**Department of Energy**

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November 20, 2023

Mr. David Ruckstuhl, Prime Contracts Manager
Four Rivers Nuclear Partnership, LLC
5511 Hobbs Road
Kevil, Kentucky 42053

PPPO-02-10025536-24

Dear Mr. Ruckstuhl:

**DE-EM0004895: APPROVAL OF DELIVERABLE NO. 42, FINAL ENVIRONMENTAL MONITORING PLAN FISCAL YEAR 2024, CP2-ES-0006/FR10**

Reference: Letter from M. Redfield to M. Fultz, "Four Rivers Nuclear Partnership, LLC—For Approval—Deliverable No.42—FINAL *Environmental Monitoring Plan Fiscal Year 2024 Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* CP2-ES-0006/FR10," (FRNP-23-7808), dated October 26, 2023

The U.S. Department of Energy reviewed and approves the Four Rivers Nuclear Partnership, LLC, Deliverable No. 42, Final *Environmental Monitoring Plan Fiscal Year 2024 Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, CP2-ES-0006/FR10.

If you have any questions or require additional information, please contact Richard Bonczek at (859) 321-7127.

Sincerely,

MARCIA FULTZ
Digitally signed by MARCIA FULTZ
Date: 2023.11.20 10:31:18 -05'00'

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CP2-ES-0006/FR10

# Environmental Monitoring Plan
# Fiscal Year 2024
# Paducah Gaseous Diffusion Plant,
# Paducah, Kentucky

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**CP2-ES-0006/FR10**

# Environmental Monitoring Plan
# Fiscal Year 2024
# Paducah Gaseous Diffusion Plant,
# Paducah, Kentucky

Date Issued—November 2023

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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# TABLES



# FIGURES

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# ACRONYMS

| | |
|---|---|
| AEC | Atomic Energy Commission |
| AIP | Agreement in Principle |
| ASD | alternate source demonstration |
| 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 |
| $DUF_6$ | depleted uranium hexafluoride |
| 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 |
| FRNP | Four Rivers Nuclear Partnership, LLC |
| FY | fiscal year |
| GSA | General Services Administration |
| ISMS | Integrated Safety Management System |
| *KAR* | *Kentucky Administrative Regulation* |
| KDFWR | Kentucky Department of Fish and Wildlife Resources |
| KDOW | Kentucky Division of Water |
| KDWM | Kentucky Division of Waste Management |
| KPDES | Kentucky Pollutant Discharge Elimination System |
| MCS | Mid-America Conversion Services, LLC |
| MCL | maximum contaminant level |
| MDA | minimum detectable activity |
| MDL | method detection limit |
| MEI | maximally exposed individual |
| 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 | Oak Ridge Environmental Information System |
| OU | operable unit |
| PCB | polychlorinated biphenyl |
| PGDP | Paducah Gaseous Diffusion Plant |
| PQL | practical quantification limit |
| QA | quality assurance |
| QAPP | Quality Assurance Project Plan |
| RCRA | Resource Conservation and Recovery Act |

| | |
|---|---|
| RGA | Regional Gravel Aquifer |
| RI | remedial investigation |
| ROD | Record of Decision |
| SARA | Superfund Amendments Reauthorization Act |
| SPCC | spill prevention control and countermeasure |
| SSPP | Strategic Sustainability Performance Plan |
| SWMU | solid waste management unit |
| TED | total effective dose |
| VOC | volatile organic compound |
| WKWMA | West Kentucky Wildlife Management Area |
| WMP | Watershed Monitoring Plan |

# EXECUTIVE SUMMARY

This Paducah Site Environmental Monitoring Plan (EMP) for fiscal year (FY) 2024 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.

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 (QAPP) 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 a 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 2024. 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 2025 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.

The Energy Policy Act of 1992 provided for lease of the enrichment facilities to a commercial entity that operated the enrichment facilities from 1998 to 2013. In 2014, the leased facilities were returned to the U.S. Department of Energy (DOE) control, and a DOE contractor began management of the facilities for DOE. These returned facilities are undergoing deactivation in preparation for decommissioning. DOE also is responsible for environmental remediation of the site. DOE is conducting environmental remediation activities under CERCLA. DOE also has oversight of the Depleted Uranium Hexafluoride ($DUF_6$) Conversion Facility, which converts cylinders of $DUF_6$ to a more stable form for reuse and/or disposal. Changes to the sampling programs reflected in the FY 2024 EMP include, but are not limited to, the following actions, which are described later in more detail.

- **Solid Waste Management Unit (SWMU) 211-A Performance and Long-term Monitoring Wells Program.** As part of the SWMU 211-A Enhanced *In Situ* Bioremediation Project, 18 performance monitoring and 9 long-term monitoring wells (MWs) were installed. These wells, in addition to one previously installed MW (MW203), will be sampled and inspected as EM activities beginning in March 2024.

- **Water Policy Boundary Monitoring Program.** In FY 2022, vinyl chloride was detected above the maximum containment level (MCL) in residential well R40 samples collected by the Kentucky Division of Waste Management Agreement in Principle and by DOE. Multiple sampling events were conducted at R40 in FY 2022 and the pump and tubing were replaced in the well. After the pump and tubing were replaced and additional samples were collected, vinyl chloride was not detected above the MCL. In order to continue evaluating conditions at the well, R40 will continue to be sampled quarterly

for TCE and degradation products in FY 2024. Additionally, in support of the Paducah Site Groundwater Strategy Project, MW20 will be sampled quarterly in FY 2024.

- **Environmental Surveillance Monitoring Program.** Based on TCE and Tc-99 trends, the sampling frequency for MW445, MW447, MW448, and MW450 is being changed from biennial to annual, and the sampling frequency for MW486A is being changed from biennial to semiannual. Additionally, in support of the Paducah Site Groundwater Strategy Project, MW326, MW327, and MW330 will be sampled quarterly in FY 2024.

# 1. INTRODUCTION

## 1.1 PURPOSE

This Paducah Site Environmental Monitoring Plan (EMP) for fiscal year (FY) 2024 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 2015), 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 2024 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 under the Federal Facility Agreement (FFA) for the Paducah Gaseous Diffusion Plant (PGDP) (EPA 1998). In accordance with the Paducah Site Management Plan, the following CERCLA operable units (OUs) require investigation—C-400 Complex, surface water, groundwater, soils, burial grounds, facility decontamination and decommissioning, lagoons, soils and slabs, and depleted uranium hexafluoride ($DUF_6$) footprint underlying Soils OU (DOE 2022). 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.

In order for DOE and Four Rivers Nuclear Partnership, LLC, (FRNP) to comply 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 2023a). 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 Portsmouth/Paducah Project Office Environmental Geographic Analytical Spatial Information System. Results are published and made available to the public in the form of the Annual Site Environmental Report (ASER).

QA is assured through assessments and management reviews. At a minimum, a management review 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 $DUF_6$ conversion facility, 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 2024 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 (FRNP 2019), and under CERCLA or Resource Conservation and Recovery Act (RCRA) decision documents will continue to be evaluated in FY 2024. 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 2024, 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 2025 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.

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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 2020)]. 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 2020)] and 3.5 miles south of the Ohio River. DOE property has a heavily developed industrial area, with nonindustrial lands around it. Approximately 1,973 acres of the nonindustrial land are licensed to the Commonwealth of Kentucky as part of the West Kentucky Wildlife Management Area (WKWMA). The land licensed to the Commonwealth of Kentucky contains access roads and multiple rights-of-way for electrical transmission lines, but it is otherwise a mixture of woodlands and meadows.

The population within a 50-mile radius of the Paducah Site is about 534,000. Within a 10-mile radius of the Paducah Site, the population is approximately 87,750 (DOC 2020).

### 1.4.2 Site Background Information

Before World War II, the area now occupied by the Paducah Site 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 as the 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 containing an estimated 328 grams of plutonium-239 (Pu-239), 18,400 grams of neptunium-237 (Np-237), and 661,000 grams of 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.

The Energy Policy Act of 1992 provided for lease of the enrichment facilities to a commercial entity that operated the enrichment facilities from 1998 to 2013. In 2014, the leased facilities were returned to DOE control, and a DOE contractor began management of the facilities for DOE.

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 an FFA with EPA and the Commonwealth of Kentucky (EPA 1998). The FFA became effective February 13, 1998.

## 1.5 PLAN OBJECTIVES

The following are the main objectives of this EMP.

- 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, 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 the Paducah Site. The area could, however, be impacted by other anthropogenic sources, such as emissions from industrial and 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 for the purpose of characterizing and quantifying contaminants, assessing radiation exposures of members of the public, providing a means to control effluents at or near the point of discharge, and demonstrating compliance with applicable standards and permit requirements. It also helps evaluate the effectiveness of effluent treatment and control; helps identify potential environmental problems and evaluate the need for remedial actions or mitigation measures; supports permit revision and/or reissuance; and detects, characterizes, and helps to report unplanned releases. 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[d], K020) | 14 | Monthly |
| Outfall Toxicity[e] (K001, K010[f], K011[g], K017) | 4 | Quarterly |
| **CERCLA Outfall** | | |
| C001 | 1 | Weekly and quarterly |
| **Leachate** | | |
| C-746-S Landfill | 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 cited in the Solid Waste Landfill Permit 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] K019 is sampled when the C-746-U Landfill sedimentation pond is discharged through the outfall.
[e] K001, K010, and K011 are monitored for chronic toxicity. K017 is monitored for acute toxicity.
[f] Chronic toxicity is not required when the effluent from the C-617 Lagoon is discharged through Outfall 011.
[g] 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 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* Part 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 limit (MDL)/minimum detectable activity (MDA) and accuracy by analyte;
- QA components; and
- Effluent outfall alarms (not required at the Paducah Site).

The preceding requirements are addressed as follows.

- 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

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

frequency at each location and the required analytical parameters and analytical methods. 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 PQLs) 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 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, 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.13).

Effluent sampling is required by the ERPP. Radiological data sets of effluent water near the KPDES outfalls (Figure C.14), along with surveillance data of surface water and sediments slightly downstream (Figures C.16 and C.17), 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 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.12) 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.13).

### 2.1.2 Leachate

**C-746-S and C-746-U Landfills Leachate.** Untreated 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 nine continuous air monitors, as described in the approved Paducah Site NESHAP Management Plan, CP2-EC-0002/FR2 (FRNP 2019). This includes a background location.

Operational sampling included in the Title V air permit (V-21-011) is considered outside the scope of the EMP. FRNP will implement the appropriate operational sampling included in the Title V air permit (V-21-011). This data will be available in the event it is needed to evaluate site conditions; however, this sampling is considered outside the scope of the EMP. Additionally, the $DUF_6$ facility maintains a Conditional Major, Operating permit (F-21-018), 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. 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 (FRNP 2019), 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 environs 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* Part 61, NESHAP. Under 40 *CFR* § 61.92, emissions of radionuclides to the ambient air from DOE facilities shall not exceed those amounts that would cause any member of the public to receive in any year an effective dose equivalent (EDE) of 10 mrem per year.

DOE activities must be conducted to ensure that radionuclides contained in liquid effluents do not cause private or community drinking water systems to exceed an annual dose of 4 mrem per year for radionuclides emitting beta particle and photon radioactivity per 40 *CFR* § 141.66 (d)(1), which is more limiting than DOE O 458.1 limit of 10 mrem per year. For monitoring of community drinking water systems, 40 *CFR* Part 141 allows for environmental surveillance data to be used in the vicinity of nuclear facilities. The nearest downstream community 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 community 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* Part 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 effective dose (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 | 41 | Annually | Grab | See Appendix C |
| Surveillance | 68 | Biennially (Sampled FY 2023—will be sampled in FY 2025) | Grab | See Appendix C |
| Surveillance | 18 | Semiannually | Grab | See Appendix C |
| Surveillance | 6 | Quarterly | Grab | See Appendix C |
| Surveillance Geochemical | 37 | Every 3 years (Sampled FY 2022—will be sampled in FY 2025) | 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 | 36 | Quarterly | Grab | See Appendix C |
| Northwest Plume | 28 | Semiannually | Grab | See Appendix C |
| Northwest Plume | 5 | Quarterly | Grab | See Appendix C |
| C-400 | 29 | Quarterly | Grab | See Appendix C |
| C-400 | 8 | Semiannually | Grab | See Appendix C |
| SWMU 1 | 7 | Semiannually | Grab | See Appendix C |
| SWMU 211-A | 28 | Semiannually | Grab | See Appendix C |
| Water Policy Boundary—NW | 23 | 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 |
| C001 (Northeast Plume) | 1/1 | Weekly/Quarterly | Grab | See Appendix C |
| | | | | |
| ***KPDES[b]*** | | | | |
| Outfall (K001) | 1 | Weekly | Grab | See Appendix C |
| Outfall (K002, K004[c], K006, K008, K009, K010, K011, K012, K013, K015, K016, K017, K019, K020) | 14 | Monthly | Grab | See Appendix C |
| Outfall Toxicity[d] (K001, K010[e], K011[f], K017) | 4 | Quarterly | Composite and Grab[d] | See Appendix C |
| | | | | |
| ***Sediment*** | | | | |
| Sediment | 14 | Semiannually | Grab | See Appendix C |
| Sediment—ERPP | 6 | Annually | Grab | See Appendix C |
| | | | | |
| ***Ambient Air*** | 9/9 | Weekly/Quarterly | N/A | See Appendix C |
| | | | | |
| ***Meteorologic[g]*** | N/A | N/A | N/A | N/A |

**Table 2. Routine Environmental Surveillance (Continued)**

| Program | Number of Locations | Sampling Frequency | Sample Type | Parameters |
|---|---|---|---|---|
| ***Environmental Dosimeters*** | 64/7 | Quarterly | Continuous | External Gamma/Neutron |

[a] Four of the same wells are cited in the Solid Waste Landfill Permit for C-746-S&T and C-746-U Landfills. 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] 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 not required when the effluent from the C-617 Lagoon is discharged through Outfall 011.
[f] Chronic toxicity is required only when the effluent from the C-617 Lagoon is discharged through the outfall.
[g] 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 *2016 Update of the Paducah Gaseous Diffusion Plant Sitewide Groundwater Flow Model* (DOE 2017) for the Paducah Site. The most recent groundwater contaminant plume maps were developed in 2023 and are contained in *Trichloroethene and Technetium-99 Groundwater Contamination in the Regional Gravel Aquifer for Calendar Year 2022 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (FRNP 2023).

An investigation is being performed under the Groundwater Strategy project to evaluate the extent of TCE and groundwater flow trends at the site. Manual water level measurements and pressure transducer measurements will be used to measure the potentiometric surface and seasonal changes in the potentiometric surface. MWs covered under this project are included in Table B.5 of Appendix B.

The synoptic water level events will continue to be performed quarterly to support the Groundwater Strategy project and groundwater modeling. Also in support of the Groundwater Strategy project and groundwater modeling, during the quarterly synoptic water level events, water level elevation at Metropolis Lake will be measured. A survey control point has been established near the lake.

### 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 stable 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*, CP2-ES-1000 (FRNP 2021a). This document is reviewed and revised, as needed, to reflect current site operations.

**Agreement in Principle Sampling.** The AIP provides sampling and inspection of the differing monitoring programs. The oversight includes inspections (including MW inspections and surface water area inspections), sample analysis, 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. Ongoing remedial actions at the Paducah Site include the following.

The *Action Memorandum for the Water Policy at the 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. 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 the action (Figures C.9 and C.10). DOE also is sampling 2 additional residential wells

and MW20 near Ogden Landing Road northwest of the Paducah Site in support of the Groundwater Strategy project and Water Policy Box evaluation (Figure C.9).

*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 2005) requires MW sampling. This sampling 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).

Per the *Memorandum of Agreement for Resolution of Informal Dispute Concerning U.S. Environmental Protection Agency and Kentucky Department for Environmental Protection Requirements for Additional Actions or Modifications Regarding the CY 2018 Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/LX/07-2426&D2* (DOE 2020), the Operation and Maintenance Plans for the Northeast and Northwest Plumes were revised to incorporate elements of Water Policy boundary monitoring conducted under the EMP.

*Operation and Maintenance Plan for the Northwest Plume Groundwater System Interim Remedial Action at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*[2] requires well sampling 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 (DOE 2021a). There are 28 wells to be sampled semiannually for the Northwest Plume (Figure C.5). In addition, five wells will be sampled quarterly in order to evaluate trends in TCE and Tc-99 concentrations along the Northwest Plume.

*Operation and Maintenance Plan for the Northeast Plume Containment System Interim Remedial Action at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*[2] (DOE 2021b), and the *Remedial Action Work Plan for the Optimization of the Northeast Plume Interim Remedial Action at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, (DOE 2018) require quarterly sampling of 36 wells for the Northeast Plume (Figure C.4). The Northeast Plume operation and maintenance (O&M) plan requires semiannual sampling of MW255 and MW256; however, these wells are sampled quarterly to provide timely assessment of Northeast Plume optimized extraction well operations. 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.

