	GWESBA, WPB-NW	A	A
MW203	RGA	Current	DOE	GWESA	A	A
MW204	UCRS	Current	DOE	NS	A	A
MW205	RGA	Current	DOE	GWESBA	A	A
MW206	RGA	AB 2014	NA	NA	NA	NA
MW207	UCRS	Current	DOE	NS	A	A
MW208	UCRS	AB 2012	NA	NA	NA	NA
MW209	UCRS	AB 2016	DOE	NS	NA	NA
MW210	UCRS	Current	DOE	NS	A	A
MW211	UCRS	Current	DOE	NS	A	A
MW212	UCRS	Current	DOE	NS	A	A
MW213	UCRS	Current	DOE	NS	A	A
MW214	UCRS	Current	DOE	NS	A	A
MW215	UCRS	Current	DOE	NS	A	A
MW216	UCRS	Current	DOE	NS	A	A
MW217	UCRS	Current	DOE	NS	A	A
MW218	UCRS	Current	DOE	NS	A	A

Table B.1. Well Program Inventory (Continued)

Well Number	Screened Zone	Status	Property Where Located	Sampled	Water Level	Inspection
MW219	UCRS	Current	DOE	NS	A	A
MW220	RGA	Current	DOE	SG	A, Q	A
MW221	RGA	Current	DOE	SG	A, Q	A
MW222	RGA	Current	DOE	SG	A, Q	A
MW223	RGA	Current	DOE	SG	A, Q	A
MW224	RGA	Current	DOE	SG	A, Q	A
MW225	URGA	Current	DOE	NS	A, Q	A
MW226	RGA	Current	DOE	GWESBA, 404G	A, Q	A
MW227	RGA	Current	DOE	GWESBA, 404G	A, Q	A
228, Not Installed	NA	NA	NA	NA	NA	NA
229, Not Installed	NA	NA	NA	NA	NA	NA
230, Not Installed	NA	NA	NA	NA	NA	NA
231, Not Installed	NA	NA	NA	NA	NA	NA
232, Not Installed	NA	NA	NA	NA	NA	NA
MW233	RGA	Current	KDFWR	GWESA	A	A
MW234	RGA	AB 2002	NA	NA	NA	NA
MW235	RGA	AB 2002	NA	NA	NA	NA
MW236	RGA	Current	KDFWR	GWESA	A	A
MW237	UCRS	Current	KDFWR	NS	A	A
MW238	RGA	Current	KDFWR	NS	A	A
MW239	McNairy	Current	KDFWR	NS	A	A
MW240	RGA	Current	KDFWR	GWESA	A	A
MW241	RGA	AB 2003	NA	NA	NA	NA
MW241A	RGA	Current	KDFWR	NS	A	A
MW242	RGA	Current	DOE	GWNWSA, GC	A	A
MW243	RGA	Current	DOE	GWNWSA	A	A
MW244	RGA	Current	DOE	GWNWSA	A	A
MW245	RGA	Current	DOE	GWNWSA	A	A
MW246	UCRS	Current	DOE	NS	A	A
MW247	McNairy	Current	DOE	NS	A	A
MW248	RGA	Current	DOE	GWNWSA	A	A
MW249	RGA	Current	DOE	NS	A	A
MW250	RGA	Current	DOE	GWNWSA	A	A
PZ251	UCRS	Current	DOE	NS	A	A
MW252	RGA	Current	Private—Residential	GWESA	A	A
MW253	RGA	Current	Private—Residential	GWESA	A	A
254, Not Installed	NA	NA	NA	NA	NA	NA
MW255	RGA	Current	DOE	GWNEQ, GWNESA	A	A
MW256	RGA	Current	DOE	GWNEQ, GWNESA, GC	A	A
MW257	RGA	Current	DOE	GC	A	A
MW258	RGA	Current	DOE	GWNEQ, GWNESA, GC	A	A
259, Not Installed	NA	NA	NA	NA	NA	NA
MW260	RGA	Current	DOE	GWESBA, GC	A	A
MW261	RGA	Current	DOE	GWESA, GC	A	A
MW262	RGA	Current	DOE	GWESBA	A	A
MW263	RGA	AB 2003	NA	NA	NA	NA
MW264	RGA	AB 2003	NA	NA	NA	NA

Table B.1. Well Program Inventory (Continued)

Well Number	Screened Zone	Status	Property Where Located	Sampled	Water Level	Inspection
MW265	RGA	AB 2000	NA	NA	NA	NA
MW266	RGA	AB 2003	NA	NA	NA	NA
MW267	RGA	AB 2003	NA	NA	NA	NA
MW268	RGA	AB 2002	NA	NA	NA	NA
MW269	RGA	AB 2002	NA	NA	NA	NA
MW270	RGA	AB 2000	NA	NA	NA	NA
MW271	RGA	AB 2002	NA	NA	NA	NA
MW272	RGA	AB 2002	NA	NA	NA	NA
MW273	RGA	AB 2002	NA	NA	NA	NA
MW274	RGA	AB 2002	NA	NA	NA	NA
MW275	RGA	AB 2002	NA	NA	NA	NA
MW276	RGA	AB 2002	NA	NA	NA	NA
MW277	RGA	AB 2000	NA	NA	NA	NA
PZ278	UCRS	AB 97	NA	NA	NA	NA
PZ279	UCRS	AB 97	NA	NA	NA	NA
PZ280	UCRS	AB 97	NA	NA	NA	NA
PZ281	UCRS	AB 97	NA	NA	NA	NA
PZ282	UCRS	AB 97	NA	NA	NA	NA
MW283	RGA	Current	DOE	GWNEQ, GWNESA	A	A
MW284	RGA	Current	DOE	NS	A	A
285, Not Installed	NA	NA	NA	NA	NA	NA
286, Not Installed	NA	NA	NA	NA	NA	NA
PZ287	RGA	Current	DOE	NS	A	A
MW288	RGA	Current	DOE	GWNEQ, GWNESA, GC	A	A
PZ289	RGA	Current	DOE	NS	A	A
PZ290	RGA	Current	DOE	NS	A	A
MW291	RGA	Current	DOE	GWNEQ, GWNESA	A	A
MW292	RGA	Current	DOE	GWNEQ, GWNESA, GC	A	A
MW293	RGA	AB 2003	NA	NA	NA	NA
MW293A	RGA	Current	DOE	GWNEQ, GWNESA	A	A
MW294	RGA	AB 2003	NA	NA	NA	NA
MW294A	RGA	Current	DOE	NS	A	A
295, Not Installed	NA	NA	NA	NA	NA	NA
296, Not Installed	NA	NA	NA	NA	NA	NA
297, Not Installed	NA	NA	NA	NA	NA	NA
298, Not Installed	NA	NA	NA	NA	NA	NA
299, Not Installed	NA	NA	NA	NA	NA	NA
MW300	Terrace Gravels	Current	DOE	KG	A	A
MW301	Terrace Gravels	AB 2014	NA	NA	NA	NA
MW302	Terrace Gravels	Current	DOE	KG	A	A
MW303	Terrace Gravels	AB 94	NA	NA	NA	NA
MW304	Terrace Gravels	Current	DOE	NS	A	A
MW305	Eocene	Current	DOE	NS	A	A
MW306	Eocene	Current	DOE	NS	A	A
MW307	Eocene	Current	DOE	NS	A	A
MW308	Eocene	Current	DOE	NS	A	A

Table B.1. Well Program Inventory (Continued)

Well Number	Screened Zone	Status	Property Where Located	Sampled	Water Level	Inspection
MW309	Terrace Gravels	Current	DOE	NS	A	A
MW310	Terrace Gravels	Current	DOE	NS	A	A
MW311	Terrace Gravels	Current	DOE	NS	A	A
MW312	UCRS	AB 2016	DOE	NS	NA	NA
MW313	UCRS	Current	DOE	NS	A	A
MW314	UCRS	AB 2016	DOE	NS	NA	NA
MW315	UCRS	Current	DOE	NS	A	A
MW316	UCRS	Current	DOE	NS	A	A
MW317	Terrace Gravels	Current	DOE	NS	A	A
MW318	Terrace Gravels	AB 2016	DOE	NS	NA	NA
319, Not Installed	NA	NA	NA	NA	NA	NA
320, Not Installed	NA	NA	NA	NA	NA	NA
321, Not Installed	NA	NA	NA	NA	NA	NA
322, Not Installed	NA	NA	NA	NA	NA	NA
323, Not Installed	NA	NA	NA	NA	NA	NA
324, Not Installed	NA	NA	NA	NA	NA	NA
MW325	RGA	Current	DOE	NS	A	A
MW326	RGA	Current	DOE	NS	A	A
MW327	RGA	Current	DOE	NS	A	A
MW328	RGA	Current	DOE	GWESBA, GC	A	A
MW329	RGA	Current	DOE	GWESBA, GC	A	A
MW330	RGA	Current	DOE	NS	A	A
331, Not Installed	NA	NA	NA	NA	NA	NA
332, Not Installed	NA	NA	NA	NA	NA	NA
MW333	RGA	Current	DOE	GWESBA, 404G	A, Q	A
PZ334	UCRS	Current	DOE	NS	A	A
PZ335	UCRS	Current	DOE	NS	A	A
PZ336	UCRS	Current	DOE	NS	A	A
MW337	RGA	Current	DOE	GWESBA, 404G	A, Q	A
MW338	RGA	Current	DOE	GWESBA, 404G	A, Q	A
MW339	RGA	Current	DOE	GWNWSA, GC	A	A
MW340	RGA	Current	DOE	GWNWSA	A	A
MW341	RGA	Current	DOE	GWNEQ, GWESBA	A	A
MW342	RGA	Current	DOE	400GSA	A	A
MW343	LRGA	Current	DOE	GWESBA, 400GSA, GC	A	A
MW344	Terrace Gravels	Current	DOE	KG	A	A
MW345	Rubble Zone	Current	DOE	GWESA	A	A
MW346	Rubble Zone	Current	DOE	NS	A	A
MW347	Rubble Zone	Current	DOE	NS	A	A
PZ348	UCRS	Current	DOE	NS	A	A
PZ349	RGA	Current	DOE	NS	A	A
PZ350	UCRS	Current	DOE	NS	A	A
PZ351	RGA	Current	DOE	NS	A	A
MW352	RGA	AB 2002	NA	NA	NA	NA
MW353	RGA	Current	DOE	NS	A, Q	A

Table B.1. Well Program Inventory (Continued)

Well Number	Screened Zone	Status	Property Where Located	Sampled	Water Level	Inspection
MW354	RGA	Current	DOE	GWESQ	A	A
MW355	RGA	Current	DOE	GWNWSA	A	A
MW356 [b]	McNairy	Current	DOE	GWESBA	A	A
MW357	URGA	Current	DOE	UG	A, Q	A
MW358	LRGA	Current	DOE	UG	A, Q	A
MW359	UCRS	Current	DOE	UG	A, Q	A
MW360	URGA	Current	DOE	UG	A, Q	A
MW361	LRGA	Current	DOE	UG	A, Q	A
MW362	UCRS	Current	DOE	UG	A, Q	A
MW363	URGA	Current	DOE	UG	A, Q	A
MW364	LRGA	Current	DOE	UG	A, Q	A
MW365	UCRS	Current	DOE	UG	A, Q	A
MW366	URGA	Current	DOE	UG	A, Q	A
MW367	LRGA	Current	DOE	UG	A, Q	A
MW368	UCRS	Current	DOE	UG	A, Q	A
MW369	URGA	Current	DOE	UG/SG	A, Q	A
MW370	LRGA	Current	DOE	UG/SG	A, Q	A
MW371	UCRS	Current	DOE	UG	A, Q	A
MW372	URGA	Current	DOE	UG/SG	A, Q	A
MW373	LRGA	Current	DOE	UG/SG	A, Q	A
MW374	UCRS	Current	DOE	UG	A, Q	A
MW375	UCRS	Current	DOE	UG	A, Q	A
MW376	LRGA	Current	DOE	UG	A, Q	A
MW377	UCRS	Current	DOE	UG	A, Q	A
378, Not Installed	NA	NA	NA	NA	NA	NA
379, Not Installed	NA	NA	NA	NA	NA	NA
MW380	RGA	Current	KDFWR	NS	A	A
MW381	RGA	Current	KDFWR	GC	A	A
382, Not Installed	NA	NA	NA	NA	NA	NA
383, Not Installed	NA	NA	NA	NA	NA	NA
MW384	URGA	Current	DOE	SG	A, Q	A
MW385	LRGA	Current	DOE	SG	A, Q	A
MW386	UCRS	Current	DOE	SG	A, Q	A
MW387	URGA	Current	DOE	SG	A, Q	A
MW388	LRGA	Current	DOE	SG	A, Q	A
MW389	UCRS	Current	DOE	SG	A, Q	A
MW390	UCRS	Current	DOE	SG	A, Q	A
MW391	URGA	Current	DOE	SG	A, Q	A
MW392	LRGA	Current	DOE	SG	A, Q	A
MW393	UCRS	Current	DOE	SG	A, Q	A
MW394	URGA	Current	DOE	SG	A, Q	A
MW395	LRGA	Current	DOE	SG	A, Q	A
MW396	UCRS	Current	DOE	SG	A, Q	A
MW397	LRGA	Current	DOE	SG	A, Q	A
398, Not Installed	NA	NA	NA	NA	NA	NA
399, Not Installed	NA	NA	NA	NA	NA	NA
400, Not Installed	NA	NA	NA	NA	NA	NA
MW401	RGA	Current	DOE	NS	A	A

Table B.1. Well Program Inventory (Continued)

Well Number	Screened Zone	Status	Property Where Located	Sampled	Water Level	Inspection
MW402	RGA	Current	DOE	NS	A	A
MW403	RGA	Current	DOE	GWESQ, GC	A	A
MW404	RGA	Current	DOE	GWESBA, GC	A	A
MW405	RGA	Current	DOE	GWESBA, 400GQ	A	A
MW406	RGA	Current	DOE	GWESBA, 400GQ	A	A
MW407	RGA	Current	DOE	GWESBA, 400GQ	A	A
MW408	RGA	Current	DOE	GWESBA, 400GQ	A	A
MW409	RGA	Current	Private—Residential	GWNESA, GC	A	A
MW410	RGA	Current	Private—Residential	GWNESA	A	A
MW411	RGA	Current	Private—Residential	GWNESA	A	A
412, Not Installed	NA	NA	NA	NA	NA	NA
413, Not Installed	NA	NA	NA	NA	NA	NA
MW414	RGA	Current	DOE	GWESBA, GC	A, Q	A
MW415	RGA	Current	DOE	GWESBA	A, Q	A
MW416	RGA	Current	DOE	GWESBA	A, Q	A
MW417	RGA	Current	DOE	GWESBA	A	A
MW418	RGA	Current	DOE	GWESA	A, Q	A
MW419	RGA	Current	DOE	GWESA	A, Q	A
MW420	URGA	Current	DOE	404G	A, Q	A
MW421	RGA	Current	DOE	400GSA	A	A
MW422	RGA	Current	DOE	400GSA	A	A
MW423	RGA	Current	DOE	400GSA	A	A
MW424	RGA	Current	DOE	400GSA	A	A
MW425	RGA	Current	DOE	400GSA	A	A
MW426	RGA	Current	DOE	GC, WPB-NW	A	A
MW427	RGA	Current	DOE	GC, WPB-NW	A	A
MW428	RGA	Current	DOE	GWNWSA	A	A
MW429	RGA	AB 2009	NA	NA	NA	NA
MW429 A	RGA	Current	DOE	GWNWSA	A	A
MW430	RGA	Current	DOE	GWNWSA	A	A
MW431	RGA	Current	DOE	GWESQ	A	A
MW432	RGA	Current	DOE	GWESBA, WPB-NW	A	A
MW433	RGA	Current	TVA	WPB-NW	A	A
434, Not Installed	NA	NA	NA	NA	NA	NA
MW435	RGA	Current	TVA	GWESBA, WPB-NW	A	A
436, Not Installed	NA	NA	NA	NA	NA	NA
437, Not Installed	NA	NA	NA	NA	NA	NA
438, Not Installed	NA	NA	NA	NA	NA	NA
MW439	RGA	Current	TVA	GWESBA, GC	A	A
MW440	RGA	Current	TVA	NS	A	A
MW441	RGA	Current	TVA	GC, WPB-NW	A	A
MW442	RGA	Current	KDFWR	GWESBA	A	A
MW443	RGA	Current	KDFWR	GWESBA	A	A
MW444	RGA	Current	KDFWR	GWESBA	A	A
MW445	RGA	Current	TVA	GWESBA	A	A
446, Not Installed	NA	NA	NA	NA	NA	NA

Table B.1. Well Program Inventory (Continued)

Well Number	Screened Zone	Status	Property Where Located	Sampled	Water Level	Inspection
MW447	RGA	Current	TVA	GWESBA, GC	A	A
MW448	RGA	Current	KDFWR	GWESBA	A	A
449, Not Installed	NA	NA	NA	NA	NA	NA
MW450	RGA	Current	KDFWR	GWESBA	A	A
MW451	RGA	Current	KDFWR	GWESBA	A	A
MW452	RGA	Current	KDFWR	GWESBA, WPB-NW	A	A
MW453	RGA	Current	KDFWR	GWESA	A	A
MW454	RGA	Current	KDFWR	GWESA	A	A
MW455	RGA	Current	DOE	GWNWSA	A	A
MW456	RGA	Current	DOE	GWNWSA	A	A
MW457	RGA	Current	DOE	GWNWSA	A	A
MW458	RGA	Current	DOE	GWNWSA	A	A
MW459	RGA	Current	DOE	GWNWSA	A	A
MW460	RGA	Current	DOE	GWNWQ	A	A
MW461	RGA	Current	DOE	GWNWSA	A	A
MW462	RGA	Current	DOE	GWNWSA	A	A
MW463	RGA	Current	TVA	GWESA	A	A
MW464	RGA	Current	TVA	GWESA	A	A
MW465	RGA	Current	Private—Residential	GWESBA	A	A
MW466	RGA	Current	Private—Residential	GWESBA	A	A
MW467	RGA	Current	Private—Residential	GWESBA	A	A
MW468	RGA	Current	Private—Residential	GWESBA, GC	A	A
MW469	RGA	Current	Private—Residential	GWESA	A	A
MW470	RGA	Current	Private—Residential	GWESA	A	A
MW471	RGA	Current	Private—Residential	GWESA	A	A
MW472	RGA	Current	Private—Residential	GWESA	A	A
MW473	RGA	Current	Private—Residential	GWESBA, GC	A	A
MW474	RGA	Current	Private—Residential	GWESBA, GC	A	A
MW475	RGA	Current	Private—Residential	GWESBA	A	A
MW476	RGA	Current	Private—Residential	GWESBA	A	A
MW477	RGA	Current	TVA	GWESBA	A	A
MW478	RGA	Current	DOE	GWESBA, GWNEQ	A	A
MW479	RGA	Current	DOE	GWESBA, GWNEQ	A	A
MW480	RGA	Current	DOE	GWESBA, GWNEQ	A	A
MW481	RGA	Current	DOE	GWESBA	A	A
MW482	RGA	Current	DOE	GWESBA	A	A
MW483	RGA	Current	Private—Residential	GWESA	A	A
MW484	RGA	Current	Private—Residential	GWESA	A	A
MW485	RGA	Current	Private—Residential	GWESBA	A	A
MW486	RGA	Current	Private—Residential	GWESBA	A	A
MW487	RGA	Current	Private—Residential	GWESBA	A	A
MW488	RGA	Current	Private—Residential	GWESBA	A	A
MW489	RGA	Current	KDFWR	GWESBA	A	A
MW490	RGA	Current	KDFWR	GWESBA	A	A
MW491	RGA	Current	DOE	GWESBA	A	A
MW492	RGA	Current	DOE	GWESBA	A	A
MW493	RGA	Current	DOE	GWESBA	A	A

Table B.1. Well Program Inventory (Continued)

Well Number	Screened Zone	Status	Property Where Located	Sampled	Water Level	Inspection
MW494	RGA	Current	DOE	GWESBA	A	A
MW495	RGA	Current	DOE	GWESBA, GWNEQ	A	A
MW496	RGA	Current	DOE	GWESBA, GWNEQ	A	A
MW497	URGA	Current	DOE	GWNWSA	A	A
MW498	LRGA	Current	DOE	GWNWSA	A	A
MW499	URGA	Current	DOE	GWNWSA	A	A
MW500	LRGA	Current	DOE	GWNWSA	A	A
MW501	URGA	Current	DOE	GWNWSA	A	A
MW502	LRGA	Current	DOE	GWNWSA	A	A
MW503	URGA	Current	DOE	GWNWSA	A	A
MW504	LRGA	Current	DOE	GWNWSA	A	A
MW505	RGA	Current	DOE	400GQ	A	A
MW506	RGA	Current	DOE	400GQ	A	A
MW507	RGA	Current	DOE	400GQ	A	A
MW508	RGA	AB 2014	DOE	NS	NA	NA
MW509	RGA	AB 2014	DOE	NS	NA	NA
MW510	RGA	AB 2014	DOE	NS	NA	NA
MW511[c]	UCRS	Current	DOE	NS	A	A
MW512[c]	UCRS	Current	DOE	NS	A	A
MW513[c]	UCRS	Current	DOE	NS	A	A
MW514[c]	UCRS	Current	DOE	NS	A	A
MW515[c]	UCRS	Current	DOE	NS	A	A
MW516[c]	UCRS	Current	DOE	NS	A	A
MW517 (PZ)[d]	UCRS	Current	DOE	NS	A	A
MW518 (PZ)[d]	UCRS	Current	DOE	NS	A	A
MW519 (PZ)[d]	UCRS	Current	DOE	NS	A	A
MW520 (PZ)[d]	UCRS	Current	DOE	NS	A	A
MW521 (PZ)[d]	UCRS	Current	DOE	NS	A	A
MW522 (PZ)[d]	UCRS	Current	DOE	NS	A	A
MW523 (PZ)[d]	UCRS	Current	DOE	NS	A	A
MW524[e]	RGA	Current	DOE	GWNEQ[f]	A	A
MW525[e]	RGA	Current	DOE	GWNEQ[f]	A	A
MW526[e]	RGA	Current	DOE	GWNEQ[f]	A	A
MW527[e]	RGA	Current	DOE	GWNEQ[f]	A	A
MW528[e]	RGA	Current	DOE	GWNEQ[f]	A	A
MW529[e]	RGA	Current	DOE	GWNEQ[f]	A	A
MW530[e]	RGA	Current	DOE	GWNEQ[f]	A	A
MW531	RGA	Current	DOE	GWNEQ	A	A
MW532 (PZ)[f]	RGA	Current	DOE	NS	A	A
MW533	RGA	Current	DOE	GWNEQ	A	A
MW534 (PZ)[f]	RGA	Current	DOE	NS	A	A
MW535 (PZ)[f]	RGA	Current	DOE	NS	A	A
MW536	RGA	Current	DOE	GWNEQ	A	A
MW537	RGA	Current	DOE	GWNEQ	A	A
MW538	RGA	Current	DOE	GWNEQ	A	A
MW539	RGA	Current	DOE	GWNEQ	A	A
MW540 (PZ)[f]	RGA	Current	DOE	NS	A	A

Table B.1. Well Program Inventory (Continued)

Well Number	Screened Zone	Status	Property Where Located	Sampled	Water Level	Inspection
MW541 (PZ)[f]	RGA	Current	DOE	NS	A	A
MW542	RGA	Current	DOE	GWSWMU1	A	A
MW543	RGA	Current	DOE	GWSWMU1	A	A
MW544	RGA	Current	DOE	GWSWMU1	A	A
MW545	RGA	Current	DOE	GWSWMU1	A	A
MW546	RGA	Current	DOE	GWSWMU1	A	A
MW547	RGA	Current	DOE	GWSWMU1	A	A
MW548	RGA	Current	DOE	GWESBA	A, Q	A
MW549	RGA	Current	DOE	GWESBA, 404G	A, Q	A
MW550	RGA	Current	DOE	GWESBA	A	A
MW551	RGA	Current	DOE	GWESBA	A	A
552, Not Installed	NA	NA	NA	NA	NA	NA
MW553 (PZ)[f]	RGA	Current	DOE	NS	A	A
MW554 (PZ)[f]	RGA	Current	DOE	NS	A	A
MW555 (PZ)[f]	RGA	Current	DOE	NS	A	A
MW556	RGA	Current	DOE	GWNEQ	A	A
R2	Unknown	Current	Private—Residential	WPB-NW	A	FYR
R9	Unknown	Current	Private—Residential	WPB-NE	A	FYR
R13	Unknown	Current	Private—Residential	WPB-NW	A	FYR
R14	Unknown	Current	Private—Residential	WPB-NW	A	FYR
R20	RGA	Current	Private—Residential	WPB-NE	A	FYR
R21	Unknown	Current	Private—Residential	WPB-NE	A	FYR
R26	Unknown	Current	Private—Residential	WPB-NW	A	FYR
R53	Unknown	Current	Private—Residential	WPB-NW	A	FYR
R83	Unknown	Current	Private—Residential	WPB-NE	A	FYR
R90	Unknown	Current	Private—Residential	WPB-NE	A	Outside Water Policy
R114	Unknown	Current	Private—Residential	WPB-NE	A	Outside Water Policy
R245	Unknown	Current	Private—Residential	WPB-NW	A	FYR
R302	RGA	Current	Private—Residential	WPB-NE	A	FYR
R424	RGA	Current	Private—Residential	CARB	NS	Outside Water Policy

[a] MW91 has been abandoned and replaced by MW91A.
[b] MW Initial lithologic log indicated well was completed in the RGA; however, the lithology has been reinterpreted to show a higher top of McNairy.
[c] MWs associated with Southwest Plume project. These MWs are not required to be sampled in FY 2018.
[d] PZs associated with the SWMU 4 project. These PZs are scheduled to be abandoned as this project concludes.
[e] Transect monitoring wells associated with the Northeast Plume Optimization project.
[f] PZs associated with the Northeast Plume Optimization project.
Note: Piezometers now will be given an MW designation and noted as (PZ) to be consistent with the remedial action work plans.
Note: Residential wells inside of the water policy box will be inspected during a Comprehensive Environmental Response, Compensation, and Liability Act Five-Year Review period to verify that the well is not functioning as a water source. There are residential wells that are not sampled and are not listed in this table, but will be included in this inspection. Those residential wells outside of the water policy box may be accessed by the landowner.

WATER LEVELS

Water level measurements are divided into two programs: (1) measurement of water levels at wells that support potentiometric surface map development in relation to the permitted landfills (measured quarterly as indicated on page B-19); and (2) measurement of water levels at the remaining wells (measured annually). The remaining wells are defined as those remaining wells from Appendix B of this Environmental Monitoring Plan. Wells associated with the potentiometric surface maps at the permitted landfills are measured within as short a time period as possible, not to exceed a three-day period. (Note: Wells denoted as "commitment wells" are those wells formally agreed upon to be measured, but are not listed specifically in the permit. Wells denoted as "noncommitment wells" are measured as a best management practice.) All remaining wells are measured on an annual basis. In FY 2018, the remaining wells will be measured between July 1 and August 30.

WATER LEVELS IN SUPPORT OF PERMITTED LANDFILLS

C-404 Landfill Quarterly Water Levels (9) Permitted Wells
MW84
MW85
MW87
MW88
MW90A
MW91A [a]
MW93
MW94
MW420
Commitment Wells (7)[b]
MW67
MW76
MW227
MW333
MW337
MW414
MW416
Noncommitment Wells (9)
MW86
MW89
MW92
MW95A
MW226
MW338
MW415
MW548
MW549

C-746-U Landfill Quarterly Water Levels (21) Permitted Wells	
MW357	MW368
MW358	MW369[c]
MW359	MW370[c]
MW360	MW371
MW361	MW372[c]
MW362	MW373[c]
MW363	MW374
MW364	MW375
MW365	MW376
MW366	MW377
MW367	
Noncommitment Wells (9)	
MW 98	MW173
MW100	MW193
MW125	MW197
MW139	MW200
MW165A	

C-746-S&T Landfills Quarterly Water Levels (25) Permitted Wells
MW220
MW221
MW222
MW223
MW224
MW225[d]
MW353[d]
MW384
MW385
MW386
MW387
MW388
MW389
MW390
MW391
MW392
MW393
MW394
MW395
MW396
MW397
MW369[c]
MW370[c]
MW372[c]
MW373[c]

Noncommitment Wells (2)
MW418
MW419

[a] MW91 has been abandoned and replaced by MW91A.

[b] Per a DOE commitment, PPPO-02-640-08, (pertaining to C-404 Landfill permitting process) water level measurements will be taken for seven additional wells that were not cited within the permit within a 24 hour window of when water level measurements are collected on the C-404 permitted wells. Although these wells are not identified in the permit, the obtained water level measurement data will be reported to Kentucky Division of Waste Management as part of the semiannual report.

[c] Wells are cited in the C-746-U Landfill and the C-746-S&T Landfill permits.

[d] Based on the approved permit on for the C-746-S&T Landfills, these two wells are permitted wells; however, they are permitted only for water level measurements.

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APPENDIX C

ENVIRONMENTAL SAMPLING FREQUENCY AND PARAMETERS

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CONTENTS

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TABLES

FIGURES

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ACRONYMS

ASER	Annual Site Environmental Report
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CY	calendar year
DOE	U.S. Department of Energy
EM	environmental monitoring
EMP	Environmental Monitoring Plan
ERPP	Environmental Radiation Protection Program
FFA	Federal Facility Agreement
FPDP	Fluor Federal Services, Inc., Paducah Deactivation Project
FRNP	Four Rivers Nuclear Partnership, LLC
FY	fiscal year
KDOW	Kentucky Division of Water
KDWM	Kentucky Division of Waste Management
KPDES	Kentucky Pollutant Discharge Elimination System
MCL	maximum contaminant level
MCS	Mid-America Conversion Services, LLC
MW	monitoring well
NTNCWS	non-transient non-community water system
PGDP	Paducah Gaseous Diffusion Plant
RFI	Resource Conservation and Recovery Act Facility Investigation
ROD	record of decision
SDWA	Safe Drinking Water Act
TLD	thermoluminescent dosimeter
TSS	total suspended solids

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C.1. INTRODUCTION

Three-hundred ninety-nine monitoring wells (MWs) and piezometers are active and monitored as part of the Environmental Monitoring (EM) Program. Active wells either are in an analytical sampling program or may be evaluated only for water level measurements. This appendix shows a summary of each analytical sampling program.

In addition to MW locations, the sampling programs within this appendix include sampling parameters for other locations covered in the EM Program (i.e., surface water and sediment programs).

Each summary includes the environmental sampling frequencies, parameters, analytical methods, the sampling drivers, rationale for conducting the sampling, which document(s) the sampling results are reported in, and a list of locations that are sampled.

An effort has been made to reduce the amount of sampling performed to support fiscal responsibility of the EM program at the site. The criteria used to determine less frequent sampling include the following:

- New understanding of contaminant migration pathways and contaminants present,
- Review of historical results and long-term trends,
- Analyses to determine if the MW meets the current and future objectives of the Groundwater Operable Unit, and
- Addition of new MWs that may eliminate the need for sampling older MWs.

A brief summary of changes that have been made from the fiscal year (FY) 2017 to the FY 2018 Environmental Monitoring Plan (EMP) is included in each sampling program section. The changes described in this appendix were made using the criteria listed above. Data collected under the sampling programs defined in this appendix will be evaluated in FY 2018. Based on trending results, if changes are deemed appropriate, they will be proposed via a permit modification or via modification of the appropriate driver and reflected in the FY 2019 EMP. In those cases where sampling cannot be performed due to an uncontrollable condition, such as blocked access to an MW due to flooding conditions, the sampling staff will denote the reason as to why the sample could not be collected.

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C.2. GROUNDWATER MONITORING

The Paducah Site samples MWs and residential wells on a routine basis. Additionally, MWs are monitored for water levels on a routine basis. The EM manager is responsible for accepting any new MWs installed and assuring that the wells meet the following standards:

(1) Construction requirements, as outlined in either the statement of work, field sampling plan, or work plan for the project;

(2) Acceptance criteria for well development, as outlined in the U.S. Department of Energy's (DOE) Four Rivers Nuclear Partnership, LLC (FRNP) procedures;

(3) Requirements for pump and packer placement; and

(4) The well is functioning properly and has no deficiencies.

MWs that do not meet these requirements will not be accepted by the EM manager until all deficiencies have been corrected. More specific requirements to the acceptance of MWs are detailed in procedure CP4-ES-0069, *Monitoring Well and Associated Infrastructure Installation*. MWs are inspected, at a minimum, on an annual basis per the procedure CP4-ES-0074, *Monitoring Well Inspection and Maintenance*. Outlines for well rehabilitation methods are found in CP2-ES-0024, *Monitoring Well Maintenance Implementation Plan for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*.

Specified methods found in Appendix C are EPA-approved methods, as applicable. In some instances, such as with radionuclides, EPA-approved methods are unavailable. For this EMP, the currently used laboratory's analytical procedure is noted as the method of choice. If an analysis is conducted at another laboratory during FY 2018, an equivalent procedure will be used upon approval by the environmental monitoring and reporting manager.

C.2.1 GROUNDWATER MONITORING PROGRAM FOR LANDFILL OPERATIONS

C-746-S, C-746-T, and C-746-U Landfills (Solid Waste Landfill Monitoring)

Frequency: Quarterly

Driver: Sampling requirements are outlined in the solid waste landfill permit issued by the Kentucky Division of Waste Management (KDWM).

Reported: Quarterly Compliance Monitoring Reports, as required by the permit and the Annual Site Environmental Report (ASER)

Rationale: To evaluate the potential impact of historical waste disposal activities at the C-746-S&T Landfills, as well as historical and current waste disposal activities at the C-746-U Landfill on groundwater quality and to comply with compliance monitoring requirements, as set forth in the solid waste landfill permit.

Comments: For permit, SW07300014, SW07300015, and SW07300045, the reporting requirement for maximum contaminant level (MCL) is as follows: "If the analysis of the groundwater sample results indicates contamination [i.e., a statistical or MCL exceedance] as specified in 401 *KAR* 48:300 Section 8(1), the owner or operator shall notify the cabinet within

(forty-eight) 48 hours of receiving the results and shall arrange to split sample no later than ten (10) days from the receipt of the results [401 *KAR* 48:300 Section 7]."

MW sampling is performed and reported collectively for the C-746-S and C-746-T Landfills. Per Technical Attachment 25, to the permit for C-746-S, C-746-T, and C-746-U Landfills, sample collection order is specified. The order is as follows: volatiles (including total organic halides), dissolved gases and total organic carbon, semivolatile organics, metals and cyanide, water quality cations and anions, and radionuclides. If samples are being collected at a location where it is anticipated that sample volume is not adequate, then the order of collection will be volatiles followed by radionuclides.

Data collected under this program will be evaluated. Based on trending results, if changes are deemed appropriate, they will be proposed via a permit modification and reflected in the FY 2019 EMP.

Tables C.1 and C.2 list MWs for the C-746-S, C-746-T, and C-746-U Landfills, and Table C.3 lists the quarterly analytical parameters for these landfills. Locations are shown on Figure C.1.

Table C.1. C-746-S and C-746-T Landfills Wells (23)[a]

MW220	MW370[b]	MW387	MW393
MW221	MW372[b]	MW388	MW394
MW222	MW373[b]	MW389	MW395
MW223	MW384	MW390	MW396
MW224	MW385	MW391	MW397
MW369[b]	MW386	MW392	

[a] The total number of permitted wells associated with the C-746-S&T Landfills is 25; however, two of these wells (MW225, MW353) are permitted only for water level measurement. The total number of analytically measured wells, therefore, is 23.
[b] Wells are sampled with the C-746-U Landfill sampling event; these four wells are not counted in the sampling event for the C-746-S&T Landfills, but are reported in the Compliance Monitoring Reports for both the C-746-U and C-746-S&T Landfills. These wells are upgradient wells for the C-746-U Landfill and are downgradient wells for the C-746-S&T Landfills.

Table C.2. C-746-U Landfill Wells (21)

MW357	MW363	MW368	MW373*
MW358	MW364	MW369*	MW374
MW359	MW365	MW370*	MW375
MW360	MW366	MW371	MW376
MW361	MW367	MW372*	MW377
MW362			

*These four wells are not counted in the totals for the C-746-S&T Landfills, but are reported in the Compliance Monitoring Reports for both the C-746-U and C-746-S&T Landfills. These wells are upgradient wells for the C-746-U Landfill and are downgradient wells for the C-746-S&T Landfills.

Table C.3. C-746-S, C-746-T, C-746-U Quarterly Analytical Parameters

Volatiles—Method 8260B unless noted		
1,1,1,2-Tetrachloroethane	Acetone	Dibromochloromethane
1,1,1-Trichloroethane	Acrolein	Dibromomethane
1,1,2,2-Tetrachloroethane	Acrylonitrile	Dimethylbenzene, Total[a]
1,1,2-Trichloroethane	Benzene	Ethylbenzene
1,1-Dichloroethane	Bromochloromethane	Iodomethane
1,1-Dichloroethene	Bromodichloromethane	Methylene Chloride
1,2,3-Trichloropropane	Bromoform	Styrene
1,2-Dibromo-3-chloropropane—8011	Bromomethane	Tetrachloroethene
1,2-Dibromoethane	Carbon Disulfide	Toluene
1,2-Dichlorobenzene	Carbon Tetrachloride	*trans*-1,2-Dichloroethene
1,2-Dichloroethane	Chlorobenzene	*trans*-1,3-Dichloropropene
1,2-Dichloropropane	Chloroethane	*trans*-1,4-Dichloro-2-Butene
1,4-Dichlorobenzene	Chloroform	Trichloroethene
2-Butanone	Chloromethane	Trichlorofluoromethane
2-Hexanone	*cis*-1,2-Dichloroethene	Vinyl Acetate
4-Methyl-2-pentanone	*cis*-1,3-Dichloropropene	Vinyl Chloride
Anions—Method 9056		
Bromide	Fluoride	Sulfate
Chloride	Nitrate as Nitrogen	
Metals—Method 6020 unless noted		
Aluminum		Silver
Antimony	Iron	Sodium
Arsenic	Lead	Tantalum
Barium	Magnesium	Thallium
Beryllium	Manganese	Uranium
Boron	**Mercury—7470A**	Vanadium
Cadmium	Molybdenum	Zinc
Calcium	Nickel	Barium, Dissolved
Chromium	Potassium	Chromium, Dissolved
Cobalt	Rhodium	Uranium, Dissolved
Copper	Selenium	
Miscellaneous—Method as follows		
Chemical Oxygen Demand—410.4	**Iodide—300.0**	**Total Dissolved Solids—160.1**
Cyanide—9012	**Total Organic Carbon—9060**	**Total Organic Halides—9020B**
Field Parameters		
Conductivity	Redox	Temperature
Depth to Water	pH	Turbidity
Dissolved Oxygen		
PCBs[b]—Method 8082		
PCB, Total	PCB-1232	PCB-1254
PCB-1016	PCB-1242	PCB-1260
PCB-1221	PCB-1248	PCB-1268
Radionuclides—Method as follows		
Alpha Activity—9310	**Radium-228[c]—904.0**	**Thorium-230—Th-01-RC**
Beta Activity—9310	**Strontium-90—905.0**	**Thorium-232[c]—Th-01-RC**
Radium-226—AN-1418	**Technetium-99—TC-02-RC**	**Tritium—906.0**

[a] Xylenes

[b] Polychlorinated biphenyls (PCBs) are required under the solid waste permits to be monitored quarterly for the C-746-U Landfill and annually for the C-746-S&T Landfills.

[c] Permit does not require analysis of radium-228 and thorium-232. These parameters are analyzed in support of demonstrating compliance with DOE Order 458.1 for the C-746-U Landfill.

Methods included in table are equivalent methods to those listed in the current *Groundwater Monitoring Plan for the Solid Waste Permitted Landfills (C-746-S Residential Landfill, C-746-T Inert Landfill, And C-746-U Contained Landfill) at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, PAD-PROJ-0139.

Bolded parameters are sampled by different method than specified in header.

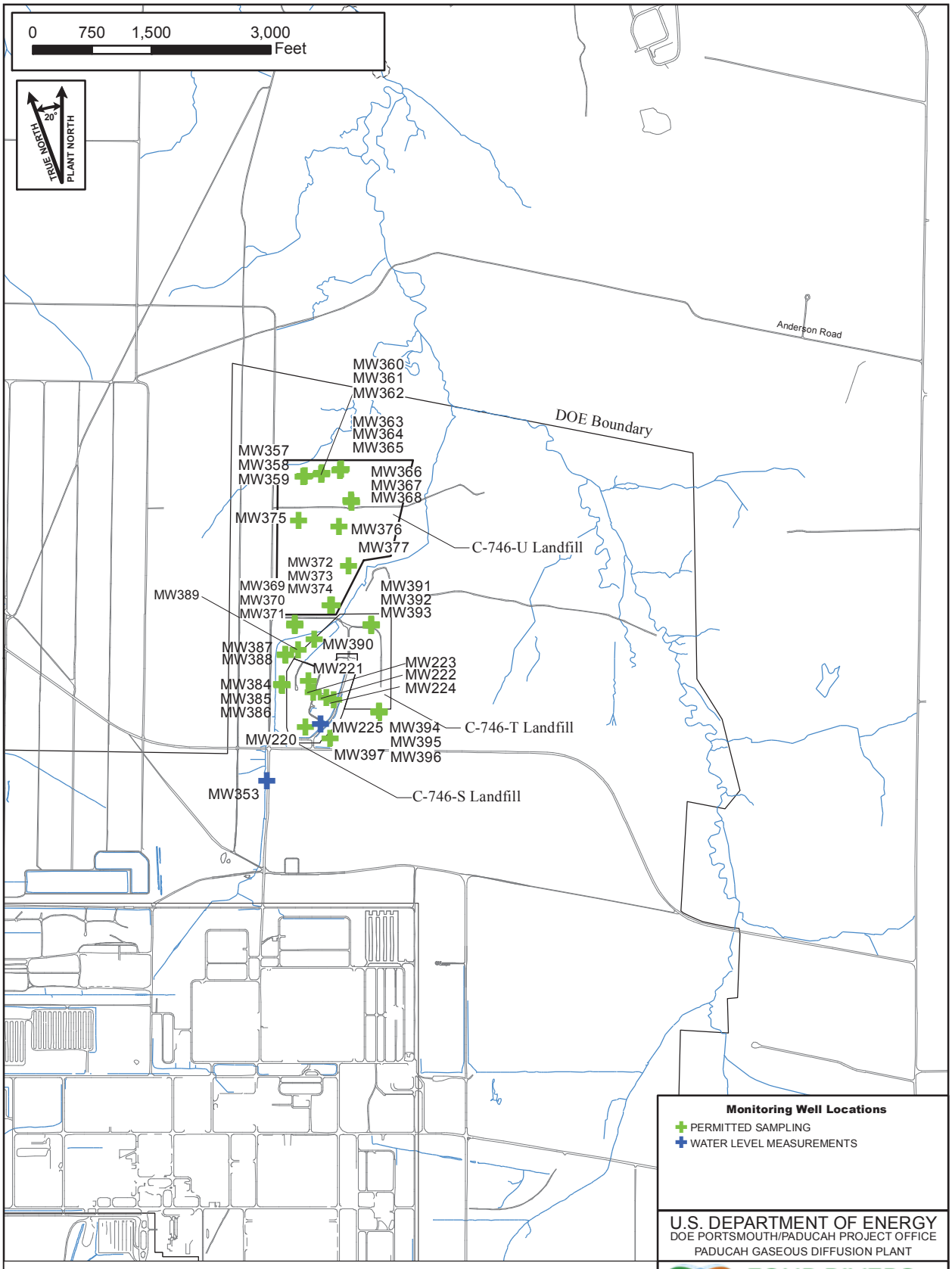

Figure C.1. Groundwater Monitoring Wells near the C-746-S, T, and U Landfills

FIGURE No. EMP\2017\EMPWellsSTU_2017R1.mxd
DATE 11-11-2016

C-404 Low-Level Radioactive Waste Burial Ground (Resource Conservation and Recovery Act Detection Status Monitoring)

Frequency: Semiannually

Driver: The semiannual parameters are required to be sampled per Hazardous Waste Facility Permit, KY8-890-008-982.

MWs 226, 227, 333, 337, and 338 are monitored in support of the *Record of Decision for Interim Remedial Action at Solid Waste Management Unit 2 and 3 of Waste Area Group 22 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/06-1351&D1, July 1995.

Reported: Semiannual C-404 Groundwater Monitoring Report required by the permit, Semiannual Federal Facility Agreement (FFA) Progress Report, and the ASER

Rationale: To monitor the C-404 Low-Level Radioactive Waste Burial Ground under detection monitoring program regulations.

Rule: Determine, within 30 days of the completion of data validation, if there is a statistical increase over background for permit parameters using the Analysis of Variance method. If there is an increase, then evaluate if the contamination is from the C-404 Landfill or another source. If another source is the cause of the contamination, then a notification must be submitted to KDWM within 7 days.

Comments: In the event that only a partial sample can be obtained, the following priority will be followed: field parameters, trichloroethene (TCE), and metals. The dissolved metal samples (arsenic, cadmium, chromium, lead, mercury, selenium, and uranium) are filtered at the off-site laboratory.

Sampling frequencies and sampling parameters were not modified for this sampling program for FY 2018.

Field parameters (pH, temperature, conductivity, dissolved oxygen, oxidation-reduction potential, and turbidity) are measured using a Hydrolab water quality meter. Other field parameters, such as depth to water and barometric pressure, are measured prior to sampling.

Prior to sample collection, KDWM shall be notified one week in advance. Notification may be made in writing or electronic format. Electronic mail shall be submitted to pgdp.notify@ky.gov, and other pertinent KDWM field personnel.

A listing of MWs for the C-404 Landfill is presented in Table C.4 and the analytical parameters are presented in Table C.5. Locations are shown on Figure C.2.

Table C.4. C-404 Landfill Wells

C-404 Landfill Wells (9)			
MW84	MW88	MW91A[a]	MW94
MW85	MW90A	MW93	MW420
MW87			
Opted to Sample—Not Committed to KDWM (12)[b]			
TCE, Tc-99, and Field Parameters			
MW67	MW89	MW226[c]	MW337[c]
MW76	MW92	MW227[c]	MW338[c]
MW86	MW95A	MW333[c]	MW549[d]

[a] MW91 has been abandoned and replaced by MW91A.
[b] Routine sampling of these wells is not required by the permit. MWs 414 and 416 are also part of this special sampling event; however, only depth to water measurements are collected for these two wells.
[c] MWs 226, 227, 333, 337, and 338 are monitored in support of the *Record of Decision for Interim Remedial Action at Solid Waste Management Unit 2 and 3 of Waste Area Group 22 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/06-1351&D1, July 1995.
[d] MW549 was installed during Phase V of Solid Waste Management Unit (SWMU) 4 and is intended to serve as a complementary well to MW333 in order to detect trends for TCE in the RGA near the C-404 Landfill.

Table C.5. C-404 Landfill Semiannual Analytical Parameters

Volatiles—Method 8260B			
Trichloroethene			
Metals—6020 unless noted			
Arsenic	Lead	Uranium	Lead, Dissolved
Cadmium	Manganese	Arsenic, Dissolved	**Mercury, Dissolved—7470A**
Chromium	**Mercury—7470A**	Cadmium, Dissolved	Selenium, Dissolved
Iron	Selenium	Chromium, Dissolved	Uranium, Dissolved
Field Parameters			
Barometric Pressure	Depth to Water	Redox	Temperature
Conductivity	Dissolved Oxygen	pH	Turbidity
Radionuclides—Method U-02-RC unless noted			
Technetium-99—TC-02-RC	Uranium-234	Uranium-235	Uranium-238
Miscellaneous—Method 9060*			
			Total Organic Carbon

*Not required by the permit.
Bolded parameters are sampled by different method than specified in header.
Alternate SW-846 methods may be substituted with prior written approval from KDWM.

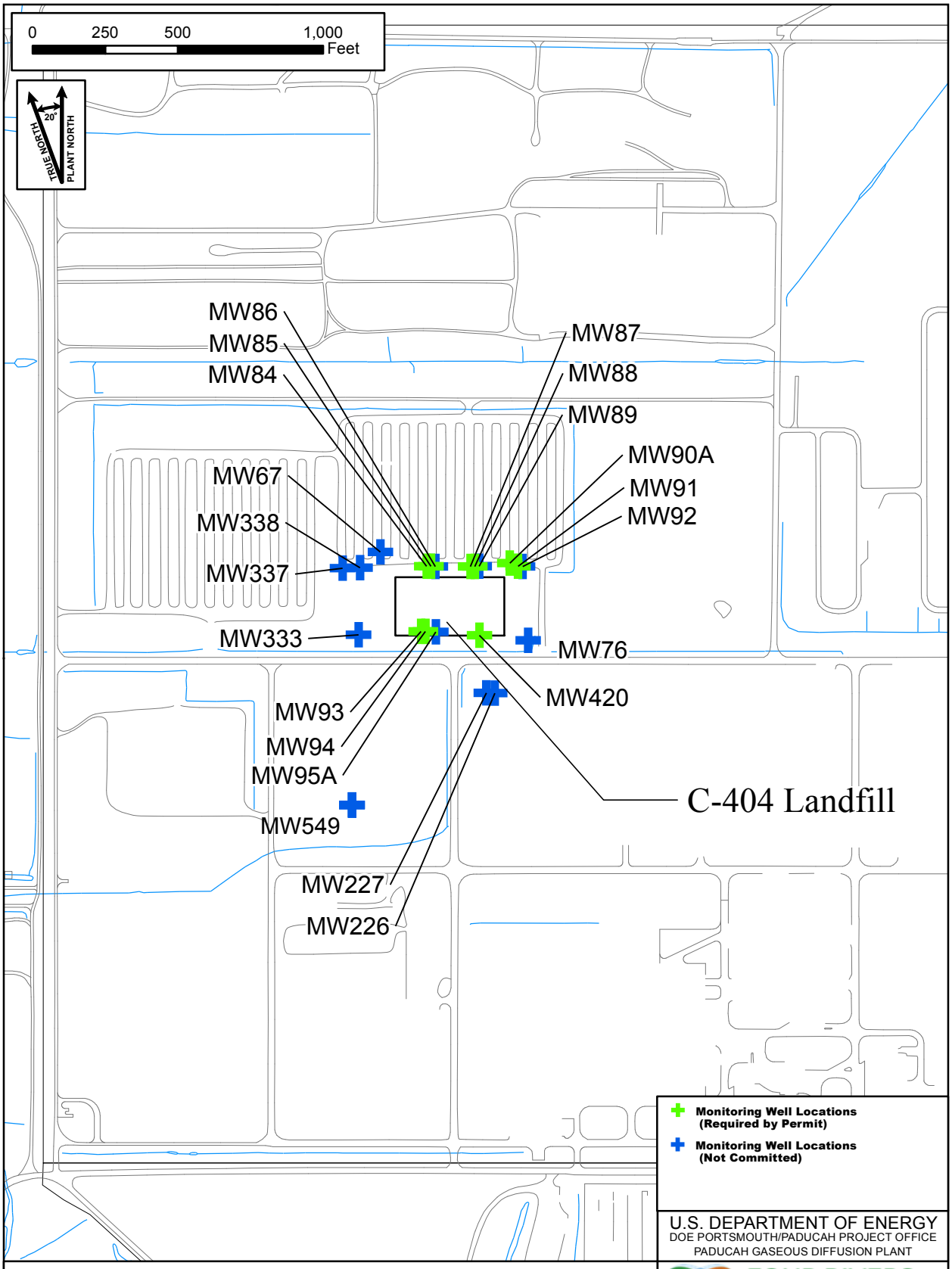

Figure C.2. Groundwater Monitoring Wells near C-404 Landfill

C-746-K Landfill Monitoring

Frequency: Semiannually

Driver: *Record of Decision for Waste Area Groups 1 and 7 for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/06-1470&D2, September 1997: Even though the Record of Decision (ROD) for Waste Area Groups 1 and 7 was a Surface Water Operable Unit decision document, sampling of MWs is noted in the ROD. The ROD also allows for annual evaluation of the program with documentation in the *Sampling and Analysis Plan Addendum*, KY/ER-2, which previously was superseded by the EMP.

Reported: Semiannual FFA Progress Report and the ASER

Rationale: To evaluate the potential impact of historical waste disposal activities at the C-746-K Landfill on groundwater quality.

Comments: In the event a well becomes dry while purging, no sample will be taken; however, it should be recorded that no sample was collected because the well was dry. Starting in 2005, the frequency was reduced from quarterly to semiannually.

Sampling frequencies and sampling parameters were not modified for this sampling program for FY 2018.

Tables C.6 and C.7 provide a listing of landfill wells and analytical parameters, respectively. Locations are shown on Figure C.3.

Table C.6. C-746-K Landfill Wells (3)

MW300	MW302	MW344

Table C.7. C-746-K Landfill Semiannual Analytical Parameters

Volatiles—Method 8260B			
1,1,1-Trichloroethane	Benzene	*cis*-1,2-Dichloroethene	Toluene
1,1,2-Trichloroethane	Bromodichloromethane	Dimethylbenzene, Total*	*trans*-1,2-Dichloroethene
1,1-Dichloroethane	Carbon Tetrachloride	Ethylbenzene	Trichloroethene
1,1-Dichloroethene	Chloroform	Tetrachloroethene	Vinyl Chloride
1,2-Dichloroethane			
Field Parameters			
Conductivity	Ferrous Iron (Fe^{+2})	pH	Turbidity
Barometric Pressure	Depth to Water Dissolved Oxygen	Temperature	Redox
Miscellaneous—310.1			
Alkalinity			
Metals—Method 6020			
Barium, Dissolved	Uranium, Dissolved	Cadmium	Manganese
Beryllium, Dissolved	Aluminum	Calcium	Nickel
Cadmium, Dissolved	Arsenic	Iron	Potassium
Lead, Dissolved	Barium	Lead	Sodium
Arsenic, Dissolved	Beryllium	Magnesium	Uranium
Radionuclides—Method 9310 unless noted			
Alpha Activity	Beta Activity	**Technetium-99—TC-02-RC**	
Anions—Method 9056			
Chloride	Sulfate	Nitrate	

*Xylenes
Bolded parameters are sampled by different method than specified in header.

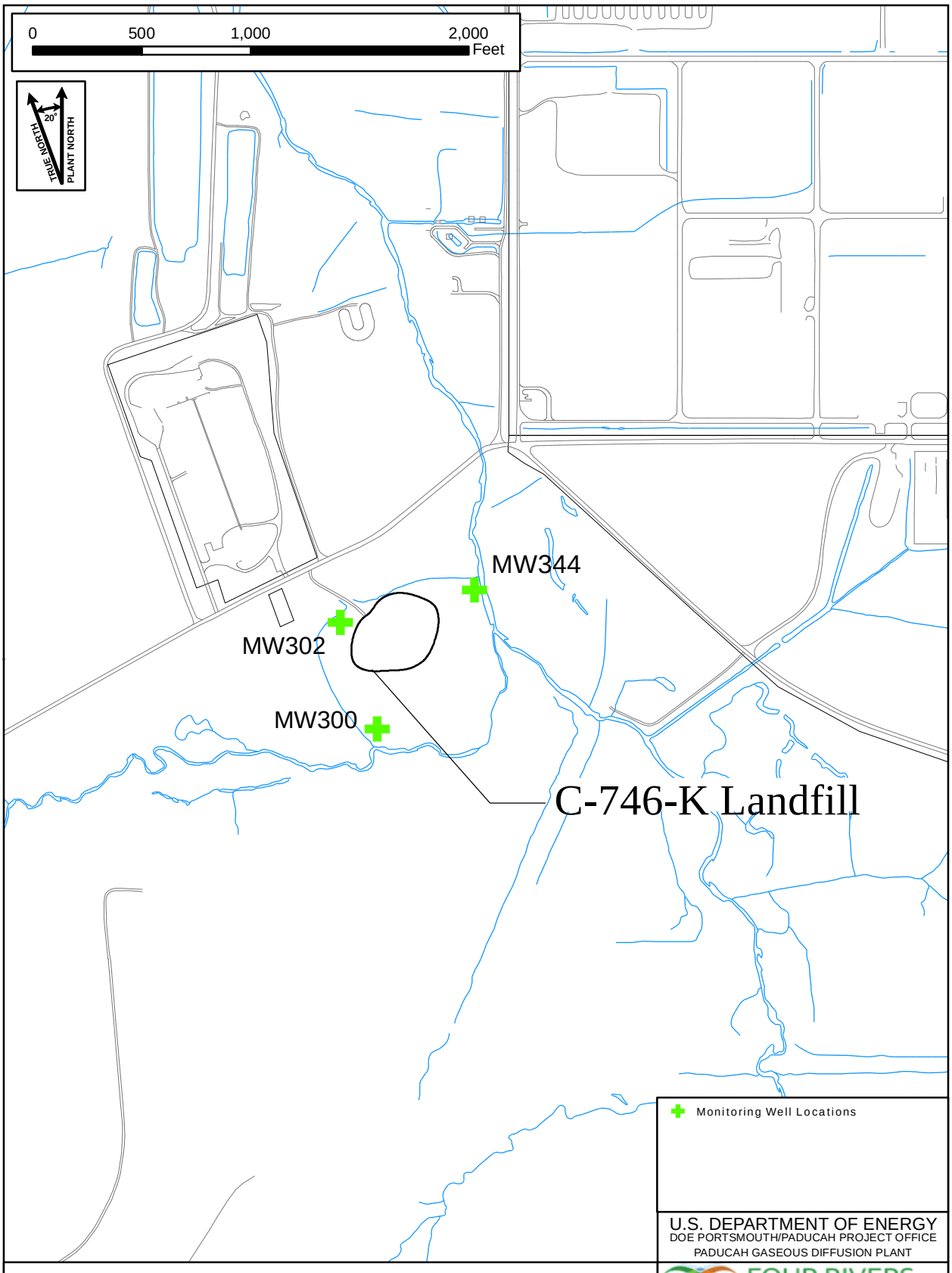

Figure C.3. Groundwater Monitoring Wells near C-746-K Landfill

C.2.2 NORTHEAST PLUME OPERATIONS AND MAINTENANCE PROGRAM

Northeast Plume Monitoring

Frequency: Quarterly and Semiannually

Driver: The MWs are required to be sampled by the *Operation and Maintenance Plan for the Northeast Plume Containment System Interim Remedial Action at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/OR/07-1535&D3/R4, August 2013, and by the *Remedial Action Work Plan for the Optimization of the Northeast Plume Interim Action at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/LX/07-1280&D2/R3, April 2016.

Reported: Semiannual FFA Progress Report and ASER

Rationale: To monitor the nature and extent of groundwater contamination and to evaluate any cyclic trends in water quality that may affect contaminant migration.

Comments: The extraction wells (or other operational samples) are not sampled under the groundwater program as part of the EM Program. They are sampled as specified under the Operations and Maintenance Plan for the Northeast Plume.

Sampling frequencies and sampling parameters were not modified for this sampling program for FY 2018.

Table C.8 provides a listing of MWs sampled semiannually and the associated parameters. Table C.9 provides a listing of MWs sampled quarterly and the associated parameters. The Northeast Plume extraction well system has undergone an optimization. New extraction wells have been installed in new locations closer to the site due to the decreasing concentration of contaminants at their current locations. This optimization program included two new extraction wells, EW234 and EW235, and 22 piezometers and MWs. Sampling frequencies and sampling parameters required by the *Remedial Action Work Plan for the Optimization of the Northeast Plume Interim Action at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/LX/07-1280&D2/R3, April 2016, are included in Table C.10. The extraction wells (and other operational samples) are not sampled under the groundwater program as part of the EM Program. They are sampled as specified under the Operations and Maintenance Plan listed above for the Northeast Plume. Locations are shown on Figure C.4.

Table C.8. Northeast Plume Semiannual Wells and Parameters

Semiannual Wells (14)			
MW124	MW256	MW291	MW410[a]
MW126	MW258	MW292	MW411[a]
MW145	MW283	MW293A	
MW255	MW288	MW409[a]	
Semiannual Analytical Parameters			
Volatiles—Method 8260B			
1,1,1-Trichloroethane	Benzene	*cis*-1,2-Dichloroethene	Toluene
1,1,2-Trichloroethane	Bromodichloromethane	Dimethylbenzene, Total[b]	*trans*-1,2-Dichloroethene
1,1-Dichloroethane	Carbon Tetrachloride	Ethylbenzene	Trichloroethene
1,1-Dichloroethene	Chloroform	Tetrachloroethene	Vinyl Chloride
1,2-Dichloroethane			
Radionuclides—Method 9310 unless noted			
Alpha Activity	Beta Activity	**Technetium-99—TC-02-RC**	
Field Parameters			
Barometric Pressure	Depth to Water	Redox	Temperature
Conductivity	Dissolved Oxygen	pH	Turbidity

[a] MW409, MW410, and MW411 are sampled in this program, for trichloroethene only, as a best management practice. Adding these wells to this program does not increase the frequency at which they are sampled. This change captures the program designation under which they are sampled for ease in sample management. They were identified by a footnote as part of the surveillance program in the FY 2013 EMP to be sampled semiannually, as opposed to annually.

[b] Xylenes

Bolded parameters are sampled by different method than specified in header.

Table C.9. Northeast Plume Quarterly Wells and Parameters

Quarterly Wells (2)			
MW255	MW256		
Quarterly Analytical Parameters			
Radionuclides—Method TC-02-RC			
Technetium-99			
Field Parameters			
Barometric Pressure	Depth to Water	Redox	Temperature
Conductivity	Dissolved Oxygen	pH	Turbidity

Table C.10. Northeast Plume Optimization Quarterly Wells and Parameters

Quarterly Wells (32)			
MW124	MW126	MW144	MW145
MW155	MW156	MW258	MW283
MW288	MW291	MW292	MW293A
MW341	MW478	MW479	MW480
MW495	MW496	MW524	MW525
MW526	MW527	MW528	MW529
MW530	MW531	MW533	MW536
MW537	MW538	MW539	MW556
Quarterly Analytical Parameters			
Volatiles—Method 8260B			
1,1-Dichloroethene	Trichloroethene		
Radionuclides—Method TC-02-RC			
Technetium-99			
Field Parameters			
Barometric Pressure	Depth to Water	Redox	Temperature
Conductivity	Dissolved Oxygen	pH	Turbidity

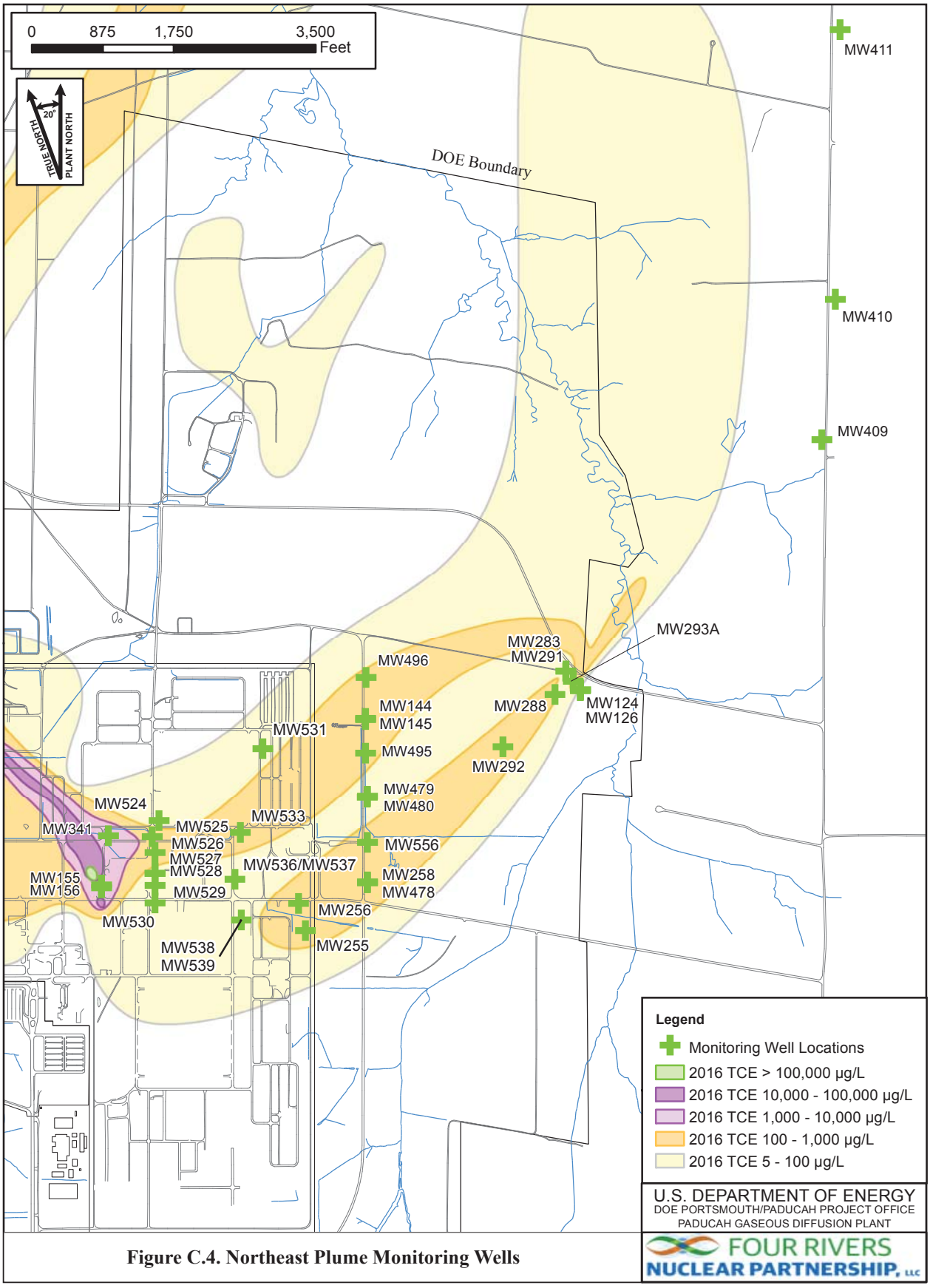

Figure C.4. Northeast Plume Monitoring Wells

C.2.3 NORTHWEST PLUME OPERATIONS AND MAINTENANCE PROGRAM

Northwest Plume Monitoring

Frequency: Quarterly and Semiannually

Driver: The MWs are required to be sampled by the *Operation and Maintenance Plan for the Northwest Plume Groundwater System Interim Remedial Action at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1253&D4/R5, September 2010.

Reported: Semiannual FFA Progress Report and the ASER

Rationale: To determine the effectiveness of the optimization of Northwest Plume operations, monitor the nature and extent of groundwater contamination, and evaluate any cyclic trends in water quality that may affect contaminant migration.

Comments: The extraction wells (or other operational samples) are not sampled under the groundwater program as part of the EM Program. They are sampled as specified under the Operations and Maintenance Plan for the Northwest Plume.

The sampling frequency for MW460 within the Operations and Maintenance Plan is semiannual; however, the frequency of sampling has been increased to quarterly in order to evaluate trends in TCE concentrations along the Northwest Plume.

Table C.11 provides a listing of MWs, and Table C.12 provides the analytical parameters for these MWs. Locations are shown on Figure C.5.

Table C.11. Northwest Plume Wells

Semiannual Wells (32)					
MW63	MW243	MW340	MW456	MW497	MW503
MW65	MW244	MW355	MW457	MW498	MW504
MW66	MW245	MW428	MW458	MW499	
MW165A	MW248	MW429A	MW459	MW500	
MW173	MW250	MW430	MW461	MW501	
MW242	MW339	MW455	MW462	MW502	
Quarterly Well (1)					
MW460					

Table C.12. Northwest Plume Analytical Parameters

Volatiles—Method 8260B			
1,1,1-Trichloroethane	Benzene	*cis*-1,2-Dichloroethene	Toluene
1,1,2-Trichloroethane	Bromodichloromethane	Dimethylbenzene, Total*	*trans*-1,2-Dichloroethene
1,1-Dichloroethane	Carbon Tetrachloride	Ethylbenzene	Trichloroethene
1,1-Dichloroethene	Chloroform	Tetrachloroethene	Vinyl Chloride
1,2-Dichloroethane			
Field Parameters			
Barometric Pressure	Depth to Water	Redox	Temperature
Conductivity	Dissolved Oxygen	pH	Turbidity
Radionuclides—Method 9310 unless noted			
Alpha Activity	Beta Activity	**Technetium-99—TC-02-RC**	

*Xylenes
Bolded parameters are sampled by different method than specified in header.

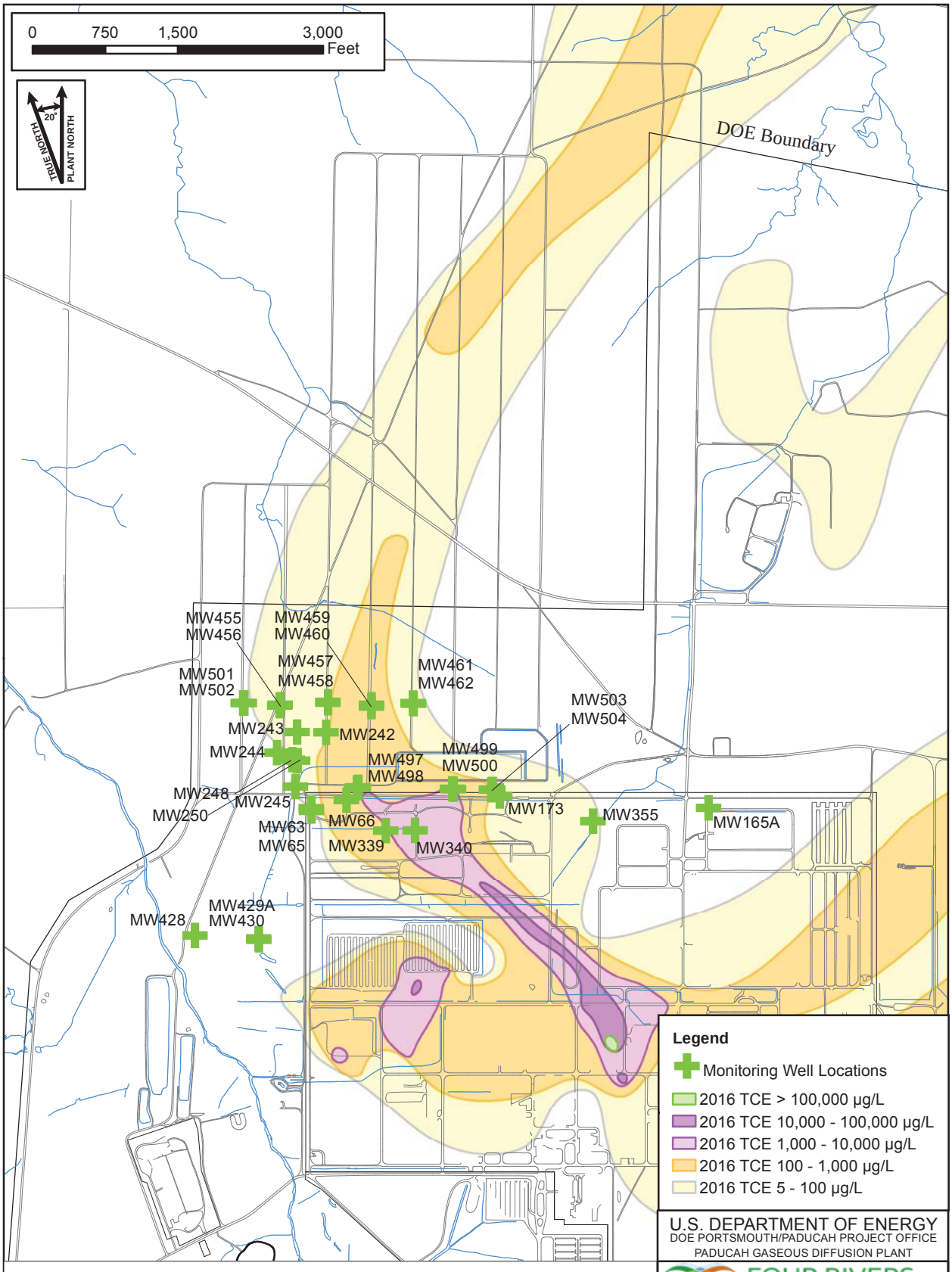

Figure C.5. Northwest Plume Monitoring Wells

C.2.4 C-400 MONITORING WELLS

C-400 Wells

Frequency: Quarterly and Semiannually

Driver: The MWs are required to be sampled by the *Record of Decision for Interim Remedial Action for the Groundwater Operable Unit for the Volatile Organic Compound Contamination at the C-400 Cleaning Building at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-2150&D2/R2.