*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 2014) requires sampling of MWs in order to monitor the progress of contaminant reduction in the Regional Gravel Aquifer (RGA) groundwater following soil mixing. Seven wells will be sampled semiannually in FY 2024 (Figure C.7).

Both the *Remedial Action Work Plan for SWMU 211-A Enhanced In Situ Bioremediation for Volatile Organic Compound Sources to the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-2443&D2 (DOE 2021c); and the *Certified for Construction Remedial Design Report for SWMU 211-A for Volatile Organic Compound Sources to the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, (DOE 2019) require semiannual sampling (FY 2024—FY 2028) of 18 performance MWs and 10 long-term MWs (Figure C.8). Sampling will be conducted to assess ongoing bioremediation in the subsurface, assess zero-valent iron for continued volatile organic compound (VOC) reduction, and assess continued reduction of TCE and degradation products such that VOC migration from contaminated subsurface soils in the treatment areas of

[2] O&M plans also specify production sampling. Sampling and monitoring of treatment systems are not captured within this EMP.

SWMU 211-A do not result in the exceedance of MCLs in the RGA over time as EISB degrades TCE in the UCRS.

#### 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 the treatment system is not captured within this document because it is part of the daily operations of the landfill.

The sample collection 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 the Hazardous Waste Management Facility 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.

An alternate source demonstration (ASD) was conducted in 2021 in response to a statistical exceedance for Tc-99 in MW84A. This ASD has determined that the Tc-99 contamination is indicative of dissolved contamination in the RGA and is not derived from contamination associated with construction of RGA well MW84A (FRNP 2021b). In accordance with the permit, compliance monitoring for radiological constituents was conducted quarterly at the C-404 Landfill during FY 2022 and the first quarter of FY 2023. Compliance monitoring for radiological constituents was completed in FY 2023 and will be discontinued during FY 2024.

In support of a potential future ASD at the C-404 Landfill, the current sampling and analysis for metals and sulfate will continue in the upper RGA monitoring wells of the C-404 Landfill and upgradient areas. The additional metals and sulfate analysis will be extended to MW337 and MW338. Sulfate analyses will be extended to upgradient monitoring wells MW227, MW333, MW414, MW549, MW550, and MW551.

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 that no longer meets the requirements of 40 *CFR* Part 264 Subpart F, the well will be abandoned in accordance with 401 *KAR* 6:350 and the Hazardous Waste Management Facility 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 Management Facility 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 1998) 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, 68 nonbackground MWs and 1 background well are sampled biennially, 41 nonbackground MWs and 1 background well are monitored annually, 18 MWs are sampled semiannually, and 6 MWs are sampled quarterly, as shown in Figure C.11. 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.

Per the *Memorandum of Agreement for Resolution of Informal Dispute Concerning U.S. Environmental Protection Agency and Kentucky Department for Environmental Protection Requirements for Additional Actions or Modifications Regarding the CY 2018 Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/LX/07-2426&D2*, (DOE 2020) the *Operation and Maintenance Plan for the Northeast Plume Containment System Interim Remedial Action at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, (DOE 2021b) was revised to incorporate elements of Water Policy boundary monitoring conducted under the EMP. MW100, MW150, MW409, MW410, MW411, MW473, MW474, MW475, and MW476 are sampled in support of the Environmental Surveillance program, and these wells also are sampled in support of Water Policy boundary monitoring.

The sampling frequency for this program was modified in the FY 2011 EMP 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. Eighty-three biennial MWs were sampled in FY 2023; therefore, the biennial MWs will not be sampled in FY 2024.

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.

MW152 was abandoned in October 2018 to enable Tennessee Valley Authority to construct a new process water basin. Another location has been selected for installation of a new well once construction activities

have been completed. This new well will be MW583, and it will be included in the annual group of MWs once it has been installed.

**Environmental Surveillance (Geochemical Monitoring) Program.** In order to monitor the effects of natural attenuation of groundwater contamination and to monitor groundwater quality, 37 MWs are to be sampled every 3 years (Table C.25). 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 2022 as part of the triennial basis sampling strategy; therefore, these wells will not be sampled in FY 2024.

MW152 was abandoned in October 2018 to enable Tennessee Valley Authority to construct a new process water basin. Another location has been selected for installation of a new well once construction activities have been completed. This new well will be MW583, which is the replacement well for MW152, and will be included in this program once it has been installed.

### 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, 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*, CP2-ES-1000 (FRNP 2021a), 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) A schedule of required inspections, as applicable; and

(g) Certification of the plan by the appropriate Paducah Site 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 polychlorinated biphenyls (PCBs) and TCE at 19 locations upstream and downstream from Paducah Site operations. The current KPDES permit does not require this sampling; therefore, these locations were removed from this program in 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 1998). In addition, one seep location in Little Bayou Creek is sampled quarterly for TCE (Figure C.16).

For radiological parameters, surface water is sampled quarterly at seven locations and annually at two locations (Figure C.16). 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 (FRNP 2022). 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.17). 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 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 (KDFWR) 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 detectable 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[3] 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.

[3] Additional information regarding modeling is provided in the annual NESHAP report.

#### 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. The air modeling uses default values, which may not be reflective of the Paducah Site.

#### 4.3.1.4 Wildlife

Wildlife monitoring (e.g., 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 background-corrected 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 and is not used to determine public exposure, but is used for information purposes only.

### 4.4.1 Objectives

A primary objective is to calculate the ED of the maximally exposed individual (MEI) member of the public using DOE-approved dose conversion factors, realistically expected parameters from the Risk Methods Document (DOE 2023b), and background corrected values, as applied to all objectives.

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 DOE Reservation to the KDFWR 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 Paducah Site 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 Property Protection Area 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 Property Protection Area security fence, Paducah Site 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[4] 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, CP2-EC-0002/FR2, ambient air is monitored to measure concentrations of radionuclides from all sources, including fugitive and diffuse (FRNP 2019). The ambient air monitoring network is comprised of nine air monitoring stations surrounding the site, including one background station (Figure C.19). 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 2024 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.

[4] For Paducah Site radionuclides of concern, ED is equivalent to EDE.

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 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.

# 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 2023b). 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 50 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 low level 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 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 2023b).

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

| | |
|---|---|
| **Releases to water** | Remain dissolved or suspended in water<br>Deposit on ground via irrigation*<br>Deposit on vegetation via irrigation*<br>Deposit in sediment<br>Uptake to biota |
| **Releases to air** | Remain suspended in air<br>Deposit on ground<br>Deposit on vegetation<br>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.

This information was compared to modeling results to identify the MEI. Demographic data from 2017 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 (CH2M HILL 1991), 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 1 and 2 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.

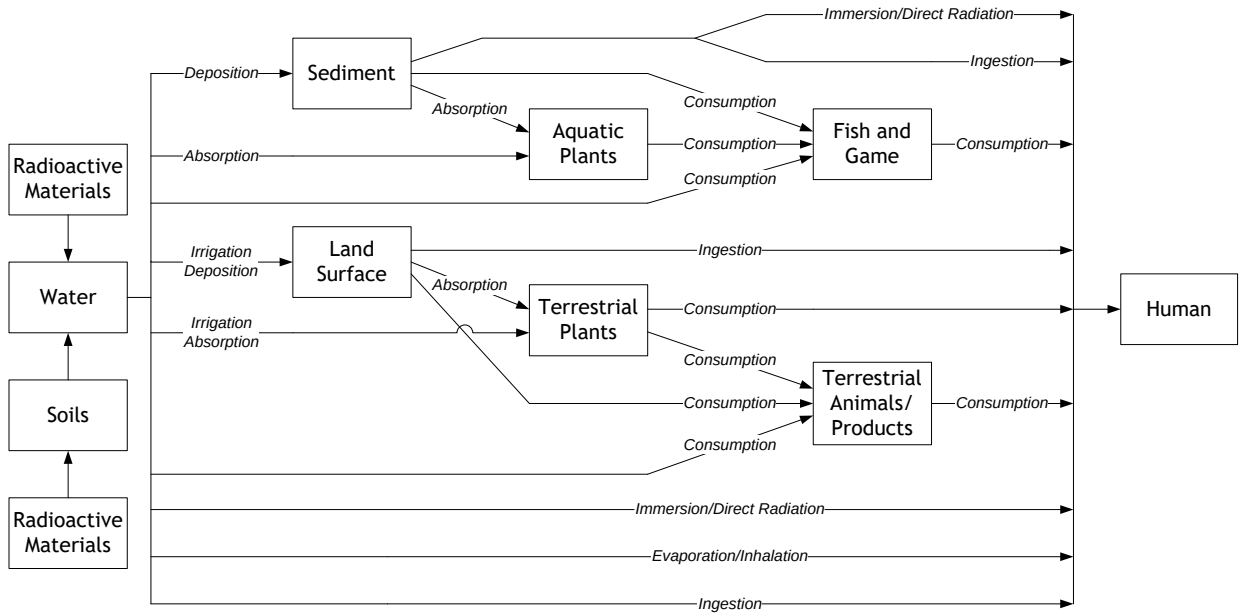


**Figure 1. Possible Pathways between Radioactive Materials Released to the Water and Humans**

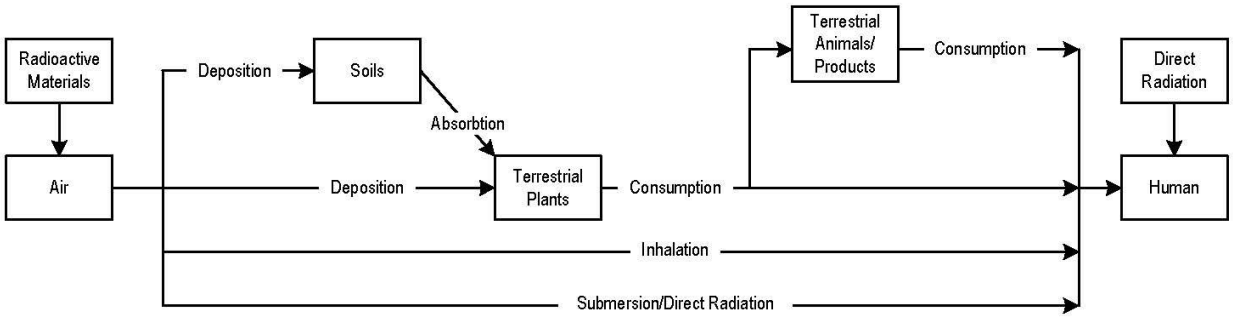


**Figure 2. Possible Pathways between Radioactive Materials Released to the Air and Humans**

## 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,[5] 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 for public dose calculations; however, a programmatic working group develops information to support transport modeling. This information is used to better understand sources of contamination found in groundwater off-site and to support risk management decisions made for CERCLA projects.

### 5.3.3 Soil Transport

Contaminants deposited in soils and sediments may be absorbed into plants and vegetation that are consumed by farm animals or humans. Additional routes of exposure from soils and sediment are direct irradiation, indirect pathways, and incidental ingestion. Dose calculations on soil releases are discussed in Sections 5.4.3 through 5.4.5.

## 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* Part 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 2, 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-

[5] 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.

state, Gaussian plume, atmospheric dispersion model[6] 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.

### 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 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 (MCL) in 40 *CFR* Part 141. Per 40 *CFR* Part 141, environmental surveillance data may be used in the vicinity of a nuclear facility to verify compliance with 40 *CFR* Part 141 radiological limits for drinking water. Surveillance data from Bayou and Little Bayou Creeks also may be used to verify compliance with 40 *CFR* Part 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 Paducah Site 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 (CH2M HILL 1991). 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 (DOE 1994), property surrounding the Paducah Site is evaluated annually to ensure there have been no changes to property ownership. Dose to the hypothetical MEI is calculated based on incidental ingestion of surface water due to swimming in Bayou and Little Bayou Creeks (outfall locations are not included because water within these locations is not indicative of a body of water that a person could enter). The assumptions based on the Risk Methods Document are that a hypothetical recreator may swim 45 days a year, for 2.6 hours a day, with an incidental ingestion of 0.092 liters per hour, and be in different locations throughout the wildlife management area (DOE 2023b). The annual average of the surface water results from the various sampling locations are utilized to calculate a dose for each sample location and the sample location with the maximum estimated dose is assigned to the MEI. Collective dose is not calculated for the incidental ingestion of surface water pathway because it is unlikely that a population of individuals would swim repeatedly in either Bayou or Little Bayou Creeks. This pathway is more likely to involve individuals; therefore, it is more suited for MEI dose calculation.

[6] Additional information regarding modeling is provided in the annual NESHAP report.

In September 1988, following the discovery of contamination in residential drinking water wells, water was supplied to all residents whose wells contained detectable levels of TCE and gross beta. 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* Part 141 and DOE O 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 2023b). 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. 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. An estimated collective dose for the incidental ingestion of sediment within plant creeks and ditches pathway has been calculated by multiplying the dose to the MEI from incidental ingestion of sediment by a total estimated number of visitors hiking within the wildlife management area annually (150 persons) (DOE 2023b). 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.

### 5.4.4 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 (CH2M HILL 1991).

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.

### 5.4.5 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 (CH2M HILL 1991).

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.

### 5.4.6 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 aquatic community are not sampled. Biota in the watersheds were sampled previously to the extent that further collection of aquatic organisms would have had deleterious effects on the aquatic community (PRS 2006).

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,[7] 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 2011). 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.

### 5.4.7 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.

## 5.5 INTERNAL DOSIMETRY MODELS

The results of all dose calculations are reported in terms of TED, the sum of ED[8] 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 standard values given in DOE-STD-1196-2022 may be used in assessing the magnitude of dose to the public associated with measured concentrations of radionuclides in liquid effluents and can be used for evaluation of when to apply best available technology.

## 5.6 RADIATION DOSE TO AQUATIC AND TERRESTRIAL BIOTA

Compliance with DOE-STD-1153-2019, *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 a graded approach to show compliance with DOE dose limits using RESRAD-BIOTA software. 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.

[7]Additional information regarding modeling is provided in the annual NESHAP report.
[8] For Paducah Site radionuclides of concern, EDE is equivalent to ED.

## 5.7 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 2.f.(2), 2.f.(5), 2.g.(4), 2.g.(5)(a), 2.g.(7), 2.g.(8)(a)4 or 2.i.(1) of DOE O 458.1 Chg 4 (LtdChg), *Radiation Protection of the Public and the Environment*, dated September 15, 2020, 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.”

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# 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. The ASER includes a summary of sampling results collected throughout the year as part of programmatic, environmental sampling activities and regulatory permit requirements. 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* Part 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 | The 28th of each month | 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 |
|---|---|---|---|
| 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 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 Solid Waste Landfill Permit SW07300014, SW07300015, SW07300045. |
| Landfill Quarterly Operating Report | Quarterly | 401 *KAR* 47:130 | This report is required in accordance with the Solid Waste Landfill Permit SW07300014, SW07300015, SW07300045. |
| C-746-S&T Landfills Compliance Monitoring Report | Quarterly | 401 *KAR* 47:130 | This report is required in accordance with the Solid Waste Landfill Permit SW07300014, SW07300015, SW07300045. |
| C-404 Landfill Groundwater Monitoring Report | May, November | 40 *CFR* Part 264 Subpart F | This report is required in accordance with Paducah Hazardous Waste Management Facility 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 August 2021 | 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 January 2020 | 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 May 2022 | 40 *CFR* Part 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 Radiation Monitoring Report | March 1 | DOE O 458.1 (and ERPP) | This report estimates the external radiation 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. |

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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 for Air Quality | 9/12/2026 | V-21-011 | Four Rivers Nuclear Partnership, LLC (FRNP) |
| Conditional Major Operating Air Permit | Kentucky Division for Air Quality | 7/27/2026 | F-21-018 | Mid-America Conversion Services, LLC (MCS) |
| **WATER** | | | | |
| Kentucky Pollutant Discharge Elimination System (KPDES) | Kentucky Division of Water (KDOW) | 1/31/2028 | KY0004049 | U.S. Department of Energy (DOE), FRNP, and MCS |
| 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** | | | | |
| Solid Waste Landfill Permit [C-746-S Residential Landfill (Closed), C-746-T Inert Landfill (Closed), C-746-U Contained Landfill] | Kentucky Division of Waste Management (KDWM) | 11/04/2026 | SW07300014<br>SW07300015<br>SW07300045 | DOE/FRNP |
| **RCRA** | | | | |
| Hazardous Waste Management Facility Permit | KDWM | 8/25/2025 | KY8-890-008-982 | DOE/FRNP |

*Operational sampling included in the Title V air permit is considered outside the scope of the Environmental Monitoring Plan. FRNP will implement the appropriate operational sampling to meet the requirements of the Title V air permit.

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

| Agreement | Effective Date | Expiration Date | Entities |
|---|---|---|---|
| TSCA CA (Toxic Substances Control Act Compliance Agreement) | 05/2017 (Modification) | N/A | U.S. Environmental Protection Agency (EPA) and DOE |
| Federal Facility Compliance Agreement 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

| | |
|---|---|
| 211SA | SWMU 211-A groundwater well semiannually |
| 400GQ | C-400 groundwater well quarterly |
| 400GSA | C-400 groundwater well semiannually |
| 404G | C-404 Landfill groundwater well |
| A | annually |
| AB | abandoned |
| AB-IP | abandoned in place |
| CARB | residential well sampled under the Carbon Filter Treatment System |
| CM | construction monitoring well |
| DOE | U.S. Department of Energy |
| EW | extraction well |
| 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 | groundwater environmental surveillance annual sampling |
| GWESBA | groundwater environmental surveillance biennial sampling |
| GWESQ | groundwater environmental surveillance quarterly sampling |
| GWESSA | groundwater 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 |
| KDFWR | Kentucky Department of Fish and Wildlife Resources |
| KG | C-746-K Landfill groundwater well |
| LRGA | Lower Regional Gravel Aquifer |
| M | In the Water Level column, “M” indicates water levels are collected monthly |
| M2 | In the Water Level column, “M2” indicates water levels are collected bimonthly |
| MRGA | Middle Regional Gravel Aquifer |
| MW | monitoring well |
| NA | not applicable |
| NS | not sampled |
| PT | pressure transducer |
| PZ | piezometer |
| Q | In the Water Level column, “Q” indicates water levels are collected quarterly |
| R | residential |
| RGA | Regional Gravel Aquifer |
| SA | In the Water Level column, “SA” indicates water levels are collected semiannually |
| SG | C-746-S&T Landfills groundwater well |
| SWMU | solid waste management unit |
| 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 | In the Water Level column, “W” indicates water levels are collected weekly |
| WPB-NE | Water Policy Boundary Monitoring Program—Northeast annual sampling |
| WPB-NW | Water Policy Boundary Monitoring Program—Northwest quarterly sampling |

Table B.1 includes 434 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 | Q | A |
| PZ5S | Unknown | Current | DOE | NS | Q | 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) | URGA | Current | KDFWR | WPB-NE | Q | 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 |
| MW38 | RGA | AB 94 | NA | NA | NA | NA |
| MW39 | RGA | 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 |
|---|---|---|---|---|---|---|
| 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 | URGA | Current | DOE | GWNWSA | Q | A |
| MW64 | UCRS | Current | DOE | NS | Q | A |
| MW65 | LRGA | Current | DOE | GWNWSA | W,Q | A |
| MW66 | URGA | Current | DOE | GWNWSA | Q | A |
| MW67 | MRGA | Current | DOE | GWESBA, 404G | Q | A |
| MW68 | LRGA | Current | DOE | GWESA | Q | A |
| MW69 | UCRS | Current | DOE | NS | Q | A |
| MW70 | RGA | AB 94 | NA | NA | NA | NA |
| MW71 | URGA | Current | DOE | GWESA | Q | A |
| MW72 | MRGA | Current | DOE | NS | Q | A |
| MW73 | MRGA | Current | DOE | NS | Q | A |
| PZ74 | UCRS | Current | DOE | NS | Q | A |
| MW75 | UCRS | Current | DOE | NS | Q | A |
| MW76 | MRGA | Current | DOE | GWESBA, 404G | Q | A |
| MW77 (PZ) | MRGA | Current | DOE | NS | Q | A |
| MW78 | MRGA | Current | DOE | NS | Q | A |
| MW79 | MRGA | Current | DOE | NS | Q | A |
| MW80 | MRGA | Current | DOE | NS | Q | A |
| MW81 | MRGA | Current | DOE | NS | Q | A |
| MW82 | UCRS | Current | DOE | NS | Q | A |
| MW83 | UCRS | Current | DOE | NS | Q | A |
| MW84 | RGA | AB 2019 | NA | NA | NA | NA |
| MW84A | MRGA | Current | DOE | 404G | Q | A |
| MW85 | UCRS | Current | DOE | 404G | Q | A |
| MW86 | LRGA | Current | DOE | GWESBA, 404G | Q | A |
| MW87 | RGA | AB 2019 | NA | NA | NA | NA |
| MW87A | MRGA | Current | DOE | 404G | Q | A |
| MW88 | UCRS | Current | DOE | 404G | Q | A |

**Table B.1. Well Program Inventory (Continued)**

| Well Number | Screened Zone | Status | Property Where Located | Sampled | Water Level | Inspection |
|---|---|---|---|---|---|---|
| MW89 | LRGA | Current | DOE | GWESBA, 404G | Q | A |
| MW90 | RGA | AB 2001 | NA | NA | NA | NA |
| MW90A | URGA | Current | DOE | 404G | Q | A |
| MW91 | UCRS | AB 2017 | NA | NA | NA | NA |
| MW91A | UCRS | Current | DOE | 404G | Q | A |
| MW92 | LRGA | Current | DOE | GWESBA, 404G | Q | A |
| MW93 | RGA | AB 2019 | NA | NA | NA | NA |
| MW93A | MRGA | Current | DOE | 404G | Q | A |
| MW94 | UCRS | Current | DOE | 404G | Q | A |
| MW95 | RGA | AB 2001 | NA | NA | NA | NA |
| MW95A | LRGA | Current | DOE | GWESBA, 404G | Q | A |
| MW96 | UCRS | Current | DOE | NS | Q | A |
| MW97 | RGA | AB 97 | NA | NA | NA | NA |
| MW98 | MRGA | Current | DOE | GWESSA | Q | A |
| MW99 | MRGA | Current | TVA | GWESA, GC | Q | A |
| MW100 | LRGA | Current | TVA | GWESA, GC | Q | A |
| PZ101 | Terrace Gravel | Current | DOE | NS | Q | A |
| MW102 | McNairy | Current | DOE | GWESSA | Q | A |
| MW103 | MRGA | Current | DOE | GWESBA | Q | 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 | MRGA | Current | DOE | GWESBA, WPB-NW | W, Q | A |
| PZ107 | URGA | Current | DOE | NS | Q | A |
| MW108 | MRGA | Current | DOE | NS | Q | A |
| PZ109 | MRGA | Current | DOE | NS | Q | A |
| PZ110 | MRGA | Current | DOE | NS | Q | A |
| PZ111 | UCRS | Current | DOE | NS | Q | A |
| PZ112 | UCRS | AB 2017 | NA | NA | NA | NA |
| PZ113 | RGA | AB 2017 | NA | NA | NA | NA |
| PZ114 | McNairy | Current | DOE | NS | Q | A |
| PZ115 | McNairy | Current | DOE | NS | Q | A |
| PZ116 | RGA | AB 2017 | NA | NA | NA | NA |
| PZ117 | MRGA | Current | DOE | NS | Q | A |
| PZ118 | MRGA | Current | DOE | NS | Q | A |
| MW119 | RGA | AB | NA | NA | NA | NA |
| MW120 | McNairy | Current | DOE | GWESSA | Q | A |
| MW121 | McNairy | Current | KDFWR | GWESSA | Q | A |
| MW122 | McNairy | Current | DOE | GWESSA | Q | A |
| MW123 | MRGA | Current | KDFWR | NS | Q | A |
| MW124 | LRGA | Current | DOE | GWNEQ | Q | A |
| MW125 | LRGA | Current | KDFWR | GWESA, GC | Q | A |
| MW126 | MRGA | Current | DOE | GWNEQ | Q | A |
| MW127 | UCRS | AB-IP | NA | NA | NA | NA |
| 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 | LRGA | Current | DOE | NS | M, Q | A |
| MW133 | McNairy | Current | TVA | GWESSA | Q | A |
| MW134 | LRGA | Current | KDFWR | GC, WPB-NW | Q | A |

**Table B.1. Well Program Inventory (Continued)**

| Well Number | Screened Zone | Status | Property Where Located | Sampled | Water Level | Inspection |
|---|---|---|---|---|---|---|
| MW135 | LRGA | Current | TVA | GWESSA | Q | A |
| MW136 | UCRS | AB | NA | NA | NA | NA |
| MW137 | MRGA | Current | TVA | NS | Q | A |
| MW138 | UCRS | Current | TVA | NS | Q | A |
| MW139 | MRGA | Current | DOE | GWESA | M2, 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 | LRGA | Current | DOE | GWNEQ | Q | A |
| MW145 | LRGA | Current | DOE | GWNEQ, GC | Q | A |
| MW146 | LRGA | Current | TVA | GWESBA, WPB-NW | Q | A |
| MW147 | MRGA | Current | TVA | NS | Q | A |
| MW148 | MRGA | Current | Private—Residential | GWESBA | Q | A |
| MW149 | UCRS | Current | Private—Residential | GWESBA | Q | A |
| MW150 | LRGA | Current | Private—Residential | GWESA | Q | A |
| MW151 | Terrace Gravels | Current | Private—Residential | NS | Q | A |
| MW152[f] | RGA | AB 2018 | NA | NA | NA | NA |
| MW153[g] | UCRS | AB 2018 | NA | NA | NA | NA |
| MW154 | UCRS | Current | DOE | NS | Q | A |
| MW155 | LRGA | Current | DOE | 400GQ, GWNEQ | Q | A |
| MW156 | URGA | Current | DOE | 400GQ, GWNEQ | Q | A |
| MW157 | UCRS | Current | DOE | NS | Q | 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 | LRGA | Current | DOE | GWSWMU1, GWESA, GC | Q | A |
| MW162 | UCRS | Current | DOE | NS | Q | A |
| MW163 | LRGA | Current | DOE | GWESBA, GWNEQ, GC | Q | A |
| MW164 | UCRS | Current | DOE | NS | Q | A |
| MW165 | RGA | AB 2014 | NA | NA | NA | NA |
| MW165A | URGA | Current | DOE | GWNWSA | Q | A |
| MW166 | UCRS | Current | DOE | NS | Q | A |
| MW167 | UCRS | Current | DOE | NS | Q | A |
| MW168 | URGA | Current | DOE | GWESBA | Q | A |
| MW169 | MRGA | Current | DOE | GWESBA | Q | A |
| MW170 | UCRS | Current | DOE | NS | Q | A |
| MW171 | UCRS | Current | DOE | NS | Q | A |
| MW172 | UCRS | Current | DOE | NS | Q | A |
| MW173 | URGA | Current | DOE | GWNWSA | Q | A |
| MW174 | UCRS | Current | DOE | GWESBA | Q | A |
| MW175 | MRGA | Current | DOE | 400GSA | Q | A |
| MW176 | UCRS | Current | DOE | NS | Q | A |
| MW177 | UCRS | Current | DOE | NS | Q | A |
| MW178 | URGA | Current | DOE | 400GQ | Q | A |

**Table B.1. Well Program Inventory (Continued)**

| Well Number | Screened Zone | Status | Property Where Located | Sampled | Water Level | Inspection |
|---|---|---|---|---|---|---|
| MW179 | RGA | AB 2003 | NA | NA | NA | NA |
| MW180 | UCRS | Current | DOE | NS | Q | A |
| MW181 | RGA | AB 2000 | NA | NA | NA | NA |
| MW182 | UCRS | Current | DOE | GWESA | Q | A |
| 183, Not Installed | NA | NA | NA | NA | NA | NA |
| MW184 | UCRS | AB 98 | NA | NA | NA | NA |
| MW185 | MRGA | Current | DOE | NS | Q | A |
| MW186 | UCRS | Current | DOE | GWESA | Q | A |
| MW187 | UCRS | Current | DOE | GWESA | Q | A |
| MW188 | MRGA | Current | DOE | GC | Q | A |
| MW189 | UCRS | Current | DOE | NS | Q | A |
| MW190 | UCRS | Current | DOE | NS | Q | A |
| MW191 | MRGA | Current | DOE | GWESA | Q | A |
| MW192 | UCRS | Current | DOE | NS | Q | A |
| MW193 | URGA | Current | DOE | GWESBA, GC | M2, Q | A |
| MW194 | MRGA | Current | KDFWR | WPB-NW | Q | A |
| MW195 | UCRS | AB 94 | NA | NA | NA | NA |
| MW196 | Terrace Gravels | Current | DOE | NS | Q | A |
| MW197 | URGA | Current | DOE | GWESSA | Q | A |
| MW198 | UCRS | Current | DOE | NS | Q | A |
| MW199 | LRGA | Current | Private—Residential | WPB-NW | Q | A |
| MW200 | MRGA | Current | KDFWR | GWESBA | Q | A |
| MW201 | MRGA | Current | KDFWR | GWESBA, GC, WPB-NW | Q | A |
| MW202 | LRGA | Current | KDFWR | GWESBA, WPB-NW | Q | A |
| MW203 | MRGA | Current | DOE | GWESA, 211SA | Q | A |
| MW204 | UCRS | Current | DOE | NS | Q | A |
| MW205 | URGA | Current | DOE | GWESBA | Q | A |
| MW206 | RGA | AB 2014 | NA | NA | NA | NA |
| MW207 | UCRS | Current | DOE | NS | Q | A |
| MW208 | UCRS | AB 2012 | NA | NA | NA | NA |
| MW209 | UCRS | AB 2016 | DOE | NA | NA | NA |
| MW210 | UCRS | Current | DOE | NS | Q | A |
| MW211 | UCRS | Current | DOE | NS | Q | A |
| MW212 | UCRS | Current | DOE | NS | Q | A |
| MW213 | UCRS | Current | DOE | NS | Q | A |
| MW214 | UCRS | Current | DOE | NS | Q | A |
| MW215 | UCRS | Current | DOE | NS | Q | A |
| MW216 | UCRS | Current | DOE | NS | Q | A |
| MW217 | UCRS | Current | DOE | NS | Q | A |
| MW218 | UCRS | Current | DOE | NS | Q | A |
| MW219 | UCRS | Current | DOE | NS | Q | A |
| MW220 | URGA | Current | DOE | SG | Q | A |
| MW221 | URGA | Current | DOE | SG | Q | A |
| MW222 | URGA | Current | DOE | SG | Q | A |
| MW223 | URGA | Current | DOE | SG | Q | A |
| MW224 | URGA | Current | DOE | SG | Q | A |
| MW225 | URGA | Current | DOE | NS | Q | A |
| MW226 | LRGA | Current | DOE | GWESBA, 404G | Q | A |

**Table B.1. Well Program Inventory (Continued)**

| Well Number | Screened Zone | Status | Property Where Located | Sampled | Water Level | Inspection |
|---|---|---|---|---|---|---|
| MW227 | URGA | Current | DOE | GWESBA, 404G | 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 | MRGA | Current | KDFWR | NS | Q | A |
| MW234 | RGA | AB 2002 | NA | NA | NA | NA |
| MW235 | RGA | AB 2002 | NA | NA | NA | NA |
| MW236 | LRGA | Current | KDFWR | GWESA | Q | A |
| MW237 | UCRS | Current | KDFWR | NS | Q | A |
| MW238 | MRGA | Current | KDFWR | NS | Q | A |
| MW239 | McNairy | Current | KDFWR | GWESSA | Q | A |
| MW240 | MRGA | Current | KDFWR | GWESA | Q | A |
| MW241 | RGA | AB 2003 | NA | NA | NA | NA |
| MW241A | MRGA | Current | KDFWR | NS | Q | A |
| MW242 | MRGA | Current | DOE | GWNWSA, GC | Q | A |
| MW243 | MRGA | Current | DOE | GWNWSA | Q | A |
| MW244 | MRGA | Current | DOE | GWNWSA | Q | A |
| MW245 | MRGA | Current | DOE | GWNWSA | W, Q | A |
| MW246 | UCRS | Current | DOE | NS | Q | A |
| MW247 | McNairy | Current | DOE | GWESSA | Q | A |
| MW248 | MRGA | Current | DOE | GWNWSA | Q | A |
| MW249 | MRGA | Current | DOE | NS | M, Q | A |
| MW250 | MRGA | Current | DOE | GWNWSA | Q | A |
| PZ251 | UCRS | Current | DOE | NS | Q | A |
| MW252 | LRGA | Current | Private—Residential | GWESA | Q | A |
| MW253 | RGA | AB 2019 | NA | NA | NA | NA |
| MW253A | LRGA | Current | Private—Residential | GWESA | Q | A |
| 254, Not Installed | NA | NA | NA | NA | NA | NA |
| MW255 | LRGA | Current | DOE | GWNEQ | Q | A |
| MW256 | LRGA | Current | DOE | GWNEQ, GC | Q | A |
| MW257 | MRGA | Current | DOE | GC | W, Q | A |
| MW258 | LRGA | Current | DOE | GWNEQ, GC | Q | A |
| 259, Not Installed | NA | NA | NA | NA | NA | NA |
| MW260 | LRGA | Current | DOE | GWESBA, GWNESA, GC | Q | A |
| MW261 | LRGA | Current | DOE | GWESA, GC | W, Q | A |
| MW262 | LRGA | Current | DOE | GWESBA | Q | A |
| MW263 | RGA | AB 2003 | NA | NA | NA | NA |
| MW264 | RGA | AB 2003 | NA | NA | NA | NA |
| 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 |