Reported: Semiannual FFA Progress Report and the ASER

Rationale: These MWs will provide a meaningful tool for evaluating the downgradient dissolved-phase contamination in the Northwest Plume and the efficacy of the C-400 Interim Remedial Action.

Comments: Sampling frequencies and sampling parameters were not modified for this sampling program for FY 2018.

Table C.13 provides a listing of the C-400 MWs, and Table C.14 provides the analytical parameters for these MWs. Locations are shown on Figure C.6.

Table C.13. C-400 Monitoring Wells (17)

Quarterly Wells (9)		
MW155	MW406: Port 5	MW505[a]
MW156	MW407: Port 4	MW506[a]
MW405: Port 5	MW408: Port 5	MW507[a]
Semiannual Wells (8)		
MW175	MW421: Port 1, Port 2, Port 3	MW424: Port 1, Port 2, Port 3
MW342	MW422: Port 1, Port 2, Port 3	MW425: Port 1, Port 2, Port 3
MW343	MW423: Port 1, Port 2, Port 3	

[a] MW68 and MW71 will be sampled under the Annual Environmental Surveillance sampling program, but will be sampled at the same time as these wells during the second quarter of the calendar year (CY).

Table C.14. C-400 Monitoring Wells Analytical Parameters

Volatiles—Method 8260B			
1,1-Dichloroethene	*trans*-1,2-Dichloroethene	Trichloroethene	Vinyl Chloride
cis-1,2-Dichloroethene			
Anions—Method 9056			
Chloride			
Radionuclides—Method TC-02-RC			
Technetium-99			
Field Parameters[b]			
Barometric Pressure	Depth to Water[a]	Redox	Temperature
Conductivity	Dissolved Oxygen	pH	Turbidity

[a] As applicable, depth to water measurements cannot be obtained for multiport wells.
[b] Sampling staff may be prohibited from collecting some field measurements due to elevated temperatures as a result of the remediation field activities. In such cases, the sampling staff will document the issue on the sample data form.

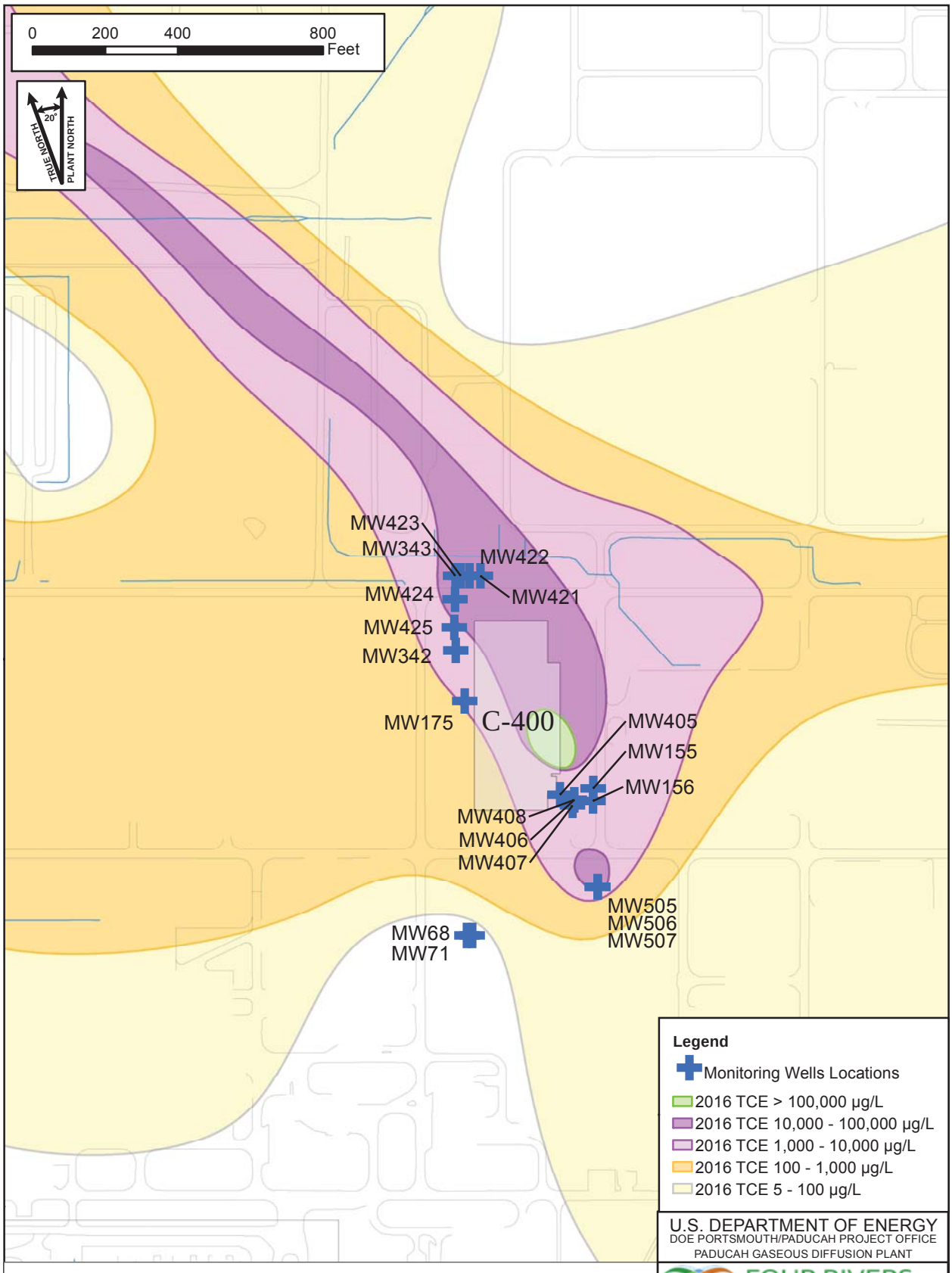

Figure C.6. C-400 Monitoring Wells with TCE Plume Shown

C.2.5 SWMU 1 MONITORING WELLS

SWMU 1 Wells

Frequency: Semiannually

Driver: The MWs are required to be sampled by 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, December 2013.

Reported: ASER

Rationale: To monitor the progress of contaminant reduction in the RGA groundwater following soil mixing.

Comments: These MWs will be sampled semiannually in FY 2018. Table C.15 provides a listing of MWs, and Table C.16 provides the analytical parameters. Locations are shown on Figure C.7.

Table C.15. SWMU 1 Wells

Semiannual Wells (7)					
MW161	MW543	MW544	MW545	MW546	MW547
MW542					

Table C.16. SWMU 1 Analytical Parameters

Volatiles—Method 8260B			
1,1-Dichloroethene			
cis-1,2-Dichloroethene			
trans-1,2-Dichloroethene			
Trichloroethene			
Vinyl Chloride			
Field Parameters			
Barometric Pressure	Depth to Water	Redox	Temperature
Conductivity	Dissolved Oxygen	pH	Turbidity

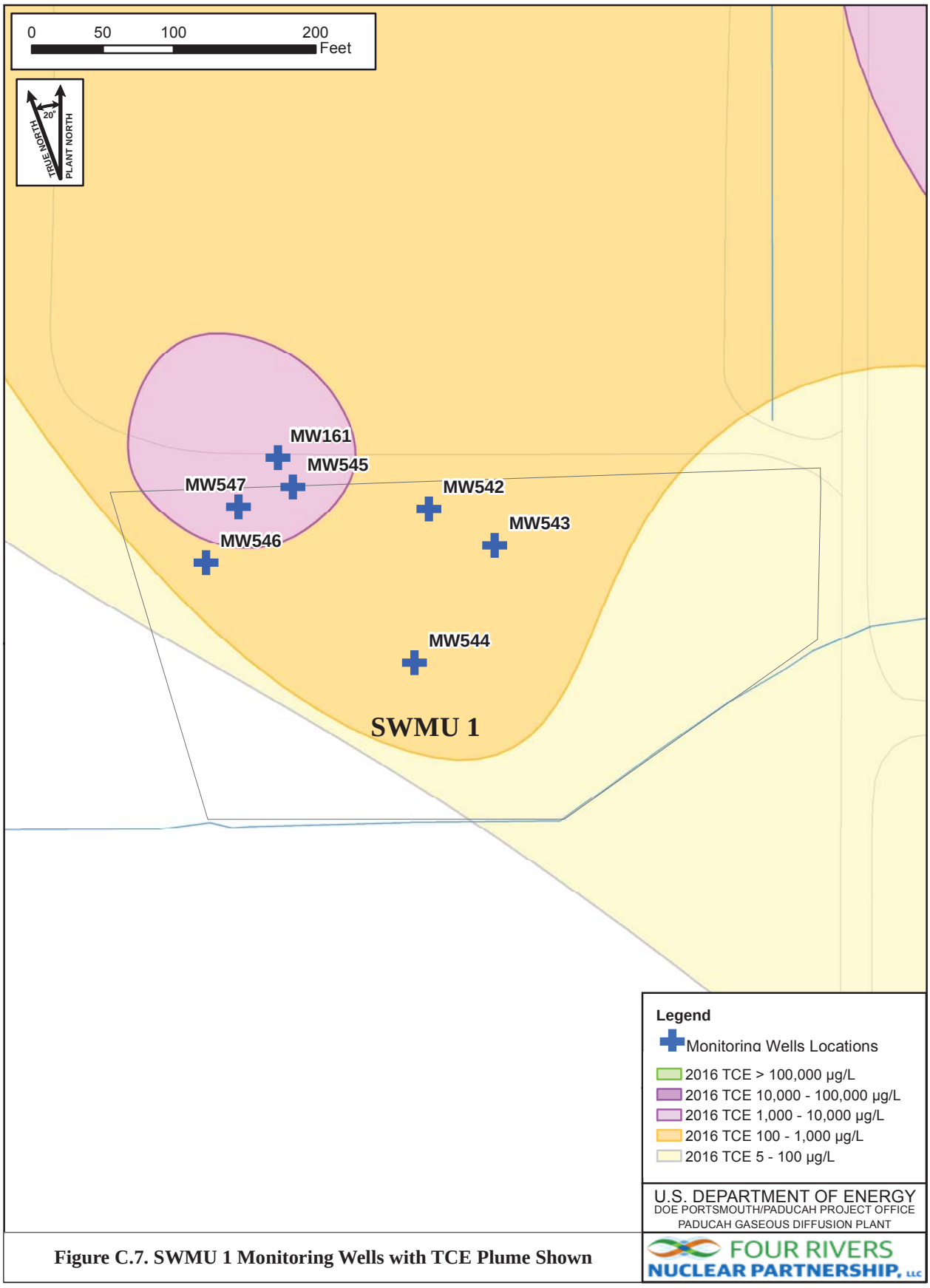

Figure C.7. SWMU 1 Monitoring Wells with TCE Plume Shown

C.2.6 WATER POLICY BOUNDARY MONITORING PROGRAM

Frequency: Quarterly and Annually

Driver: The *Action Memorandum for the Water Policy at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/06-1201&D2, June 1994 stipulated the need to ensure that residential landowners were provided with water whose well water is contaminated by Paducah Gaseous Diffusion Plant (PGDP) sources. The Action Memorandum provided the sampling strategy only at the time the document was prepared and referred future sampling to the Sampling and Analysis Plan Addendum, which previously was superseded by the EMP.

Reported: Residential well data will be reported to the landowner and may be reported in the ASER. MW data for those MWs located on private property also will be reported to the landowner. Monitoring wells, regardless if located on private property or on DOE property, will be reported in the ASER.

Rationale: A group of residential wells and MWs were chosen to confirm plume migration paths of the Northwest and Northeast Plumes, near the boundaries of the Water Policy Box. Because of the predominant northern flow of groundwater from the site, the concentration of selected wells is more toward the west and east of the site, as opposed to south (see Tables C.17, C.18, and C.19).

Reviews of the data generated through this program may warrant changes to the Water Policy Box [see Figure C.8 (northwest wells) and Figure C.9 (northeast wells)].

Comments: The Water Policy Boundary Monitoring Program was introduced in FY 2013 under this format. Sampling of the residential wells and MWs stated below were previously a part of other programs contained in prior years' EMPs. In order to better capture the objectives stated above, this program was defined as a unique sampling program.

Sampling frequencies and sampling parameters were not modified for this sampling program for FY 2018.

Table C.17. Northwestern Wells

Quarterly (20)						
R2	R26	MW106A	MW194	MW202	MW432	MW441
R13	R53	MW134	MW199	MW426	MW433	MW452
R14	R245	MW146	MW201	MW427	MW435	

Table C.18. Northeastern Wells

Annually (7)			
R9	R21	R90	R302
R20	R83	R114	

Table C.19. Residential Analytical Parameters—Northwest and Northeast Analytical Parameters

Field Parameters		
Barometric Pressure	Dissolved Oxygen	pH
Conductivity	Redox	Temperature
Depth to Water*		
Radionuclides—Method as follows		
Technetium-99—TC-02-RC	**Uranium-235—U-02-RC**	
Uranium-234—U-02-RC	**Uranium-238—U-02-RC**	
Volatiles—Method 8260B		
Trichloroethene		

*As applicable.
Bolded parameters are sampled by different method than specified in header.

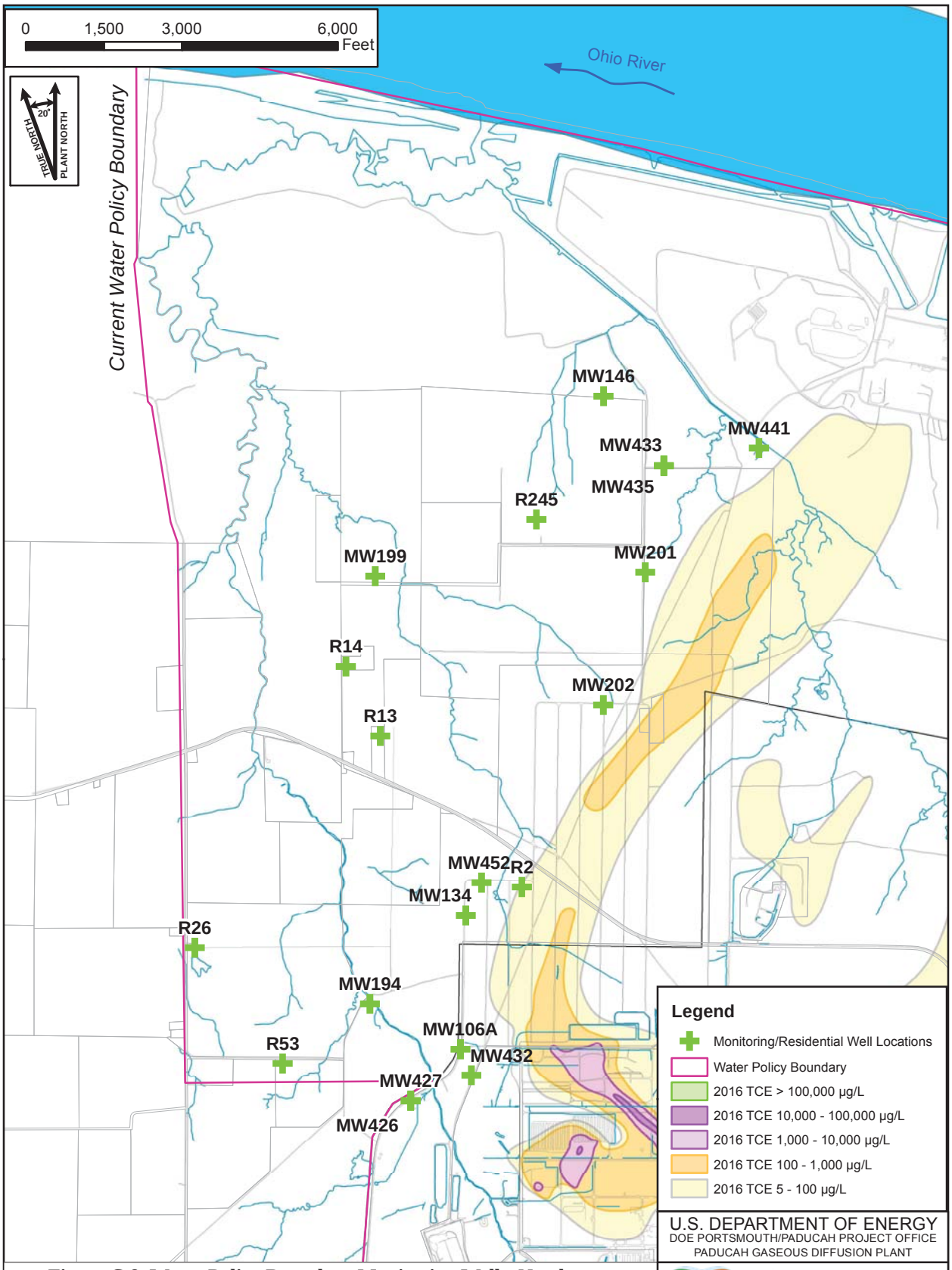

Figure C.8. Water Policy Boundary Monitoring Wells, Northwest with TCE Plume Shown

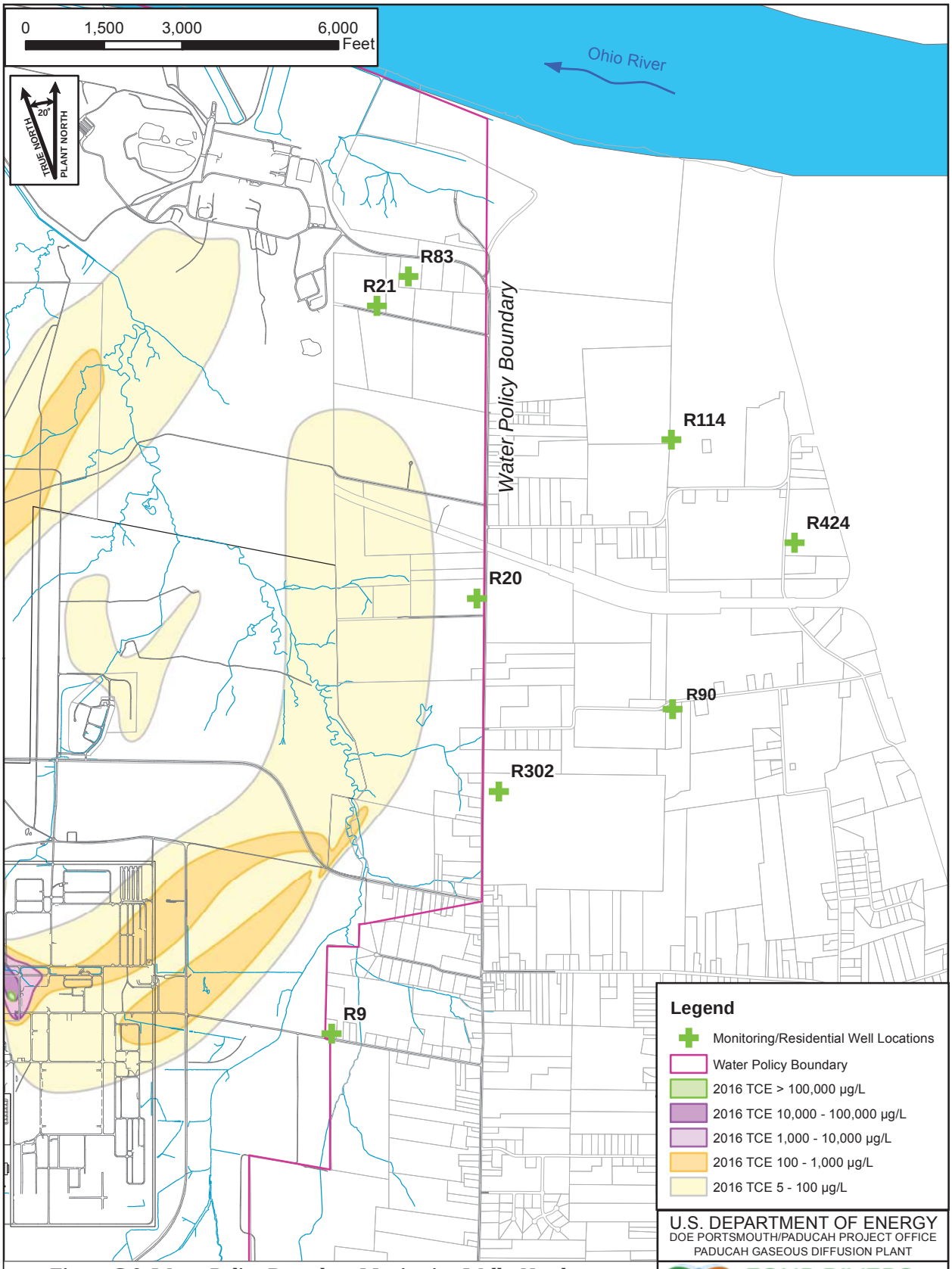

Figure C.9. Water Policy Boundary Monitoring Wells, Northeast with TCE Plume Shown

C.2.7 CARBON FILTER TREATMENT SYSTEM

Frequency: Semiannually (one before treatment sample and one after treatment sample per each semiannual event)

Driver: DOE Order 458.1 (based on a DOE decision)

Reported: Letter to landowner on a semiannual basis and the ASER

Comments: DOE is maintaining a treatment system for one landowner who is outside the Water Policy Box.

DOE Order 458.1 requires that contractors implement radiation protection for persons consuming water from a drinking water system operated by DOE or its contractors equivalent to 40 *CFR* § 141. Provisions of 40 *CFR* § 141 allow for environmental surveillance to be used for reduced sampling requirements. Review of the historical analytical data at this location indicates minimal risk and reduced monitoring is appropriate; therefore sampling for radiological parameters has been reduced from the specified frequencies in DOE Order 458.1. Parameters required by 40 *CFR* § 141 are beta emitters, tritium, and strontium-90 (Sr-90). Tc-99 is the only radiological parameter in this group that is a contaminant of potential concern in groundwater from DOE activities; however, based on reviews of the groundwater modeling and historical data, the groundwater at this location is not impacted by site operations. Based on these conditions, Tritium and Sr-90 will not be sampled, nor will alpha activity or beta activity be analyzed; and Tc-99 sampling frequency will be reduced from the monthly requirement to semiannual requirement to verify the Tc-99 is below reporting limits. A review of the FY 2017 Tc-99 data did not indicate a need for increased radionuclide analysis; therefore, no changes in sample strategy were made.

Tables C.20 and C.21 identify carbon filter treatment system well and carbon filter treatment system analytical parameters, respectively. Location is shown on Figure C.9.

Table C.20. Carbon Filtration System (1)

R424: Port 1 direct groundwater	R424: Port 3 after ultraviolet light and carbon filter

Table C.21. Carbon Filtration System Analytical Parameters

Field Parameters		
Conductivity	Redox	Temperature
Dissolved Oxygen	pH	
Radionuclides—Method TC-02-RC		
Technetium-99		
Volatiles—Method 8260B		
Trichloroethene		
Miscellaneous—Method 9223		
Total Coliform		

C.2.8 ENVIRONMENTAL SURVEILLANCE GROUNDWATER MONITORING PROGRAM

Environmental Surveillance Monitoring

Frequency: Biennially, Annually, Semiannually, and Quarterly

Driver: DOE Order 436.1 and the Paducah FFA

Reported: ASER

Rationale: Monitoring is conducted to determine the nature and extent of groundwater contamination and groundwater quality. Sampling of these MWs is conducted in support of the Paducah FFA Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Investigation; Resource Conservation and Recovery Act Facility Investigations (RFIs); and DOE Order 436.1.

Comments: The program was modified in FY 2011 to focus on sampling key MWs annually and reduce sampling of other MWs to a biennial basis. The biennial grouping of MWs was sampled in FY 2017; therefore, they will not be sampled in FY 2018.

The sampling frequencies for MW354, MW403, and MW431 have been increased to quarterly, and MW453 and MW454 have been increased to annually in order to evaluate trends in TCE concentrations along the Northwest Plume. The sampling frequencies for MW98, MW135, and MW197 have been increased to semiannually in order to evaluate trends in TCE along the eastern edge of the Northwest Plume. The background location for the biennial sampling has been changed from MW194 to MW103. Recent detections of TCE in MW194 suggest the groundwater quality in that area may be influenced by dissolved contamination originating at the Paducah Site. In order to better represent background water quality, MW103, located upgradient of the industrial area at the Paducah Site, will be used for a background well in place of MW194. All of these changes within the Environmental Surveillance Groundwater Monitoring program are being made as a result of data evaluations conducted by the EM and groundwater remediation organizations.

The MWs to be monitored annually were selected based on their location within the plumes. Some MWs are key for early detection of plume migration; others are key for ongoing CERCLA decisions.

Tables C.22 and C.23 identify MWs and analytical parameters, respectively. Locations are shown on Figure C.10.

Table C.22. Surveillance Wells (118)

Biennial (85)					
MW67	MW193	MW356	MW445	MW479	MW548[b]
MW76	MW200	MW404: Port 4	MW447	MW480	MW549[b]
MW86	MW201	MW405: Port 5	MW448	MW481	MW550[b]
MW89	MW202	MW406: Port 5	MW450	MW482	MW551[b]
MW92	MW205	MW407: Port 4	MW451	MW485	**Background (1)**
MW95A	MW226	MW408: Port 5	MW452	MW486	MW103
MW106A	MW227	MW414	MW465	MW487	
MW146	MW260	MW415	MW466	MW488	
MW148	MW262	MW416	MW467	MW489	
MW149	MW328	MW417	MW468	MW490	
MW163	MW329	MW432	MW473	MW491	
MW168	MW333	MW435	MW474	MW492	
MW169	MW337	MW439	MW475	MW493	
MW174	MW338	MW442	MW476	MW494	
MW186	MW341	MW443	MW477	MW495	
MW187	MW343	MW444	MW478	MW496	
Annual (31)					
MW68[a]	MW152	MW236	MW418[c]	MW469	**Background (1)**
MW71[a]	MW161	MW240	MW419[c]	MW470	MW150
MW99	MW182[c]	MW252	MW453	MW471	
MW100	MW191	MW253	MW454	MW472	
MW125	MW203	MW261	MW463	MW483	
MW139	MW233	MW345	MW464	MW484	
Semiannual (3)					
MW98	MW135	MW197			
Quarterly (3)					
MW354	MW403: Port 3	MW431			

[a] Sampling will occur at the same time as the second quarter CY sampling event for MW505, MW506, and MW507, which are under the C-400 MW sampling program.
[b] SWMU 4 MWs
[c] These three wells will be sampled for PCBs in addition to the remaining parameters.

Table C.23. Environmental Surveillance and Analytical Parameters

Biennial, Annual, Semiannual, and Quarterly			
Field Parameters			
Barometric Pressure	Depth to Water	pH	Temperature
Conductivity	Dissolved Oxygen	Redox	Turbidity
PCBs (MW182, MW418, and MW419)—Method 8082			
PCB, Total	PCB-1232	PCB-1248	PCB-1260
PCB-1016	PCB-1242	PCB-1254	
PCB-1221			
Radionuclides—Method TC-02-RC			
Technetium-99			
Volatiles—Method 8260B			
1,1,1-Trichloroethane	Benzene	*cis*-1,2-Dichloroethene	Toluene
1,1,2-Trichloroethane	Bromodichloromethane	Dimethylbenzene, Total*	*trans*-1,2-Dichloroethene
1,1-Dichloroethane	Carbon Tetrachloride	Ethylbenzene	Trichloroethene
1,1-Dichloroethene	Chloroform	Tetrachloroethene	Vinyl Chloride
1,2-Dichloroethane			

*Xylenes

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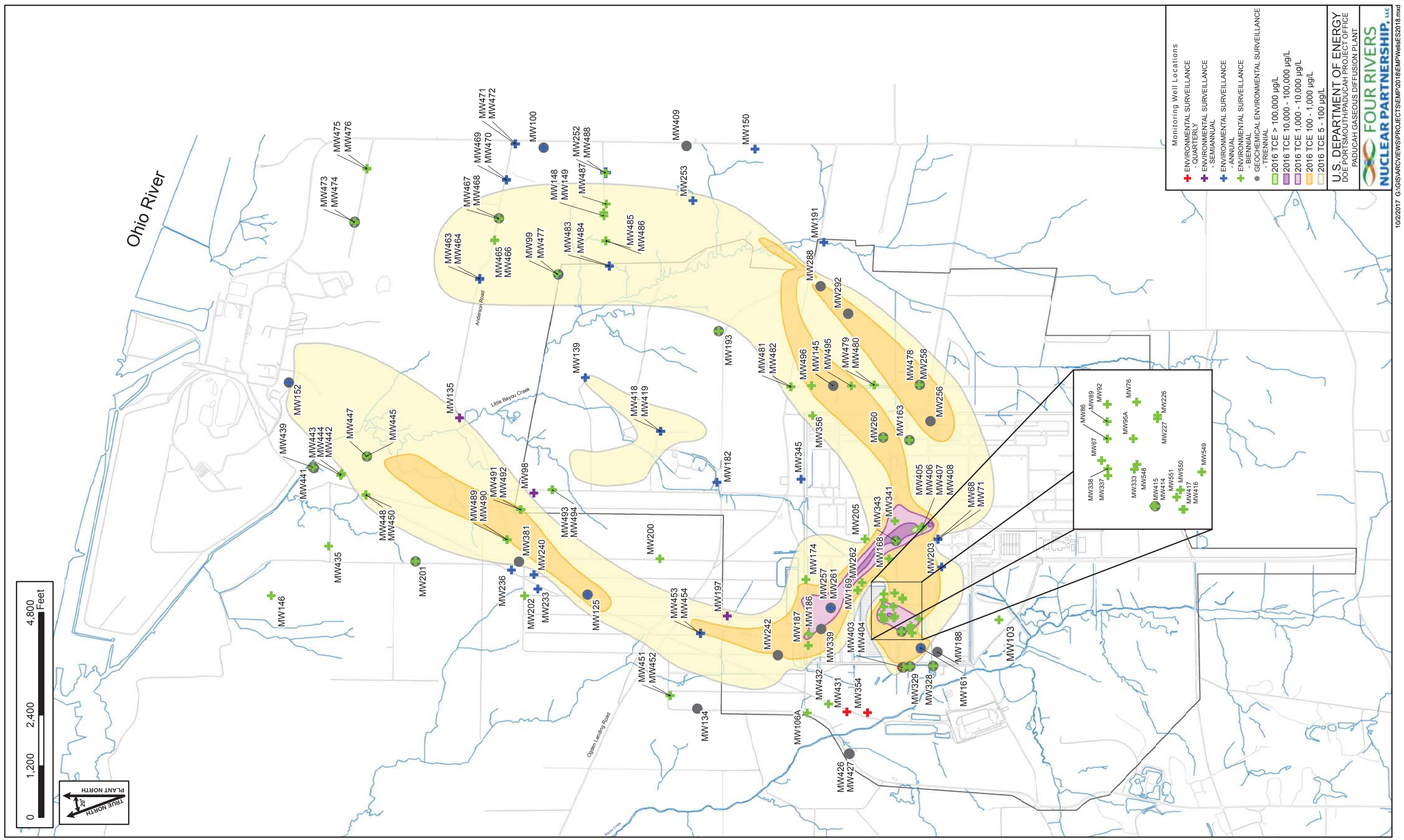

Figure C.10. Environmental Surveillance Groundwater Monitoring Wells with TCE Plume Shown

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Geochemical Environmental Surveillance Monitoring

Frequency: Triennially

Driver: DOE Order 436.1 and the Paducah FFA

Reported: ASER

Rationale: Monitor the extent of groundwater contamination and groundwater quality. Sampling of these MWs is conducted in support of the Paducah FFA CERCLA Investigation, RFIs, and DOE Order 436.1.

Comments: The program was modified in FY 2011 to reduce sampling from an annual basis to a triennial basis. The MWs were sampled in FY 2016; therefore, they will not be sampled in FY 2018. The MWs are included in Table C.24, but are shaded and noted to indicate sampling will not be conducted in FY 2018.

Tables C.24 and C.25 show MWs and analytical parameters, respectively. Locations are shown on Figure C.10.

Table C.24. Surveillance Geochemical Wells (38)[a]

MW99	MW188	MW261	MW403: Port 3	MW439
MW100	MW193	MW288	MW404: Port 3	MW441
MW125	MW201	MW292	MW404: Port 4	MW447
MW134	MW242	MW328	MW404: Port 5	MW468
MW145	MW256	MW329	MW409	MW473
MW152	MW257	MW339	MW414	MW474
MW161	MW258	MW343	MW426	
MW163	MW260	MW381	MW427	

[a] These wells were sampled in FY 2016; therefore, they will not be sampled in FY 2018.

Table C.25. Surveillance Geochemical Triennial Analytical Parameters

Anions—Method 9056			
Chloride	Nitrate	Phosphate	Sulfate
Fluoride			
Miscellaneous—As noted			
Alkalinity—310.1		**Silica—200.7**	
Total Dissolved Solids—160.1	**Total Organic Carbon—9060**		
Field Parameters			
Barometric Pressure	Depth to Water	Redox	Temperature
Conductivity	Dissolved Oxygen	pH	Ferrous Iron (Fe^{+2})
Volatiles—Procedure RSK 175			
Ethene	Ethane	Methane	
Metals—Method 6020			
Aluminum	Calcium	Magnesium	Silver
Antimony	Chromium	Manganese	Selenium
Arsenic	Cobalt	Molybdenum	Sodium
Barium	Copper	Nickel	Zinc
Beryllium	Iron	Potassium	Uranium
Cadmium	Lead		

Bolded parameters are sampled by different method than specified in header.

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C.3. SURFACE WATER, SEDIMENT, AND WATERSHED BIOLOGICAL MONITORING

C.3.1 EFFLUENT WATERSHED MONITORING PROGRAM

C-746-S, C-746-T, and C-746-U Landfills Surface Water

Frequency: Quarterly

Driver: Solid waste landfill permit, Technical Attachment 24, as follows: SW07300014 (C-746-S Landfill), SW07300015 (C-746-T Landfill), and SW07300045 (C-746-U Landfill), which includes the surface water monitoring plans.

Reported: Quarterly C-746-S&T and C-746-U Landfills Groundwater Compliance Monitoring Reports and the ASER

Rationale: Monitor rain runoff from the C-746-S&-T and C-746-U Landfills.

Comments: Sampling frequencies and sampling parameters were not modified for this sampling program in FY 2018 because it is permit driven.

Surface water sampling is performed and reported collectively for the C-746-S and C-746-T Landfills.

Tables C.26 and C.27 show landfill surface water locations and landfill surface water parameters, respectively. Locations are shown on Figure C.11.

Table C.26. Landfill Surface Water Locations (6)

C-746-S&T		
L135	L136	L154*
C-746-U		
L150	L154*	L351

*L154 is reported in the Compliance Monitoring Reports for both the C-746-U and C-746-S&T Landfills.

Table C.27. Landfill Surface Water Parameters

Anions—Method 300.0		
Chloride	Sulfate	
Field Measurements		
Conductivity	Dissolved Oxygen	Flow Rate
pH	Temperature	
Metals—Method 200.8		
Iron	Sodium	Uranium
Miscellaneous—Methods as follows		
Total Dissolved Solids—160.1	**Total Solids—SM 2540B**	**Total Organic Carbon—9060**
Total Suspended Solids—160.2	**Chemical Oxygen Demand—410.4**	
Radionuclides—Method 9310		
Alpha Activity	Beta Activity	

Bolded parameters are sampled by different method than specified in header.

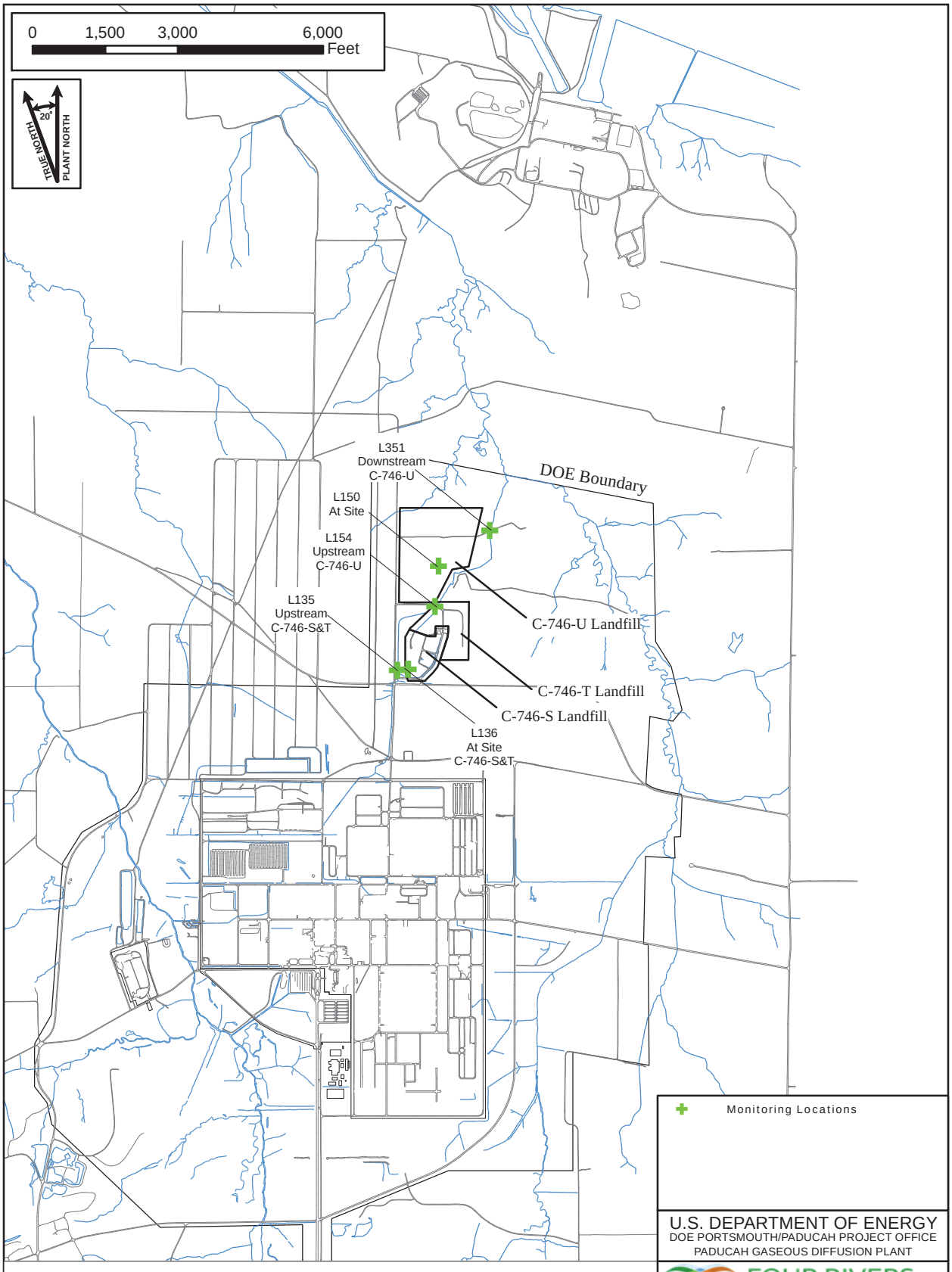

Figure C.11. Landfill Surface Water Locations

Kentucky Pollutant Discharge Elimination System Outfall Sampling

Frequency: Weekly, Monthly, and Quarterly

Driver: Kentucky Pollutant Discharge Elimination System (KPDES) permit for PGDP, permit number KY0004049, which was issued by the Kentucky Division of Water (KDOW) to DOE, Fluor Federal Services, Inc., Paducah Deactivation Project (FPDP), and Mid-America Conversion Services, LLC, (MCS) and became effective September 1, 2017. A permit modification dated October 12, 2017, changed the co-permittee from FPDP to FRNP.

Reported: Monthly and Quarterly Discharge Monitoring Reports; weekly sampling is reported in the monthly reports and ASER

Rationale: Monitor effluent and surface water runoff as it is discharged to the receiving streams and tributaries.

Comments: Table C.28 shows the KPDES outfall sampling locations, frequency of sampling, and parameters required by permit KY0004049. Locations are shown on Figure C.12.

Sampling frequencies and sampling parameters have been modified for this sampling program for FY 2018 to reflect requirements included in the new KPDES permit, permit number KY0004049. This new permit became effective September 1, 2017.

CERCLA Outfall Sampling

Frequency: Weekly and Quarterly

Driver: Sampling of this outfall is required by the *Operation and Maintenance Plan for the Northeast Plume Containment System Interim Remedial Action at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1535&D3/R4, August 2013.

Reported: Semiannual FFA Progress Report and ASER

Rationale: Monitor effluent from the Northeast Plume containment system.

Comments: Table C.29 shows the frequency of sampling and parameters required for this CERCLA outfall (C001). Sampling of C001 is funded under the Northeast Plume pump-and-treat project.

Table C.28. KY0004049 Permit
KPDES Outfall Sampling Locations, Frequency, and Parameters

Analysis-Method	Frequency of Sampling at KPDES Locations W—Weekly; M—Monthly; Q—Quarterly														
	K001	**K002**	**K004**	**K006**	**K008**	**K009**	**K010**	**K011**	**K012**	**K013**	**K015**	**K016**	**K017**	**K019**	**K020**
Flow (Mgd)—Field	D	M	2/M	M	M	M	M	M	M	M	M	M	M	M	M
Total Suspended Solids (mg/L)—SM 2540 D	W	M	2/M	M	M	M	M	M	M	M	M	M	M	M	M
Oil & Grease (mg/L)—1664A	W	M		M	M	M	M	M	M	M	M	M	M	M	M
Total Residual Chlorine (µg/L)—Field	W			M	M										
Temperature (°F)—Field	W				M										
PCBs (µg/L)—608	W	M			M	M	M	M	M	M	M	M	M	M	M
Trichloroethene (µg/L)—624	W	M			M	M	M	M	M	M	M	M	M	M	M
Total Phosphorus (mg/L)—365.4	W				M										
Alpha Activity (pCi/L)—9310	W	M			M	M	M	M	M	M	M	M	M	M	M
Beta Activity (pCi/L)—9310	W	M			M	M	M	M	M	M	M	M	M	M	M
Uranium (µg/L)—-200.8	W	M			M	M	M	M	M	M	M	M	M	M	M
Acute Toxicity (TU_A)[a]—2000.0/2002.0													Q		

Table C.28. KY0004049 Permit
KPDES Outfall Sampling Locations, Frequency, and Parameters (Continued)

Analysis-Method	Frequency of Sampling at KPDES Locations W—Weekly; M—Monthly; Q—Quarterly														
	K001	**K002**	**K004**	**K006**	**K008**	**K009**	**K010**	**K011**	**K012**	**K013**	**K015**	**K016**	**K017**	**K019**	**K020**
Chronic Toxicity (TU_c)[b]—1000.0/1002.0	Q						Q	[c]							
Total Recoverable Copper (µg/L)—200.8		M													
Total Recoverable Zinc (µg/L)—200.8										M			M		
Technetium-99 (pCi/L)—TC-02-RC	Q	M	E		M	M	M	M	M	M	M	M	M	M	M
Hardness (as mg/L $CaCO_3$)—SM 2340 B		M								M			M		
BOD_5 (mg/L)—SM 5210 B			2/M												
pH—Field	W	M		M	M	M	M	M	M	M	M	M	M	M	M

[a] Acute toxicity sampling requires two discrete grab samples collected approximately 12 hours apart. A different lab method is used for each species.
[b] Chronic toxicity sampling requires three 24-hour composite samples. Monitoring for K010 is not required when the effluent from the C-617 Lagoon is discharged through K011. A different lab method is used for each species.
[c] Monitoring for K011 is required only when the effluent from the C-617 Lagoon is discharged through the outfall.

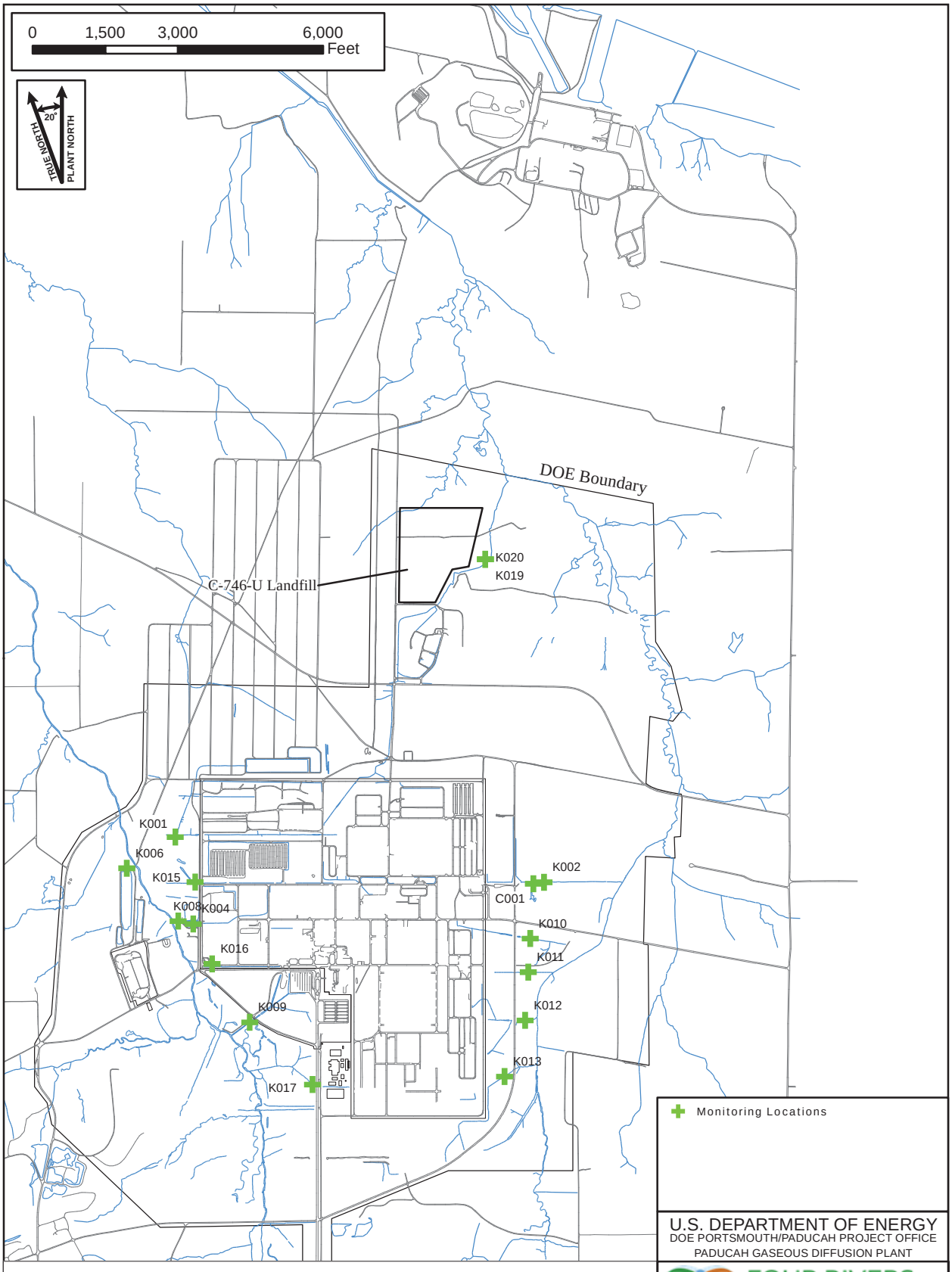

Figure C.12. KPDES and CERCLA Outfall Sampling Locations

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8/25/2017

Table C.29. C001 Outfall Sampling Frequency and Parameters

Analysis-Method	Frequency of Sampling at C001 Outfall W—Weekly; Q—Quarterly
	C001
Flow (Mgd)—Field	W
Total Suspended Solids (mg/L)—SM 2540 D	W
Oil & Grease (mg/L)—1664A	W
Total Residual Chlorine (mg/L)—Field	W
Temperature (°F)—Field	W
Trichloroethene (mg/L)—624	W
1,1-Dichloroethene (mg/L)—624	W
Chronic Toxicity (TU_c)[a] —1000.0/1002.0	Q
Technetium-99 (pCi/L)—TC-02-RC	Q
pH—Field	W

[a] Chronic toxicity sampling requires three 24-hour composite samples. A different lab procedure is used for each species.

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C.3.2 ENVIRONMENTAL RADIATION PROTECTION PROGRAM—EFFLUENT AND SURFACE WATER RUNOFF

Frequency: Monthly

Driver: DOE Order 458.1 and DOE-STD-1196-2011, Derived Concentration Technical Standard

Reported: ASER

Rationale: Monitor effluent and surface water runoff for radiological constituents as it is discharged to the receiving streams and tributaries.

Comments: DOE Order 458.1 was implemented during FY 2013 with the effective date being January 2, 2013. DOE Order 458.1 requires compliance in accordance with DOE-STD-1196-2011, *Derived Concentration Technical Standard*. DOE Order 458.1 also requires that settleable solids on liquid discharges do not exceed limits set forth in DOE Order 458.1, Attachment 1 2.g.(4).

Isotopic analysis for all radionuclides listed will be performed at each location unless the alpha and beta activity levels are below established threshold limits. These limits are established at activity based concentration values, so that radionuclides could not be present in concentrations greater than 10% of the quantities specified in the Derived Concentration Standard. Based on a review of historical data sets from plant effluent and surface water runoff, the threshold limit established for alpha activity is 14 pCi/L and the beta activity is 300 pCi/L. If the threshold values are not exceeded at a location, then the dose calculated according to the pathway assumptions in the Risk Methods Document will be less than 0.09 mrem/yr. This is assumed to pose minimal risk to the public or the environment. If, by the end of the CY, no threshold values have been exceeded at a location, then the isotopic analysis for all radionuclides will be performed on the final sample of each year to provide a data point for calculation of dose. Also, it should be noted, that the sample aliquots collected for the isotopic analysis will be submitted to the laboratory; however, the analysis only will be performed, pending the alpha and beta activity results.

Sampling frequencies and sampling parameters were not modified for this sampling program in FY 2018.

Table C.30 lists the sampling locations, frequencies, and parameters. Locations are shown on Figure C.13.

Table C.30. ERPP Effluent and Surface Water Runoff

Analysis—Method	Analytical Parameters M—Monthly													
	K001 ERPP	K002 ERPP	K004 ERPP	K008 ERPP	K009 ERPP	K010 ERPP	K011 ERPP	K012 ERPP	K013 ERPP	K015 ERPP	K016 ERPP	K017 ERPP	K019 ERPP	K020 ERPP
Alpha activity (pCi/L)—9310	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Beta activity (pCi/L)—9310	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Americium-241 (pCi/L)*—AM-05-RC	M		M	M	M	M	M	M		M	M			
Cesium-137 (pCi/L)*—901.1			M	M						M	M			
Neptunium-237 (pCi/L)*—1475-00aM	M		M	M	M	M	M	M		M	M			
Plutonium-238 (pCi/L)*—PU-11-RC	M		M	M	M	M	M	M		M	M			
Plutonium-239/240 (pCi/L)*—PU-11-RC	M		M	M	M	M	M	M		M	M			
Technetium-99 (pCi/L)*—TC-02-RC	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Thorium-230 (pCi/L)*—Th-01-RC	M		M	M	M	M	M	M		M	M			
Alpha activity on the filtered material [Settleable Solids (pCi/g)]—9310	M	M	M	M	M	M	M	M	M	M	M	M	M	
Beta activity on the filtered material [Settleable Solids (pCi/g)]—9310	M	M	M	M	M	M	M	M	M	M	M	M	M	
Uranium-234 (pCi/L)*—U-02-RC	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Uranium-235 (pCi/L)*—U-02-RC	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Uranium-238 (pCi/L)*—U-02-RC	M	M	M	M	M	M	M	M	M	M	M	M	M	M

*Sample will be collected, but will not be analyzed unless alpha activity exceeds 14 pCi/L or beta activity exceeds 300 pCi/L.
NOTE: Samples are being collected from locations near the outfalls listed in KPDES permit KY0004049.

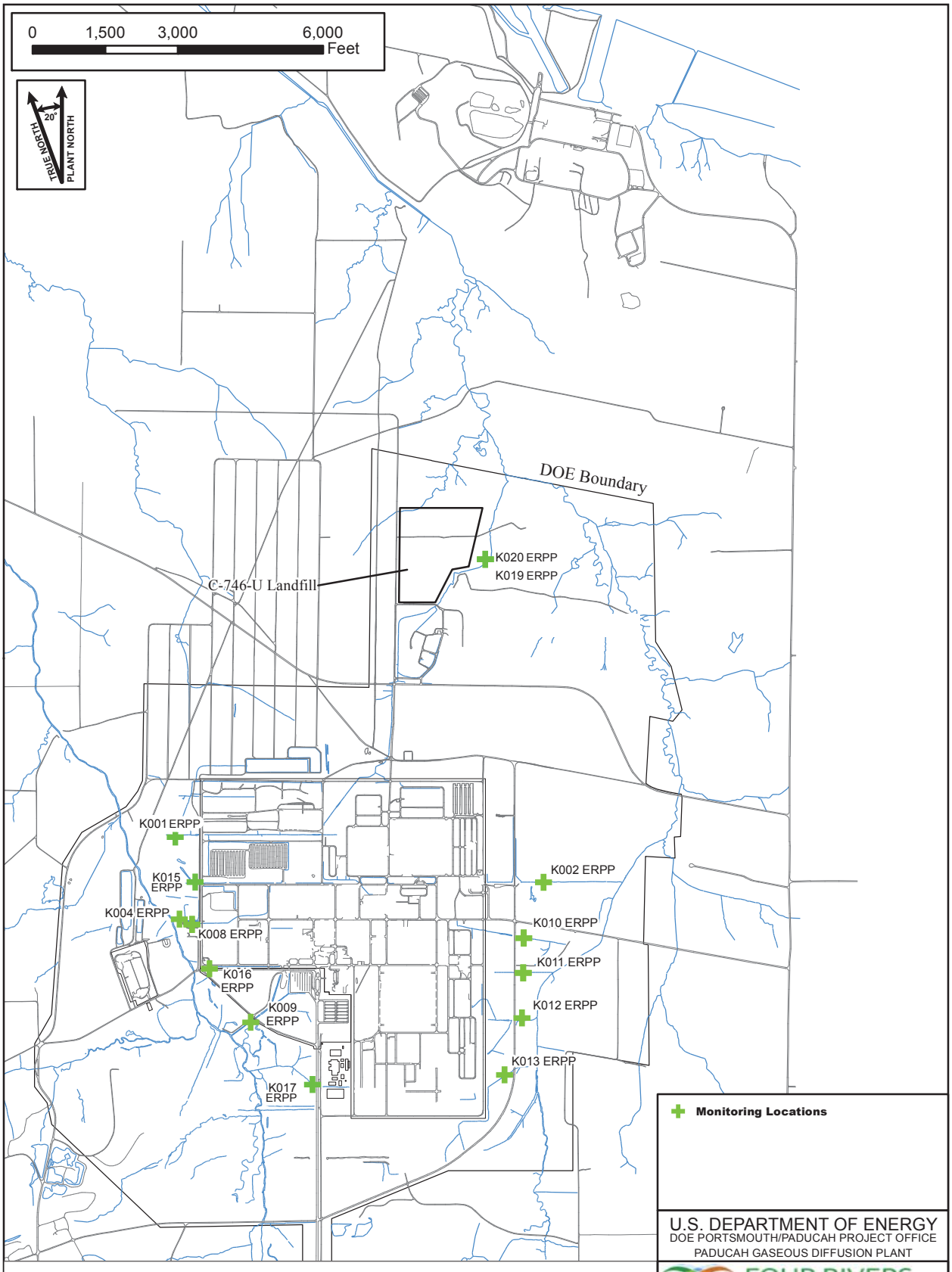

Figure C.13. Surface Water Monitoring near KPDES Outfalls

C.3.3 C-613 NORTHWEST STORM WATER CONTROL FACILITY

C-613 Sediment Basin—Storm Water

Frequency: Quarterly

Driver: Quarterly sampling is required by the *Operation and Maintenance Plan for the Northwest Storm Water Control Facility at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-2044&D1/R4, September 2009.

Reported: Reported to KDWM via electronic mail.

Rationale: Prior to a discharge event, the pH and total suspended solids (TSS) is measured to prevent a discharge that would cause the effluent monitored at KPDES Outfall 001 to exceed regulatory limits. Operational monitoring is not covered under the EM Program but is managed by the operations manager or designee. As specified in the Operations and Maintenance Plan, a sample is to be collected each quarter to confirm the pH and TSS field measurements.

Comments: Table C.31 provides a listing of the analytical parameters. Location of the C-613 Sediment Basin is shown on Figure C.14.

Sampling frequencies and sampling parameters were not modified for this sampling program for FY 2018.

Table C.31. C-613 Sediment Basin Quarterly Water Parameters

Miscellaneous—Method as follows	
Total Suspended Solids—160.2	
Field Parameters	
pH	Turbidity

Bolded parameters are sampled by different method than specified in header.

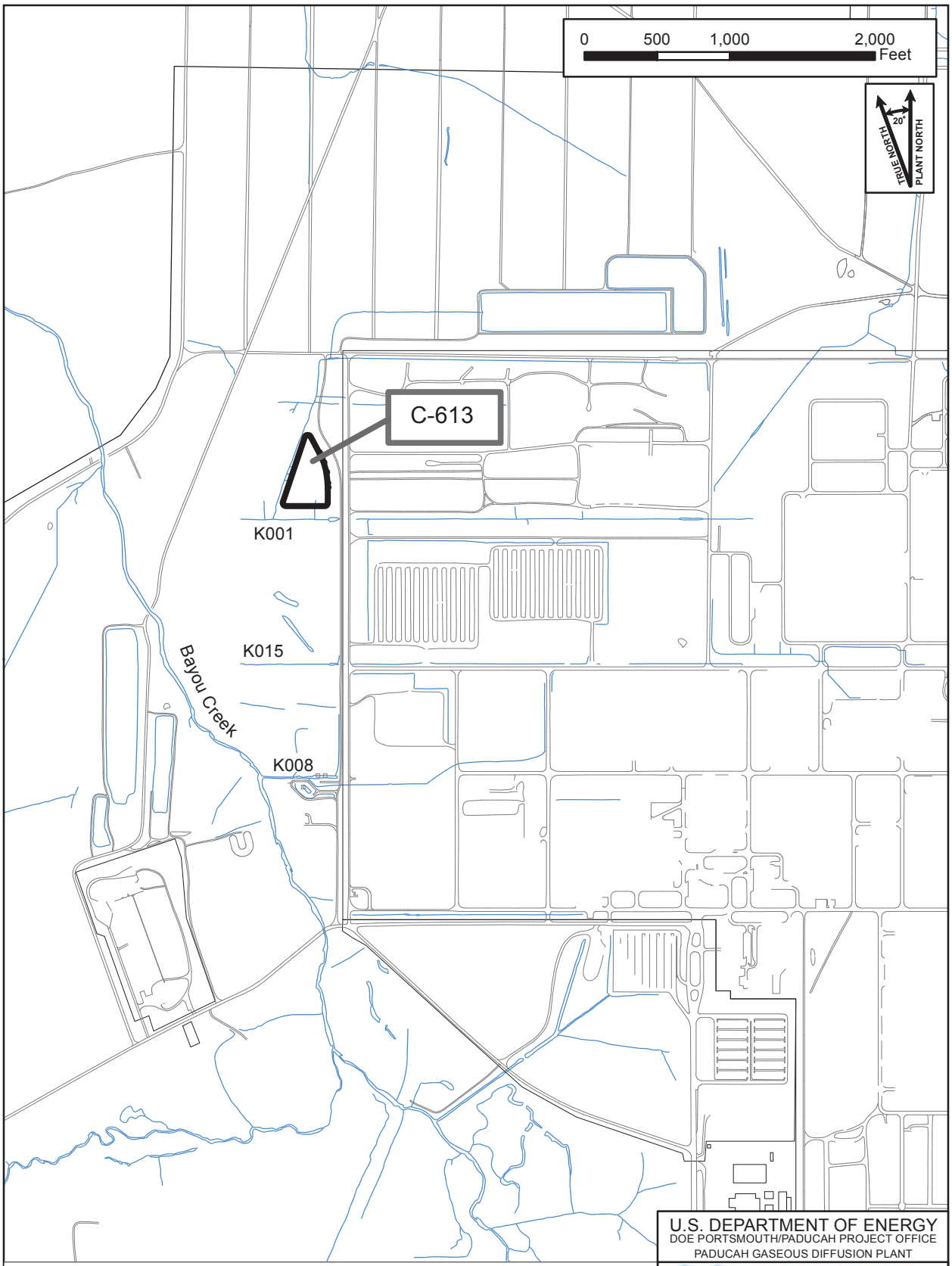

Figure C.14. C-613 Sediment Basin

C.3.4 ENVIRONMENTAL SURVEILLANCE WATERSHED MONITORING PROGRAM

Surface Water Monitoring

Frequency: Quarterly and Annually

Driver: *Record of Decision for Waste Area Groups 1 and 7 for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/OR/06-1470&D2, September 1997, requires monitoring of surface water locations near the C-746-K Landfill. DOE Order 458.1 requires radiological monitoring.

Reported: ASER

Rationale: To monitor potential contamination released into Bayou Creek and Little Bayou Creek surface water from plant operations.

Comments: DOE Order 458.1 requires that environmental surveillance be performed in accordance with DOE/HDBK-1216-2015. Sampling locations were selected to determine site-specific radiation exposure pathway analysis. Locations were prioritized for areas of public access, introduction of plant effluents to the environment and verification of the effectiveness of PGDP effluent monitoring. Isotopic analysis for all radionuclides listed will be performed at each location unless the alpha and beta activity levels are below established threshold limits. These limits are established at activity based concentration values, so that radionuclides could not be present in concentrations greater than 10% of the quantities specified in the Derived Concentration Standard. Based on a review of historical data sets from plant effluent and surface water runoff, the threshold limit established for alpha activity is 14 pCi/L and the beta activity is 300 pCi/L. If the threshold values are not exceeded at a location, then the dose calculated according to the pathway assumptions in the Risk Methods Document will be less than 0.09 mrem/yr. This is assumed to pose minimal risk to the public or the environment. If, by the end of the CY, no threshold values have been exceeded at a location, then the isotopic analysis for all radionuclides will be performed on the final sample of each year to provide a data point for calculation of dose. Background location, L1, was chosen to support data comparisons of data generated as part of this program, as well as the Environmental Radiation Protection Program (ERPP) Effluent and Surface Water Runoff program outlined in Section C.3.2.

The previous KPDES permit required that 19 in-stream surface water locations be sampled quarterly for PCBs and TCE. The new KPDES permit, permit number KY0004049, does not require this sampling; therefore this sampling program has been modified to include only locations near C-746-K Landfill (C746K-5 and K746KTB1A) and a seep location (LBCSP5) in Little Bayou Creek. The sampling of surface water near the C-746-K Landfill meets the requirements of, the ROD listed above and will be analyzed for volatiles and metals. The seep location will be monitored for TCE and is being sampled for continued evaluation of trends in groundwater upwelling at this location. The surface water monitoring program will be evaluated for FY 2019 to determine if any changes are needed. L14 has been added to the quarterly ERPP sampling program. L14 is being added to include monitoring upstream of the C-746-S&T and C-746-U Landfills.

Table C.32 details surface water and the seep sampling locations. Tables C.33 and C.34 detail the surface water and seep sampling analytical parameters. Tables C.35 through C.38 detail the surface water and seep sampling analytical parameters by location for the ERPP. Sampling to support the ERPP will be conducted on a quarterly basis, with the exception of the background locations (L1 and L30), which will be sampled annually. Locations are shown on Figure C.15.

Table C.32. Surface Water and Seep Quarterly Sampling Locations (3)

Surface Water (2)	
C-746-K-5	**Seep (1)**
C746KTB1A	LBCSP5*

*Unable to obtain flow rates.

Table C.33. Surface Water Quarterly Analytical Parameters

Metals—Method 200.8		
Aluminum	Calcium	Nickel
Arsenic	Iron	Potassium
Barium	Lead	Sodium
Beryllium	Magnesium	Uranium
Cadmium	Manganese	
Field Measurements		
Alkalinity	Dissolved Oxygen	pH
Conductivity	Flow*	Temperature
Volatiles—Method 624		
1,1-Dichloroethene	*cis*-1,2-Dichloroethene	*trans*-1,2-Dichloroethene
Trichloroethene	Vinyl Chloride	

*See Table C.34 for locations where flow rates are not collected.

Table C.34. Seep Location Quarterly Analytical Parameters

Volatiles—Method 624	
Trichloroethene	
Field Measurements	
pH	Dissolved Oxygen
Temperature	Conductivity

Table C.35. Surface Water—ERPP Little Bayou Creek Locations and Quarterly Analytical Parameters

Locations		
L10	L14	L241
Radionuclides—Method U-02-RC unless noted		
Alpha Activity—9310		Uranium-234[a]
Beta Activity—9310		Uranium-235[a]
Technetium-99*—TC-02-RC		Uranium-238[a]
Uranium*		

*Sample will be collected, but will not be analyzed unless alpha activity at the associated location exceeds 14 pCi/L or beta activity at the associated location exceeds 300 pCi/L.
Bolded parameters are sampled by different method than specified in header.

Table C.36. Surface Water—ERPP Bayou Creek Location and Quarterly Analytical Parameters

Location	
L5	
Radionuclides—Method U-02-RC unless noted	
Alpha Activity—9310	**Cesium-137*—901.1**
Beta Activity—9310	**Technetium-99*—TC-02-RC**
Neptunium-237*—1475-00aM	Uranium
Plutonium-238*—PU-11-RC	Uranium-234*
Plutonium-239/240*—PU-11-RC	Uranium-235*
Thorium-234*—901.1	Uranium-238*
Potassium-40*—901.1	

*Sample will be collected, but will not be analyzed unless alpha activity at the associated location exceeds 14 pCi/L or beta activity at the associated location exceeds 300 pCi/L.
Bolded parameters are sampled by different method than specified in header.

Table C.37. Surface Water—ERPP North-South Diversion Ditch Location and Quarterly Analytical Parameters

Locations	
L11	
Radionuclides—Method U-02-RC unless noted	
Alpha Activity—9310	Uranium*
Beta Activity—9310	Uranium-234*
Thorium-230*—Th-01-RC	Uranium-235*
Technetium-99*—TC-02-RC	Uranium-238*

*Sample will be collected, but will not be analyzed unless alpha activity at the associated location exceeds 14 pCi/L or beta activity at the associated location exceeds 300 pCi/L.
Bolded parameters are sampled by different method than specified in header.

Table C.38. Surface Water—ERPP Background and Nearest Public Water Source Location and Quarterly/Annual Analytical Parameters

Locations	
Annually L1 (BG) and L30 (BG to PWS) Quarterly L29A (BG) and L306 (PWS at Cairo, Illinois)	
Radionuclides—Method U-02-RC unless noted	
Alpha Activity—9310	**Cesium-137*—901.1**
Beta Activity—9310	**Technetium-99*—TC-02-RC**
Americium-241*—AM-05-RC	Uranium*
Neptunium-237*—1475-00aM	Uranium-234*
Plutonium-238*—PU-11-RC	Uranium-235*
Plutonium-239/240*—PU-11-RC	Uranium-238*
Thorium-230*—Th-01-RC	

BG = Background locations
PWS + Public Water Source locations
*Samples for L29A and L306 will be collected, but will not be analyzed unless alpha activity at the associated location exceeds 14 pCi/L or beta activity at the associated location exceeds 300 pCi/L.
Alpha activity on the filtered material [settleable solids (pCi/g)].
Beta activity on the filtered material [settleable solids (pCi/g)].
Bolded parameters are sampled by different method than specified in header.

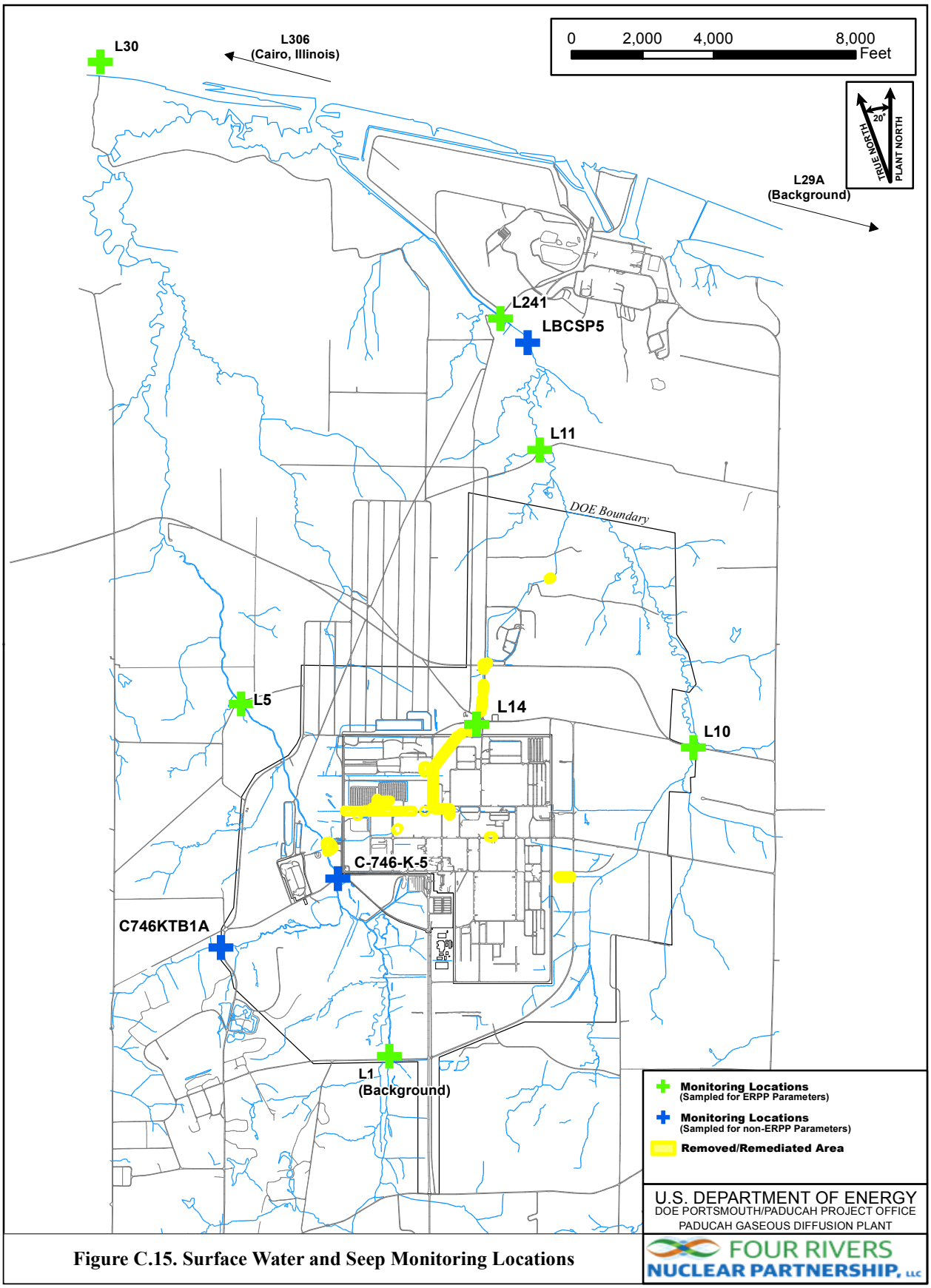

Figure C.15. Surface Water and Seep Monitoring Locations

Sediment Monitoring

Frequency: Semiannually (PCBs) and Annually (Radionuclides)

Driver: *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, Volume 1. Human Health, U.S. Department of energy, Paducah, Kentucky*, DOE/LX/07-0107&D2/R7/V1, U.S. Department of Energy, Paducah, KY, June 2016. DOE Order 458.1 requires radiological monitoring. This radiological monitoring will be conducted on an annual basis.