**Table B.1. Well Program Inventory (Continued)**

| Well Number | Screened Zone | Status | Property Where Located | Sampled | Water Level | Inspection |
|---|---|---|---|---|---|---|
| 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 | LRGA | Current | DOE | GWNEQ | Q | A |
| MW284 | LRGA | Current | DOE | NS | Q | A |
| 285, Not Installed | NA | NA | NA | NA | NA | NA |
| 286, Not Installed | NA | NA | NA | NA | NA | NA |
| PZ287 | LRGA | Current | DOE | NS | Q | A |
| MW288 | LRGA | Current | DOE | GWNEQ, GC | Q | A |
| PZ289 | LRGA | Current | DOE | NS | Q | A |
| PZ290 | LRGA | Current | DOE | NS | Q | A |
| MW291 | LRGA | Current | DOE | GWNEQ | Q | A |
| MW292 | LRGA | Current | DOE | GWNEQ, GC | Q | A |
| MW293 | RGA | AB 2003 | NA | NA | NA | NA |
| MW293A | MRGA | Current | DOE | GWNEQ | Q | A |
| MW294 | RGA | AB 2003 | NA | NA | NA | NA |
| MW294A | LRGA | Current | DOE | NS | Q | 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 | Q | A |
| MW301 | Terrace Gravels | AB 2014 | NA | NA | NA | NA |
| MW302 | Terrace Gravels | Current | DOE | KG | Q | A |
| MW303 | Terrace Gravels | AB 94 | NA | NA | NA | NA |
| MW304 | Terrace Gravels | Current | DOE | NS | Q | A |
| MW305 | Eocene | AB 2020 | NA | NA | NA | NA |
| MW306 | Eocene | AB 2020 | NA | NA | NA | NA |
| MW307 | Eocene | AB 2020 | NA | NA | NA | NA |
| MW308 | Eocene | AB 2020 | NA | NA | NA | NA |
| MW309 | Terrace Gravels | AB 2020 | NA | NA | NA | NA |
| MW310 | Terrace Gravels | AB 2020 | NA | NA | NA | NA |
| MW311 | Terrace Gravels | AB 2020 | NA | NA | NA | NA |
| MW312 | UCRS | AB 2016 | DOE | NA | NA | NA |
| MW313 | UCRS | Current | DOE | NS | Q | A |
| MW314 | UCRS | AB 2016 | DOE | NA | NA | NA |
| MW315 | UCRS | Current | DOE | NS | Q | A |
| MW316 | UCRS | Current | DOE | NS | Q | A |
| MW317 | Terrace Gravels | Current | DOE | NS | Q | A |
| MW318 | Terrace Gravels | AB 2016 | DOE | NA | 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 |

**Table B.1. Well Program Inventory (Continued)**

| Well Number | Screened Zone | Status | Property Where Located | Sampled | Water Level | Inspection |
|---|---|---|---|---|---|---|
| 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 | LRGA | Current | DOE | NS | Q | A |
| MW326 | LRGA | Current | DOE | GWESQ | Q | A |
| MW327 | LRGA | Current | DOE | GWESQ | Q | A |
| MW328 | MRGA | Current | DOE | GWESBA, GC | Q | A |
| MW329 | URGA | Current | DOE | GWESBA, GC | Q | A |
| MW330 | MRGA | Current | DOE | GWESQ | Q | A |
| 331, Not Installed | NA | NA | NA | NA | NA | NA |
| 332, Not Installed | NA | NA | NA | NA | NA | NA |
| MW333 | MRGA | Current | DOE | GWESBA, 404G | Q | A |
| PZ334 | UCRS | Current | DOE | NS | Q | A |
| PZ335 | UCRS | Current | DOE | NS | Q | A |
| PZ336 | UCRS | Current | DOE | NS | Q | A |
| MW337 | MRGA | Current | DOE | GWESBA, 404G | Q | A |
| MW338 | MRGA | Current | DOE | GWESBA, 404G | Q | A |
| MW339 | LRGA | Current | DOE | GWNWSA, GC | Q | A |
| MW340 | LRGA | Current | DOE | GWNWSA | Q | A |
| MW341 | MRGA | Current | DOE | 400GQ, GWNEQ, GWESBA | Q | A |
| MW342 | MRGA | Current | DOE | 400GSA | Q | A |
| MW343 | LRGA | Current | DOE | GWESBA, 400GSA, GC | Q | A |
| MW344 | URGA | Current | DOE | KG | Q | A |
| MW345 | Rubble Zone | Current | DOE | GWESA | Q | A |
| MW346 | Rubble Zone | Current | DOE | GWESA | Q | A |
| MW347 | Rubble Zone | Current | DOE | GWESA | Q | A |
| PZ348 | UCRS | Current | DOE | NS | Q | A |
| PZ349 | URGA | Current | DOE | NS | W | A |
| PZ350 | UCRS | Current | DOE | NS | Q | A |
| PZ351 | URGA | Current | DOE | NS | Q | A |
| MW352 | RGA | AB 2002 | NA | NA | NA | NA |
| MW353 | MRGA | Current | DOE | NS | Q | A |
| MW354 | MRGA | Current | DOE | GWESQ | Q | A |
| MW355 | LRGA | Current | DOE | GWNWSA | W, Q | A |
| MW356[a] | McNairy | Current | DOE | GWESSA | Q | A |
| MW357 | URGA | Current | DOE | UG | Q | A |
| MW358 | LRGA | Current | DOE | UG | Q | A |
| MW359 | UCRS | Current | DOE | UG | Q | A |
| MW360 | URGA | Current | DOE | UG | Q | A |
| MW361 | MRGA | Current | DOE | UG | Q | A |
| MW362 | UCRS | Current | DOE | UG | Q | A |
| MW363 | URGA | Current | DOE | UG | Q | A |
| MW364 | LRGA | Current | DOE | UG | Q | A |
| MW365 | UCRS | Current | DOE | UG | Q | A |
| MW366 | URGA | Current | DOE | UG | Q | A |
| MW367 | LRGA | Current | DOE | UG | Q | A |
| MW368 | UCRS | Current | DOE | UG | Q | A |
| MW369 | URGA | Current | DOE | UG/SG | Q | A |
| MW370 | MRGA | Current | DOE | UG/SG | Q | A |

**Table B.1. Well Program Inventory (Continued)**

| Well Number | Screened Zone | Status | Property Where Located | Sampled | Water Level | Inspection |
|---|---|---|---|---|---|---|
| MW371 | UCRS | Current | DOE | UG | Q | A |
| MW372 | URGA | Current | DOE | UG/SG | Q | A |
| MW373 | LRGA | Current | DOE | UG/SG | Q | A |
| MW374 | UCRS | Current | DOE | UG | Q | A |
| MW375 | UCRS | Current | DOE | UG | Q | A |
| MW376 | UCRS | Current | DOE | UG | Q | A |
| MW377 | UCRS | Current | DOE | UG | Q | A |
| 378, Not Installed | NA | NA | NA | NA | NA | NA |
| 379, Not Installed | NA | NA | NA | NA | NA | NA |
| MW380 | LRGA | Current | KDFWR | NS | Q | A |
| MW381 | MRGA | Current | KDFWR | GC | Q | A |
| 382, Not Installed | NA | NA | NA | NA | NA | NA |
| 383, Not Installed | NA | NA | NA | NA | NA | NA |
| MW384 | URGA | Current | DOE | SG | Q | A |
| MW385 | LRGA | Current | DOE | SG | Q | A |
| MW386 | UCRS | Current | DOE | SG | Q | A |
| MW387 | URGA | Current | DOE | SG | Q | A |
| MW388 | MRGA | Current | DOE | SG | Q | A |
| MW389 | UCRS | Current | DOE | SG | Q | A |
| MW390 | UCRS | Current | DOE | SG | Q | A |
| MW391 | MRGA | Current | DOE | SG | Q | A |
| MW392 | LRGA | Current | DOE | SG | Q | A |
| MW393 | UCRS | Current | DOE | SG | Q | A |
| MW394 | URGA | Current | DOE | SG | Q | A |
| MW395 | MRGA | Current | DOE | SG | Q | A |
| MW396 | UCRS | Current | DOE | SG | Q | A |
| MW397 | LRGA | Current | DOE | SG | 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 | LRGA | Current | DOE | NS | Q | A |
| MW402 | MRGA | Current | DOE | NS | Q | A |
| MW403 | RGA (Multi-zone) | Current | DOE | GWESQ, GC | Q | A |
| MW404 | RGA (Multi-zone) | Current | DOE | GWESBA, GC | Q | A |
| MW405 | RGA (Multi-zone) | Current | DOE | GWESBA, 400GQ | Q | A |
| MW406 | RGA (Multi-zone) | Current | DOE | GWESBA, 400GQ | Q | A |
| MW407 | RGA (Multi-zone) | Current | DOE | GWESBA, 400GQ | Q | A |
| MW408 | RGA (Multi-zone) | Current | DOE | GWESBA, 400GQ | Q | A |
| MW409 | LRGA | Current | Private—Residential | GWESSA, GC | Q | A |
| MW410 | LRGA | Current | Private—Residential | GWESSA | Q | A |
| MW411 | MRGA | Current | Private—Residential | GWESSA | Q | A |
| 412, Not Installed | NA | NA | NA | NA | NA | NA |
| 413, 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 |
|---|---|---|---|---|---|---|
| MW414 | MRGA | Current | DOE | 404G, GWESBA, GC | Q | A |
| MW415 | LRGA | Current | DOE | GWESBA | Q | A |
| MW416 | MRGA | Current | DOE | 404G, GWESBA | Q | A |
| MW417 | LRGA | Current | DOE | GWESBA | Q | A |
| MW418 | MRGA | Current | DOE | GWESA | Q | A |
| MW419 | LRGA | Current | DOE | GWESA | Q | A |
| MW420 | MRGA | Current | DOE | 404G | Q | A |
| MW421 | RGA (Multi-zone) | Current | DOE | 400GSA | Q | A |
| MW422 | RGA (Multi-zone) | Current | DOE | 400GSA | Q | A |
| MW423 | RGA (Multi-zone) | Current | DOE | 400GSA | Q | A |
| MW424 | RGA (Multi-zone) | Current | DOE | 400GSA | Q | A |
| MW425 | RGA (Multi-zone) | Current | DOE | 400GSA | Q | A |
| MW426 | URGA | Current | DOE | GC, WPB-NW | Q | A |
| MW427 | LRGA | Current | DOE | GC, WPB-NW | Q | A |
| MW428 | LRGA | Current | DOE | GWNWSA | Q | A |
| MW429 | RGA | AB 2009 | NA | NA | NA | NA |
| MW429A | URGA | Current | DOE | GWNWSA | Q | A |
| MW430 | LRGA | Current | DOE | GWNWSA | Q | A |
| MW431 | LRGA | Current | DOE | GWESQ | Q | A |
| MW432 | MRGA | Current | DOE | GWESBA, WPB-NW | Q | A |
| MW433 | MRGA | Current | TVA | WPB-NW | Q | A |
| 434, Not Installed | NA | NA | NA | NA | NA | NA |
| MW435 | LRGA | Current | TVA | GWESBA, WPB-NW | Q | 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 | MRGA | Current | TVA | GWESBA, GC | Q | A |
| MW440 | LRGA | Current | TVA | NS | Q | A |
| MW441 | LRGA | Current | TVA | GC, WPB-NW | Q | A |
| MW442 | LRGA | Current | KDFWR | GWESBA | Q | A |
| MW443 | LRGA | Current | KDFWR | GWESBA | Q | A |
| MW444 | LRGA | Current | KDFWR | GWESBA | Q | A |
| MW445 | MRGA | Current | TVA | GWESA | Q | A |
| 446, Not Installed | NA | NA | NA | NA | NA | NA |
| MW447 | LRGA | Current | TVA | GWESA, GC | Q | A |
| MW448 | MRGA | Current | KDFWR | GWESA | Q | A |
| 449, Not Installed | NA | NA | NA | NA | NA | NA |
| MW450 | LRGA | Current | KDFWR | GWESA | Q | A |
| MW451 | URGA | Current | KDFWR | GWESBA | Q | A |
| MW452 | LRGA | Current | KDFWR | GWESBA, WPB-NW | Q | A |
| MW453 | URGA | Current | KDFWR | GWESA | Q | A |
| MW454 | LRGA | Current | KDFWR | GWESA | Q | A |
| MW455 | MRGA | Current | DOE | GWNWSA | Q | A |
| MW456 | LRGA | Current | DOE | GWNWSA | M, Q | A |

**Table B.1. Well Program Inventory (Continued)**

| Well Number | Screened Zone | Status | Property Where Located | Sampled | Water Level | Inspection |
|---|---|---|---|---|---|---|
| MW457 | URGA | Current | DOE | GWNWSA | Q | A |
| MW458 | LRGA | Current | DOE | GWNWSA | M, Q | A |
| MW459 | URGA | Current | DOE | GWNWSA | Q | A |
| MW460 | LRGA | Current | DOE | GWNWQ | M, Q | A |
| MW461 | URGA | Current | DOE | GWNWSA | Q | A |
| MW462 | LRGA | Current | DOE | GWNWSA | M, Q | A |
| MW463 | MRGA | Current | TVA | GWESA | M, Q | A |
| MW464 | LRGA | Current | TVA | GWESA | M, Q | A |
| MW465 | MRGA | Current | TVA | GWESBA | Q | A |
| MW466 | MRGA | Current | TVA | GWESBA | Q | A |
| MW467 | URGA | Current | TVA | GWESBA | Q | A |
| MW468 | MRGA | Current | TVA | GWESBA, GC | Q | A |
| MW469 | MRGA | Current | TVA | GWESA | Q | A |
| MW470 | LRGA | Current | TVA | GWESA | Q | A |
| MW471 | MRGA | Current | TVA | GWESA | Q | A |
| MW472 | LRGA | Current | TVA | GWESA | Q | A |
| MW473 | LRGA | Current | Private—Residential | GWESBA, GC | Q | A |
| MW474 | LRGA | Current | Private—Residential | GWESBA, GC | Q | A |
| MW475 | MRGA | Current | Private—Residential | GWESBA | Q | A |
| MW476 | LRGA | Current | Private—Residential | GWESBA | Q | A |
| MW477 | LRGA | Current | TVA | GWESBA | M, Q | A |
| MW478 | MRGA | Current | DOE | GWESBA, GWNEQ | Q | A |
| MW479 | URGA | Current | DOE | GWESBA, GWNESA | Q | A |
| MW480 | LRGA | Current | DOE | GWESBA, GWNEQ | Q | A |
| MW481 | MRGA | Current | DOE | GWESSA | Q | A |
| MW482 | LRGA | Current | DOE | GWESSA | Q | A |
| MW483 | MRGA | Current | Private—Residential | GWESA | M, Q | A |
| MW484 | LRGA | Current | Private—Residential | GWESA | M, Q | A |
| MW485 | MRGA | Current | Private—Residential | GWESBA | Q | A |
| MW486 | RGA | AB 2019 | NA | NA | NA | NA |
| MW486A | LRGA | Current | Private—Residential | GWESSA | Q | A |
| MW487 | LRGA | Current | Private—Residential | GWESBA | Q | A |
| MW488 | MRGA | Current | Private—Residential | GWESA | Q | A |
| MW489 | MRGA | Current | KDFWR | GWESBA | Q | A |
| MW490 | LRGA | Current | KDFWR | GWESBA | Q | A |
| MW491 | URGA | Current | DOE | GWESBA | Q | A |
| MW492 | LRGA | Current | DOE | GWESBA | Q | A |
| MW493 | URGA | Current | DOE | GWESBA | Q | A |
| MW494 | MRGA | Current | DOE | GWESBA | Q | A |
| MW495 | LRGA | Current | DOE | GWESBA, GWNEQ | Q | A |
| MW496 | LRGA | Current | DOE | GWESBA, GWNESA | Q | A |
| MW497 | MRGA | Current | DOE | GWNWSA | Q | A |