Reported: ASER

Rationale: Monitor potential contamination released into Bayou Creek and Little Bayou Creek sediments from historical plant operations.

Comments: DOE Order 458.1 requires that environmental surveillance of sediment be performed in accordance with DOE/HDBK-1216-2015. Sampling locations were selected to determine site-specific radiation exposure pathway analysis and to provide an indication of the accumulation of undissolved radionuclides in the aquatic environment. Locations were prioritized for areas of public access, introduction of plant effluents to the environment, and verification of the effectiveness of PGDP effluent monitoring. Sampling for radionuclides will occur annually.

Table C.39 details sediment sampling locations and parameters. Table C.40 details the sediment sampling locations and parameters driven by the ERPP. The previous KPDES permit required that 14 locations be sampled semiannually for PCBs. The new KPDES permit, permit number KY0004049, no longer requires this sampling; however, these locations will continue to be sampled semiannually for PCBs in FY 2018 in order to evaluate action levels for PCBs in sediment. Locations are shown on Figure C.16.

Table C.39. Sediment—Location and Semiannual Analytical Parameters Sampling Locations (14)

Locations		
C612	S1	S31
C616	S2	S32
746KTB2	S20 (BG)	S33
K001	S27	S34
L194	S28 (BG)	
PCBs—Method 8082		
PCB, Total	PCB-1232	PCB-1254
PCB-1016	PCB-1242	PCB-1260
PCB-1221	PCB-1248	

Analytical laboratory results will be reported on a dry weight basis, as applicable, unless specified otherwise.

Table C.40. Sediment—ERPP Location and Annual Analytical Parameters Sampling Locations (6)

Locations		
S1	S20 (BG)	S33
S2	S27	S34
Radionuclides—Method U-02-RC unless noted		
Alpha Activity—9310	**Plutonium-238—PU-11-RC**	**Technetium-99—TC-02-RC**
Beta Activity—9310	**Plutonium-239/240—PU-11-RC**	Uranium
Americium-241—AM-05-RC	**Thorium-230—Th-01-RC**	Uranium-234
Neptunium-237—1475-00aM	**Cesium-137—HASL 300**	Uranium-235
		Uranium-238

Bolded parameters are sampled by different method than specified in header.
Analytical laboratory results will be reported on a dry weight basis, as applicable, unless specified otherwise.

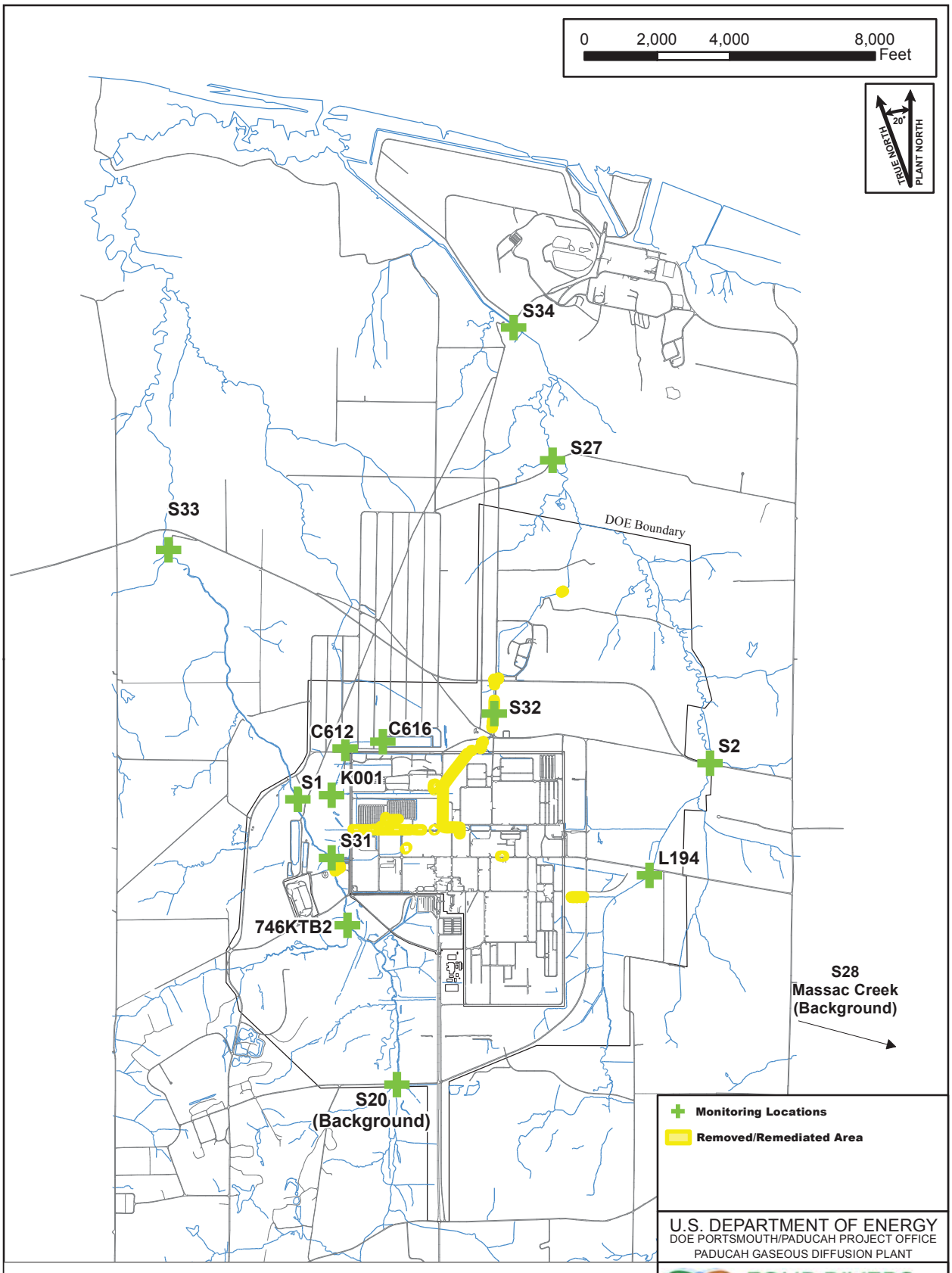

Figure C.16. Semiannual Sediment Locations

C.4. LANDFILL LEACHATE SAMPLING

C-746-S&T and C-746-U Landfills Leachate Monitoring

Frequency: Annually

Driver: C-746-S, C-746-T, and C-746-U Landfill permit issued by KDWM, Permit Number SW07300014, SW07300015, and SW07300045.

Reported: Quarterly Compliance Operating Reports, as required by the applicable solid waste landfill permit and the ASER

Rationale: Solid waste landfill permit SW07300014 (C-746-S Landfill), SW07300015 (C-746-T Landfill), and SW07300045 (C-746-U Landfill).

Comments: Leachate sampling is performed and reported collectively for the C-746-S and C-746-T Landfills.

Sampling frequencies and sampling parameters were not modified for this sampling program in FY 2018 because it is permit driven.

Annual leachate parameters for C-746-S, C-746-T, and C-746-U Landfills are presented in Table C.41.

Table C.41. C-746-S&T and C-746-U Landfills Annual Leachate Parameters

Volatiles—Method 624 unless noted			
1,1,1,2-Tetrachloroethane	1,4-Dichlorobenzene	Carbon Disulfide	Iodomethane
1,1,1-Trichloroethane	2-Butanone	Carbon Tetrachloride	Methylene Chloride
1,1,2,2-Tetrachloroethane	2-Hexanone	Chlorobenzene	Styrene
1,1,2-Trichloroethane	4-Methyl-2-pentanone	Chloroethane	Tetrachloroethene
1,1-Dichloroethane	Acetone	Chloroform	Toluene
1,1-Dichloroethene	Acrolein	Chloromethane	*trans*-1,2-Dichloroethene
1,2,3-Trichloropropane	Acrylonitrile	*cis*-1,2-Dichloroethene	*trans*-1,3-Dichloropropene
1,2-Dibromo-3-chloropropane—8011	Benzene	*cis*-1,3-Dichloropropene	*trans*-1,4-Dichloro-2-Butene
1,2-Dibromoethane	Bromochloromethane	Dibromochloromethane	Trichloroethene
1,2-Dichlorobenzene	Bromodichloromethane	Dibromomethane	Trichlorofluoromethane
1,2-Dichloroethane	Bromoform	Dimethylbenzene, Total[a]	Vinyl Acetate
1,2-Dichloropropane	Bromomethane	Ethylbenzene	Vinyl Chloride
PCBs—Method 8082			
PCB, Total	PCB-1232	PCB-1248	PCB-1260
PCB-1016	PCB-1242	PCB-1254	PCB-1268
PCB-1221			
Radionuclides—Method U-02-RC unless noted			
Alpha Activity—9310	**Cobalt-60—901.1**	Uranium-235, Dissolved	**Cesium-137, Dissolved—901.1**
Beta Activity—9310	**Thorium-234—901.1**	Uranium-234, Dissolved	**Cobalt-60, Dissolved—901.1**
Radium-226—AN-1418	**Americium-241—AM-05-RC**	Uranium-238, Dissolved	**Thorium-234, Dissolved—901.1**
Strontium-90—905.0	**Neptunium-237—1475-00aM**	Uranium	**Americium-241, Dissolved—HASL 300**
Technetium-99—TC-02-RC	**Plutonium-239/240—PU-11-RC**	Uranium, Dissolved	**Neptunium-237, Dissolved—1475-00aM**
Thorium-230—Th-01-RC	Uranium-235	**Dissolved Alpha—9310**	**Plutonium-239/240, Dissolved—PU-11-RC**
Tritium—906.0	Uranium-234	**Dissolved Beta—9310**	**Thorium-230, Dissolved—Th-01-RC**
Cesium-137—901.1	Uranium-238	**Technetium-99, Dissolved—TC-02-RC**	
Metals—Method 6020 unless noted			
Aluminum	Lead	Thallium	Cobalt, Dissolved
Antimony	Magnesium	Tin	Copper, Dissolved
Arsenic	Manganese	Titanium	Lead, Dissolved
Barium	**Mercury—7470A**	Uranium	Manganese, Dissolved
Beryllium	Molybdenum	Vanadium	Nickel, Dissolved
Boron	Nickel	Zinc	Selenium, Dissolved
Cadmium	Potassium	Barium, Dissolved	Silver, Dissolved
Calcium	Rhodium	Chromium, Dissolved	Tin, Dissolved
Chromium	Selenium	Antimony, Dissolved	Titanium, Dissolved
Cobalt	Silver	Arsenic, Dissolved	Uranium, Dissolved
Copper	Sodium	Cadmium, Dissolved	Vanadium, Dissolved
Iron	Tantalum		Zinc, Dissolved
Anions—Method 9056			
Bromide	Fluoride	Nitrate as Nitrogen	Sulfate
Chloride			
Field Parameters			
Conductivity	Redox	Temperature	pH
Dissolved Oxygen			
Miscellaneous—Method as follows			
Total Dissolved Solids—160.1	**Total Organic Halides—9020B**	**Phosphorus—365.4**	**Carbonaceous Biochemical Oxygen Demand—5210B**
Chemical Oxygen Demand—410.4	**Total Organic Carbon—9060**	**Hardness—Total as $CaCO_3$—130.2**	
Cyanide—9012	**Oil and Grease—1664A**	**Iodide—300.0**	**Total Suspended Solids—160.2**

[a] Xylenes

Bolded parameters are sampled by different method than specified in header.

C-404 Low-Level Radioactive Waste Burial Ground Leachate Monitoring

Frequency: As needed

Driver: The leachate parameters are required to be sampled per the Hazardous Waste Facility Permit, number KY8-890-008-982.

Reported: C-404 Semiannual Groundwater Report and the ASER

Rationale: Hazardous Waste Facility Permit, KY8-890-008-982

Comments: Sampling frequencies and sampling parameters were not modified for this sampling program in FY 2018 because it is permit driven.

Leachate analytical parameters for C-404 Landfill are presented in Table C.42.

Table C.42. C-404 Landfill Leachate Analytical Parameters

Volatiles—Method 8260B			
Trichloroethene			
Radionuclides—Method U-02-RC unless noted			
Technetium-99—TC-02-RC	Uranium-235	**Plutonium-239/240—PU-11-RC**	**Cesium-137[a]—901.1**
Uranium-234	Uranium-238	**Thorium-230—Th-01-RC**	**Neptunium-237—1475-00aM**
PCBs[b]—Method 8082			
PCB, Total	PCB-1232	PCB-1248	PCB-1260
PCB-1016	PCB-1242	PCB-1254	
PCB-1221			
Metals—Method 6020 unless noted			
Barium	Iron	Silver	**Mercury—7470A**
Cadmium	Lead	Zinc	Selenium
Chromium	Nickel	Arsenic	Uranium
Copper			
Miscellaneous—Method as follows			
Fluoride—9056	**Ammonia as Nitrogen—350.1**		
Field Parameters			
pH	Dissolved Oxygen	Redox	Temperature
Conductivity			

[a] Cesium is not required by the HWFP, but is requested per management decision.
[b] PCBs are not required by the HWFP for disposal purposes.
Bolded parameters are sampled by different method than specified in header.

C.5. EXTERNAL GAMMA AND NEUTRON RADIOLOGICAL MONITORING

Frequency: Collected continuously and analyzed quarterly; external gamma dosimeters at 64 monitoring locations and neutron dosimeters at 7 monitoring locations are changed quarterly for external radiation monitoring.

Driver: DOE Order 436.1 and DOE Order 458.1

Reported: ASER

Rationale: Monitor the effective dose from site operations in order to ensure operational limits are not exceeded.

Comments: Figure C.17 shows thermoluminescent dosimeter (TLD) monitoring locations. The number of locations and frequency were not modified for this program in FY 2018.

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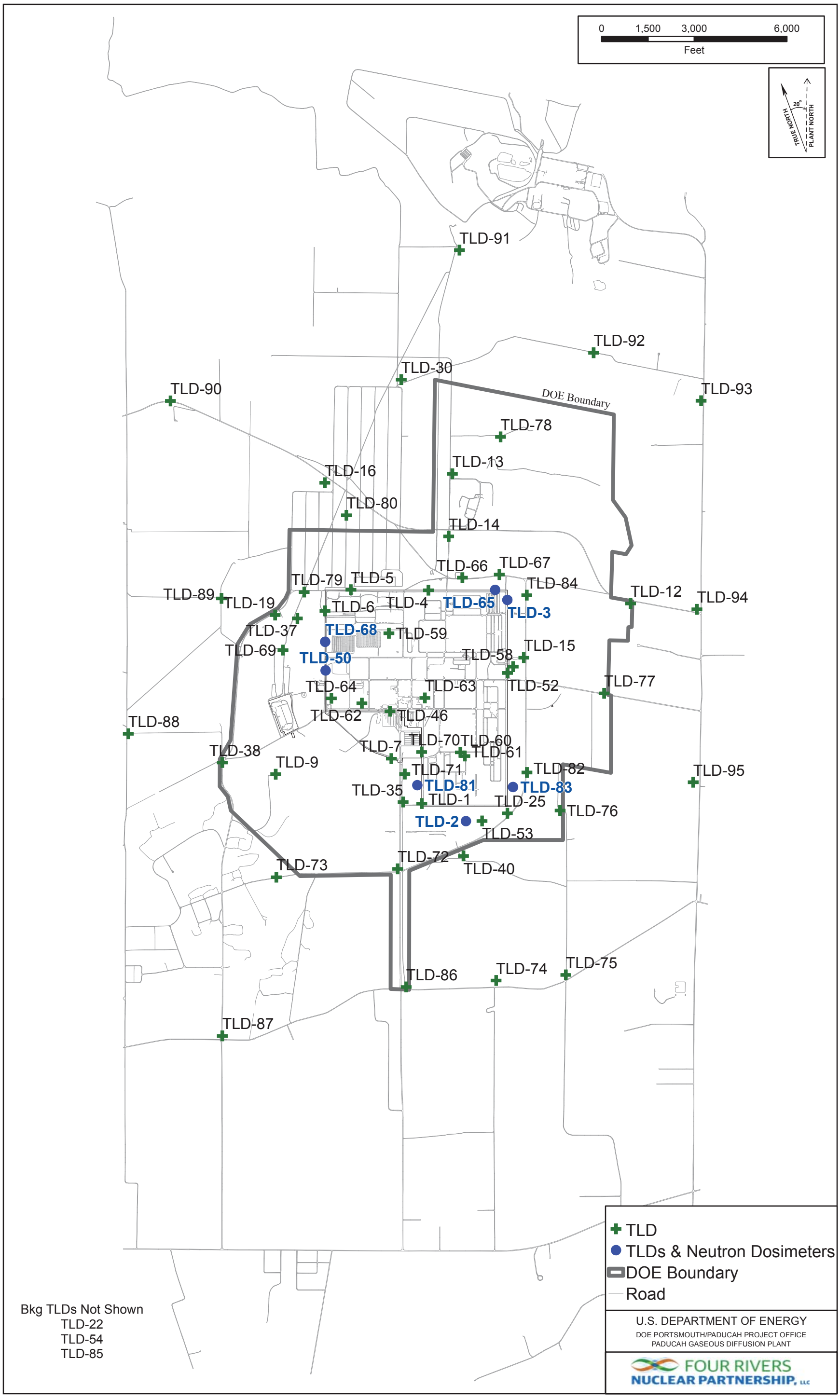

Figure C.17. Environmental Dosimeter Locations

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C.6. AMBIENT AIR MONITORING

Frequency: Weekly/Quarterly

Driver: *National Emission Standards for Hazardous Air Pollutants Management Plan for Emission of Radionuclides for the U.S. Department of Energy Operations at the Paducah Site, Paducah, Kentucky*, PAD-REG-1017, November 2013

Reported: NESHAP Annual Report and ASER

Rationale: Monitor radionuclide emissions from Paducah Site activities.

Comments: Ambient air is monitored to verify the concentrations of radionuclides from all sources, including fugitive and diffuse. The ambient air monitoring network is comprised of nine air monitoring stations surrounding the site, including one background location.

Location identifications are found in Table C.43. Filter samples are collected on a weekly basis and analyzed for gross alpha and beta, as shown in Table C.44. The laboratory retains the filter and compiles all of the weekly samples for each quarterly period. At the end of each quarter, the filters are compiled and analyzed for the isotopes defined in the quarterly analysis table, C.45. Locations are shown on Figure C.18.

Table C.43. Ambient Air Monitoring Locations (9)

AMDBCP (BG)	AMD002	AMD612
AMD57	AMDNE	AMD746S
AMD012	AMD015	AMD746U

BG = Background

Table C.44. Ambient Air Monitoring Weekly Analytical Parameters

Radionuclides—Method 9310	
Alpha Activity	Beta Activity

Table C.45. Ambient Air Monitoring Quarterly Analytical

Radionuclides—Methods as follows		
Americium-241—HASL300 4.5.2.3	**Plutonium-239/240—Pu-11-RC M**	**Uranium-234—U-02-RC M**
Neptunium-237/Protactinium-233—HASL300 4.5.2.3	**Technetium-99—Tc-02-RC**	**Uranium-235—U-02-RC M**
Plutonium-238—Pu-11-RC M	**Thorium-234/Uranium-238—HASL300 4.5.2.3**	**Uranium-238—U-02-RC M**

Bolded parameters are sampled by different method than specified in header.
LSC = Liquid Scintillation Counter

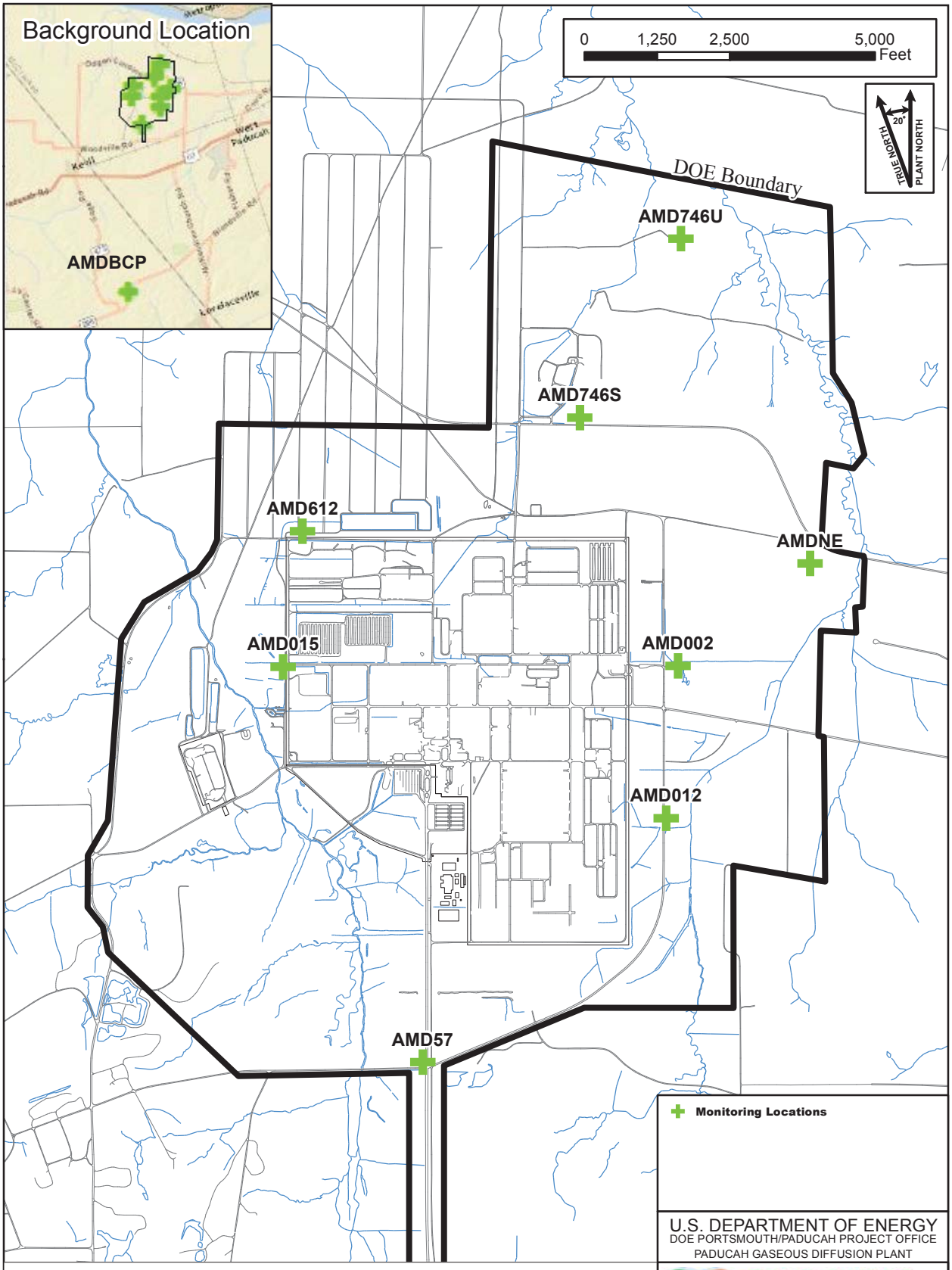

Figure C.18. DOE Ambient Air Monitoring Stations

C.7. KENTUCKY NON-TRANSIENT NON-COMMUNITY WATER SYSTEM SAMPLING

Frequency: Weekly, Monthly, Quarterly, Annually, and Triennially

Driver: Kentucky non-transient non-community water system (NTNCWS) monitoring regulations 401 *KAR* 8:150 through 401 *KAR* 8:600

Reported: Monthly and quarterly by a Commonwealth of Kentucky-certified contract laboratory for all parameters excluding lead and copper. Lead and copper results are reported as directed by KDOW within 10 days of the end of the 3-year compliance period.

Rationale: Monitor drinking water at specified locations and frequencies in accordance with monitoring plans submitted to the KDOW in accordance with applicable regulations. For parameters not subject to KDOW monitoring plans, monitor at locations and frequencies as directed by the applicable regulation.

Comments: The Paducah Site operates a NTNCWS under the Safe Drinking Water Act (SDWA). Drinking water monitoring requirements are promulgated under authority of the SDWA by KDOW. The drinking water monitoring schedule for a particular CY can be affected by the drinking water results from the previous year. Drinking water results are reviewed annually by the Regulatory Compliance organization, and the monitoring schedule for the following year is developed based on that review.

Samples for Total Organic Carbon and Alkalinity are collected monthly from raw water (Ohio River water) and combined filter effluent (water plant). Samples for trihalomethanes and haloacetic Acids are collected quarterly at C-755 and C-102-T01.

Additional monitoring requirements included in the current monitoring schedule are shown in Tables C.46 through C.49.

The results from operational samples conducted in direct support of water treatment, such as turbidity, hardness, alkalinity, etc., are reported in the Monthly Operational Report.

Table C.46. Inorganic Chemicals—401 *KAR* 8:250/300

Parameter (MCL mg/l)	1st Quarter 2017 (mg/l)	2nd Quarter 2017 (mg/l)	3rd Quarter 2017 (mg/l)	4th Quarter 2017 (mg/l)
Asbestos[2] (7 million fibers/liters)				
Antimony[1] (0.006)		X		
Arsenic[1]		X		
Barium[1] (2)		X		
Beryllium[1] (0.004)		X		
Cadmium[1] (0.005)		X		
Chromium[1] (0 .1)		X		
Cyanide[1] (0.2)		X		
Fluoride[1] (2.0)		X		
Mercury[1] (0.002)		X		
Nickel[1] (0.1)		X		
Selenium[1] (0.05)		X		
Thallium[1] (0.002)		X		
Nitrate[1] (10)		X		
Nitrite[2] (1)				
Lead[3]				
Copper[3]				

[1] Samples collected at entry point into distribution system.
[2] One asbestos and nitrite sample is required during the 2016 – 2018 compliance period.
[3] Twenty samples must be taken for lead and copper in the June – September, 2018 period per KDOW guidance.

Table C.47. Synthetic Organic Chemicals—401 *KAR* 8:250

Parameter[1] (MCL mg/l)	**1st Quarter 2017 (mg/l)**	**2nd Quarter 2017 (mg/l)**	**3rd Quarter 2017 (mg/l)**	**4th Quarter 2017 (mg/l)**
Alachlor (Lasso) (0.002)				
Aldicarb (0.003)				
Aldicarb sulfoxide (0.004)				
Aldicarb sulfone (0.002)				
Atrazine (0.003)[2]		X		
Carbofuran (0.04)				
Chlordane (0.002)				
1,2 Dibromo-3-chloropropane (DBCP) (0.0002)				
2,4-D (0.07)				
Ethylene Dibromide (EDB) (0.00005)				
Heptachlor (0.0004)				
Heptachlor epoxide (0.0002)				
Lindane (0.0002)				
Methoxychlor (0.04)				
PCB (Polychlorinated biphenyls) (0.0005)				
Pentachlorophenol (0.001)				
Toxaphene (0.003)				
2,4,5-TP (Silvex) (0.05)				
Benzo(a)pyrene (0.0002)				
Dalapon (0.2)				
Di(2-ethylhexyl)adipate (0.4)				
Di(2-ethylhexyl)phthalate (0.006)				
Dinoseb (0.007)				
Diquat (0.02)				
Endothall (0.1)				
Endrin (0.002)				
Glyphosphate (0.7)				
Hexachlorobenzene (0.001)				
Hexachlorocyclopentadiene (0.05)				
Oxamyl (vydlate) (0.2)				
Picloram (0.5)				
Simazine (0.004)[2]		X		
Dioxin / 2,3,7,8-TCDD ($3x10^{-8}$)				

[1] Samples collected at entry point into distribution system.
[2] Pollutants monitoring frequency reduced to annually (in second quarter). All other pollutants are to be monitored in 2018.

Table C.48. Volatile Organic Chemicals—401 *KAR* 8:250

Parameter[1] (MCL mg/l)	1st Quarter 2017 (mg/l)	2nd Quarter 2017 (mg/l)	3rd Quarter 2017 (mg/l)	4th Quarter 2017 (mg/l)
Benzene (0.005)			X	
Carbon Tetrachloride (0.005)			X	
Chlorobenzene (mono) (0.1)			X	
cis-1,2-Dichloroethylene (0.07)			X	
Dichloromethane/Methylene Chloride (0.005)			X	
Ethylbenzene (0.07)			X	
o-Dichlorobenzene (1,2-) (0.6)			X	
p-Dichlorobenzene (1,4-) (0.075)			X	
Styrene (0.1)			X	
Tetrachloroethylene (PCE) (0.005)			X	
Toluene (1.0)			X	X
trans-1,2-Dichloroethylene (0.1)			X	
Trichloroethylene (TCE) (0.005)			X	
Vinyl Chloride (0.002)			X	
Xylenes, total (10)			X	
1,1-Dichloroethylene (0.007)			X	
1,1,1-Trichloroethane (0.2)			X	
1,1,2-Trichloroethane (0.005)			X	
1,2-Dichloroethane (0.005)			X	X
1,2,-Dichloropropane (0.005)			X	
1,2,4-Trichlorobenzene (0.07)			X	

[1] Samples collected at entry point into distribution system.

Table C.49. Secondary Contaminants—401 *KAR* 8:600

Parameter[1] (MCL mg/l)	1st Quarter 2017 (mg/l)	2nd Quarter 2017 (mg/l)	3rd Quarter 2017 (mg/l)	4th Quarter 2017 (mg/l)
Alkalinity, Bicarbonate				
Alkalinity, Carbonate				
Alkalininty, Phenolphthalein				
Alkalinity, Total				
Aluminum (0.2)			X	
Chloride (250)			X	
Color (15 color units)			X	
Copper (1.3)			X	
Corrosivity (noncorrosive)			X	
Foaming Agents/Surfactants (0.5)			X	
Hardness, Calcium				
Hardness, Total				
Iron (0.3)			X	
Manganese (0.05)			X	
Odor (3 threshold odor number)			X	
pH (6.5 – 8.5 pH units)[2]			X	
Silver (0.1)			X	
Sulfate (250)			X	
Temperature (C)[2]			X	
Total Dissolved Solids (500)			X	
Zinc (5)			X	

[1] Samples collected at entry point into distribution system.
[2] Field measurements

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APPENDIX D

ENVIRONMENTAL MONITORING QUALITY ASSURANCE PROJECT PLAN

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CONTENTS

QAPP WORKSHEETS

ACRONYMS

CAS	Chemical Abstracts Service
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
COPC	chemical or radionuclide of potential concern
DOE	U.S. Department of Energy
DOECAP	DOE Consolidated Audit Program
DQI	Data Quality Indicator
DQO	data quality objective
ECD	electron capture detector
EDD	Electronic Data Deliverable
EMP	Environmental Monitoring Plan
EPA	U.S. Environmental Protection Agency
FFA	Federal Facility Agreement
FID	flame ionization detector
FIDLER	field instrument for detection of low energy
FPDP	Fluor Federal Services, Inc., Paducah Deactivation Project
FRNP	Four Rivers Nuclear Partnership, LLC
GS	gas chromatography
GS-MS	gas chromatography mass spectrometer
GPS	Global Positioning System
ICP-AES	inductively coupled plasma atomic emission spectroscopy
KDEP	Kentucky Department for Environmental Protection
KPDES	Kentucky Pollutant Discharge Elimination System
LSRS	LATA-Sharp Remediation Services, LLC
MCL	maximum contaminant level
MDA	minimum detectable activity
MDL	method detection limit
MRL	minimum reporting limit
MS	matrix spike
NAL	no action level
NDIRD	nondispersive infrared detector
OREIS	Paducah Oak Ridge Environmental Information System
PARCCS	precision, accuracy, representativeness, comparability, completeness, and sensitivity
PCB	polychlorinated biphenyl
PGDP	Paducah Gaseous Diffusion Plant
PQL	practical quantitation limit
PT	proficiency testing
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RPD	relative percent difference
SOP	standard operating procedure
TLD	thermoluminescent dosimeter
TOC	total organic carbon
UFP	Uniform Federal Policy
VOC	volatile organic compound
XRF	X-ray fluorescence

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INTRODUCTION

The Environmental Monitoring (EM) Quality Assurance Project Plan (QAPP) has been prepared by Four Rivers Nuclear Partnership, LLC, (FRNP) based on the updated programmatic QAPP, DOE/LX/07-2409&D1, *Programmatic Quality Assurance Project Plan*, February 2017, which was developed in alignment with the *Uniform Federal Policy for Quality Assurance Project Plans* (UFP-QAPP Manual) guidelines for QAPPs, March 2005, as updated by the *Optimized UFP-QAPP Worksheets* guidance, March 2012.

This EM QAPP is Appendix D to the *Environmental Monitoring Plan Fiscal Year 2018*, CP2-ES-0006/FR1. It describes the project-specific quality assurance activities that will be conducted to support ongoing monitoring programs of varying media (e.g., groundwater, surface water, air, and sediment) at the site.

This EM QAPP does the following:

- Refers to the SOPs already developed for the site and in place;
- Identifies analytical limits, units of reporting, and methods requested by each program; these values will be used to procure laboratory services. If the laboratory cannot meet the limits, units, or methods specified in the QAPP, the project manager and/or compliance organization will be contacted so a determination can be made if the proposed conditions are acceptable to meet current project objectives. If the conditions are found to be acceptable, the Sample Management Office will document the acceptance with rationale;
- Identifies analytical limits and methods that may be required by a given project [e.g., permits, maximum contaminant level (MCL), etc.];
- Incorporates the *Data and Documents Management and Quality Assurance Plan for Paducah Environmental Management and Enrichment Facilities*, DOE/OR/07-1595&D2 (DOE 1998); and
- Standardizes data validation processes by linking the process to SOPs (see Worksheet #21).

This document supports the EM procedures *Quality Assured Data*, CP3-ES-5003; *Environmental Monitoring Data Management Plan*, CP2-ES-0063; and *Developing, Implementing, and Maintaining Data Management Implementation Plans*, CP3-ES-1003.

This QAPP focuses on providing fixed laboratory methods, although Appendix C of the Environmental Monitoring Plan (EMP) identifies field measurements requested on each of the programs. Field methods [e.g., X-ray fluorescence (XRF), colorimetric methods for polychlorinated biphenyls (PCBs), and radionuclide surveys] that may be implemented in support of the programs within this EMP are not covered in either of the discussion of the EMP or within this QAPP.[1]

This QAPP does not cover the analysis of the thermoluminescent dosimeters (TLDs) for gamma emissions although the program is detailed with sample locations in Appendix C of the EMP. Those

[1] Project-specific QAPPs contain information concerning implemented field methods.

analyses are conducted utilizing quality standards set forth and evaluated by the Environment, Safety, and Health organization. Additionally, samples collected in the ambient air monitoring program are not covered in this QAPP. While the ambient air program, like the TLD environmental monitoring program, is important for overall evaluation of site operations, it is not considered to fit the typical QAPP guidelines and should not be forced into the parameter listing within the QAPP on the sole reason that they are included in Appendix C of the EMP.

Worksheets #10 and #17 are not included in this QAPP. Based on the programmatic QAPP, completion of these worksheets in project-specific QAPPs is at the discretion of the project. Considering the information is already included in the body of the EMP, the decision was made to not include these worksheets in this QAPP.

Worksheets #12 and #15 were adapted from the programmatic QAPP. Only those worksheets containing parameters required under the EMP were included in this QAPP.

This QAPP provides limited information on some analyses considered as miscellaneous tests. Miscellaneous tests are defined in Worksheet #23. Samples for these analyses are collected using standard operating procedures (SOPs) employed by the sampling staff and quality assurance standards specified in procedures such as CP3-ES-5003, *Quality Assured Data*. They are not listed in Worksheets #12 and #15 because they are not considered contaminants of concern at the site. These parameters are requested by programs within Appendix C of the EMP because they are indicators of overall water quality or, in some instances, are required as conditions of permits (e.g., toxicity, ferrous iron, and coliform).

QAPP Worksheets #1 and #2. Title and Approval Page

Site Name/Project Name: Paducah Gaseous Diffusion Plant/Environmental Monitoring
Site Location: Paducah, Kentucky
Site Number/Code: KY8890008982
Contractor Name: FRNP
Contractor Number: DE-EM0004895
Contract Title: Paducah Gaseous Diffusion Plant Paducah Deactivation and Remediation Project
Work Assignment Number: N/A

Document Title: *Environmental Monitoring Quality Assurance Project Plan*

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

Preparer's Name and Organizational Affiliation: Lisa Crabtree, Four Rivers Nuclear Partnership, LLC (FRNP)

Preparer's Address, Telephone Number, and E-mail Address: 5511 Hobbs Road, Kevil, KY, 42053, Phone (270) 441-5135, lisa.crabtree@pad.pppo.gov

Preparation Date (Month/Year): 11/2017

Document Control Number: CP2-ES-0006/FR1, Appendix D

FRNP Signature: _____ Date: 11/30/17
Curt B. Walker
Environmental Services Project Director

FRNP Signature: _____ Date: 11/29/17
Kelly Layne
Environmental Stewardship Manager

FRNP Signature: _____ Date: 11/29/17
Lisa Crabtree
Environmental Monitoring and Sample Management Office Manager

QAPP Worksheets #1 and #2. Title and Approval Page (Continued)

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.

   Intergovernmental Data Quality Task Force, March 2012. *Uniform Federal Policy for Quality Assurance Project Plans, Optimized UFP QAPP Worksheets,* 42 pages.

   Paducah Gaseous Diffusion Plant Programmatic Quality Assurance Project Plan, DOE/LX/07-2409&D1.

2. Identify regulatory program: The EMP is not submitted to regulatory agencies for review or approval; however, many of the sampling programs defined within the EMP are required by regulatory decision documents, permits or DOE Orders (O); therefore, those regulatory programs are pertinent. They include the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); *Federal Facility Agreement for the Paducah Gaseous Diffusion Plant*, DOE/OR/07-1707 (FFA); Kentucky Department for Environmental Protection (Kentucky Division of Waste Management, Kentucky Division of Water); and DOE Orders.

3. Identify approval entity: DOE

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

5. List dates of scoping sessions that were held: August 10, 2017—Data Quality Objective (DQO) Session with Fluor Federal Services, Inc., Paducah Deactivation Project (FPDP) and DOE

QAPP Worksheets #1 and #2. Title and Approved Page (Continued)

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

Title:	**Approval Date:**
Data and Documents Management and Quality Assurance Plan for Paducah Environmental Management and Enrichment Facilities, DOE/OR/07-1595&D2 (DOE 1998)	10/5/1998
Paducah Gaseous Diffusion Plant Programmatic Quality Assurance Project Plan, Paducah, Kentucky, DOE/LX/07-2409&D1 (QAPP)	February 2017

7. List organizational partners (stakeholders) and connection with lead organization:
EPA Region 4 (FFA member); Kentucky Department for Environmental Protection (KDEP) (regulates hazardous and solid waste landfills, effluent discharge permits, FFA member); DOE (lead organization); and FRNP (DOE Prime Contractor)

8. List data users: DOE, FRNP, subcontractors, EPA Region 4, Commonwealth of Kentucky

9. This QAPP includes 26 worksheets that are required based on UFP-QAPP guidance. Worksheets #10 and #17 have been omitted because the problem definitions are described in detail within the body of the Environmental Monitoring Plan, of which this QAPP is an appendix.

Table 1. Crosswalk: UFP-QAPP Workbook to 2106-G-05-QAPP

Optimized UFP-QAPP Worksheets		**CIO 2106-G-05 QAPP Guidance Section**	
1 & 2	Title and Approval Page	2.2.1	Title, Version, and Approval/Sign-Off
3 & 5	Project Organization and QAPP Distribution	2.2.3	Distribution List
		2.2.4	Project Organization and Schedule
4, 7, & 8	Personnel Qualifications and Sign-off Sheet	2.2.1	Title, Version, and Approval/Sign-Off
		2.2.7	Special Training Requirements and Certification
6	Communication Pathways	2.2.4	Project Organization and Schedule
9	Project Planning Session Summary	2.2.5	Project Background, Overview, and Intended Use of Data
11	Project/Data Quality Objectives	2.2.6	Data/Project Quality Objectives and Measurement Performance Criteria
12	Measurement Performance Criteria	2.2.6	Data/Project Quality Objectives and Measurement Performance Criteria
13	Secondary Data Uses and Limitations	Chapter 3	QAPP ELEMENTS FOR EVALUATING EXISTING DATA
14 & 16	Project Tasks and Schedule	2.2.4	Project Organization and Schedule
15	Project Action Limits and Laboratory-Specific Detection/Quantitation Limits	2.2.6	Data/Project Quality Objectives and Measurement Performance Criteria
18	Sampling Locations and Methods	2.3.1	Sample Collection Procedure, Experimental Design, and Sampling Tasks
		2.3.2	Sampling Procedures and Requirements
19 & 30	Sample Containers, Preservation, and Hold Times	2.3.2	Sampling Procedures and Requirements
20	Field QC	2.3.5	Quality Control Requirements
21	Field SOPs	2.3.2	Sampling Procedures and Requirements
22	Field Equipment Calibration, Maintenance, Testing, and Inspection	2.3.6	Instrument/Equipment Testing, Calibration and Maintenance Requirements, Supplies and Consumables
23	Analytical SOPs	2.3.4	Analytical Methods Requirements and Task Description
24	Analytical Instrument Calibration	2.3.6	Instrument/Equipment Testing, Calibration and Maintenance Require
25	Analytical Instrument and Equipment Maintenance, Testing, and Inspection	2.3.6	Instrument/Equipment Testing, Calibration and Maintenance Requirements, Supplies and Consumables
26 & 27	Sample Handling, Custody, and Disposal	2.3.3	Sample Handling, Custody Procedures, and Documentation
28	Analytical Quality Control and Corrective Action	2.3.5	Quality Control Requirements
29	Project Documents and Records	2.2.8	Documentation and Records Requirements
31, 32, & 33	Assessments and Corrective Action	2.4	ASSESSMENTS AND DATA REVIEW (CHECK)
		2.5.5	Reports to Management
34	Data Verification and Validation Inputs	2.5.1	Data Verification and Validation Targets and Methods
35	Data Verification Procedures	2.5.1	Data Verification and Validation Targets and Methods
36	Data Validation Procedures	2.5.1	Data Verification and Validation Targets and Methods
37	Data Usability Assessment	2.5.2	Quantitative and Qualitative Evaluations of Usability
		2.5.3	Potential Limitations on Data Interpretation
		2.5.4	Reconciliation with Project Requirements

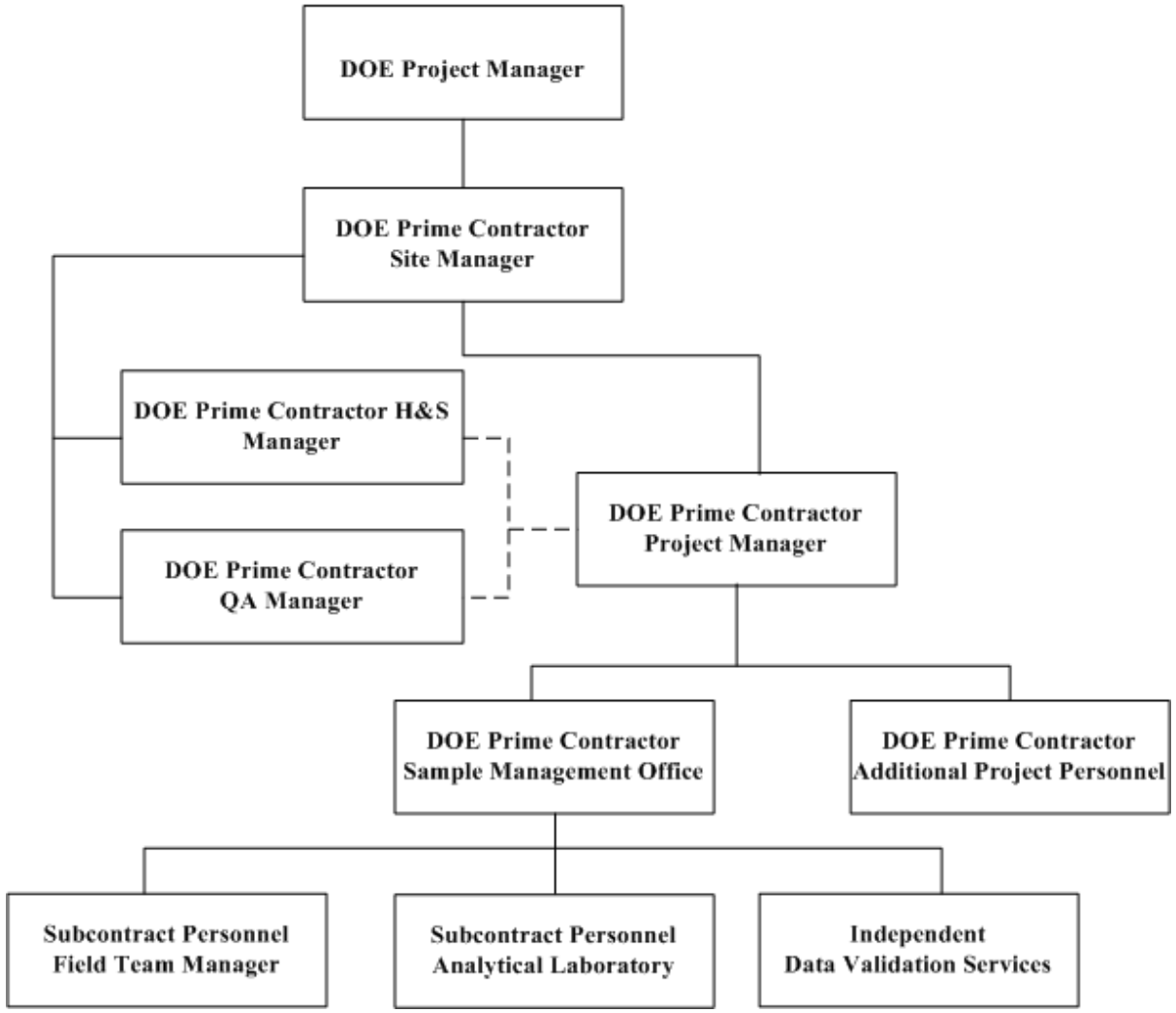
QAPP Worksheets #3 and #5.
Project Organization and QAPP Distribution

Distribution is based on the position title. A change in the individual within an organization will not trigger a resubmittal of the QAPP. DOE may choose to update the sheet and submit changes to the document holders. These managers will be responsible for distribution of the EMP, including this QAPP, to their staff.

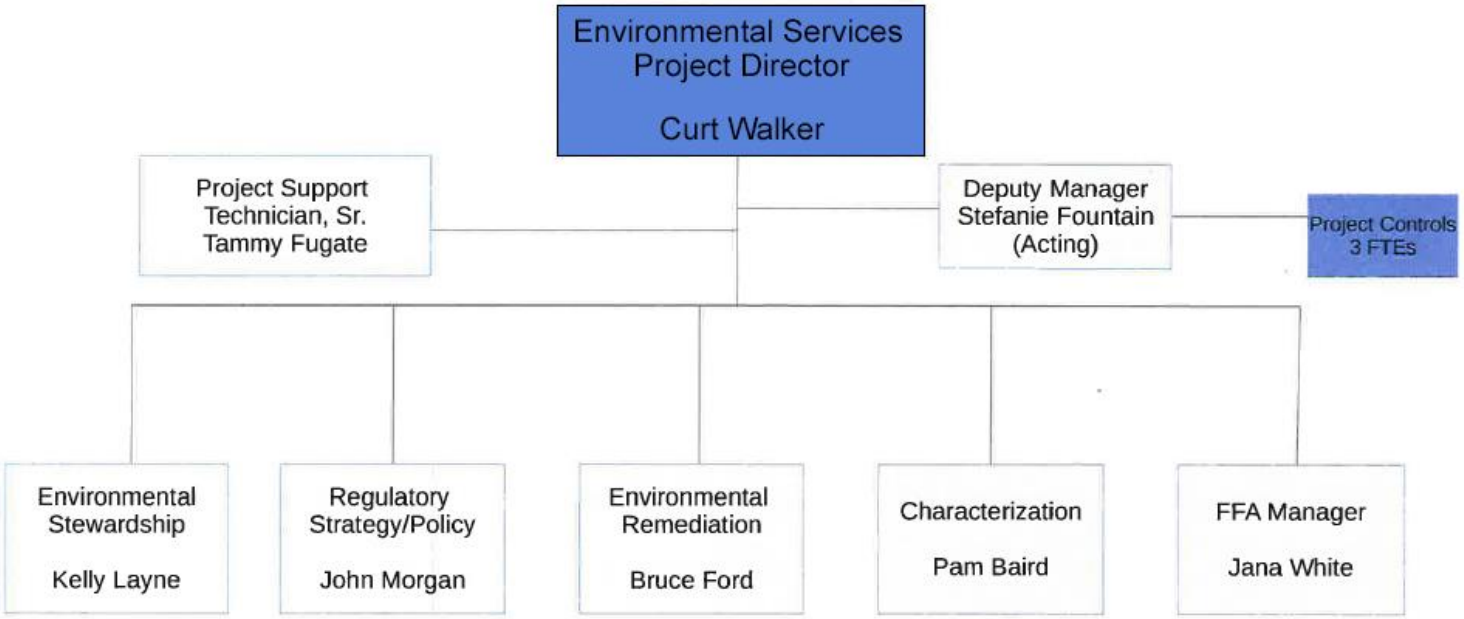
Controlled copies of the QAPP will be distributed according to the distribution list below. This list will be updated, as needed, and kept by the FRNP Records Management Department. Each person receiving a controlled copy also will receive any updates/revisions. If uncontrolled copies are distributed, 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
Paducah Site Lead	DOE	Jennifer Woodard	(270) 441-6820	jennifer.woodard@lex.doe.gov	1
Project Manager	DOE	David Dollins	(270) 441-6819	dave.dollins@lex.doe.gov	2
FFA Manager	DOE	Tracey Duncan	(270) 441-6862	tracey.duncan@lex.doe.gov	3
Environmental Services Project Director	FRNP	Curt Walker	(270) 441-5226	curt.walker@pad.pppo.gov	4
Environmental Stewardship Manager	FRNP	Kelly Layne	(270) 441-6726	kelly.layne@pad.pppo.gov	5
Environmental Radiation Protection and Risk Assessment Manager	FRNP	LeAnne Garner	(270) 441-5436	leanne.garner@pad.pppo.gov	6
FFA Manager	FRNP	Jana White	(270) 441-5185	jana.white@pad.pppo.gov	7
Quality Assurance/Quality Control Manager	FRNP	Glenn Barberi	(270) 441-5741	glenn.barberi@pad.pppo.gov	8
Environmental Monitoring and Sample Management Office Manager	FRNP	Lisa Crabtree	(270) 441-5135	lisa.crabtree@pad.pppo.gov	9
Health, Safety, Support, and Quality (HSS&Q) Director	FRNP	Roland Chretien	(270) 441-6238	roland.chretien@pad.pppo.gov	10
Sample Management Office	FRNP	Jaime Morrow	(270) 441-5508	jaime.morrow@pad.pppo.gov	11

QAPP Worksheet #5-A.
Project Level Organizational Chart



QAPP Worksheet #5-B.
Project Contractor Environmental Management Organizational Chart



Approved By: _____

Date: 10/17/17

QAPP Worksheet #4.
Project Personnel Sign-Off Sheet: Sample Collection, Data Analysis, Data Validation

Personnel actively engaged in sample collection, data analysis, and data validation for the projects are required to read applicable sections of this QAPP and sign a Personnel Sign-off Sheet. The master list of signatures will be kept by the Environmental Monitoring and Sample Management Office Manager (or designee) and will be made available upon request.

Project Position Title	Organization	Specialized Training/Certification, if any	Signature	Date
Sample Team Leads	GEO Consultants	None. See Training Project Description (TPD).		
Environmental Monitoring and Sample Management Office Manager	FRNP	None. See TPD.		
Sample Management Office Scientist	FRNP	None. See TPD.		
Independent Third-Party Data Validator	Wastren Advantage, Inc.	N/A		
Environmental Radiation Protection and Risk Assessment Manager	FRNP	None. See TPD.		

QAPP Worksheet #7.
Personnel Responsibility and Qualifications Table

ORGANIZATION: FRNP

Name	Position Title Responsible	Organization Affiliation	Responsibilities	Education and Experience Qualifications[1]
Curt Walker	Environmental Services Project Director	FRNP	Overall project responsibility	> 4 years relevant work experience
Kelly Layne	Environmental Stewardship Manager	FRNP	Project environmental compliance responsibility	Bachelor degree plus > 4 years work experience
Jana White	FFA Manager	FRNP	Project compliance with the FFA	> 4 years work relevant experience
Lisa Crabtree	Environmental Monitoring and Sample Management Office Manager	FRNP	Support project on sampling, data management, and reporting activities	> 4 years relevant work experience
Jaime Morrow	Sample Management Office Scientist	FRNP	Project sample and data management	> 2 years relevant work experience
Darren Tinsley	Health and Safety Representative	FRNP	Project safety and health responsibility	Bachelor degree plus > 1 year relevant experience
Mike Zeiss	Waste Facility Operations Manager	FRNP	Overall project waste management responsibility	> 4 years relevant experience
Wastren Advantage, Inc.	Data Validator	Independent third party contractor	Performing data validation according to specified procedures	Bachelor degree plus relevant experience
Valerie Davis	Analytical Laboratory Project Manager	GEL Laboratories	Sample analysis and data reporting	Bachelor degree plus relevant experience
Archie Fugate	Analytical Laboratory Project Manager	McCoy & McCoy Laboratories, Inc.	Sample analysis and data reporting	Bachelor degree plus relevant experience

[1] Candidates who do not have a certificate or required degree but demonstrate additional "equivalent relevant work experience" can be considered when evaluating qualifications. This assessment will be conducted by the PM as he/she assembles the appropriate team for the project.

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.

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*
Project Tasks	There has been no specialized training identified for this program other than what normally is required for site work at PGDP. The contractor will evaluate specific tasks and personnel will be assigned training as necessary to perform those tasks. Training may address health and safety aspects of specific tasks as well as contractor-specific, site-specific, and task-specific requirements.	FRNP	Prior to Monitoring	Based upon required duties	FRNP staff, subcontractors	Training files are maintained by the FRNP training organization. A training database is utilized to manage and track training.

*Training records are maintained by the FRNP training department. If training records and/or certificates do not exist or are not available, then this should be noted.

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 Site Lead	Paducah Site Lead	Formal communication among DOE, EPA, and KDEP.
Federal Facility Agreement DOE/OR/07-1707	DOE Paducah	DOE Project Manager	Formal communication between DOE and contractor for Environmental Remediation Projects.
Project requirements	FRNP	Environmental Services Project Director	Formal communication among the project, the Site Lead, and the DOE Project Manager.
Project requirements	FRNP	Project Manager	Communication between the project and the FRNP Environmental Services Project Director.
Project QA requirements	FRNP	Quality Assurance/Quality Control Program Manager	Project quality related communication between the QA department and FRNP project personnel.
FFA compliance	FRNP	FFA Manager	Internal communication regarding FFA compliance with the FRNP Project Manager.

QAPP Worksheet #6. (Continued)
Communication Pathways

Communication Drivers	Organizational Affiliation	Position Title Responsible	Organizational Department Manager	Procedure
Sampling Requirements	FRNP	Sample Team Leads	Sampling Operations Front Line Manager	Internal communication regarding field sampling with the FRNP Project Manager.
Analytical Laboratory Interface	FRNP	Scientist	Sample Management Office	Communication between FRNP and analytical laboratory.
Waste Management Requirements	FRNP	Waste Facility Operations Manager	Waste and Materials Director	Internal communication regarding project waste management with FRNP Project Manager.
Environmental Compliance Requirements	FRNP	Regulatory Compliance Manager	Environmental Stewardship Manager	Internal correspondence regarding environmental requirements and compliance with the FRNP Project Manager.
Subcontractor Requirements (if applicable)	FRNP	Subcontract Administrator	Subcontracts/ Procurement Lead	Correspondence between the project and subcontractors, if applicable.
Health and Safety Requirements	FRNP	Health and Safety Representative	HSS&Q Director	Internal communication regarding safety and health requirements with the FRNP Project Manager.

QAPP Worksheet #9.
Project Scoping Session Participant Sheet

Project scoping is the key to the success of any project and is part of the systematic planning process. For this QAPP, this included review of past documents produced and previous years DQO sessions. It was determined that a formal DQO session was needed for the FY 2018 EMP. The worksheet identifies participants who discussed the sampling strategy in the DQO session held on August 10, 2017.

Name of Project: Environmental Monitoring Plan Fiscal Year 2018
Date of Session: August 10, 2017
Scoping Session Purpose: Identify sampling strategies of EM programs

Position Title	Affiliation	Name	Phone #	E-mail Address	Project Role
Project Manager	Department of Energy	David Dollins	270-441-6819	dave.dollins@lex.doe.gov	Project Management
Project Manager Risk	Department of Energy	Rich Bonczek	859-219-4051	rich.bonczek@lex.doe.gov	Subject Matter Expert
Scientist	Pro2Serve	Tracy Taylor	270-441-6866	tracy.taylor@lex.doe.gov	Subject Matter Expert
Scientist	Pro2Serve	Jennifer Johnson	270-441-6846	jennifer.johnson@lex.doe.gov	Subject Matter Expert
Environmental Monitoring and Reporting Project Manager	LSRS	Lisa Crabtree	270-441-5135	lisa.crabtree@ffspaducah.com	Project Management, Laboratory and Sampling Requirements
Acting Regulatory Affairs Manager	FPDP	Kelly Layne	270-441-6726	kelly.layne@ffspaducah.com	Project Management
Project Support Manager	LSRS	Teresa Overby	270-441-5188	teresa.overby@ffspaducah.com	Subject Matter Expert
Project Support	Geosyntec	Stefanie Fountain	865-291-4689	sfountain@geosyntec.com	Subject Matter Expert

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

This QAPP has been prepared to detail the minimum standards, particularly for field and analytical data quality. Analytical data will be generated by DOE Consolidated Audit Program (DOECAP) laboratories utilizing approved laboratory test methods. The overall project quality objectives are to develop and implement procedures for field sampling, chain-of-custody, laboratory analysis, and reporting that will provide results that are legally defensible in a court of law. Specific procedures for sampling, chain-of-custody, instrument calibration/preventive maintenance, chemical analysis, internal QC, reporting data, audits, and corrective actions are described in other sections of this QAPP.

QAPP Worksheet #11 details the project quality objectives developed through the systematic planning process.

Who will use the data? DOE, FRNP, Commonwealth of Kentucky, and EPA.

What will the data be used for? Data required to be reported via permits or other regulatory decision documents will be reported as required (Appendix C of the EMP lists applicable reports).

What type of data is needed? (target analytes, analytical groups, field screening, on-site analytical or off-site laboratory techniques, sampling techniques) Required list of analytes are specified by program within Appendix C of the EMP. Both field screening and on-site and off-site laboratory analyses are used for data collection.

How "good" do the data need to be in order to support the environmental decision? Data needs to meet the measurement quality objective and data quality indicators established by the systematic planning process consistent with procedures *Quality Assured Data*, CP3-ES-5003; *Environmental Monitoring Data Management Plan*, CP2-ES-0063; and CP3-ES-1003, *Developing, Implementing, and Maintaining Data Management Implementation Plans*.

Where, when, and how should the data be collected/generated? See Appendix C for frequency of sample collection.

Who will collect and generate the data? FRNP. Additionally, meteorological data may be acquired from other sources (as needed).

How will the data be reported? Field data will be recorded on chain-of-custody forms, in field logbooks, and field data sheets. The fixed-base laboratory will provide data in an Electronic Data Deliverable (EDD). Project data following verification assessment and validation will be placed into and reported from the Paducah Oak Ridge Environmental Information System (OREIS). Data loaded into Paducah OREIS will be made available to the public stakeholders via the PPPO Environmental Geographic Analytical Spatial Information System (PEGASIS).

How will the data be archived? Electronic data will be archived in OREIS in accordance with Section 8.5 (Data and Records Archival) of the *Data and Documents Management and Quality Assurance Plan* (DOE 1998).

QAPP Worksheet #12-D.
Measurement Performance Criteria

Matrix	Sediment
Analytical Group[1]	PCBs
Concentration Level	Low

Sampling Procedure[2]	Analytical Method/SOP[3, 4]	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
CP4-ES-2302, *Collection of Sediment Samples Associated with Surface Water*	SW-846-8082	Precision—Lab	RPD–≤ 25%	Laboratory Duplicates	A
		Precision	RPD–≤ 35%	Field Duplicates	S
		Accuracy/Bias	% recovery[6]	Laboratory Sample Spikes	A
		Accuracy/Bias Contamination	No target compounds > PQL	Method Blanks/Instrument Blanks	A
		Accuracy/Bias Contamination	No target compounds > PQL	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > PQL	Equipment Rinseates	S
		Completeness[5]	90%	Data completeness check	S&A

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

QAPP Worksheet #12-E.
Measurement Performance Criteria

Matrix	Sediment
Analytical Group[1]	Radionuclides (uranium[8], uranium-234, uranium-235, uranium-238)
Concentration Level	Low

Sampling Procedure[2]	**Analytical Method/SOP**[3, 4]	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
CP4-ES-2302, *Collection of Sediment Samples Associated with Surface Water*	Alpha spectroscopy[7]	Precision—Lab	RPD–≤ 25%	Laboratory Duplicates	A
		Precision	RPD–≤ 50%	Field Duplicates	S
		Accuracy/Bias	% recovery[6]	Laboratory Sample Spikes	A
		Accuracy/Bias Contamination	No target compounds > MDA	Method Blanks/Instrument Blanks	A
		Accuracy/Bias Contamination	No target compounds > MDA	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > MDA	Equipment Rinseates	S
		Completeness[5]	90%	Data completeness check	S&A

MDA = minimum detectable activity; RPD = relative percent difference
Analytical laboratory results will be reported on a dry weight basis, as applicable, unless specified otherwise.
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] The most current version of the method will be used.
[5] Completeness is calculated as the number of samples planned to be collected divided by the number of sample results that were rejected.
[6] Percent recovery is laboratory-specific, calculated from studies performed every six months. Percent recovery ranges will be provided in the laboratory data packages based on the most current study.
[7] Appendix C of the EMP references the analytical laboratory's SOP; however, for the purpose of the QAPP, general analytical methodology is denoted so as to document the preferred analytical method should another laboratory be utilized.
[8] The total uranium listed represents the total of the uranium isotopes that is analyzed by alpha spectroscopy.

QAPP Worksheet #12-F.
Measurement Performance Criteria

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

Sampling Procedure[2]	Analytical Method/SOP[3, 4]	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
CP4-ES-2302, *Collection of Sediment Samples Associated with Surface Water*	Alpha spectroscopy[7]	Precision—Lab	RPD–≤ 25%	Laboratory Duplicates	A
		Precision	RPD–≤ 50%	Field Duplicates	S
		Accuracy/Bias	% recovery[6]	Laboratory Sample Spikes	A
		Accuracy/Bias Contamination	No target compounds > MDA	Method Blanks/Instrument Blanks	A
		Accuracy/Bias Contamination	No target compounds > MDA	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > MDA	Equipment Rinseates	S
		Completeness[5]	90%	Data completeness check	S&A

MDA = minimum detectable activity; RPD = relative percent difference
Analytical laboratory results will be reported on a dry weight basis, as applicable, unless specified otherwise.
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] The most current version of the method will be used.
[5] Completeness is calculated as the number of samples planned to be collected divided by the number of sample results that were rejected.
[6] Percent recovery is laboratory-specific, calculated from studies performed every six months. Percent recovery ranges will be provided in the laboratory data packages based on the most current study.
[7] Appendix C of the EMP references the analytical laboratory's SOP; however, for the purpose of the QAPP, general analytical methodology is denoted so as to document the preferred analytical method should another laboratory be utilized.

QAPP Worksheet #12-G.
Measurement Performance Criteria

Matrix	Sediment
Analytical Group[1]	Radionuclides (cesium-137)
Concentration Level	Low

Sampling Procedure[2]	Analytical Method/SOP[3, 4]	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
CP4-ES-2302, *Collection of Sediment Samples Associated with Surface Water*	Gamma spectroscopy[6]	Precision—Lab	RPD–≤ 25%	Laboratory Duplicates	A
		Precision	RPD–≤ 50%	Field Duplicates	S
		Accuracy/Bias Contamination	No target compounds > MDA	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > MDA	Equipment Rinseates	S
		Completeness[5]	90%	Data completeness check	S&A

MDA = minimum detectable activity; RPD = relative percent difference
Analytical laboratory results will be reported on a dry weight basis, as applicable, unless specified otherwise.
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] The most current version of the method will be used.
[5] Completeness is calculated as the number of samples planned to be collected divided by the number of sample results that were rejected.
[6] Appendix C of the EMP references the analytical laboratory's SOP; however, for the purpose of the QAPP, general analytical methodology is denoted so as to document the preferred analytical method should another laboratory be utilized.

QAPP Worksheet #12-H.
Measurement Performance Criteria

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

Sampling Procedure[2]	**Analytical Method/SOP**[3, 4]	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
CP4-ES-2302, *Collection of Sediment Samples Associated with Surface Water*	Liquid scintillation[7]	Precision—Lab	RPD–≤ 25%	Laboratory Duplicates	A
		Precision	RPD–≤ 50%	Field Duplicates	S
		Accuracy/Bias	% recovery[6]	Laboratory Sample Spikes	A
		Accuracy/Bias Contamination	No target compounds > MDA	Method Blanks/Instrument Blanks	A
		Accuracy/Bias Contamination	No target compounds > MDA	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > MDA	Equipment Rinseates	S
		Completeness[5]	90%	Data completeness check	S&A

MDA = minimum detectable activity; RPD = relative percent difference
Analytical laboratory results will be reported on a dry weight basis, as applicable, unless specified otherwise.
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] The most current version of the method will be used.
[5] Completeness is calculated as the number of samples planned to be collected divided by the number of sample results that were rejected.
[6] Percent recovery is laboratory-specific, calculated from studies performed every six months. Percent recovery ranges will be provided in the laboratory data packages based on the most current study.
[7] Appendix C of the EMP references the analytical laboratory's SOP; however, for the purpose of the QAPP, general analytical methodology is denoted so as to document the preferred analytical method should another laboratory be utilized.

QAPP Worksheet #12-K.
Measurement Performance Criteria

Matrix	Water/Groundwater and Surface Water
Analytical Group[1]	VOC
Concentration Level	Low

Sampling Procedure[2]	**Analytical Method/SOP**[3, 4]	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
CP4-ES-2101, *Groundwater Sampling*" and CP4-ES-2203, *Surface Water Sampling*	SW-846-8260 and EPA-624	Precision—Lab	RPD–≤ 25%	Laboratory Duplicates	A
		Precision	RPD–≤ 25%	Field Duplicates	S
		Accuracy/Bias	% recovery[6]	Laboratory Sample Spikes	A
		Accuracy/Bias Contamination	No target compounds > PQL	Method Blanks/Instrument Blanks	A
		Accuracy/Bias Contamination	No target compounds > PQL	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > PQL	Trip Blanks	S
		Accuracy/Bias Contamination	No target compounds > PQL	Equipment Rinseates	S
		Completeness[5]	90%	Data completeness check	S&A

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

QAPP Worksheet #12-L.
Measurement Performance Criteria

Matrix	Water/Groundwater and Surface Water
Analytical Group[1]	Metals (all except mercury)
Concentration Level	Low

Sampling Procedure[2]	**Analytical Method/SOP**[3, 4]	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
CP4-ES-2101, *Groundwater Sampling*, and CP4-ES-2203, *Surface Water Sampling*	EPA-200.8/ SW-846-6010/6020	Precision—Lab	RPD–≤ 20%	Laboratory Duplicates	A
		Precision	RPD–≤ 25%	Field Duplicates	S
		Accuracy/Bias	% recovery[6]	Laboratory Sample Spikes	A
		Accuracy/Bias Contamination	No target compounds > PQL	Method Blanks/Instrument Blanks	A
		Accuracy/Bias Contamination	No target compounds > PQL	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > PQL	Equipment Rinseates	S
		Completeness[5]	90%	Data completeness check	S&A

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

QAPP Worksheet #12-M.
Measurement Performance Criteria

Matrix	Water/Groundwater and Surface Water
Analytical Group[1]	Metals (Mercury)
Concentration Level	Low

Sampling Procedure[2]	**Analytical Method/SOP**[3, 4]	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
CP4-ES-2101, *Groundwater Sampling*, and CP4-ES-2203, *Surface Water Sampling*	SW-846-7470	Precision—Lab	RPD–≤ 20%	Laboratory Duplicates	A
		Precision	RPD–≤ 25%	Field Duplicates	S
		Accuracy/Bias	% recovery[6]	Laboratory Sample Spikes	A
		Accuracy/Bias Contamination	No target compounds > PQL	Method Blanks/Instrument Blanks	A
		Accuracy/Bias Contamination	No target compounds > PQL	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > PQL	Equipment Rinseates	S
		Completeness[5]	90%	Data completeness check	S&A

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

QAPP Worksheet #12-N.
Measurement Performance Criteria

Matrix	Water/Groundwater and Surface Water
Analytical Group[1]	PCBs
Concentration Level	Low

Sampling Procedure[2]	**Analytical Method/SOP**[3, 4]	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
CP4-ES-2101, *Groundwater Sampling*, and CP4-ES-2203, *Surface Water Sampling*	SW-846-8082/ EPA 608	Precision—Lab	RPD–≤ 25%	Laboratory Duplicates	A
		Precision	RPD–≤ 25%	Field Duplicates	S
		Accuracy/Bias	% recovery[6]	Laboratory Sample Spikes	A
		Accuracy/Bias Contamination	No target compounds > PQL	Method Blanks/Instrument Blanks	A
		Accuracy/Bias Contamination	No target compounds > PQL	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > PQL	Equipment Rinseates	S
		Completeness[5]	90%	Data completeness check	S&A

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

QAPP Worksheet #12-O.
Measurement Performance Criteria

Matrix	Water/Groundwater and Surface Water
Analytical Group[1]	Radionuclides (americium-241, neptunium-237, plutonium-238, plutonium-239/240, thorium-230, uranium,[8] uranium-234, uranium-235, uranium-238)
Concentration Level	Low

Sampling Procedure[2]	**Analytical Method/SOP**[3, 4]	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
CP4-ES-2101, *Groundwater Sampling*, and CP4-ES-2203, *Surface Water Sampling*	Alpha spectroscopy[7]	Precision—Lab	RPD–≤ 25%	Laboratory Duplicates	A
		Precision	RPD–≤ 25%	Field Duplicates	S
		Accuracy/Bias	% recovery[6]	Laboratory Sample Spikes	A
		Accuracy/Bias Contamination	No target compounds > MDA	Method Blanks/Instrument Blanks	A
		Accuracy/Bias Contamination	No target compounds > MDA	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > MDA	Equipment Rinseates	S
		Completeness[5]	90%	Data completeness check	S&A

MDA = minimum detectable activity; RPD = relative percent difference

[1] If information varies within an analytical group, separate by individual analyte.

[2] Reference number from QAPP Worksheet #21.

[3] Reference number from QAPP Worksheet #23.

[4] The most current version of the method will be used.

[5] Completeness is calculated as the number of samples planned to be collected divided by the number of sample results that were rejected.

[6] Percent recovery is laboratory-specific, calculated from studies performed every six months. Percent recovery ranges will be provided in the laboratory data packages based on the most current study.

[7] Appendix C of the EMP references the analytical laboratory's SOP; however, for the purpose of the QAPP, general analytical methodology is denoted so as to document the preferred analytical method should another laboratory be utilized.

[8] The total uranium listed represents the total of the uranium isotopes that is analyzed by alpha spectroscopy.