**Table B.1. Well Program Inventory (Continued)**

| Well Number | Screened Zone | Status | Property Where Located | Sampled | Water Level | Inspection |
|---|---|---|---|---|---|---|
| MW498 | LRGA | Current | DOE | GWNWSA | M, Q | A |
| MW499 | MRGA | Current | DOE | GWNWSA | Q | A |
| MW500 | LRGA | Current | DOE | GWNWSA | M, Q | A |
| MW501 | MRGA | Current | DOE | GWNWSA | Q | A |
| MW502 | LRGA | Current | DOE | GWNWSA | M, Q | A |
| MW503 | LRGA | Current | DOE | GWNWSA | M, Q | A |
| MW504 | URGA | Current | DOE | GWNWSA | Q | A |
| MW505 | URGA | Current | DOE | 400GQ | Q | A |
| MW506 | MRGA | Current | DOE | 400GQ | Q | A |
| MW507 | LRGA | Current | DOE | 400GQ | Q | A |
| MW508 | UCRS | AB 2014 | DOE | NA | NA | NA |
| MW509 | UCRS | AB 2014 | DOE | NA | NA | NA |
| MW510 | UCRS | AB 2014 | DOE | NA | NA | NA |
| MW511 | UCRS | AB 2020 | DOE | NA | NA | NA |
| MW512 | UCRS | AB 2020 | DOE | NA | NA | NA |
| MW513 | UCRS | AB 2020 | DOE | NA | NA | NA |
| MW514[b] | UCRS | Current | DOE | NS | Q | A |
| MW515[b] | UCRS | Current | DOE | NS | Q | A |
| MW516[b] | UCRS | Current | DOE | NS | Q | A |
| MW517 (PZ)[c] | UCRS | Current | DOE | NS | Q | A |
| MW518 (PZ)[c] | UCRS | Current | DOE | NS | Q | A |
| MW519 (PZ)[c] | UCRS | Current | DOE | NS | Q | A |
| MW520 (PZ)[c] | UCRS | Current | DOE | NS | Q | A |
| MW521 (PZ)[c] | UCRS | Current | DOE | NS | Q | A |
| MW522 (PZ)[c] | UCRS | Current | DOE | NS | Q | A |
| MW523 (PZ)[c] | UCRS | Current | DOE | NS | Q | A |
| MW524[d] | MRGA | Current | DOE | GWNEQ | Q | A |
| MW525[d] | MRGA | Current | DOE | GWNEQ | Q | A |
| MW526[d] | MRGA | Current | DOE | GWNEQ | Q | A |
| MW527[d] | MRGA | Current | DOE | GWNEQ | Q | A |
| MW528[d] | LRGA | Current | DOE | GWNEQ | Q | A |
| MW529[d] | LRGA | Current | DOE | GWNEQ | Q | A |
| MW530[d] | LRGA | Current | DOE | GWNEQ | Q | A |
| MW531 | LRGA | Current | DOE | GWNEQ | Q | A |
| MW532 (PZ)[e] | LRGA | Current | DOE | NS | Q | A |
| MW533 | LRGA | Current | DOE | GWNEQ | Q | A |
| MW534 (PZ)[e] | LRGA | Current | DOE | NS | Q | A |
| MW535 (PZ)[e] | LRGA | Current | DOE | NS | Q | A |
| MW536 | LRGA | Current | DOE | GWNEQ | Q | A |
| MW537 | LRGA | Current | DOE | GWNEQ | Q | A |
| MW538 | MRGA | Current | DOE | GWNEQ | Q | A |
| MW539 | LRGA | Current | DOE | GWNEQ | Q | A |
| MW540 (PZ)[e] | LRGA | Current | DOE | NS | Q | A |
| MW541 (PZ)[e] | LRGA | Current | DOE | NS | Q | A |
| MW542 | URGA | Current | DOE | GWSWMU1 | Q | A |
| MW543 | URGA | Current | DOE | GWSWMU1 | Q | A |
| MW544 | URGA | Current | DOE | GWSWMU1 | Q | A |
| MW545 | URGA | Current | DOE | GWSWMU1 | Q | A |
| MW546 | URGA | Current | DOE | GWSWMU1 | Q | A |
| MW547 | URGA | Current | DOE | GWSWMU1 | Q | A |
| MW548 | LRGA | Current | DOE | GWESBA, 404G | Q | A |

**Table B.1. Well Program Inventory (Continued)**

| Well Number | Screened Zone | Status | Property Where Located | Sampled | Water Level | Inspection |
|---|---|---|---|---|---|---|
| MW549 | URGA | Current | DOE | GWESBA, 404G | Q | A |
| MW550 | URGA | Current | DOE | GWESBA, 404G | Q | A |
| MW551 | URGA | Current | DOE | GWESBA, 404G | Q | A |
| 552, Not Installed | NA | NA | NA | NA | NA | NA |
| MW553 (PZ)[e] | LRGA | Current | DOE | NS | Q | A |
| MW554 (PZ)[e] | LRGA | Current | DOE | NS | Q | A |
| MW555 (PZ)[e] | LRGA | Current | DOE | NS | Q | A |
| MW556 | LRGA | Current | DOE | GWNEQ | Q | A |
| MW557[h] | URGA | Current | DOE | 400GQ | Q | A |
| MW558[h] | MRGA | Current | DOE | 400GQ | Q | A |
| MW559[h] | LRGA | Current | DOE | 400GQ | Q | A |
| MW560[h] | URGA | Current | DOE | 400GQ | Q | A |
| MW561[h] | MRGA | Current | DOE | 400GQ | Q | A |
| MW562[h] | LRGA | Current | DOE | 400GQ | Q | A |
| MW563[h] | URGA | Current | DOE | 400GQ | Q | A |
| MW564[h] | MRGA | Current | DOE | 400GQ | Q | A |
| MW565[h] | LRGA | Current | DOE | 400GQ | Q | A |
| MW566[h] | URGA | Current | DOE | 400GQ | Q | A |
| MW567[h] | MRGA | Current | DOE | 400GQ | Q | A |
| MW568[h] | LRGA | Current | DOE | 400GQ | Q | A |
| MW569[h] | URGA | Current | DOE | 400GQ | Q | A |
| MW570[h] | MRGA | Current | DOE | 400GQ | Q | A |
| MW571[h] | LRGA | Current | DOE | 400GQ | Q | A |
| MW572[h] | LRGA | Current | DOE | 400GQ | Q | A |
| MW573[h] | LRGA | Current | DOE | 400GQ | Q | A |
| MW574[h] | URGA | Current | DOE | 400GQ | Q | A |
| MW575 | URGA | Current | DOE | 211SA | Q | A |
| MW576 | MRGA | Current | DOE | 211SA | Q | A |
| MW577 | URGA | Current | DOE | 211SA | Q | A |
| MW578 | MRGA | Current | DOE | 211SA | Q | A |
| MW579 | URGA | Current | DOE | 211SA | Q | A |
| MW580 | MRGA | Current | DOE | 211SA | Q | A |
| MW581 | URGA | Current | DOE | 211SA | Q | A |
| MW582 | URGA | Current | DOE | 211SA | Q | A |
| MW583[f] | RGA | Planned | TVA | NA | NA | NA |
| MW584 (PZ)[j] | UCRS | Current | DOE | NS | NA | NA |
| MW585 (PZ)[j] | UCRS | Current | DOE | NS | NA | NA |
| MW586 | MRGA | Current | DOE | 211SA | Q | A |
| PW001 | URGA | Current | DOE | 211SA | NA | A |
| PW002 | UCRS | Current | DOE | 211SA | NA | A |
| PW003 | UCRS | Current | DOE | 211SA | NA | A |
| PW004 | URGA | Current | DOE | 211SA | NA | A |
| PW005 | UCRS | Current | DOE | 211SA | NA | A |
| PW006 | UCRS | Current | DOE | 211SA | NA | A |
| PW007 | URGA | Current | DOE | 211SA | NA | A |
| PW008 | UCRS | Current | DOE | 211SA | NA | A |
| PW009 | UCRS | Current | DOE | 211SA | NA | A |
| PW010 | URGA | Current | DOE | 211SA | NA | A |
| PW011 | UCRS | Current | DOE | 211SA | NA | A |
| PW012 | UCRS | Current | DOE | 211SA | NA | A |
| PW013 | URGA | Current | DOE | 211SA | NA | A |

**Table B.1. Well Program Inventory (Continued)**

| Well Number | Screened Zone | Status | Property Where Located | Sampled | Water Level | Inspection |
|---|---|---|---|---|---|---|
| PW014 | UCRS | Current | DOE | 211SA | NA | A |
| PW015 | UCRS | Current | DOE | 211SA | NA | A |
| PW016 | URGA | Current | DOE | 211SA | NA | A |
| PW017 | UCRS | Current | DOE | 211SA | NA | A |
| PW018 | UCRS | Current | DOE | 211SA | NA | A |
| R2 | Unknown | Current | Private—Residential | WPB-NW | Q | FYR |
| R9 | Unknown | Current | Private—Residential | WPB-NE | NS | FYR |
| R10[i] | Unknown | Current | Private—Residential | WPB-NW | NA | NA |
| R13 | Unknown | Current | Private—Residential | WPB-NW | Q | FYR |
| R14 | Unknown | Current | Private—Residential | WPB-NW | Q | FYR |
| R20 | RGA | Current | Private—Residential | WPB-NE | Q | FYR |
| R21 | Unknown | Current | Private—Residential | WPB-NE | Q | FYR |
| R26 | Unknown | Current | Private—Residential | WPB-NW | Q | FYR |
| R40[i] | Unknown | Current | Private—Residential | WPB-NW | NA | NA |
| R53 | Unknown | Current | Private—Residential | WPB-NW | Q | FYR |
| R83 | Unknown | Current | Private—Residential | WPB-NE | Q | FYR |
| R90 | Unknown | Current | Private—Residential | WPB-NE | NS | Outside Water Policy |
| R114 | Unknown | Current | Private—Residential | WPB-NE | NS | Outside Water Policy |
| R245 | Unknown | Current | Private—Residential | WPB-NW | Q | FYR |
| R302 | RGA | Current | Private—Residential | WPB-NE | Q | FYR |
| R424 | RGA | Current | Private—Residential | CARB | NS | Outside Water Policy |

[a] MW initial lithologic log indicated well was completed in the RGA; however, the lithology has been reinterpreted to show a higher top of McNairy.
[b] MWs associated with Southwest Plume project. These MWs are not required to be sampled in fiscal year (FY) 2024.
[c] PZs associated with the Solid Waste Management Unit (SWMU) 4 project. These PZs will be evaluated for their acceptance into the environmental monitoring program. Abandonment will be determined after the completion of the evaluation.
[d] Transect monitoring wells associated with the Northeast Plume Optimization project.
[e] PZs associated with the Northeast Plume Optimization project.
[f] MW152 was abandoned in October 2018 in order for the Tennessee Valley Authority to construct a new process water basin. Another location has been selected for installation of a new well. This new well will be MW583.
[g] MW153 was abandoned in October 2018 in order for the Tennessee Valley Authority to construct a new process water basin.
[h] MWs installed as part of the C-400 Remedial Investigation/Feasibility Study.
[i] Residential wells along Ogden Landing Road are being sampled in support of the Groundwater Strategy project and Water Policy.
[j] PZs are associated with the C-400 Remedial Investigation/Feasibility Study. Water level measurements are not collected from these PZs.
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.

Table B.2 includes an inventory of nonconventional borings. Nonconventional borings are defined as those borings that were installed as part of a short-term project where the borings never were part of the Environmental Monitoring well inventory or the borings were not part of the well inventory in recent years.

**Table B.2. Nonconventional Borings Inventory**

| Project Installed | ID | Status |
|---|---|---|
| 6-Phase | (22) Vacuum Piezometers | Abandoned in 2010 |
| C-400, Phase I | (10) Vacuum Piezometers | Abandoned |
| Cylinder Drop Test Site Investigation | PE01 | Abandoned |
| | PE02 | |
| | PN01 | |
| | PN02 | |
| | PS01 | |
| | PS02 | |
| | PW01 | |
| | PW02 | |
| | PZ01 | |
| | PZ02 | |
| | PZ03 | |
| | PZ04 | |
| | PZ05 | |
| | PZ06 | |
| | PZ07 | |
| | PZ08 | |
| | PZ09 | |
| | PZ10 | |
| | PZ11 | |
| | PZ12 | |
| Groundwater Phase III | SWMU2-10 (20') | Abandoned |
| | Z-1 | |
| | Z-2 | |
| | Z-3 | |
| | Z-5 | |
| | Z-6 | |
| | Z-7 | |
| | Z-9 | |
| | Z-10 | |
| | Z-II | |
| | Z-13 | |
| | Z-14 | |
| | Z-15 | |

**Table B.2. Nonconventional Borings Inventory (Continued)**

| Project Installed | ID | Status |
|---|---|---|
| LASAGNA | 2A-PZ01 | Abandoned |
| NE Plume Aquifer Test | PZ1G | Abandoned |
| | PZ2G | |
| | PZ4G | |
| | PZ4S | |
| Outfalls 10, 11, & 12 Investigation | LB-04 PZ | Abandoned |
| | 011-02PZ | |
| | 012-04 PZ | |
| | 204-02 | |
| | 204-07 | |
| | 204-08 | |
| | 204-09 | |
| | 204-10 | |
| | 204-11 | |
| | 204-12 | |
| | 204-14 | |
| | 204-15 | |
| | 204-26 | |
| | 204-27 | |
| Seismic | Z-12 | Present |
| | Z-16 | |
| SI Phase II Aquifer Test | PZ3G | Abandoned in 2020 |
| | PZ3S | |
| SW Plume Permeable Treatment Zone | CM01 | Abandoned in 2020 |
| | CM02 | |
| | CM03 | |
| | CM04 | |
| | CM05 | |
| | CM06 | |
| | CM07 | |
| | CM08 | |
| | CM09 | |
| | CM10 | |
| | CM11 | |
| | CM12 | |
| SWMU 13 Investigation | 1-013-001 | Abandoned |
| | 4-013-004 | No Evidence of PZ Found |
| | 7-013-009 | Abandoned |

**Table B.2. Nonconventional Borings Inventory (Continued)**

| Project Installed | ID | Status |
|---|---|---|
| UK Creek Studies | BB1A | Abandoned |
| | BB1B | Abandoned |
| | BB1Y | Abandoned |
| | BB1Z | Abandoned |
| | BB2A | Abandoned |
| | BB2B | Abandoned |
| | BB3A | Abandoned |
| | BB3B | Abandoned |
| | BB3Y | Abandoned |
| | BB4A | Abandoned |
| | BB4B | Destroyed by flood |
| | BB5A | Destroyed by flood |
| | BB5B | Abandoned |
| | BB5C | Abandoned |
| | BB5Y | Abandoned |
| | BB5Z | Abandoned |
| | LB1A | Destroyed by flood |
| | LB1B | Destroyed by flood |
| | LB1C | Destroyed by flood |
| | LB1D | Abandoned |
| | LB1E | Abandoned |
| | LB1F | Abandoned |
| | LB1G | Abandoned |
| | LB1Y | Abandoned |
| | LB1Z | Abandoned |
| | LB2A | Destroyed by flood |
| | LB2B | Destroyed by flood |
| | LB2C | Destroyed by flood |
| | LB2D | Abandoned |
| | LB2E | Abandoned |
| | LB6A | Abandoned |
| | LB6B | Abandoned |
| | LB6Y | Abandoned |
| | LB6Z | Abandoned |
| | LB3A | Abandoned |
| | LB3B | Abandoned |
| | LB4A | Abandoned |
| | LB4B | Abandoned |
| | LB7Y | Abandoned |

**Table B.2. Nonconventional Borings Inventory (Continued)**

| Project Installed | ID | Status |
|---|---|---|
| WAG 3 | 004-009PZ | No Evidence of PZ Found |
| | 004-033PZ | |
| | 004-035PZ | |
| | 004-036PZ | |
| | 004-037PZ | |
| | 004-045 PZ | |
| | 005-016PZ | |
| | 006-017PZ | |
| | 006-018PZ | |
| | 006-028PZ | |
| | 006-029PZ | |
| WAG 6 | 011-008 | Abandoned |
| | 026-002 | |
| | 040-001 | |
| | 047-001 | |
| | 203-001 | |
| | 400-003 | |
| | 400-016 | |
| | 400-017 | |
| | 400-021 | |
| | 400-022 | |
| | 400-025 | |
| | 400-026 | |
| | 400-027 | |
| | 400-030 | |
| | 400-031 | |
| | 400-033 | |
| | 400-063 | |
| | 400-083 | |
| WAG 22, SWMUs 2 & 3 | SWMU 2-3 (20’) | No Evidence of PZ Found |
| | SWMU 2-5 (20’) | |
| | SWMU 2-8 (10’) | |
| | SWMU 2-10 (10’) | |
| | SWMU 2-16 (20’) | |
| | SWMU 2-17 (10’) | |
| | SWMU 2-17 (20’) | |
| WAG 22, SWMUs 7 & 30 | GWS-1 | No Evidence of PZ Found |
| | GWS-2 | |
| | WLM-1 | |
| | WLM-2 | |
| | WLM-5 | |

**Table B.2. Nonconventional Borings Inventory (Continued)**

| Project Installed | ID | Status |
|---|---|---|
| WAG 27 | PZ1/720-012 | Abandoned in 2020 |
| | PZ-2/720-013 | |
| | PZ-3/720-015 | |
| | PZ-4/720-017 | |
| | PZ-5/720-019 | |
| WDA Temp PZs | 5A-1 | Abandoned in 2020 |
| | 5A-2 | |
| | 5A-3 | |
| | 5A-4 | |
| | 5A-5 | |
| | 5A-6 | |
| | 5A-7 | |
| | 5A-8 | |
| | 5A-9 | |
| | 5A-10 | |
| | 11-1 (T1-1) | Abandoned in 2020 |
| | 11-2 (T1-2) | Abandoned in 2020* |
| | 11-3 (T1-3) | Abandoned in 2020 |
| | 11-4 (T2-1) | |
| | 11-5 (T2-2) | |
| | 11-6 (T2-3) | |
| | 11-7 (T3-1) | |
| | 11-8 (T3-2) | |
| | 11-9 (T3-3) | |

*During walkdowns performed in preparation of the fieldwork for the MW abandonment project, it was discovered that this PZ had not been abandoned previously. This PZ was abandoned during the MW abandonment project in 2020.