QAPP Worksheet #12-P.
Measurement Performance Criteria

Matrix	Water/Surface Water
Analytical Group[1]	Radionuclides (cesium-137)
Concentration Level	Low

Sampling Procedure[2]	Analytical Method/SOP[3, 4]	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
CP4-ES-2101, *Groundwater Sampling*, and CP4-ES-2203, *Surface Water Sampling*	Gamma spectroscopy[6]	Precision—Lab	RPD–≤ 25%	Laboratory Duplicates	A
		Precision	RPD–≤ 25%	Field Duplicates	S
		Accuracy/Bias Contamination	No target compounds > MDA	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > MDA	Equipment Rinseates	S
		Completeness[5]	90%	Data completeness check	S&A

MDA = minimum detectable activity; RPD = relative percent difference
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] The most current version of the method will be used.
[5] Completeness is calculated as the number of samples planned to be collected divided by the number of sample results that were rejected.
[6] Appendix C of the EMP references the analytical laboratory's SOP; however, for the purpose of the QAPP, general analytical methodology is denoted so as to document the preferred analytical method should another laboratory be utilized.

QAPP Worksheet #12-Q.
Measurement Performance Criteria

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

Sampling Procedure[2]	**Analytical Method/SOP**[3, 4]	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
CP4-ES-2101, *Groundwater Sampling*, and CP4-ES-2203, *Surface Water Sampling*	Liquid scintillation[7]	Precision—Lab	RPD–≤ 25%	Laboratory Duplicates	A
		Precision	RPD–≤ 25%	Field Duplicates	S
		Accuracy/Bias	% recovery[6]	Laboratory Sample Spikes	A
		Accuracy/Bias Contamination	No target compounds > MDA	Method Blanks/Instrument Blanks	A
		Accuracy/Bias Contamination	No target compounds > MDA	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > MDA	Equipment Rinseates	S
		Completeness[5]	90%	Data completeness check	S&A

MDA = minimum detectable activity; RPD = relative percent difference

[1] If information varies within an analytical group, separate by individual analyte.

[2] Reference number from QAPP Worksheet #21.

[3] Reference number from QAPP Worksheet #23.

[4] The most current version of the method will be used.

[5] Completeness is calculated as the number of samples planned to be collected divided by the number of sample results that were rejected.

[6] Percent recovery is laboratory-specific, calculated from studies performed every six months. Percent recovery ranges will be provided in the laboratory data packages based on the most current study.

[7] Appendix C of the EMP references the analytical laboratory's SOP; however, for the purpose of the QAPP, general analytical methodology is denoted so as to document the preferred analytical method should another laboratory be utilized.

QAPP Worksheet #12-V.
Measurement Performance Criteria

Matrix	Drinking Water
Analytical Group[1]	Inorganic Chemicals
Concentration Level	Low

Sampling Procedure[2]	**Analytical Method/SOP**[3, 4]	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
CP4-ES-2101, *Groundwater Sampling*	EPA 200.7/EPA 200.8/EPA 300.0	Precision—Lab	RPD–≤ 20%	Laboratory Duplicates	A
		Accuracy/Bias	% recovery[6]	Laboratory Sample Spikes	A
		Accuracy/Bias Contamination	No target compounds > MRL	Method Blanks/Instrument Blanks	A
		Completeness[5]	90%	Data completeness check	S&A

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

QAPP Worksheet #12-Y.
Measurement Performance Criteria

Matrix	Drinking Water
Analytical Group[1]	Secondary Contaminants
Concentration Level	Low

Sampling Procedure[2]	**Analytical Method/SOP**[3, 4]	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
CP4-ES-2101, *Groundwater Sampling*	EPA 200.7/EPA 200.8	Precision—Lab	RPD–≤ 20%	Laboratory Duplicates	A
		Accuracy/Bias	% recovery[6]	Laboratory Sample Spikes	A
		Accuracy/Bias Contamination	No target compounds > MRL	Method Blanks/Instrument Blanks	A
		Completeness[5]	90%	Data completeness check	S&A

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

QAPP Worksheet #12-Z.
Measurement Performance Criteria

Matrix	Drinking Water
Analytical Group[1]	Trihalomethanes,
Concentration Level	Low

Sampling Procedure[2]	**Analytical Method/SOP**[3, 4]	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
CP4-ES-2101, *Groundwater Sampling*	EPA 524.2	Precision—Lab	RPD–≤ 20%	Laboratory Duplicates	A
		Accuracy/Bias	% recovery[6]	Laboratory Sample Spikes	A
		Accuracy/Bias Contamination	No target compounds > MRL	Method Blanks/Instrument Blanks	A
		Completeness[5]	90%	Data completeness check	S&A

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

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	Data will be used to determine the nature and extent of sediment, surface water, and groundwater contamination.	Data have been verified, assessed, and validated (if validation is required). Rejected data will not be used if there is sufficient time to resample and obtain a result that will not be rejected during validation. All data are assessed based on *Quality Assured Data*, CP3-ES-5003.
Historical Documentation	Various	Various	Information will be used as guidance on related project work.	Information from historical documents will be limited to the available documentation as it relates to a specific project. Use of historical data may be limited based on how long ago the data were collected and whether site conditions have changed since data collection.

QAPP Worksheet #14.
Summary of Project Tasks*

Sampling Tasks: Collect samples by the specified program listed in Appendix C of the EMP.

Analysis Tasks: Analysis according to current version of standard methods as listed in Worksheet 12.

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 procedures CP3-ES-5007, *Data Management Coordination*; CP3-ES-1003, *Developing, Implementing, and Maintaining Data Management Implementation Plans*; and CP2-ES-0063, *Environmental Monitoring Data Management Implementation Plan at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky.*

Documentation and Records: Documentation and records will be per procedure CP3-RD-0010, *Records Management Process.*

Assessment/Audit Tasks: Assessments and audits will be per procedure CP3-QA-1003, *Management and Self-Assessment.*

Data Review Tasks: Data review tasks, including selection of data sets for validation by a third-party independent validator(s), will be per procedure CP3-ES-5003, *Quality Assured Data*, and CP2-ES-0063, *Environmental Monitoring Data Management Plan at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*. Groundwater data from the quarterly sampling events at the C-746-U and C-746-S&T Landfills and the semiannual sampling events at the C-404 Landfill will be validated. The groundwater data to be validated was chosen because groundwater comprises the majority of the media collected by EM. Additionally, the landfill requirements encompass the majority of all types of analyses specified within the EM program. Therefore, these programs are considered an adequate representation of EM data targeted for data validation. Validation will follow FRNP validation plans. The laboratory supporting the drinking water program is required to submit the drinking water results directly to the Commonwealth of Kentucky as well as submit the results to FRNP. FRNP will notify the Commonwealth of Kentucky of any MCL exceedances and will base the monitoring schedule for the following year on these results.

*It is understood that SOPs are contractor specific.

QAPP Worksheet #16.
Project Schedule/Timeline Table

Activities	Organization	Dates		Deliverable	Deliverable Due Date
		Anticipated Date(s) of Initiation	Anticipated Date of Completion		
Routine sampling conducted throughout the fiscal year	FRNP	October 1, 2017	September 30, 2018	See Appendix C of the EMP for deliverable information	See Appendix C of the EMP for deliverable information.

QAPP Worksheet #15.
Reference Limits and Evaluation Table

The application of Worksheet #15 should be evaluated via a graded approach because the sampling dictated within the EMP is with the objective of monitoring and not as a site investigation or remediation effort wherein an "action limit" may appropriately describe the objective of the sampling efforts.

For example, Worksheets #15A through #15D pertain to the parameters of groundwater; however, trichloroethene (TCE) detected in a groundwater well located in the close proximity to the DOE boundary that had never shown TCE may have a differing response action than a response to the exact same TCE concentration in a well located within the groundwater plume which has shown TCE at or above that concentration since monitoring commenced in the 1990s. A better approach would be comparing the data sets to the historical data for the specific locations in question.

Worksheets #15A through #15D combine groundwater and surface water information. Laboratory methods for groundwater and surface water typically do not vary. Action limits between the two may differ. For example, the laboratory will use the same method for the requested analytes on a groundwater sample as they do on a surface water sample regardless if it was collected from a groundwater monitoring well or from an effluent outfall location. But, response actions to the same concentration for a given parameter may or may not differ between the two samples because it would be dependent upon the program under which it is monitored and the location from where the samples were collected. Therefore, the matrices for "water" in the following spreadsheets are shown with groundwater being the primary driver with the exception of the last worksheet, Worksheet #15-K, which specifically addresses the surface water samples required by the Kentucky Pollutant Discharge Elimination System (KPDES) permit that have a permit limit associated with the parameter. The action limits included in worksheets #15A through #15D are well below MCL or derived concentration technical standard values. These action limits were included in the Programmatic QAPP for those projects that perform routine monitoring. These limits will allow those projects to evaluate trends at lower concentrations successfully.

QAPP Worksheet #15-A.
Project Action Limits Laboratory-Specific Detection/Quantitation Limits

Matrix: Water
Analyte Group: VOCs

VOCs	CAS Number	Project Action Limit/NAL (µg/L)	Project Action Limit Reference[a]	Site COPC?[b]	Laboratory-Specific	
					PQLs (µg/L)	MDLs (µg/L)
Acrylonitrile	107-13-1	0.052/0.0523	Tapwater[c]/NAL	Yes	5	1.5
Benzene	71-43-2	5.0/0.454	MCL/NAL	Yes	1	0.3
Carbon tetrachloride	56-23-5	5.0/0.453	MCL/NAL	Yes	1	0.3
Chloroform	67-66-3	80/0.221	MCL/NAL	Yes	1	0.3
1,1-Dichloroethene	75-35-4	7.0/28.5	MCL/NAL	Yes	1	0.3
cis-1,2-Dichloroethene	156-59-2	70/3.61	MCL/NAL	Yes	1	0.3
trans-1,2-Dichloroethene	156-60-5	100/9.29	MCL/NAL	Yes	1	0.3
Ethylbenzene	100-41-4	700/1.49	MCL/NAL	Yes	1	0.3
Tetrachloroethene	127-18-4	5.0/4.06	MCL/NAL	Yes	1	0.3
Trichloroethene	79-01-6	5.0/0.282	MCL/NAL	Yes	1	0.3
Vinyl Chloride	75-01-4	2.0/0.0188	MCL/NAL	Yes	1	0.3

QAPP Worksheet #15-A. (Continued)
Project Action Limits Laboratory-Specific Detection/Quantitation Limits

VOCs	CAS Number	Project Action Limit/NAL (µg/L)	Project Action Limit Reference[a]	Site COPC?[b]	Laboratory-Specific	
					PQLs (µg/L)	MDLs (µg/L)
Total Xylenes	1330-20-7	10,000/19.3	MCL/NAL	Yes	3	0.3
o-Xylene	95-47-6	19/19.3	Tapwater[c]/NAL	Yes	1	0.3
m-Xylene	108-38-3	19/19.3	Tapwater[c]/NAL	Yes	2	0.3
p-Xylene	106-42-3	19/19.3	Tapwater[c]/NAL	Yes	2	0.3

CAS = Chemical Abstracts Service
COPC = chemical or radionuclide of potential concern
MCL = maximum contaminant level
MDL = method detection limit
NAL = no action level for child resident scenario from the Risk Methods Document (DOE 2016)
PQL = practical quantitation limit
VOC = volatile organic compound

[a] This QAPP references the MCLs (if available) to support project planning and identify whether lower reporting limits may be needed for some constituents. The worksheet also lists the NALs established by the Risk Methods Document (DOE 2016) for the child resident scenario.
[b] Analytes marked with COPC are from Table 2.1 of the Risk Methods Document (DOE 2016) and represent the list of chemicals, compounds, and radionuclides compiled from chemicals of potential concern retained as contaminants of concern in risk assessments performed at PGDP between 1990 and 2008.
[c] Tapwater—Source: EPA regional screening levels, Tapwater Supporting Table (Target Risk = 1E-6, Hazard Quotient = 0.1) May 2016.

QAPP Worksheet #15-B.
Project Action Limits Laboratory-Specific Detection/Quantitation Limits

Matrix: Water
Analytical Group: Metals

Metals	CAS Number	Project Action Limit/NAL (mg/L)	Project Action Limit Reference[a]	Site COPC?[b]	Laboratory-Specific	
					PQLs (mg/L)	MDLs (mg/L)
Aluminum	7429-90-5	2.0/2.00	Tapwater[g]/NAL	Yes	0.05	0.015
Antimony	7440-36-0	0.0060/0.000779	MCL/NAL	Yes	0.003	0.001
Arsenic	7440-38-2	0.010/0.0000517	MCL/NAL	Yes	0.005	0.0017
Barium	7440-39-3	2/0.377	MCL/NAL	Yes	0.002	0.0006
Beryllium	7440-41-7	0.0040/0.00246	MCL/NAL	Yes	0.0005	0.0002
Boron	7440-42-8	0.40/0.399	Tapwater[g]/NAL	Yes	0.015	0.004
Cadmium	7440-43-9	0.0050/0.000921	MCL/NAL	Yes	0.001	0.00011
Chromium (total)	7440-47-3	0.10/2.25	MCL/NAL	Yes	0.010	0.002
Cobalt	7440-48-4	0.0006/0.000601	Tapwater[g]/NAL	Yes	0.001	0.0001
Copper	7440-50-8	1.3/0.0799	MCL/NAL	Yes	0.001	0.00035
Iron	7439-89-6	1.4/1.40	Tapwater[g]/NAL	Yes	0.1	0.033
Lead	7439-92-1	0.015/0.0150	MCL[c]/NAL	Yes	0.002	0.0005
Manganese	7439-96-5	0.043/0.0433	Tapwater[g]/NAL	Yes	0.005	0.001

QAPP Worksheet #15-B. (Continued)
Project Action Limits Laboratory-Specific Detection/Quantitation Limits

Matrix: Water
Analytical Group: Metals

Metals	CAS Number	Project Action Limit/ NAL (mg/L)	Project Action Limit Reference[a]	Site COPC?[b]	Laboratory-Specific	
					PQLs (mg/L)	MDLs (mg/L)
Mercury (inorganic salts)	7439-97-6[h]	0.0020[h]/0.000566[h]	MCL/NAL	Yes	0.0002	0.000067
Molybdenum	7439-98-7	0.010/0.00998	Tapwater[g] /NAL	Yes	0.0005	0.000165
Nickel (soluble salts)	7440-02-0[h]	0.039[h]/0.0392[h]	Tapwater[g] /NAL	Yes	0.002	0.0005
Selenium	7782-49-2	0.050/0.00998	MCL/NAL	Yes	0.005	0.0015
Silver	7440-22-4	0.0094/0.00940	Tapwater[g] /NAL	Yes	0.001	0.0002
Thallium (soluble salts)	7440-28-0[h]	0.0020[h]/0.0000200[h]	MCL/NAL	Yes	0.002	0.00045
Uranium[d]	7440-61-1	0.030/0.00599	MCL/NAL	Yes	0.0002	0.000067
Vanadium[e]	7440-62-2	0.0086/0.00864	Tapwater[g] /NAL	Yes	0.01	0.003
Zinc[f]	7440-66-6	0.60/0.600	Tapwater[g] /NAL	Yes	0.01	0.0035

CAS = Chemical Abstracts Service
COPC = chemical or radionuclide of potential concern
MCL = maximum contaminant level
MDL = method detection limit
NAL = no action level for child resident scenario from the Risk Methods Document (DOE 2016)
PQL = practical quantitation limit

[a] This QAPP references the MCLs (if available) to support project planning and identify whether lower reporting limits may be needed for some constituents. The worksheet also lists the NALs established by the Risk Methods Document (DOE 2016) for the child resident scenario.
[b] Analytes marked with COPC are from Table 2.1 of the Risk Methods Document (DOE 2016) and represent the list of chemicals, compounds, and radionuclides compiled from chemicals of potential concern retained as contaminants of concern in risk assessments performed at PGDP between 1990 and 2008.
[c] The MCL established by the EPA for lead is based on a treatment technique action level of 0.015 mg/L.
[d] The NAL provided is for uranium (soluble salts).
[e] The NAL provided is for vanadium and compounds.
[f] The NAL provided is for zinc and compounds.
[g] Tapwater-Source: EPA regional screening levels, Tapwater Supporting Table (Target Risk = 1E-6, Hazard Quotient = 0.1) May 2016.
[h] The PAL/NAL values (for metals identified as salts) were derived for metal salts; the CAS number is presented for the elemental form.

QAPP Worksheet #15-C.
Project Action Limits Laboratory-Specific Detection/Quantitation Limits

Matrix: Water
Analytical Group: PCBs

PCBs	CAS Number	Project Action Limit (µg/L)	Project Action Limit Reference[a]	Site COPC?[b]	Laboratory-Specific	
					PQLs (µg/L)	MDLs (µg/L)
Aroclor 1016	12674-11-2	0.50[c]/0.140	MCL/NAL	Yes	0.1	0.0333
Aroclor 1221	11104-28-2	0.50[c]/0.00463	MCL/NAL	Yes	0.1	0.0333
Aroclor 1232	11141-16-5	0.50[c]/0.00463	MCL/NAL	Yes	0.1	0.0333
Aroclor 1242	53469-21-9	0.50[c]/0.00785	MCL/NAL	Yes	0.1	0.0333
Aroclor 1248	12672-29-6	0.50[c]/0.00785	MCL/NAL	Yes	0.1	0.0333
Aroclor 1254	11097-69-1	0.50[c]/0.00785	MCL/NAL	Yes	0.1	0.0333
Aroclor 1260	11096-82-5	0.50[c]/0.00785	MCL/NAL	Yes	0.1	0.0333

CAS = Chemical Abstracts Service
COPC = chemical or radionuclide of potential concern
MCL = maximum contaminant level
MDL = method detection limit
NAL = no action level for child resident scenario from the Risk Methods Document (DOE 2016)
PCB = polychlorinated biphenyl
PQL = practical quantitation limit

[a] This QAPP references the MCLs (if available) to support project planning and identify whether lower reporting limits may be needed for some constituents. The worksheet also lists the NALs established by the Risk Methods Document (DOE 2016) for the child resident scenario.
[b] Analytes marked with COPC are from Table 2.1 of the Risk Methods Document (DOE 2016) and represent the list of chemicals, compounds, and radionuclides compiled from chemicals of potential concern retained as contaminants of concern in risk assessments performed at PGDP between 1990 and 2008.
[c] MCL for Total PCBs.

QAPP Worksheet #15-D.
Project Action Limits Laboratory-Specific Detection/Quantitation Limits

Matrix: Water
Analytical Group: Radionuclides

Radionuclides	CAS Number	Project Action Limit (pCi/L)	Project Action Limit Reference[a]	Site COPC?[b]	Laboratory-Specific MDAs (pCi//L)
Americium-241	14596-10-2	0.504	NAL	Yes	1
Cesium-137	10045-97-3	1.71	NAL	Yes	10
Neptunium-237	13994-20-2	0.763	NAL	Yes	1
Plutonium-238	13981-16-3	0.398	NAL	Yes	1
Plutonium-239/240	15117-48-3/14119-33-6	0.387	NAL	Yes	1
Technetium-99	14133-76-7	4 mRem/year-dose[d] , 900/19.0	MCL/NAL	Yes	25
Thorium-230	14269-63-7	0.572	NAL	Yes	1 (4[c])
Uranium-234	13966-29-5	10.24/0.739	MCL[e]/NAL	Yes	1 (17[c])
Uranium-235	15117-96-1	0.466/0.728	MCL[e] /NAL	Yes	1 (18[c])
Uranium-238	24678-82-8	9.99/0.601	MCL[e]/NAL	Yes	1 (19[c])

CAS = Chemical Abstract Service
COPC = chemical or radionuclide of potential concern
MDA = minimum detectable activity
N/A = not applicable analyte not identified as a site COPC
NAL = no action level for child resident scenario from the Risk Methods Document (DOE 2016)

[a] This QAPP references the MCLs (if available) to support project planning and identify whether lower reporting limits may be needed for some constituents. The worksheet also lists the NALs established by the Risk Methods Document (DOE 2016) for the child resident scenario
[b] Analytes marked with COPC are from Table 2.1 of the Risk Methods Document (DOE 2016) and represent the list of chemicals, compounds, and radionuclides compiled from chemicals of potential concern retained as contaminants of concern in risk assessments performed at PGDP between 1990 and 2008.
[c] The value in parentheses reflects MDAs requested under the Environmental Radiation Protection Program.
[d] The value derived by the EPA from the 4 mrem/year MCL for Tc-99 is 900 pCi/L (see http://www.epa.gov/reg-flex/radionuclides-drinking-water-small-entity-compliance-guide-february-2002). An alternate value derived by the EPA from the 4 mrem/year MCL is 3,790 pCi/L and was proposed in the July 18, 1991, *Federal Register*, http://nepis.epa.gov (document number 570-Z-91-049).
[e] The uranium MCL is 30 µg/L. The Risk Methods Document (DOE 2016) has converted the MCL using an uranium activity expected at PGDP. Isotopic uranium values derived from this conversion are 10.24 pCi/L for U-234, 0.466 pCi/L for U-235, and 9.99 pCi/L for U-238.

QAPP Worksheet #15-F.
Project Action Limits Laboratory-Specific Detection/Quantitation Limits

Matrix: Sediment
Analytical Group: PCBs

PCBs	CAS Number	Project Action Limit (mg/kg)	Project Action Limit Reference[a]	Site COPC?[b]	Laboratory-Specific	
					PQLs (mg/kg)	MDLs (mg/kg)
Aroclor 1016	12674-11-2	0.206	NAL	Yes	0.0033	0.001099
Aroclor 1221	11104-28-2	0.0710	NAL	Yes	0.0033	0.001099
Aroclor 1232	11141-16-5	0.0708	NAL	Yes	0.0033	0.001099
Aroclor 1242	53469-21-9	0.0796	NAL	Yes	0.0033	0.001099
Aroclor 1248	12672-29-6	0.0788	NAL	Yes	0.0033	0.001099
Aroclor 1254	11097-69-1	0.0588	NAL	Yes	0.0033	0.001099
Aroclor 1260	11096-82-5	0.0803	NAL	Yes	0.0033	0.001099

CAS = Chemical Abstracts Service
COPC = chemical or radionuclide of potential concern
MDL = method detection limit
NAL = no action level for child resident scenario from the Risk Methods Document (DOE 2016)
PCB = polychlorinated biphenyl
PQL = practical quantitation limit

Analytical laboratory results will be reported on a dry weight basis, as applicable, unless specified otherwise.
[a] This QAPP references the MCLs (if available) to support project planning and identify whether lower reporting limits may be needed for some constituents. The worksheet also lists the NALs established by the Risk Methods Document (DOE 2016) for the child resident scenario.
[b] Analytes marked with COPC are from Table 2.1 of the Risk Methods Document (DOE 2016) and represent the list of chemicals, compounds, and radionuclides compiled from chemicals of potential concern retained as contaminants of concern in risk assessments performed at PGDP between 1990 and 2008.

QAPP Worksheet #15-G.
Project Action Limits Laboratory-Specific Detection/Quantitation Limits

Matrix: Sediment
Analytical Group: Radionuclides

Radionuclides	CAS Number	Project Action Limit (pCi/g)	Project Action Limit Reference[a]	Site COPC?[b]	Laboratory-Specific MDAs (pCi/g)
Americium-241	14596-10-2	3.03	NAL	Yes	1
Cesium-137	10045-97-3	0.116	NAL	Yes	0.1
Neptunium-237	13994-20-2	0.239	NAL	Yes	1
Plutonium-238	13981-16-3	4.42	NAL	Yes	1
Plutonium-239/240	15117-48-3/ 14119-33-6	3.87	NAL	Yes	1
Technetium-99	14133-76-7	117	NAL	Yes	5
Thorium-230	14269-63-7	5.22	NAL	Yes	1
Uranium-234	13966-29-5	5.93	NAL	Yes	1
Uranium-235	15117-96-1	0.347	NAL	Yes	1
Uranium-238	24678-82-8	1.28	NAL	Yes	1

CAS = Chemical Abstracts Service
COPC = chemical or radionuclide of potential concern
NAL = no action level for child resident scenario from the Risk Methods Document (DOE 2016)
MDA = minimum detectable activity

Analytical laboratory results will be reported on a dry weight basis, as applicable, unless specified otherwise.
[a] This QAPP references the MCLs (if available) to support project planning and identify whether lower reporting limits may be needed for some constituents. The worksheet also lists the NALs established by the Risk Methods Document (DOE 2016) for the child resident scenario.
[b] Analytes marked with COPC are from Table 2.1 of the Risk Methods Document (DOE 2016) and represent the list of chemicals, compounds, and radionuclides compiled from chemicals of potential concern retained as contaminants of concern in risk assessments performed at PGDP between 1990 and 2008.

QAPP Worksheet #15-K.
Project Action Limits Laboratory-Specific Detection/Quantitation Limits

Matrix: Surface
Analyte Group: KPDES permit

KPDES Parameters with Permit Limits	CAS Number	Project Action Limit	Outfall	Site COPC?[a]	Laboratory-Specific	
					PQLs	MDLs
Total Suspended Solids	N/A	30 mg/L	Outfall 001, Outfall 004, Outfall 006, Outfall 013, Outfall 019, Outfall 020, C001	No	5 mg/L	1 mg/L
Oil & Grease	N/A	10 mg/L	Outfall 001, Outfall 006, Outfall 013, Outfall 019, Outfall 020, C001	No	7 mg/L	3.5 mg/L
Aroclor-1016	12674-11-2	500 ng/l	Outfall 001, Outfall 002, Outfall 008, Outfall 009, Outfall 010, Outfall 011, Outfall 012, Outfall 013, Outfall 015, Outfall 016, Outfall 017, Outfall 019, Outfall 020	Yes	0.1 µg/L	0.0333 µg/L
Aroclor-1221	11104-28-2	500 ng/l	Outfall 001, Outfall 002, Outfall 008, Outfall 009, Outfall 010, Outfall 011, Outfall 012, Outfall 013, Outfall 015, Outfall 016, Outfall 017, Outfall 019, Outfall 020	Yes	0.1 µg/L	0.0333 µg/L
Aroclor-1232	11141-16-5	500 ng/l	Outfall 001, Outfall 002, Outfall 008, Outfall 009, Outfall 010, Outfall 011, Outfall 012, Outfall 013, Outfall 015, Outfall 016, Outfall 017, Outfall 019, Outfall 020	Yes	0.1 µg/L	0.0333 µg/L
Aroclor-1242	53469-21-9	500 ng/l	Outfall 001, Outfall 002, Outfall 008, Outfall 009, Outfall 010, Outfall 011, Outfall 012, Outfall 013, Outfall 015, Outfall 016, Outfall 017, Outfall 019, Outfall 020	Yes	0.1 µg/L	0.0333 µg/L
Aroclor-1248	12672-29-6	500 ng/l	Outfall 001, Outfall 002, Outfall 008, Outfall 009, Outfall 010, Outfall 011, Outfall 012, Outfall 013, Outfall 015, Outfall 016, Outfall 017, Outfall 019, Outfall 020	Yes	0.1 µg/L	0.0333 µg/L
Aroclor-1254	11097-69-1	500 ng/l	Outfall 001, Outfall 002, Outfall 008,	Yes	0.1 µg/L	0.0333 µg/L

Matrix: Surface
Analyte Group: KPDES permit

KPDES Parameters with Permit Limits	CAS Number	Project Action Limit	Outfall	Site COPC?[a]	Laboratory-Specific	
					PQLs	MDLs
			Outfall 009, Outfall 010, Outfall 011, Outfall 012, Outfall 013, Outfall 015, Outfall 016, Outfall 017, Outfall 019, Outfall 020			
Aroclor-1260	11096-82-5	500 ng/l	Outfall 001, Outfall 002, Outfall 008, Outfall 009, Outfall 010, Outfall 011, Outfall 012, Outfall 013, Outfall 015, Outfall 016, Outfall 017, Outfall 019, Outfall 020	Yes	0.1 µg/L	0.0333 µg/L
Zinc	7440-66-6	119 µg/L	Outfall 013	Yes	10 µg/L	3.5 µg/L
Biochemical Oxygen Demand (BOD_5)	N/A	30 mg/L	Outfall 004	No	2 mg/L	1 mg/L

[a] Analytes marked with COPC (chemical or radionuclide of potential concern) are from Table 2.1 of the Risk Methods Document (DOE 2016) and represent the list of chemicals, compounds, and radionuclides compiled from COPCs retained as contaminants of concern in risk assessments performed at PGDP between 1990 and 2008.

QAPP Worksheet #15-M.
Project Action Limits Laboratory-Specific Detection/Quantitation Limits

Matrix: Drinking Water
Analytical Group: Inorganic Chemicals

Inorganic Chemicals	CAS Number	Project Action Limit (mg/L)	Project Action Limit Reference	Site COPC?[a]	Laboratory-Specific MRLs (mg/L)[b]
Antimony	7440-36-0	0.0060	MCL	Yes	0.004
Arsenic	7440-38-2	0.010	MCL	Yes	0.0005
Barium	7440-39-3	2	MCL	Yes	0.002
Beryllium	7440-41-7	0.0040	MCL	Yes	0.002
Cadmium	7440-43-9	0.0050	MCL	Yes	0.0005
Chromium (total)	7440-47-3	0.10	MCL	Yes	0.002
Copper	7440-50-8	1.3	MCL	Yes	0.001
Fluoride	16984-48-8	2	MCL	Yes	0.2
Lead	7439-92-1	0.015	MCL	Yes	0.0005
Mercury	7439-97-6	0.0020	MCL	Yes	0.0002
Nickel	7440-02-0	0.10	MCL	Yes	0.002
Selenium	7782-49-2	0.050	MCL	Yes	0.001
Thallium	7440-28-0	0.0020	MCL	Yes	0.0005

CAS = Chemical Abstracts Service
COPC = chemical or radionuclide of potential concern
MCL = maximum contaminant level
MRL = minimum reporting limit

[a] Analytes marked with COPC are from Table 2.1 of the Risk Methods Document (DOE 2016) and represent the list of chemicals, compounds, and radionuclides compiled from chemicals of potential concern retained as contaminants of concern in risk assessments performed at PGDP between 1990 and 2008.
[b] The drinking water laboratory is required to report MRLs to the Commonwealth of Kentucky.

QAPP Worksheet #15-N.
Project Action Limits Laboratory-Specific Detection/Quantitation Limits

Matrix: Drinking Water
Analytical Group: Synthetic Organic Chemicals

Synthetic Organic Chemicals	CAS Number	Project Action Limit (mg/L)	Project Action Limit Reference	Site COPC?[a]	Laboratory-Specific MRLs (mg/L)[b]
Benzo(a)pyrene	192-97-2	0.0002	MCL	Yes	0.00002
Dioxin / 2,3,7,8-TCDD	1746-01-6	0.00000003	MCL	Yes	0.000000005
Hexachlorobenzene	118-74-1	0.001	MCL	Yes	0.0001
PCB (Polychlorinated biphenyls)	1336-36-3	0.0005	MCL	Yes	0.0001
Pentachlorophenol	87-86-5	0.001	MCL	Yes	0.0004

CAS = Chemical Abstracts Service
COPC = chemical or radionuclide of potential concern
MCL = maximum contaminant level
MRL = minimum reporting limit

[a] Analytes marked with COPC are from Table 2.1 of the Risk Methods Document (DOE 2016) and represent the list of chemicals, compounds, and radionuclides compiled from chemicals of potential concern retained as contaminants of concern in risk assessments performed at PGDP between 1990 and 2008.
[b] The drinking water laboratory is required to report MRLs to the Commonwealth of Kentucky.

QAPP Worksheet #15-O.
Project Action Limits Laboratory-Specific Detection/Quantitation Limits

Matrix: Drinking Water
Analytical Group: Volatile Organic Chemicals

Volatile Organic Chemicals	CAS Number	Project Action Limit (mg/L)	Project Action Limit Reference	Site COPC?[a]	Laboratory-Specific MRLs (mg/L)[b]
1,1-Dichloroethene	75-35-4	0.007	MCL	Yes	0.0005
1,1,1-Trichloroethane	71-55-6	0.2	MCL	Yes	0.0005
1,1,2-Trichloroethane	79-00-5	0.005	MCL	Yes	0.0005
1,2-Dichloroethane	107-06-2	0.005	MCL	Yes	0.0005
Benzene	71-43-2	0.005	MCL	Yes	0.0005
Carbon Tetrachloride	56-23-5	0.005	MCL	Yes	0.0005
cis-1,2-Dichloroethene	156-59-2	0.07	MCL	Yes	0.0005
Ethylbenzene	100-41-4	0.07	MCL	Yes	0.0005
Tetrachloroethene	127-18-4	0.005	MCL	Yes	0.0005
trans-1,2-Dichloroethene	156-60-5	0.1	MCL	Yes	0.0005
Trichloroethene	79-01-6	0.005	MCL	Yes	0.0005
Vinyl Chloride	75-01-4	0.002	MCL	Yes	0.0005
Xylenes, total	1330-20-7	10	MCL	Yes	0.0005

CAS = Chemical Abstracts Service
COPC = chemical or radionuclide of potential concern
MCL = maximum contaminant level
MRL = minimum reporting limit

[a] Analytes marked with COPC are from Table 2.1 of the Risk Methods Document (DOE 2016) and represent the list of chemicals, compounds, and radionuclides compiled from chemicals of potential concern retained as contaminants of concern in risk assessments performed at PGDP between 1990 and 2008.
[b] The drinking water laboratory is required to report MRLs to the Commonwealth of Kentucky.

QAPP Worksheet #15-P.
Project Action Limits Laboratory-Specific Detection/Quantitation Limits

Matrix: Drinking Water
Analytical Group: Secondary Contaminants

Inorganic Chemicals	CAS Number	Project Action Limit (mg/L)	Project Action Limit Reference	Site COPC?[a]	Laboratory-Specific MRLs (mg/L)[b]
Aluminum	7429-90-5	0.2	MCL	Yes	0.02
Copper	7440-50-8	1.3	MCL	Yes	0.001
Iron	7439-89-6	0.3	MCL	Yes	0.02
Manganese	7439-96-5	0.05	MCL	Yes	0.002
Silver	7440-22-4	0.1	MCL	Yes	0.002
Zinc	7440-66-6	5	MCL	Yes	0.01

CAS = Chemical Abstracts Service
COPC = chemical or radionuclide of potential concern
MCL = maximum contaminant level
MRL = minimum reporting limit

[a] Analytes marked with COPC are from Table 2.1 of the Risk Methods Document (DOE 2016) and represent the list of chemicals, compounds, and radionuclides compiled from chemicals of potential concern retained as contaminants of concern in risk assessments performed at PGDP between 1990 and 2008.
[b] The drinking water laboratory is required to report MRLs to the Commonwealth of Kentucky.

QAPP Worksheet #15-Q.
Project Action Limits Laboratory-Specific Detection/Quantitation Limits

Matrix: Drinking Water
Analytical Group: Trihalomethanes

Inorganic Chemicals	CAS Number	Project Action Limit (mg/L)	Project Action Limit Reference	Site COPC?[a]	Laboratory-Specific MRLs (mg/L)[b]
Bromodichloromethane	75-27-4	0.08	MCL	Yes	0.001
Chloroform	67-66-3	0.08	MCL	Yes	0.001

CAS = Chemical Abstracts Service
COPC = chemical or radionuclide of potential concern
MCL = maximum contaminant level
MRL = minimum reporting limit

[a] Analytes marked with COPC are from Table 2.1 of the Risk Methods Document (DOE 2016) and represent the list of chemicals, compounds, and radionuclides compiled from chemicals of potential concern retained as contaminants of concern in risk assessments performed at PGDP between 1990 and 2008.
[b] The drinking water laboratory is required to report MRLs to the Commonwealth of Kentucky.