# 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 in Table B.3); and (2) measurement of water levels at the remaining wells (measured quarterly) as indicated in Table B.4. 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.) In support of the Groundwater Strategy project and groundwater modeling at the site, the synoptic water level events will continue to be performed quarterly for FY 2024. Also in support of the Groundwater Strategy project, water level measurements will be collected from Metropolis Lake at the same time as the quarterly synoptic water level events.

An investigation is being performed under the Groundwater Strategy project to evaluate the extent of trichloroethene and groundwater flow trends at the site. This investigation began in January 2020 and is continuing through FY 2024. In FY 2024, manual water level measurements and pressure transducer (PT) measurements will be used to measure the potentiometric surface and seasonal changes in the potentiometric surface. MWs to be evaluated under this project are included in Table B.5.

**Table B.3. Water Levels in Support of Permitted Landfills**

| C-404 Landfill Wells Quarterly Water Levels (9) |
|---|
| MW84A |
| MW85 |
| MW87A |
| MW88 |
| MW90A |
| MW91A |
| MW93A |
| MW94 |
| MW420 |
| **Commitment Wells (7)** [a] |
| MW67 |
| MW76 |
| MW227 |
| MW333 |
| MW337 |
| MW414 |
| MW416 |
| **Noncommitment Wells (10)** |
| MW86 |
| MW89 |
| MW92 |
| MW95A |
| MW226 |
| MW338 |
| MW415 |
| MW417 |
| MW548 |
| MW549 |

| C-746-U Landfill Wells Quarterly Water Levels (21) | |
|---|---|
| MW357 | MW368 |
| MW358 | MW369 [b] |
| MW359 | MW370 [b] |
| MW360 | MW371 |
| MW361 | MW372 [b] |
| MW362 | MW373 [b] |
| MW363 | MW374 |
| MW364 | MW375 |
| MW365 | MW376 |
| MW366 | MW377 |
| MW367 | |
| **Noncommitment Wells (9)** | |
| MW98 | MW173 |
| MW100 | MW193 |
| MW125 | MW197 |
| MW139 | MW200 |
| MW165A | |

| C-746-S&T Landfills Wells Quarterly Water Levels (25) |
|---|
| MW220 |
| MW221 |
| MW222 |
| MW223 |
| MW224 |
| MW225 [c] |
| MW353 [c] |
| MW369 [b] |
| MW370 [b] |
| MW372 [b] |
| MW373 [b] |
| MW384 |
| MW385 |
| MW386 |
| MW387 |
| MW388 |
| MW389 |
| MW390 |
| MW391 |
| MW392 |
| MW393 |
| MW394 |
| MW395 |
| MW396 |
| MW397 |
| **Noncommitment Wells (2)** |
| MW418 |
| MW419 |

[a] 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 wells cited in the permit. 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.

[b] Wells are cited in the Solid Waste Landfill Permit for C-746-S&T and C-746-U Landfills.

[c] Based on the approved permit on for the C-746-S&T Landfills, these two wells are cited in the permit; however, the permit only requires water level measurements for these wells.

**Table B.4. Water Levels In Support of Northeast Plume Optimization Hydraulic Monitoring***

| Monitoring Wells (37) |
|---|
| MW145 |
| MW155 |
| MW163 |
| MW165A |
| MW200 |
| MW205 |
| MW255 |
| MW256 |
| MW258 |
| MW260 |
| MW288 |
| MW292 |
| MW341 |
| MW355 |
| MW480 |
| MW495 |
| MW496 |
| MW524 |
| MW525 |
| MW526 |
| MW528 |
| MW529 |
| MW530 |
| MW531 |
| MW533 |
| MW537 |
| MW539 |
| MW556 |
| PZ110 |
| MW532 (PZ) |
| MW534 (PZ) |
| MW535 (PZ) |
| MW540 (PZ) |
| MW541 (PZ) |
| MW553 (PZ) |
| MW554 (PZ) |
| MW555 (PZ) |

*Per the Operations & Maintenance Plan for the Northeast Plume Containment System, depending on longevity of the remedial system, these measurements may be necessary to characterize flow directions and system performance. Water levels are collected during the quarterly synoptic water level events.

**Table B.5. Groundwater Strategy—Monitoring Wells Planned For Pressure Transducer Deployment and Water Level Measurements**

| WELL NUMBER | MONTH 1 | MONTH 2 | MONTH 3 | MONTH 4 | MONTH 5 | MONTH 6 | MONTH 7 | MONTH 8 | MONTH 9 | MONTH 10 | MONTH 11 | MONTH 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MW20 (also R4) | | M1 | | | M1 | | | M1 | | | M1 | |
| MW63 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW65 | W1 | W1 | W1 | W1 | W1 | W1 | W1 | W1 | W1 | W1 | W1 | W1 |
| MW66 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW67 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW68 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW71 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW72 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW73 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW76 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW77 (PZ) | | M1 | | | M1 | | | M1 | | | M1 | |
| MW78 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW79 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW80 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW81 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW84A | | M1 | | | M1 | | | M1 | | | M1 | |
| MW86 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW87A | | M1 | | | M1 | | | M1 | | | M1 | |
| MW89 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW90A | | M1 | | | M1 | | | M1 | | | M1 | |
| MW92 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW93A | | M1 | | | M1 | | | M1 | | | M1 | |
| MW95A | | M1 | | | M1 | | | M1 | | | M1 | |
| MW98 | | M1 | | | MI | | | M1 | | | MI | |
| MW99 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW100 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW102 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW103 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW106A | W1 | W1 | W1 | W1 | W1 | W1 | W1 | W1 | W1 | W1 | W1 | W1 |
| MW108 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW120 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW121 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW122 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW123 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW124 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW125 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW126 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW132 | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT |
| MW133 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW134 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW135 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW137 | | M1 | | | M1 | | | M1 | | | M1 | |

**Table B.5. Groundwater Strategy—Monitoring Wells Planned For Pressure Transducer Deployment and Water Level Measurements (Continued)**

| WELL NUMBER | MONTH 1 | MONTH 2 | MONTH 3 | MONTH 4 | MONTH 5 | MONTH 6 | MONTH 7 | MONTH 8 | MONTH 9 | MONTH 10 | MONTH 11 | MONTH 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MW139 | M2 | M2 | M2 | M2 | M2 | M2 | M2 | M2 | M2 | M2 | M2 | M2 |
| MW144 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW145 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW146 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW147 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW148 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW150 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW151 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW155 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW156 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW161 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW163 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW165A | | M1 | | | M1 | | | M1 | | | M1 | |
| MW168 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW169 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW173 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW175 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW178 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW185 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW188 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW191 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW193 | M2 | M2 | M2 | M2 | M2 | M2 | M2 | M2 | M2 | M2 | M2 | M2 |
| MW194 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW197 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW199 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW200 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW201 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW202 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW203 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW205 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW220 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW221 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW222 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW223 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW224 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW225 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW226 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW227 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW233 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW236 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW238 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW239 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW240 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW241A | | M1 | | | M1 | | | M1 | | | M1 | |

**Table B.5. Groundwater Strategy—Monitoring Wells Planned For Pressure Transducer Deployment and Water Level Measurements (Continued)**

| WELL NUMBER | MONTH 1 | MONTH 2 | MONTH 3 | MONTH 4 | MONTH 5 | MONTH 6 | MONTH 7 | MONTH 8 | MONTH 9 | MONTH 10 | MONTH 11 | MONTH 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MW242 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW243 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW244 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW245 | W1 | W1 | W1 | W1 | W1 | W1 | W1 | W1 | W1 | W1 | W1 | W1 |
| MW247 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW248 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW249 | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT |
| MW250 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW252 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW253A | | M1 | | | M1 | | | M1 | | | M1 | |
| MW255 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW256 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW257 | W1 | W1 | W1 | W1 | W1 | W1 | W1 | W1 | W1 | W1 | W1 | W1 |
| MW258 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW260 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW261 | W1 | W1 | W1 | W1 | W1 | W1 | W1 | W1 | W1 | W1 | W1 | W1 |
| MW262 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW283 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW284 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW288 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW291 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW292 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW293A | | M1 | | | M1 | | | M1 | | | M1 | |
| MW294A | | M1 | | | M1 | | | M1 | | | M1 | |
| MW316 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW325 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW326 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW327 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW328 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW329 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW330 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW333 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW337 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW338 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW339 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW340 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW341 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW342 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW343 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW345 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW346 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW347 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW353 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW354 | | M1 | | | M1 | | | M1 | | | M1 | |

**Table B.5. Groundwater Strategy—Monitoring Wells Planned For Pressure Transducer Deployment and Water Level Measurements (Continued)**

| WELL NUMBER | MONTH 1 | MONTH 2 | MONTH 3 | MONTH 4 | MONTH 5 | MONTH 6 | MONTH 7 | MONTH 8 | MONTH 9 | MONTH 10 | MONTH 11 | MONTH 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MW355 | W1 | W1 | W1 | W1 | W1 | W1 | W1 | W1 | W1 | W1 | W1 | W1 |
| MW356 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW357 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW358 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW360 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW361 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW363 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW364 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW366 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW367 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW369 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW370 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW372 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW373 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW376 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW380 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW381 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW384 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW385 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW387 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW388 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW391 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW392 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW394 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW395 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW397 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW409 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW410 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW411 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW414 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW415 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW416 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW417 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW418 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW419 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW420 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW421 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW422 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW423 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW424 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW425 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW426 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW427 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW428 | | M1 | | | M1 | | | M1 | | | M1 | |

**Table B.5. Groundwater Strategy—Monitoring Wells Planned For Pressure Transducer Deployment and Water Level Measurements (Continued)**

| WELL NUMBER | MONTH 1 | MONTH 2 | MONTH 3 | MONTH 4 | MONTH 5 | MONTH 6 | MONTH 7 | MONTH 8 | MONTH 9 | MONTH 10 | MONTH 11 | MONTH 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MW429A | | M1 | | | M1 | | | M1 | | | M1 | |
| MW430 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW431 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW432 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW433 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW435 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW439 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW440 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW441 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW442 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW443 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW444 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW445 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW447 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW448 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW450 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW451 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW452 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW453 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW454 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW455 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW456 | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT |
| MW457 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW458 | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT |
| MW459 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW460 | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT |
| MW461 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW462 | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT |
| MW463 | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT |
| MW464 | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT |
| MW465 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW466 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW467 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW468 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW469 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW470 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW471 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW472 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW473 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW474 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW475 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW476 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW477 | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT |
| MW478 | | M1 | | | M1 | | | M1 | | | M1 | |

**Table B.5. Groundwater Strategy—Monitoring Wells Planned For Pressure Transducer Deployment and Water Level Measurements (Continued)**

| WELL NUMBER | MONTH 1 | MONTH 2 | MONTH 3 | MONTH 4 | MONTH 5 | MONTH 6 | MONTH 7 | MONTH 8 | MONTH 9 | MONTH 10 | MONTH 11 | MONTH 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MW479 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW480 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW481 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW482 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW483 | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT |
| MW484 | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT |
| MW485 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW486A | | M1 | | | M1 | | | M1 | | | M1 | |
| MW487 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW488 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW489 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW490 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW491 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW492 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW493 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW494 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW495 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW496 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW497 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW498 | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT |
| MW499 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW500 | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT |
| MW501 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW502 | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT |
| MW503 | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT | M1+PT |
| MW504 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW505 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW506 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW507 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW524 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW525 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW526 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW527 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW528 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW529 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW530 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW531 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW532 (PZ) | | M1 | | | M1 | | | M1 | | | M1 | |
| MW533 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW534 (PZ) | | M1 | | | M1 | | | M1 | | | M1 | |
| MW535 (PZ) | | M1 | | | M1 | | | M1 | | | M1 | |
| MW536 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW537 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW538 | | M1 | | | M1 | | | M1 | | | M1 | |

**Table B.5. Groundwater Strategy—Monitoring Wells Planned For Pressure Transducer Deployment and Water Level Measurements (Continued)**

| WELL NUMBER | MONTH 1 | MONTH 2 | MONTH 3 | MONTH 4 | MONTH 5 | MONTH 6 | MONTH 7 | MONTH 8 | MONTH 9 | MONTH 10 | MONTH 11 | MONTH 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MW539 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW540 (PZ) | | M1 | | | M1 | | | M1 | | | M1 | |
| MW541 (PZ) | | M1 | | | M1 | | | M1 | | | M1 | |
| MW542 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW543 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW544 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW545 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW546 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW547 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW548 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW549 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW550 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW551 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW553 (PZ) | | M1 | | | M1 | | | M1 | | | M1 | |
| MW554 (PZ) | | M1 | | | M1 | | | M1 | | | M1 | |
| MW555 (PZ) | | M1 | | | M1 | | | M1 | | | M1 | |
| MW556 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW557 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW558 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW559 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW560 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW561 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW562 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW563 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW564 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW565 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW566 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW567 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW568 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW569 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW570 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW571 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW572 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW573 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW574 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW575 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW576 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW577 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW578 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW579 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW580 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW581 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW582 | | M1 | | | M1 | | | M1 | | | M1 | |
| MW586 | | M1 | | | M1 | | | M1 | | | M1 | |

**Table B.5. Groundwater Strategy—Monitoring Wells Planned For Pressure Transducer Deployment and Water Level Measurements (Continued)**

| WELL NUMBER | MONTH 1 | MONTH 2 | MONTH 3 | MONTH 4 | MONTH 5 | MONTH 6 | MONTH 7 | MONTH 8 | MONTH 9 | MONTH 10 | MONTH 11 | MONTH 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PZ101 | | M1 | | | M1 | | | M1 | | | M1 | |
| PZ107 | | M1 | | | M1 | | | M1 | | | M1 | |
| PZ109 | | M1 | | | M1 | | | M1 | | | M1 | |
| PZ110 | | M1 | | | M1 | | | M1 | | | M1 | |
| PZ114 | | M1 | | | M1 | | | M1 | | | M1 | |
| PZ115 | | M1 | | | M1 | | | M1 | | | M1 | |
| PZ117 | | M1 | | | M1 | | | M1 | | | M1 | |
| PZ118 | | M1 | | | M1 | | | M1 | | | M1 | |
| PZ287 | | M1 | | | M1 | | | M1 | | | M1 | |
| PZ289 | | M1 | | | M1 | | | M1 | | | M1 | |
| PZ290 | | M1 | | | M1 | | | M1 | | | M1 | |
| PZ349 | W1 | W1 | W1 | W1 | W1 | W1 | W1 | W1 | W1 | W1 | W1 | W1 |
| PZ351 | | M1 | | | M1 | | | M1 | | | M1 | |
| EW232 | | M1 | | | M1 | | | M1 | | | M1 | |
| EW233 | | M1 | | | M1 | | | M1 | | | M1 | |
| EW234 | | M1 | | | M1 | | | M1 | | | M1 | |
| EW235 | | M1 | | | M1 | M1 | | M1 | | | M1 | |

M1: Manual water level collected once per month
M2: Manual water level collected twice per month
PT: pressure transducer
PW: Performance Monitoring Well
PZ: piezometer
W1: Manual water level collected once per week

# APPENDIX C

# ENVIRONMENTAL SAMPLING FREQUENCY AND PARAMETERS

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# CONTENTS

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# TABLES

# FIGURES

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# ACRONYMS

| | |
|---|---|
| ASD | alternate source demonstration |
| 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 |
| EPA | U.S. Environmental Protection Agency |
| ERPP | Environmental Radiation Protection Program |
| EW | extraction well |
| FFA | Federal Facility Agreement |
| FPDP | Fluor Federal Services, Inc., Paducah Deactivation Project |
| FRNP | Four Rivers Nuclear Partnership, LLC |
| FY | fiscal year |
| *KAR* | *Kentucky Administrative Regulation* |
| KDOW | Kentucky Division of Water |
| KDWM | Kentucky Division of Waste Management |
| KPDES | Kentucky Pollutant Discharge Elimination System |
| MCL | maximum contaminant level |
| MW | monitoring well |
| PEGASIS | PPPO Environmental Geographic Analytical Spatial Information System |
| PGDP | Paducah Gaseous Diffusion Plant |
| RFI | Resource Conservation and Recovery Act Facility Investigation |
| RGA | Regional Gravel Aquifer |
| ROD | Record of Decision |
| SWMU | solid waste management unit |
| TSS | total suspended solids |
| VOC | volatile organic compound |

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# C.1. INTRODUCTION

Four hundred thirty-three 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. (Note: Wells denoted as "noncommitment wells" are measured as a best management practice, but are not listed in the permit.)