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

Sampling Location/ID Number	Matrix	Depth (units)	Analytical Group	Concentration Level[a]	Number of Samples (Identify Field Duplicates)	Sampling SOP Reference[b]	Rationale for Sampling Location
Sitewide (see Appendix C of the EMP for specific locations)	Sediment	Surface (Creek Bed Samples)	See Appendix C of the EMP	Varies by location and analyte	See Appendix C of the EMP (Minimum of 5%)	CP4-ES-2302, *Collection of Sediment Samples Associated with Surface Water*	See Appendix C of the EMP
	Drinking Water	N/A	See Appendix C of the EMP	Varies by location and analyte	See Appendix C of the EMP (None)	CP4-ES-2101, *Groundwater Sampling*	
	Surface Water	Surface Water in Creeks and Effluent Discharge	See Appendix C of the EMP	Varies by location and analyte	See Appendix C of the EMP (Minimum of 5%)	CP4-ES-2203, *Surface Water Sampling*	
	Groundwater	UCRS, URGA, LRGA	See Appendix C of the EMP	Varies by location and analyte	See Appendix C of the EMP (Minimum of 5%)	CP4-ES-2101, *Groundwater Sampling*	

[a] If historic data provide information on anticipated concentration, that information will be populated on this sheet.
[b] See Analytical SOP References Table (Worksheet #23).

N/A = not applicable
SOP = standard operating procedure

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)
Water	VOC[a]	Varies by location and analyte	See Worksheet #23	120 mL	3 × 40 mL Glass VOA Vial	HCl; pH < 2, cool to < 4°C, no headspace	14 days for preserved
Water	Metals	Varies by location and analyte	See Worksheet #23	1 liter	1 liter Plastic	HNO_3 pH < 2, Cool to < 4°C	6 months (28 days for Hg)
Water	Anions	Varies by location and analyte	See Worksheet #23	125 mL	125 mL Plastic	Cool to < 4°C	28 days (2 days for nitrate)
Water	PCBs	Varies by location and analyte	See Worksheet #23	1 liter	1 liter Amber Glass	Cool to < 4°C	N/A[c]
Water	RADs	Varies by location and analyte	See Worksheet #23	3 liters	3 × 1 liter Plastic	HNO_3 pH < 2, Cool to < 4°C[b]	6 months
Drinking Water	Metals for Inorganic Chemicals and Secondary Contaminants	Varies by location and analyte	See Worksheet #23	500 mL	500 mL Plastic	HNO_3	6 months
Drinking Water	Fluoride - Inorganic Chemicals	Varies by location and analyte	See Worksheet #23	500 mL	500 mL Plastic	Cool to < 4°C	28 days
Drinking Water	PCBs - Synthetic Organic Chemicals	Varies by location and analyte	See Worksheet #23	2 liters	2 × 1 liter Amber Glass	$Na_2S_2O_3$, Cool to < 4°C	N/A[c]
Drinking Water	Dioxin – Synthetic Organic Chemicals	Varies by location and analyte	See Worksheet #23	2 liters	2 × 1 liter Amber Glass	$Na_2S_2O_3$, Cool to < 4°C	N/A

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)
Drinking Water	Benzo(a)pyrene, Hexachlorobenzene – Synthetic Organic Chemicals	Varies by location and analyte	See Worksheet #23	2 liters	2 x 1 liter Amber Glass	$Na_2S_2O_3$, HCl	14 days
Drinking Water	Pentachlorophenol – Synthetic Organic Chemicals	Varies by location and analyte	See Worksheet #23	2 liters	2 x 1 liter Amber Glass	$Na_2S_2O_3$, Cool to < 4°C	14 days
Drinking Water	Volatile Organic Chemicals	Varies by location and analyte	See Worksheet #23	120 mL	3 x 40 mL Amber Vial	Ascorbic acid, HCl, Cool to < 4°C	14 days
Drinking Water	Trihalomethanes	Varies by location and analyte	See Worksheet #23	120 mL	3 x 40 mL Amber Vial	$Na_2S_2O_3$, Cool to < 4°C	14 days
Sediment	PCBs	Varies by location and analyte	See Worksheet #23	30 g	125 mL wide-mouth Amber Glass	Cool to < 4°C	N/A[c]
Sediment	RADs	Varies by location and analyte	See Worksheet #23	250 g	500 mL wide-mouth Plastic Straight Side	Cool to < 4°C	6 months

NOTE: Sample volume and container requirements will be specified by the laboratory. This table includes standard requirements for routine analytical groups.
*See Analytical SOP References table (Worksheet #23).
[a] For C-746-S&T and C-746-U Landfills groundwater samples, VOCs are collected in unpreserved vials with a 7-day holding time due to acrolein and acrylonitrile.
[b] Check with specific laboratory conducting analyses to ensure that acidification will not interfere with laboratory procedures.
[c] A 45-day holding time is an expectation of the laboratory; however, since SW-846 does not indicate a holding time for PCBs, any data that exceeds the 45 days will be identified, but not qualified.
HCl = hydrochloric acid; Hg = mercury; HNO_3 = nitric acid; PCB = polychlorinated biphenyl; RAD = radionuclide; VOC = volatile organic compound

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)**	Backup Laboratory/Organization*** (Name and Address, Contact Person and Telephone Number)
Sediment	PCBs	Varies by location and analyte	See Appendix C of the EMP	See Worksheet #23	28-day	GEL Laboratories, LLC 2040 Savage Road Charleston, SC 29407 PM: Valerie Davis (843) 769-7391	TestAmerica Laboratories, Inc. 13715 Rider Trail North Earth City, MO 63045 PM: Jayna Awalt (314) 298-8566
Sediment	Radionuclides	Varies by location and analyte		See Worksheet #23	28-day		
Water	PCBs	Varies by location and analyte		See Worksheet #23	28-day		
Water	Metals	Varies by location and analyte		See Worksheet #23	28-day		
Water	Radionuclides	Varies by location and analyte		See Worksheet #23	28-day		
Water	VOCs	Varies by location and analyte		See Worksheet #23	28-day		
Water	Anions and Miscellaneous	Varies by location and analyte		See Worksheet #23	28-day		
Drinking Water	Inorganic Chemicals	Varies by location and analyte		See Worksheet #23	10-day	McCoy & McCoy Laboratories, Inc. 825 Industrial Road Madisonville, KY 42431 PM: Archie Fugate (270) 824-2236	ESC Lab Sciences 12065 Lebanon Road Mt. Juliet, TN 37122 PM: Travis Johnson (615) 519-0752

QAPP Worksheet #30. (Continued)
Analytical Services Table

Matrix	Analytical Group	Concentration Level	Sample Locations/ID Numbers	Analytical SOP*	Data Package Turnaround Time	Laboratory/Organization (Name and Address, Contact Person and Telephone Number)**	Backup Laboratory/Organization*** (Name and Address, Contact Person and Telephone Number)
Drinking Water	Synthetic Organic Chemicals	Varies by location and analyte		See Worksheet #23	10-day	McCoy & McCoy Laboratories, Inc. 825 Industrial Road Madisonville, KY 42431 PM: Archie Fugate (270) 824-2236	ESC Lab Sciences 12065 Lebanon Road Mt. Juliet, TN 37122 PM: Travis Johnson (615) 519-0752
Drinking Water	Volatile Organic Chemicals	Varies by location and analyte		See Worksheet #23	10-day	McCoy & McCoy Laboratories, Inc. 825 Industrial Road Madisonville, KY 42431 PM: Archie Fugate (270) 824-2236	ESC Lab Sciences 12065 Lebanon Road Mt. Juliet, TN 37122 PM: Travis Johnson (615) 519-0752
Drinking Water	Secondary Contaminants	Varies by location and analyte		See Worksheet #23	10-day	McCoy & McCoy Laboratories, Inc. 825 Industrial Road Madisonville, KY 42431 PM: Archie Fugate (270) 824-2236	ESC Lab Sciences 12065 Lebanon Road Mt. Juliet, TN 37122 PM: Travis Johnson (615) 519-0752
Drinking Water	Trihalomethanes	Varies by location and analyte		See Worksheet #23	10-day	McCoy & McCoy Laboratories, Inc. 825 Industrial Road Madisonville, KY 42431 PM: Archie Fugate (270) 824-2236	ESC Lab Sciences 12065 Lebanon Road Mt. Juliet, TN 37122 PM: Travis Johnson (615) 519-0752

*Analytical method SOPs for radiochemistry parameters are laboratory specific.
**These are current laboratories and are subject to change.
***TestAmerica Laboratories, Inc. will be used as a backup for GEL Laboratories, LLC, for any analyses not requiring a Kentucky wastewater laboratory certification. Southwest Research Institute will be used as a backup laboratory for Kentucky wastewater certification analyses.
ID = identification
PCB = polychlorinated biphenyl
TBD = to be determined
VOC = volatile organic compound

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	Total No. of Samples to Lab
Sediment	PCBs	Varies by location and analyte	See Worksheet #12	See Appendix C of the EMP	5%	5%	5%	5%	See Appendix C of EMP
Sediment	Radionuclides	Varies by location and analyte	See Worksheet #12	See Appendix C of the EMP	5%	5%	5%	5%	See Appendix C of EMP
Water (Groundwater and Surface Water)	VOCs	Varies by location and analyte	See Worksheet #12	See Appendix C of the EMP	5%	5%	5%	5%	See Appendix C of EMP
Water (Groundwater and Surface Water)	Metals	Varies by location and analyte	See Worksheet #12	See Appendix C of the EMP	5%	5%	5%	5%	See Appendix C of EMP
Water (Groundwater and Surface Water)	PCBs	Varies by location and analyte	See Worksheet #12	See Appendix C of the EMP	5%	5%	5%	5%	See Appendix C of EMP
Water (Groundwater and Surface Water)	Radionuclides	Varies by location and analyte	See Worksheet #12	See Appendix C of the EMP	5%	5%	5%	5%	See Appendix C of EMP

MS = matrix spike
PCB = polychlorinated biphenyl
VOC = volatile organic compound

QAPP Worksheet #21.
Project Sampling SOP References Table

Site-specific standard operating procedures (SOPs) have been developed for site sampling and data management activities.

Reference Number	Title and Number[a]	Originating Organization[b]	Equipment Type	Modified for Project Work? (Y/N)	Comments
1	CP4-ES-0043, *Temperature Control for Sample Storage*	Contractor	Sampling	N	N/A
2	CP2-WM-0001, *FRNP Waste Management Plan*	Contractor	N/A	N	N/A
3	CP2-ES-0026, *Wet Chemistry and Miscellaneous Analyses Data Verification and Validation*	Contractor	N/A	N	N/A
4	CP2-ES-0811, *Pesticide and PCB Data Verification and Validation*	Contractor	N/A	N	N/A
5	CP4-ES-1001, *Transmitting Data to the Paducah Oak Ridge Environmental Information System (OREIS)*	Contractor	N/A	N	N/A
6	CP2-ES-0063, *Environmental Monitoring Data Management Plan*	Contractor	N/A	N	N/A
7	CP4-ES-2100, *Groundwater Level Measurement*	Contractor	Sampling	N	N/A
8	CP4-ES-2101, *Groundwater Sampling*	Contractor	Sampling	N	N/A
9	CP4-ES-2203, *Surface Water Sampling*	Contractor	Sampling	N	N/A
10	CP4-ES-2302, *Collection of Sediment Samples Associated with Surface Water*	Contractor	Sampling	N	N/A
11	CP4-ES-0074, *Monitoring Well Inspection and Maintenance*	Contractor	Sampling	N	N/A
12	CP4-ES-2700, *Logbooks and Data Forms*	Contractor	N/A	N	N/A
13	CP4-ES-2702, *Decontamination of Sampling Equipment and Devices*	Contractor	Sampling	N	N/A
14	CP4-ES-2704, *Trip, Equipment, and Field Blank Preparation*	Contractor	N/A	N	N/A
15	CP4-ES-2708, *Chain-of-Custody Forms, Field Sample Logs, Sample Labels, and Custody Seals*	Contractor	N/A	N	N/A

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

Reference Number	Title and Number[a]	Originating Organization[b]	Equipment Type	Modified for Project Work? (Y/N)	Comments
16	CP3-ES-5003, *Quality Assured Data*	Contractor	N/A	N	N/A
17	CP3-ES-5004, *Sample Tracking, Lab Coordination, and Sample Handling Guidance*	Contractor	N/A	N	N/A
18	CP4-ES-5007, *Data Management Coordination*	Contractor	N/A	N	N/A
19	CP2-ES-5102, *Radiochemical Data Verification and Validation*	Contractor	N/A	N	N/A
20	CP2-ES-5103, *Polychlorinated Dibenzodioxins-Polychlorinated Dibenzofurans Analyses Data Verification and Validation*	Contractor	N/A	N	N/A
21	CP2-ES-5105, *Volatile and Semivolatile Data Verification and Validation*	Contractor	N/A	N	N/A
22	CP2-ES-5107, *Inorganic Data Validation and Verification*	Contractor	N/A	N	N/A
23	CP2-ES-0026, *Wet Chemistry and Miscellaneous Analyses Data Verification and Validation*	Contractor	N/A	N	N/A
24	CP3-ES-1003, *Developing, Implementing, and Maintaining Data Management Implementation Plans*	Contractor	N/A	N	N/A
25	CP4-ES-1002, *Submitting, Reviewing, and Dispositioning Changes to the Environmental Databases OREIS and PEMS*	Contractor	N/A	N	N/A

[a] SOPs are posted to the FRNP intranet Web site. External FFA parties can access this site using remote access with privileges upon approval. It is understood that SOPs are contractor specific.
[b] The work will be conducted by FRNP staff or a subcontractor. In either case, SOPs listed will be followed.
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
Water Quality Meter (permit application of the landfills specify Hydrolab)	Calibration check 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	Per manufacturer's specifications	Recalibrate or service as necessary	Field Team Leader	Manufacturer's specifications
Turbidity Meter (Nephthelometer)	Accuracy check at the beginning of each day's use	As needed	Measure solutions with known turbidity standards	Upon receipt, successful operation	Check daily before each use	N/A (instrument zeroed)	Service by manufacturer or replace	Field Team Leader	Manufacturer's specifications
Ferrous Iron Colorimeter	Accuracy check at the beginning of each day's use	Return to manufacturer as needed	Measure with standard solution	Upon receipt, successful operation	Check daily before each use	Within range of manufacturer's standard	Service by manufacturer or replace	Field Team Leader	Manufacturer's specifications
Colorimeter (for total residual chlorine)	Accuracy check at the beginning of each day's use	As needed	Measure with standard solution	Upon receipt, successful operation	Check daily before each use	Within range of manufacturer's standard	Service by manufacturer or replace	Field Team Leader	Manufacturer's specifications
Titrator (for total residual chlorine)	Accuracy check at the beginning of each day	As needed	Measure with standard solution	Upon receipt, successful operation	Check daily before each use	With range of manufacturer's standard	Service by manufacturer or replace	Field Team Leader	Manufacturer's specifications
Electron Water Level Meter	Accuracy check annually against a steel tape	Replace as needed	Annual verification	Upon receipt, successful operation	Check daily before each use	Pass/Fail	Service by manufacturer or replace	Field Team Leader	Manufacturer's specifications
Hach flow meter	Calibrate to readings on flume	Quarterly or as needed	Measure against flume	Upon receipt, successful operation	Weekly as needed	Pass/Fail	Service by manufacturer or replace	Field Team Leader	Manufacturer's specifications

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-846-8260/ EPA-624	Volatile Organic Compounds by Gas Chromatography/ Mass Spectrometry (GC/MS)	Definitive	VOA (Unless noted below)	Per SOP	GEL Laboratories, Charleston, SC	N
SW-846-8011	1,2-Dibromoethane and 1,2-Debromo-3-Chloropropane by Microextraction and Gas Chromatography	Definitive	VOA (1,2-Dibromo-3-chloropropane)	Per SOP	GEL Laboratories, Charleston, SC	N
SW-846-9056/ EPA-300.0	Determination of Inorganic Anions by Ion Chromatography	Definitive	Anions	Per SOP	GEL Laboratories, Charleston, SC McCoy & McCoy Laboratories, Inc., Madisonville, KY (Drinking Water)	N
N/A	RSK175	Definitive	VOA (Ethene, Ethane, Methane)	Per SOP	GEL Laboratories, Charleston, SC	N

QAPP Worksheet #23. (Continued)
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)
EPA-410.4	Determination of Chemical Oxygen Demand by Semi-Automated Colorimetry	Definitive	Miscellaneous (Chemical Oxygen Demand)	Per SOP	GEL Laboratories, Charleston, SC	N
EPA-350.1	Determination of Ammonia Nitrogen by Semi-Automated Colorimetry	Definitive	Miscellaneous (Ammonia as Nitrogen)	Per SOP	GEL Laboratories, Charleston, SC	N
SW-846-9010/9012B	Total and Amenable Cyanide	Definitive	Miscellaneous (Cyanide)	Per SOP	GEL Laboratories, Charleston, SC	N
SW-846-9040	pH Electrometric Measurement	Definitive	Miscellaneous (pH—when not as field measurement)	Per SOP	GEL Laboratories, Charleston, SC	N
SM 5210 B	Standard Method for Biochemical Oxygen Demand	Definitive	Miscellaneous (Carbonaceous Biological Oxygen Demand)	Per SOP	GEL Laboratories, Charleston, SC	N
EPA-180.1	Determination of Turbidity by Nephelometry	Definitive	Miscellaneous (Turbidity—when not as field measurement)	Per SOP	GEL Laboratories, Charleston, SC	N
EPA-130.2/ SM 2340 B	Hardness	Definitive	Miscellaneous (Hardness)	Per SOP	GEL Laboratories, Charleston, SC	N
SW-846-9060	Total Organic Carbon	Definitive	Miscellaneous (Total Organic Carbon)	Per SOP	GEL Laboratories, Charleston, SC	N

QAPP Worksheet #23. (Continued)
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)
EPA-160.1	Total Dissolved Solids	Definitive	Miscellaneous (Total Dissolved Solids)	Per SOP	GEL Laboratories, Charleston, SC	N
EPA-160.2/ SM 2540 D	Total Suspended Solids	Definitive	Miscellaneous (Total Suspended Solids)	Per SOP	GEL Laboratories, Charleston, SC	N
SM 2540 B	Solids in Water	Definitive	Miscellaneous (Total Solids)	Per SOP	GEL Laboratories, Charleston, SC	N
EPA-365.4	Phosphorous, Total	Definitive	Miscellaneous (Total Phosphorous)	Per SOP	GEL Laboratories, Charleston, SC	N
SW-846-9020	Total Organic Halides (TOX)	Definitive	Miscellaneous (Total Organic Halides)	Per SOP	GEL Laboratories, Charleston, SC	N
EPA-200.7	Trace Elements in Water, Solids, and Biosolids by Inductively Coupled Plasma-Atomic Emission Spectrometry	Definitive	Miscellaneous (Silica) Inorganic Chemicals for Drinking Water	Per SOP	GEL Laboratories, Charleston, SC McCoy & McCoy Laboratories, Inc., Madisonville, KY (Drinking Water)	N
SM 9223	Enzyme Substrate Coliform Test	Definitive	Miscellaneous (Total Coliform)	Per SOP	McCoy & McCoy Laboratories, Inc., Paducah, KY	N

QAPP Worksheet #23. (Continued)
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)
EPA-310.1	Alkalinity	Definitive	Miscellaneous (Alkalinity)	Per SOP	GEL Laboratories, Charleston, SC	N
EPA-1664 A	Determination of Oil and Grease and Total Petroleum Hydrocarbons in Waste Water	Definitive	Miscellaneous (Oil and Grease)	Per SOP	GEL Laboratories, Charleston, SC	N
SW-846-6020/ EPA-200.8	Inductively Coupled Plasma-Mass Spectrometry	Definitive	Metals (Unless noted below)	Per SOP	GEL Laboratories, Charleston, SC McCoy & McCoy Laboratories, Inc., Madisonville, KY (Drinking Water)	N
SW-846-7470/ EPA-245.2	Cold Vapor Atomic Absorption	Definitive	Metals (Mercury)	Per SOP	GEL Laboratories, Charleston, SC	N
SW-846-8082	Polychlorinated Biphenyls (PCBs) by Gas Chromatography	Definitive	PCBs	Per SOP	GEL Laboratories, Charleston, SC	N
SW-846-9310/ EPA-900.0	Gross Alpha and Gross Beta	Definitive	Radionuclides (Gross Alpha and Gross Beta)	Per SOP	GEL Laboratories, Charleston, SC	N
EPA-906.0	Tritium in Drinking Water	Definitive	Radionuclides (Tritium)	Per SOP	GEL Laboratories, Charleston, SC	N
Gamma Spec	Gamma Spectrometry	Definitive	Radionuclides (Cesium-137)	Per SOP	GEL Laboratories, Charleston, SC	N

QAPP Worksheet #23. (Continued)
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)
Gas Flow Proportional	Gas Flow Proportional	Definitive	Radionuclides (Strontium-90)	Per SOP	GEL Laboratories, Charleston, SC	N
Liquid Scintillation	Tc-99 by Liquid Scintillation	Definitive	Radionuclides (Technetium-99)	Per SOP	GEL Laboratories, Charleston, SC	N
Alpha Spec	Alpha Spectrometry	Definitive	Radionuclides (Americium-241, Thorium-230, Uranium-234, Uranium-235, Uranium-238, Neptunium-237, Plutonium-238, Plutonium-239/240)	Per SOP	GEL Laboratories, Charleston, SC	N
EPA-1613	Tetra-Through Octa-Chlorinated Dioxins and Furans by Isotope Dilution HRGC/HRMS	Definitive	Synthetic Organic Chemicals in Drinking Water	Per SOP	McCoy & McCoy Laboratories, Inc., Madisonville, KY	N
EPA-508	Determination of Chlorinated Pesticides in Water by Gas Chromatography with an Electron Capture Detector	Definitive	Synthetic Organic Chemicals in Drinking Water	Per SOP	McCoy & McCoy Laboratories, Inc., Madisonville, KY	N

QAPP Worksheet #23. (Continued)
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)
EPA-515.1	Determination of Chlorinated Acids in Water by Gas Chromatography with Electron Capture Detector	Definitive	Synthetic Organic Chemicals in Drinking Water	Per SOP	McCoy & McCoy Laboratories, Inc., Madisonville, KY	N
EPA-550.1	Polycyclic Aromatic Hydrocarbons in Drinking Water by Liquid-Solid Extraction and HPLC with Coupled Ultraviolet and Fluorescence Detection	Definitive	Synthetic Organic Chemicals in Drinking Water	Per SOP	McCoy & McCoy Laboratories, Inc., Madisonville, KY	N
EPA-524.2/EPA-524.3	Measurement of Purgeable Organic Compounds in Water by Capillary Column Gas Chromatography/ Mass Spectrometry	Definitive	Volatile Organic Chemicals and Trihalomethanes in Drinking Water	Per SOP	McCoy & McCoy Laboratories, Inc., Madisonville, KY	N

*Information will be based on laboratory used.

QAPP Worksheet #24.
Analytical Instrument Calibration Information

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.

The laboratory is responsible for maintaining instrument calibration information per their QA Plan including control charts established for all instrumentation. This information is audited annually by DOECAP. Laboratory(s) contracted will be DOECAP audited, with the exception of the laboratory used to support the drinking water program. This laboratory is drinking water certified by the Commonwealth of Kentucky and provides the required information to FRNP to be included on the approved suppliers list.

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 maintenance; replace/clip capillary column	QC standards	ECD, FID, injector, injector liner, column, column flow	As needed	Must meet initial and/or continuing calibration criteria	Repeat maintenance activity or remove from service	Laboratory Section Manager	See Worksheet #23
ICP-MS and ICP-AES	Clean plasma torch; clean filters; clean spray and nebulizer chambers; replace pump tubing	QC standards	Torch, filters, nebulizer chamber, pump, pump tubing	As needed	Must meet initial and/or continuing calibration criteria	Repeat maintenance activity or remove from service	Laboratory Area Supervisor	See Worksheet #23
pH meter	Clean probe	QC standards	Probe	As needed	The value for each of the certified buffer solutions must be within ± 0.05 pH units of the expected value	Repeat maintenance activity or remove from service	Laboratory Manager	See Worksheet #23
Spectrophotometer	Flush/replace tubing	QC standards	Tubing	As needed	Must meet initial and/or continuing calibration criteria	Repeat maintenance activity of remove from service	Laboratory Manager	See Worksheet #23
TOC Analyzer (NDIRD)	Replace sample tubing, clean sample boat, replace syringe	QC standards	Tubing, sample boat, syringe	As needed	Must meet initial and/or continuing calibration criteria	Repeat maintenance activity or remove from service	Laboratory Manager	See Worksheet #23
CVAA	Replace tubing, check instrument lines and connections, check windows in cell, ensure lamp is operational	QC standards	Instrument lines and connections, windows, and lamp	As needed	Must meet initial and/or continuing calibrations criteria	Repeat maintenance activity or remove from service	Laboratory Manager	See Worksheet #23

*The laboratory is responsible for maintaining instrument and equipment maintenance, testing, and inspection information per their QA Plan. This information is audited annually by DOECAP. Laboratory(s) contracted will be DOECAP audited, with the exception of the laboratory used to support the drinking water program. This laboratory is drinking water certified by the Commonwealth of Kentucky and provides the required information to FRNP to be included on the approved suppliers list. Field survey/sampling instrumentation will be maintained, tested, and inspected according to manufacturer's instructions.

CVAA = cold vapor atomic absorption; ECD = electron capture detector; GC = gas chromatography; GC-MS = gas chromatography mass spectrometer; ICP-AES = inductively coupled plasma atomic; emission spectroscopy; ICP-MS = inductively coupled plasma mass spectrometer; NDIRD = nondispersive infrared detector; QC = quality control; TOC = total organic carbon

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 or UPS in accordance with the on-site transportation plan or U.S. Department of Transportation requirements.
SAMPLE RECEIPT AND ANALYSIS	
Sample Receipt (Personnel/Organization):	Sample Management/Contracted Laboratory
Sample Custody and Storage (Personnel/Organization):	Sample Management/Contracted Laboratory
Sample Preparation (Personnel/Organization):	Analysts/Contracted Laboratory
Sample Determinative Analysis (Personnel/Organization):	Analysts/Contracted Laboratory
SAMPLE ARCHIVING	
Field Sample Storage (No. of days from sample collection):	The fixed-base laboratory will archive samples for 4 months or less depending on project-specific requirements.
Sample Extract/Digestate Storage (No. of days from extraction/digestion):	120 Days
Biological Sample Storage (No. of days from sample collection):	Not applicable.
SAMPLE DISPOSAL	
Personnel/Organization:	Waste Disposition/Sample Management Office/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 CP4-ES-2708, *Chain-of-Custody Forms, Field Sample Logs, Sample Labels, and Custody Seals*; and CP3-ES-5004, *Sample Tracking, Lab Coordination, and Sample Handling Guidance*.

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

Are per the DOECAP-audited or drinking water Commonwealth of Kentucky-certified laboratory's standard procedures. 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 the Environmental Monitoring Data Management Implementation Plan.

Chain-of-custody Procedures:

Chain-of-custody requirements will be per DOE Prime Contractor procedures CP4-ES-2708, *Chain-of-Custody Forms, Field Sample Logs, Sample Labels, and Custody Seals*; and CP3-ES-5004, *Sample Tracking, Lab Coordination, and Sample Handling Guidance*.

*It is understood that SOPs are contractor specific.

QAPP Worksheet #28.
QC Samples Table

Matrix: Sediment, Water (Groundwater and Surface Water)—excludes air filters and TLDs
Analytical Group/Concentration Level: VOC, Metals, PCBs, Rads
Sampling SOP: See Worksheet #12
Analytical Method/SOP Reference: See Worksheet #23
Sampler's Name/Field Sampling Organization: GEO Consultants
Analytical Organization: Environmental Monitoring
No. of Sample Locations: See Appendix C of the EMP

QC Sample	Frequency/Number*	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Field blank	Minimum 5%	≤ CRQL**	Verify results; reanalyze	Laboratory should alert project	Contamination—Accuracy/bias	See procedure CP3-ES-5003, *Quality Assured Data*
Trip blank	1 per cooler containing VOC samples	≤ CRQL**	Verify results; reanalyze		Contamination—Accuracy/bias	See procedure CP3-ES-5003, *Quality Assured Data*
Equipment blank	Minimum 5%	≤ CRQL**	Verify results; reanalyze		Contamination—Accuracy/bias	See procedure CP3-ES-5003, *Quality Assured Data*
Spiked field samples (MS and/or MSD)	1 per analytical batch	See data validation plans CP2-ES-0026, -0811, -5102, -5105, -5107	Check calculations and instrument; reanalyze affected samples	Laboratory should alert project	Accuracy/Precision	See procedure CP3-ES-5003, *Quality Assured Data*
Laboratory spiked blanks (LCS)	1 per analytical batch	See data validation plans CP2-ES-5105, -5107	Check calculations and instrument; reanalyze affected samples	Laboratory should alert project	Contamination—Accuracy/bias	See procedure CP3-ES-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 Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method blank	1 per analytical batch	See data validation plans CP2-ES-0026, -0811, -5102, -5105, -5107	Check calculations and instrument; reanalyze affected samples	Laboratory should alert project	Accuracy	See procedure CP3-ES-5003, *Quality Assured Data*
Surrogate standards	All samples, blanks, and QC samples	See data validation plans CP2-ES--0811, -5105	Check calculations and instrument; reanalyze affected samples	Laboratory should alert project	Accuracy	See procedure CP3-ES-5003, *Quality Assured Data*
Internal standards	All samples and standards	See data validation plan CP2-ES-5107	Check calculations and instrument; reanalyze affected samples	Laboratory should alert project	Accuracy	See procedure CP3-ES-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 Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Field duplicate	Minimum 5%	None	Data reviewer will place qualifiers on samples affected	Project	Homogeneity/ Precision	RPD ≤ 50% sediment, RPD < 25% aqueous
Laboratory duplicate	Per laboratory procedure	See data validation plans CP2-ES-0026, -0811, -5102, -5105, -5107	Verify results re-prepare and reanalyze	Laboratory analyst	Precision	See procedure CP3-ES-5003, *Quality Assured Data*
Tracers/Carriers	Each sample tested by a radiochemical separation method	See data validation plan CP2-ES-5102	Check calculations and instrument; reanalyze affected samples	Laboratory analyst	Accuracy	See procedure CP3-ES-5003, *Quality Assured Data*

*The number of QC samples is listed on Worksheet #20. Trip blanks are the only QC samples collected under the drinking water program.
**Unless dictated by project-specific parameters, ≤ CRQL.

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 (electronic or paper) and associated completed sampling forms; sample chains-of-custody	Laboratory data packages, OREIS database, and associated data packages	OREIS database and associated data packages	CP3-ES-5003-F01, "Data Assessment Review Checklist and Comment Form"	CP3-OP-0009-F01, "Performance Observation Checklist" form (quarterly assessment on permit driven sampling event is stipulated in the EMP)

*It is understood that SOPs are contractor specific.

OREIS = Oak Ridge Environmental Information System

QAPP Worksheet #31.
Planned Project Assessments Table

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

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

A = assessment frequency determined by QA Manager and conducted per CP3-QA-1003, *Management and Self-Assessment*.
B = assessment frequency determined by Project Manager.
*Reference: CP3-OP-0009, *Performance Observations*.

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 CP3-OP-0002, *Developing and Maintaining Performance Documents*. Field modifications are documented through the work control process per CP3-SM-1101, *Activity Level Work Request, Planning, Scheduling, and Release*. Corrective action in the field may be necessary when the sampling design is changed. For example, a change in the field may include increasing the number or type of samples or analyses, changing sampling locations, and/or modifying sampling protocol. When this occurs, the project team shall identify any suspected technical or QA deficiencies and note them in the field logbook. Listed in Worksheet #32 is how project teams will address assessment findings.

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (Name, Title, Organization)	Time frame of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response (Name, Title, Org.)	Time Frame for Response
Management, Independent, and Surveillances	CP3-QA-1003, *Management and Self-Assessment*, and form CP3-QA-3001-F02, "Issue Identification Form"	Project management, issue owner, contractor	Upon issuance of the management/ self-assessment documentation, form CP3-QA-3001-F02, "Issue Identification Form," will be completed and attached to the assessment report	CP3-QA-3001-F02, "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 CP3-QA-3001

*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
Field Audit Report	TBD as determined by QA Manager	30 days after completion of audit	QA Manager	FRNP Project Manager QA Manager
Corrective Action Plan	As needed	Within 3 weeks of request	Project Manager	QA Manager

TBD = to be determined
QA = quality assurance

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[a]	Internal/ External	Responsible for Verification (Name, Organization)
Field Logbooks/Data Forms	Field logbooks are verified per DOE Prime Contractor procedure, CP4-ES-2700, *Logbooks and Data Forms*, and CP3-ES-5003, *Quality Assured Data*.	Internal	Project Management or designee, Contractor
Chains-of-Custody	Chains-of-custody are controlled by DOE Prime Contractor procedure, CP3-ES-5004, *Sample Tracking, Lab Coordination and Sample Handling Guidance*. Chains-of-custody will be included in data assessment packages for review as part of data verification and data assessment.	Internal	Sample Management Office Personnel, and Project Management, Contractor
Field and Laboratory Data	Field and analytical data are verified and assessed per DOE Prime Contractor procedure, CP3-ES-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 Management Office Personnel, and Project Management, 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 Management Office Personnel, Project Management, and QA Personnel,[b] Contractor
Laboratory Data	All laboratory data will be verified by the laboratory performing the analysis for completeness and technical accuracy prior to submittal to FRNP. Subsequently, FRNP will evaluate the data packages for completeness and compliance.	External/ Internal	Laboratory Manager, FRNP Sample Management Office Personnel
Electronic Data Deliverables (EDDs)	Determine whether required fields and format were provided.	Internal	Sample Management Office Personnel
QAPP	All planning documents will be available to reviewers to allow reconciliation with planned activities and objectives.	Internal	All data users

[a] It is understood that SOPs are contractor specific.
[b] QA specialist performs general QA review.

QAPP Worksheet #35.
Assessment, Verification, and Validation (Steps IIa and IIb) Process Table

Step IIa/IIb	Validation Input	Description[a]	Responsible for Validation (Name, Organization)
IIa	Data Deliverables, Analytes, and Holding Times	The documentation from the contractual screening will be included in the data assessment packages, per DOE Prime Contractor procedure CP3-ES-5003, *Quality Assured Data*.	Sample Management Office Personnel, Contractor
IIa	Chain-of-Custody, Sample Handling, Sampling Methods and Procedures, and Field Transcription	These items will be validated during the data assessment process as required by DOE Prime Contractor procedure, CP3-ES-5003, *Quality Assured Data*, and CP3-ES-1003, *Developing, Implementing, and Maintaining Data Management Implementation Plans*. The documentation of this validation will be included in the data assessment packages.	Sample Management Office Personnel, Contractor
IIa	Analytical Methods and Procedures, Laboratory Data Qualifiers, and Standards	These items will be reviewed during the data validation process as required by DOE Prime Contractor data validation procedures. Data validation will be performed in parallel with data assessment. The data validation report and data validation qualifiers will be considered when the data assessment process is being finalized.	Data Validation Subcontractor, and Sample Management Office Personnel, 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 Management Office Personnel, Project, and QA Personnel, Contractor
IIb	Sampling Plan, Sampling Procedures, Collocated Field Duplicates, Project Quantitation Limits, Confirmatory Analyses, Performance Criteria	These items will be evaluated as part of the data verification and data assessment process per DOE Prime Contractor procedure, CP3-ES-5003, *Quality Assured Data*. These items will be considered when evaluating whether the project met their data quality objectives.	Sample Management Office Personnel, Project, and QA Personnel, Contractor

[a] 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	Sediments	All	All	National Functional Guidelines; Worksheets #12, #15, and #28; and CP2-ES-0026, CP2-ES-0811, CP2-ES-5102, CP2-ES-5105, and CP2-ES-5107	Data Validator[a]
Step IIa/IIb	Water	All	All		Data Validator[a]

[a] Validation is to be conducted by a qualified individual, independent from sampling, laboratory, project management, or other decision making personnel for the task. This could be an outside party or someone within FRNP who is not involved in the project.

QAPP Worksheet #37.
Usability Assessment*

FRNP 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 CP3-ES-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 plans are used: CP2-ES-0026, CP2-ES-0811, CP2-ES-5102, CP2-ES-5105, and CP2-ES-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 CP3-ES-5003, *Quality Assured Data*. This information will be included in the data assessment packages for review by project personnel. Data assessment also will include documentation of QC exceedances, trends, and/or bias in the data set. Data assessment will document any statistics used.

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

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

*It is understood that SOPs are contractor specific.