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) 2023 to the FY 2024 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 2024. 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 2025 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 U.S. Environmental Protection Agency (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 2024, an equivalent procedure will be used upon approval by the EM 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 SW07300014, SW07300015, SW07300045 issued by the Kentucky Division of Waste Management (KDWM) and *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, June 2014.

**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 Solid Waste Landfill Permit, SW07300014, SW07300015, SW07300045, the reporting requirement for maximum contaminant level (MCL) is as follows: "If the analysis of 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. Sample collection 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 2025 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 wells cited in the permit associated with the C-746-S&T Landfills is 25; however, two of these wells (MW225, MW353) only require 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 8260D 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 9056A** | | |
| Bromide | Fluoride | Sulfate |
| Chloride | Nitrate as Nitrogen | |
| **Metals—Method 6020B unless noted** | | |
| Aluminum | Iron | Silver |
| Antimony | Lead | Sodium |
| Arsenic | Magnesium | Tantalum |
| Barium | Manganese | Thallium |
| Beryllium | **Mercury—7470A** | Uranium |
| Boron | Molybdenum | Vanadium |
| Cadmium | Nickel | Zinc |
| Calcium | Potassium | Barium, Dissolved[b] |
| Chromium | Rhodium | Chromium, Dissolved[b] |
| Cobalt | Selenium | Uranium, Dissolved[b] |
| Copper | | |
| **Miscellaneous—Method as follows** | | |
| **Chemical Oxygen Demand—410.4** | **Iodide—300.0** | **Total Dissolved Solids—160.1** |
| **Cyanide—9012B** | **Total Organic Carbon—9060A** | **Total Organic Halides—9020B** |
| **Field Parameters** | | |
| Conductivity | Eh[c] (approx) | Temperature |
| Depth to Water | pH | Turbidity |
| Dissolved Oxygen | | |
| **PCBs[d]—Method 8082A** | | |
| 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[e]—904.0M** | **Thorium-230—Th-01-RC M** |
| **Beta Activity—9310** | **Strontium-90—905.0M** | **Thorium-232[e]—Th-01-RC M** |
| **Radium-226—AN-1418** | **Technetium-99—TC-02-RC M** | **Tritium—906.0M** |

[a] Xylenes
[b] Permit does not require analysis of dissolved metals. These parameters are analyzed in support of understanding the source of contaminants potentially observed in wells in comparison to total metals.
[c] Oxidation-reduction potential calibrated as Eh.
[d] 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.

## Table C.3. C-746-S, C-746-T, C-746-U Quarterly Analytical Parameters (Continued)

[e] 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 analyzed by different method than specified in header.

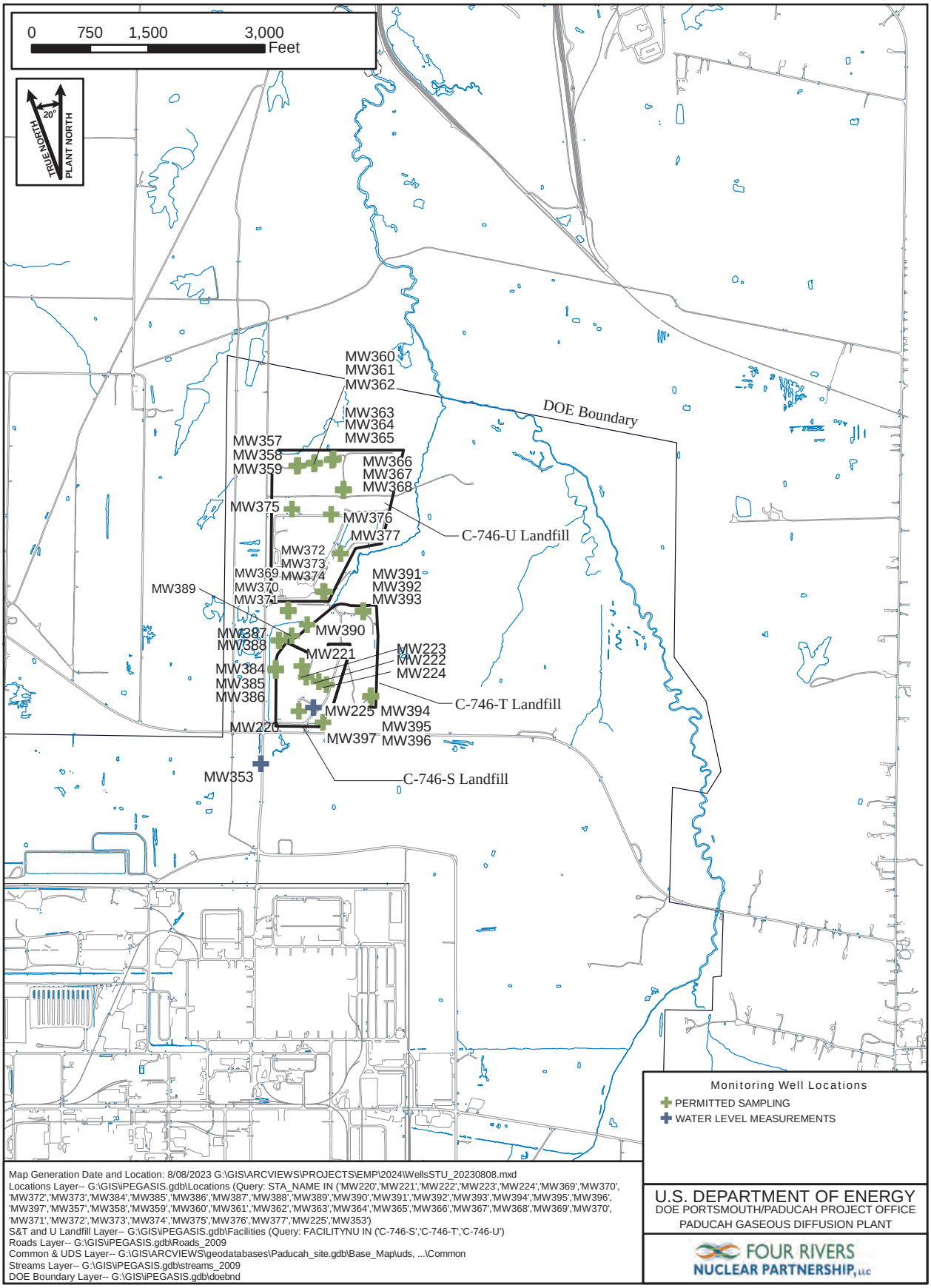


**Figure C.1. Groundwater Monitoring Wells Near the C-746-S, T, and U Landfills**

**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 Management Facility Permit, KY8-890-008-982.

**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:** Perform statistical evaluation for each constituent to determine if there is a statistically significant exceedance over background levels. If a statistically significant exceedance is indicated, notification to KDWM must be made within 7 days of confirmation of the exceedance. The statistical exceedance is evaluated with respect to the 2007 alternate source demonstration (ASD) to determine if the results are consistent with findings of the ASD. This evaluation will assess whether the contamination is from the C-404 Landfill or another source.

**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.

An ASD was conducted in 2021 in response to a statistical exceedance for Technetium-99 (Tc-99) in MW84A. This ASD has determined that the Tc-99 contamination is indicative of dissolved contamination in the Regional Gravel Aquifer (RGA) and is not derived from contamination associated with the construction of RGA well MW84A. In accordance with the permit, compliance monitoring for radiological constituents was conducted quarterly at the C-404 Landfill during FY 2022 and the first quarter of FY 2023. Compliance monitoring for radiological constituents was completed in FY 2023 and will be discontinued during FY 2024.

In support of a potential future ASD at the C-404 Landfill, the current sampling and analysis for metals and sulfate will continue in the upper RGA monitoring wells of the C-404 Landfill and upgradient areas. The additional metals and sulfate analysis will be extended to MW337 and MW338. Sulfate analyses will be extended to upgradient monitoring wells MW227, MW333, MW414, MW549, MW550, and MW551.

Field parameters (pH, temperature, conductivity, dissolved oxygen, Eh,[1] and turbidity) are measured using a water quality meter. Other field parameters, such as depth to water and barometric pressure, are measured prior to sampling.

[1] Oxidation-reduction potential calibrated as Eh.

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.

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)** | | | |
| MW84A | MW88 | MW91A | MW94 |
| MW85 | MW90A | MW93A | MW420 |
| MW87A | | | |
| **Noncommitment Wells (12)[a]** | | | |
| **TCE, Tc-99, and Field Parameters** | | | |
| MW67 | MW89 | MW226 | MW337 |
| MW76 | MW92 | MW227 | MW338 |
| MW86 | MW95A | MW333 | MW548[b] |
| **Noncommitment Wells (9)** | | | |
| **Metals, Sulfate, and Field Parameters** | | | |
| MW227 | MW338 | MW549 | |
| MW333 | MW414 | MW550 | |
| MW337 | MW416 | MW551 | |

[a] 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.
[b] MW548 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 8260D** | | | |
| Trichloroethene | | | |
| **Metals—6020B unless noted** | | | |
| Arsenic | Lead | Uranium | Lead, Dissolved[a] |
| Cadmium | Manganese[a] | Arsenic, Dissolved[a] | **Mercury, Dissolved—7470A[a]** |
| Chromium | **Mercury—7470A** | Cadmium, Dissolved[a] | Selenium, Dissolved[a] |
| Iron[a] | Selenium | Chromium, Dissolved[a] | Uranium, Dissolved[a] |
| **Metals—6010D** | | | |
| Arsenic[b] | Arsenic, Dissolved[b] | | |
| **Field Parameters** | | | |
| Barometric Pressure | Depth to Water | Eh[c] (approx) | Temperature |
| Conductivity | Dissolved Oxygen | pH | Turbidity |
| **Radionuclides—Method U-02-RC M unless noted** | | | |
| **Technetium-99—TC-02-RC M** | Uranium-234 | Uranium-235 | Uranium-238 |
| **Miscellaneous** | | | |
| **Total Organic Carbon—9060A[a]** | **Sulfate—9056A[a]** | | |

[a] Not required by the permit.
[b] MW samples will be analyzed for arsenic and dissolved arsenic by EPA Methods 6010D and 6020B during FY 2024.
[c] Oxidation-reduction potential calibrated as Eh.
Bolded parameters are analyzed by different method than specified in header.
Alternate SW-846 methods may be substituted with prior written approval from KDWM.

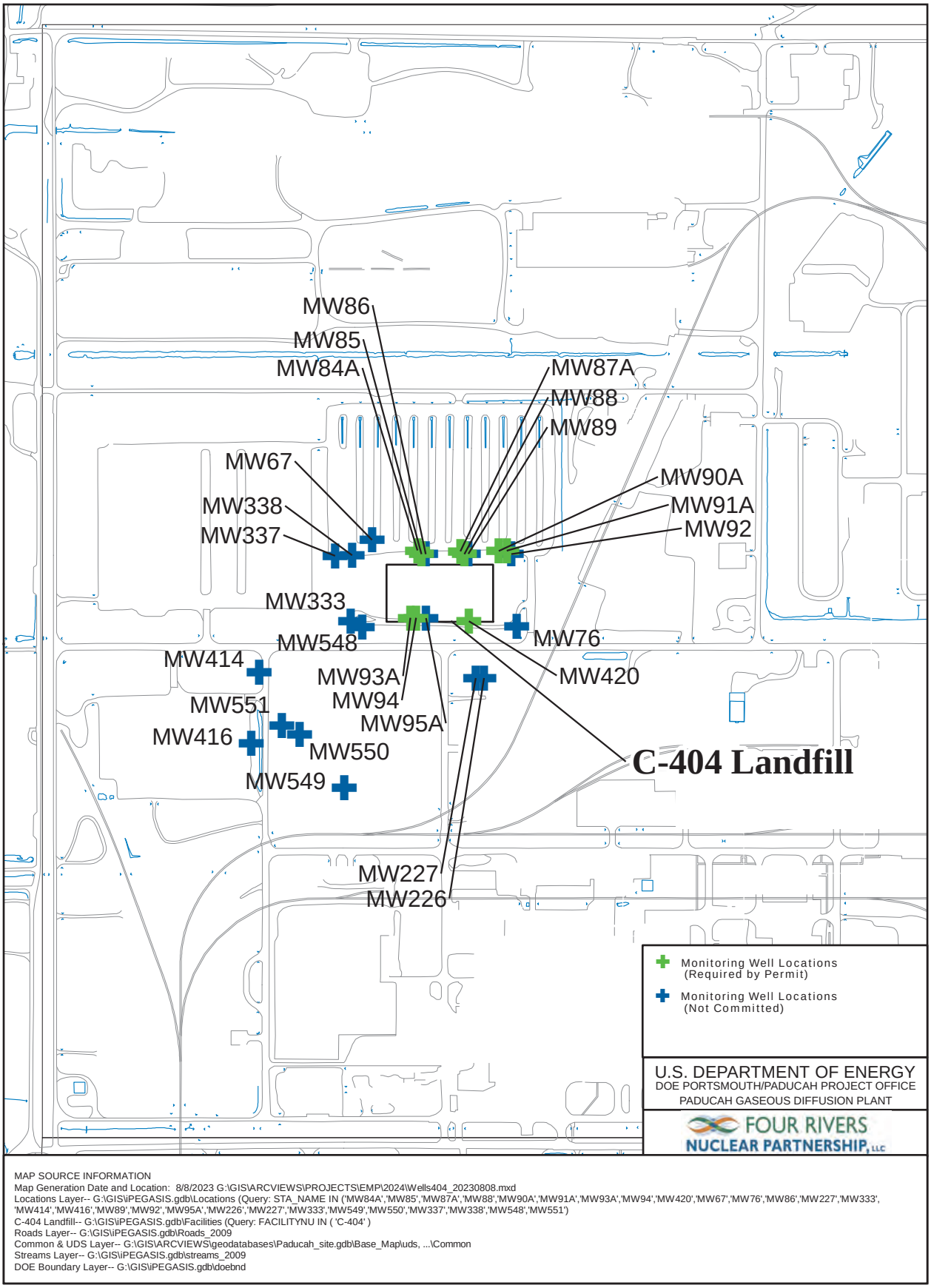


**Figure C.2. Groundwater Monitoring Wells Near C-404 Landfill**

**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 2024.

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 8260D** | | | |
| 1,1,1-Trichloroethane | Benzene | *cis*-1,2-Dichloroethene | Toluene |
| 1,1,2-Trichloroethane | Bromodichloromethane | Dimethylbenzene, Total[a] | *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 | Temperature | Eh[b] (approx) |
| | Dissolved Oxygen | | |
| **Miscellaneous—310.1** | | | |
| Alkalinity | | | |
| **Metals—Method 6020B** | | | |
| 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 M** | |
| **Anions—Method 9056A** | | | |
| Chloride | Sulfate | Nitrate | |

[a] Xylenes
[b] Oxidation-reduction potential calibrated as Eh.
Bolded parameters are analyzed by different method than specified in header.

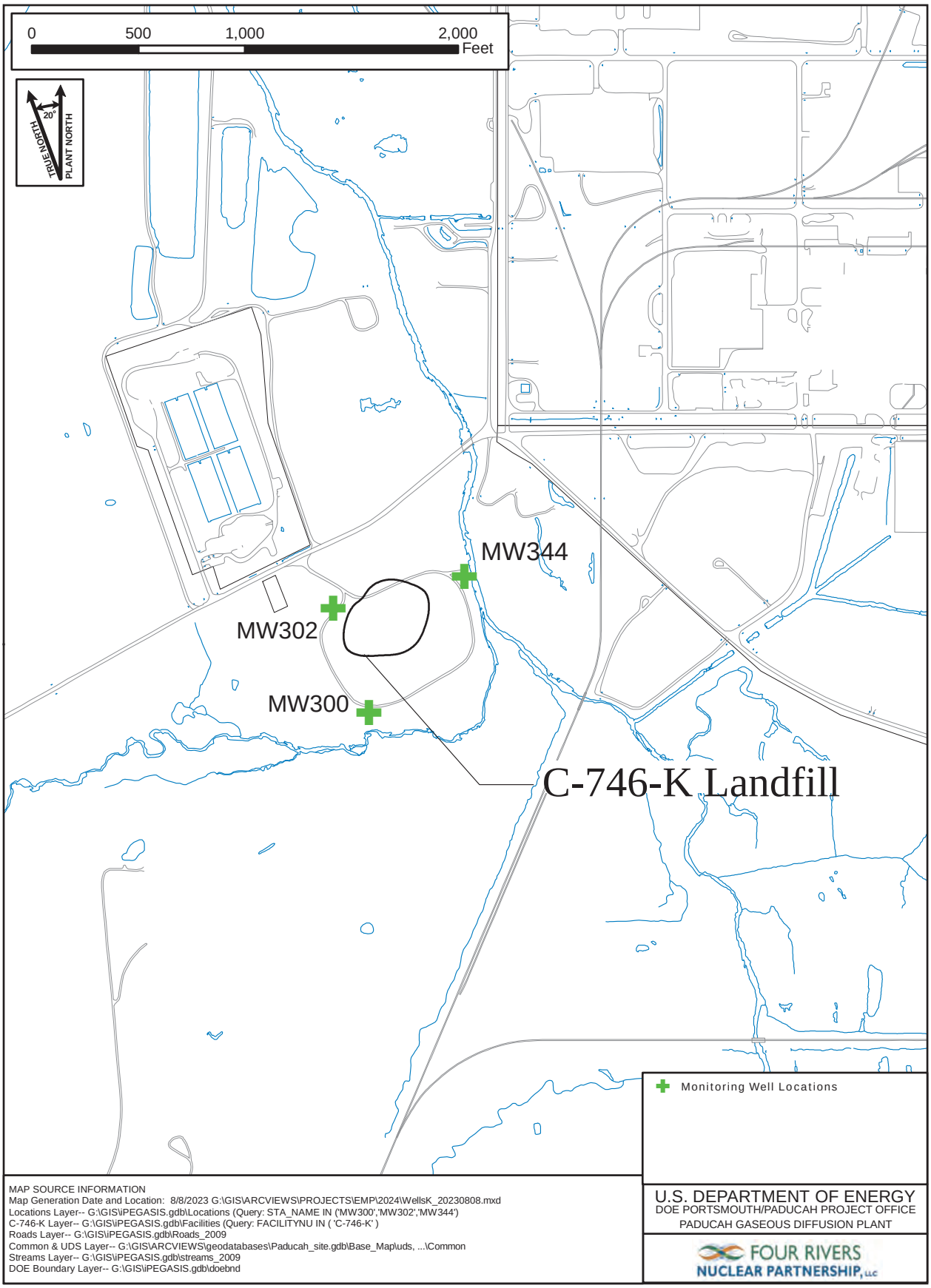


**Figure C.3. Groundwater Monitoring Wells Near C-746-K Landfill**

## C.2.2 NORTHEAST PLUME OPERATION AND MAINTENANCE PROGRAM

**Northeast Plume Monitoring**

**Frequency:** Quarterly

**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/LX/07-2470&D1, November 2021, and by the *Remedial Action Work Plan for the Optimization of the Northeast Plume Interim Remedial Action at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-1280&D2/R3/A1, July 2018.

Per the *Memorandum of Agreement for Resolution of Informal Dispute Concerning U.S. Environmental Protection Agency and Kentucky Department for Environmental Protection Requirements for Additional Actions or Modifications Regarding the CY 2018 Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, *DOE/LX/07-2426&D2*, July 2020, the Operation and Maintenance Plan for the Northeast Plume was revised to incorporate elements of Water Policy boundary monitoring currently conducted under the EMP in November 2020.

**Reported:** Semiannual FFA Progress Report and ASER

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

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

The Northeast Plume EW system has undergone an optimization. New EWs have been installed in new locations closer to the site due to the decreasing concentration of contaminants at their locations. This optimization program included two new EWs, EW234 and EW235, and 22 piezometers and MWs. Sampling frequencies and sampling parameters 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/LX/07-2470&D1, November 2021, and the *Remedial Action Work Plan for the Optimization of the Northeast Plume Interim Remedial Action at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-1280&D2/R3/A1, July 2018, are included in Table C.8. The EWs (and other operational samples) are not sampled under the groundwater program as part of the EM Program. They are sampled as specified under the Operation and Maintenance Plan listed above for the Northeast Plume. Locations are shown on Figure C.4.

Sampling frequencies and sampling parameters were not modified for the sampling program for FY 2024.

**Table C.8. Northeast Plume Optimization Quarterly Wells and Parameters**

| | | | |
|---|---|---|---|
| **Quarterly Wells (36)** | | | |
| MW124 | MW258 | MW479 | MW529 |
| MW126 | MW260 | MW480 | MW530 |
| MW144 | MW283 | MW495 | MW531 |
| MW145 | MW288 | MW496 | MW533 |
| MW155 | MW291 | MW524 | MW536 |
| MW156 | MW292 | MW525 | MW537 |
| MW163 | MW293A | MW526 | MW538 |
| MW255[a] | MW341 | MW527 | MW539 |
| MW256[a] | MW478 | MW528 | MW556 |
| **Quarterly Analytical Parameters** | | | |
| **Volatiles—Method 8260D** | | | |
| 1,1-Dichloroethene | Trichloroethene | | |
| **Radionuclides—Method TC-02-RC M** | | | |
| Technetium-99 | | | |
| **Field Parameters** | | | |
| Barometric Pressure | Depth to Water | Eh[b] (approx) | Temperature |
| Conductivity | Dissolved Oxygen | pH | Turbidity |

[a] Northeast Plume Operation and Maintenance plan requires semiannual sampling of MW255 and MW256; however, these wells are sampled more frequently (quarterly) to provide timely assessment of Northeast Plume optimized extraction well operations.
[b] Oxidation-reduction potential calibrated as Eh.

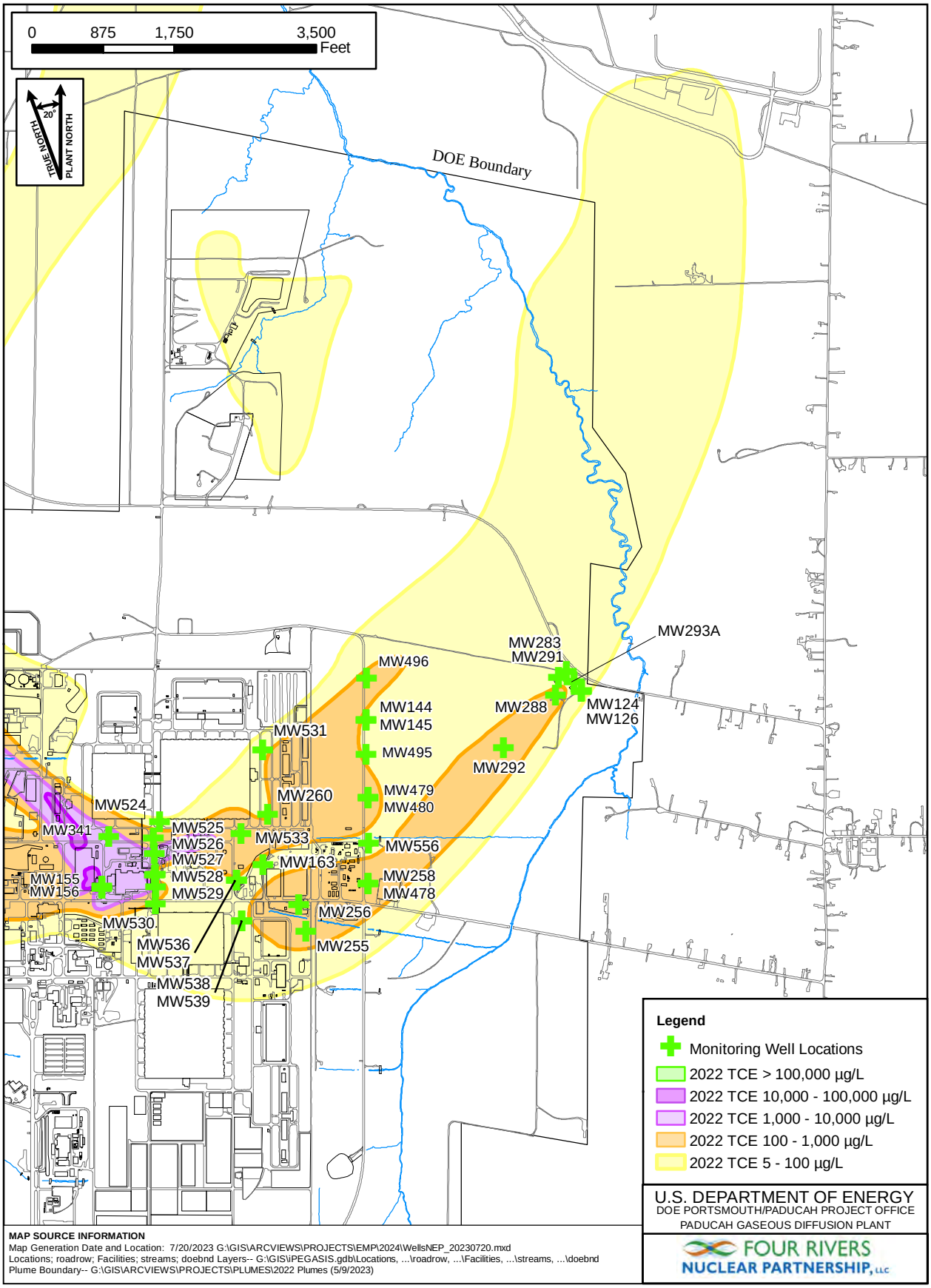


**Figure C.4. Northeast Plume Monitoring Wells**

## C.2.3 NORTHWEST PLUME OPERATION 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/LX/07-2469&D2, October 2021.

Per the *Memorandum of Agreement for Resolution of Informal Dispute Concerning U.S. Environmental Protection Agency and Kentucky Department for Environmental Protection Requirements for Additional Actions or Modifications Regarding the CY 2018 Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/LX/07-2426&D2*, July 2020, the Operation and Maintenance Plan for the Northwest Plume was revised to incorporate elements of Water Policy boundary monitoring conducted under the EMP.

**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 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 Operation and Maintenance Plan for the Northwest Plume.

The sampling frequency for MW460 within the Operation and Maintenance Plan is semiannual; however, the frequency of sampling was increased to quarterly in FY 2018 in order to evaluate trends in TCE concentrations along the Northwest Plume.

The sampling frequency for MW339, MW340, MW455, and MW456 within the Operation and Maintenance Plan is semiannual; however, the frequency of sampling was increased to quarterly in FY 2023 in order to evaluate trends in TCE and Tc-99 concentrations along the Northwest Plume.

Table C.9 provides a listing of MWs, and Table C.10 provides the analytical parameters for these MWs. Locations are shown on Figure C.5.

**Table C.9. Northwest Plume Wells**

| | | | | |
|---|---|---|---|---|
| **Semiannual Wells (28)** | | | | |
| MW63 | MW243 | MW428 | MW461 | MW501 |
| MW65 | MW244 | MW429A | MW462 | MW502 |
| MW66 | MW245 | MW430 | MW497 | MW503 |
| MW165A | MW248 | MW457 | MW498 | MW504 |
| MW173 | MW250 | MW458 | MW499 | |
| MW242 | MW355 | MW459 | MW500 | |
| **Quarterly Well (5)** | | | | |
| MW339 | MW340 | MW455 | MW456 | MW460 |

**Table C.10. Northwest Plume Analytical Parameters**

| | | | |
|---|---|---|---|
| **Volatiles—Method 8260D** | | | |
| 1,1,1-Trichloroethane | Benzene | *cis*-1,2-Dichloroethene | Toluene |
| 1,1,2-Trichloroethane | Bromodichloromethane | Dimethylbenzene, Total[a] | *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 | Eh[b] (approx) | Temperature |
| Conductivity | Dissolved Oxygen | pH | Turbidity |
| **Radionuclides—Method 9310 unless noted** | | | |
| Alpha Activity | Beta Activity | **Technetium-99—TC-02-RC M** | |

[a] Xylenes

[b] Oxidation-reduction potential calibrated as Eh.

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

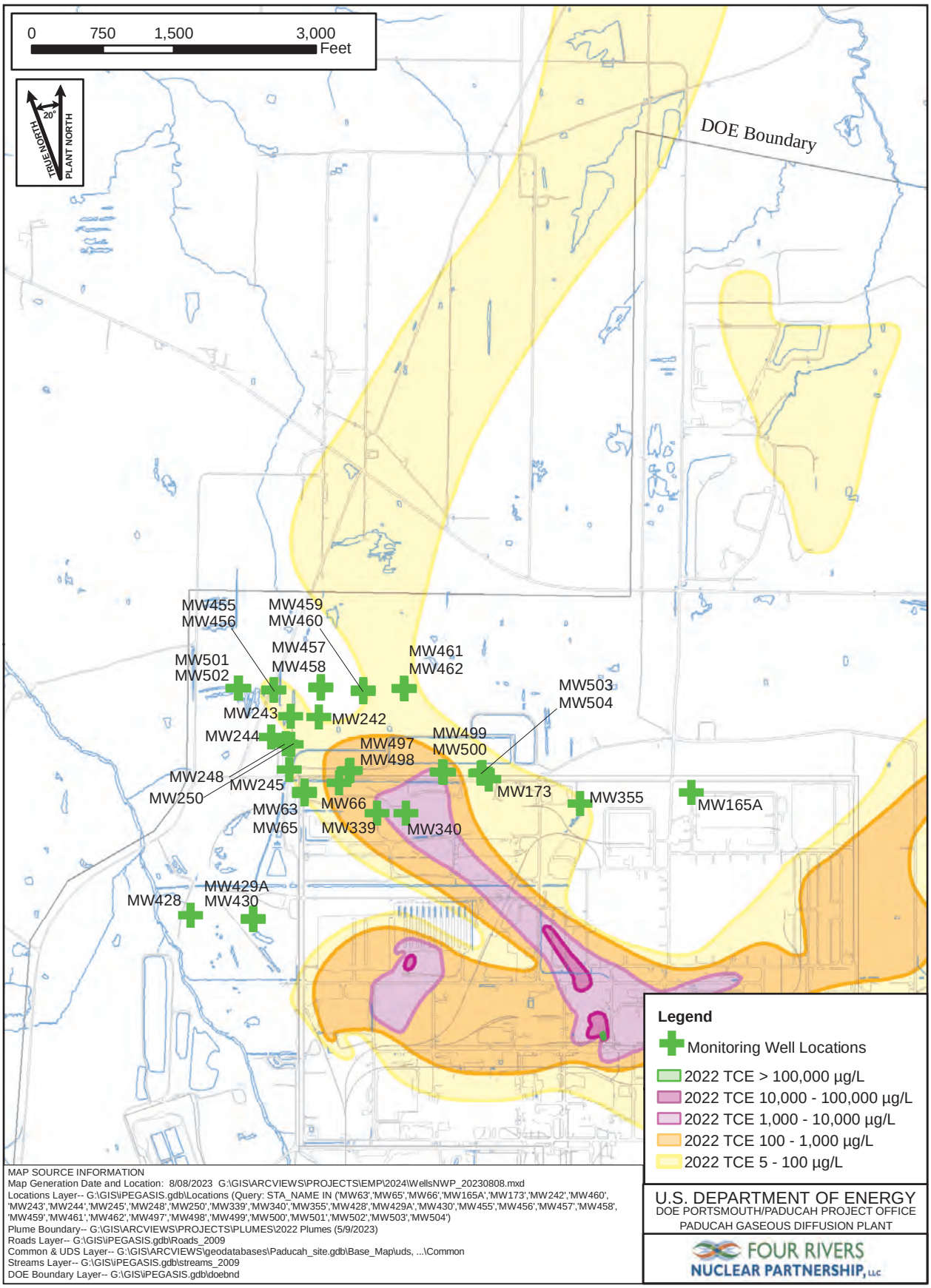


**Figure C.5. Northwest Plume Monitoring Wells**

### C.2.4 C-400 MONITORING WELLS

**C-400 Wells**

**Frequency:** Quarterly and Semiannually

**Driver:** 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, July 2005.

**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. These MWs also were sampled under the *Remedial Investigation/Feasibility Study Work Plan for the C-400 Complex Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-2433&D2/R1, March 2020. The results of continued monitoring in all MWs will support the upcoming remedial action(s) at C-400.

**Comments:** MW178 and MW341 are sampled quarterly and results will support the upcoming remedial action(s) at C-400.

Sampling frequencies and sampling parameters were not modified for this sampling program for FY 2024.

Table C.11 provides a listing of the C-400 MWs, and Table C.12 provides the analytical parameters for these MWs. Locations are shown on Figure C.6.

**Table C.11. C-400 Monitoring Wells (37)**

| | | |
|---|---|---|
| **Quarterly Wells (29)** | | |
| MW155 | MW507* | MW566 |
| MW156 | MW557 | MW567 |
| MW178 | MW558 | MW568 |
| MW341 | MW559 | MW569 |
| MW405: Port 5 | MW560 | MW570 |
| MW406: Port 5 | MW561 | MW571 |
| MW407: Port 4 | MW562 | MW572 |
| MW408: Port 5 | MW563 | MW573 |
| MW505* | MW564 | MW574 |
| MW506* | MW565 | |
| **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 | |

* 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.12. C-400 Monitoring Wells Analytical Parameters**

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

[a] As applicable, depth to water measurements cannot be obtained for multiport wells.
[b] Oxidation-reduction potential calibrated as Eh.

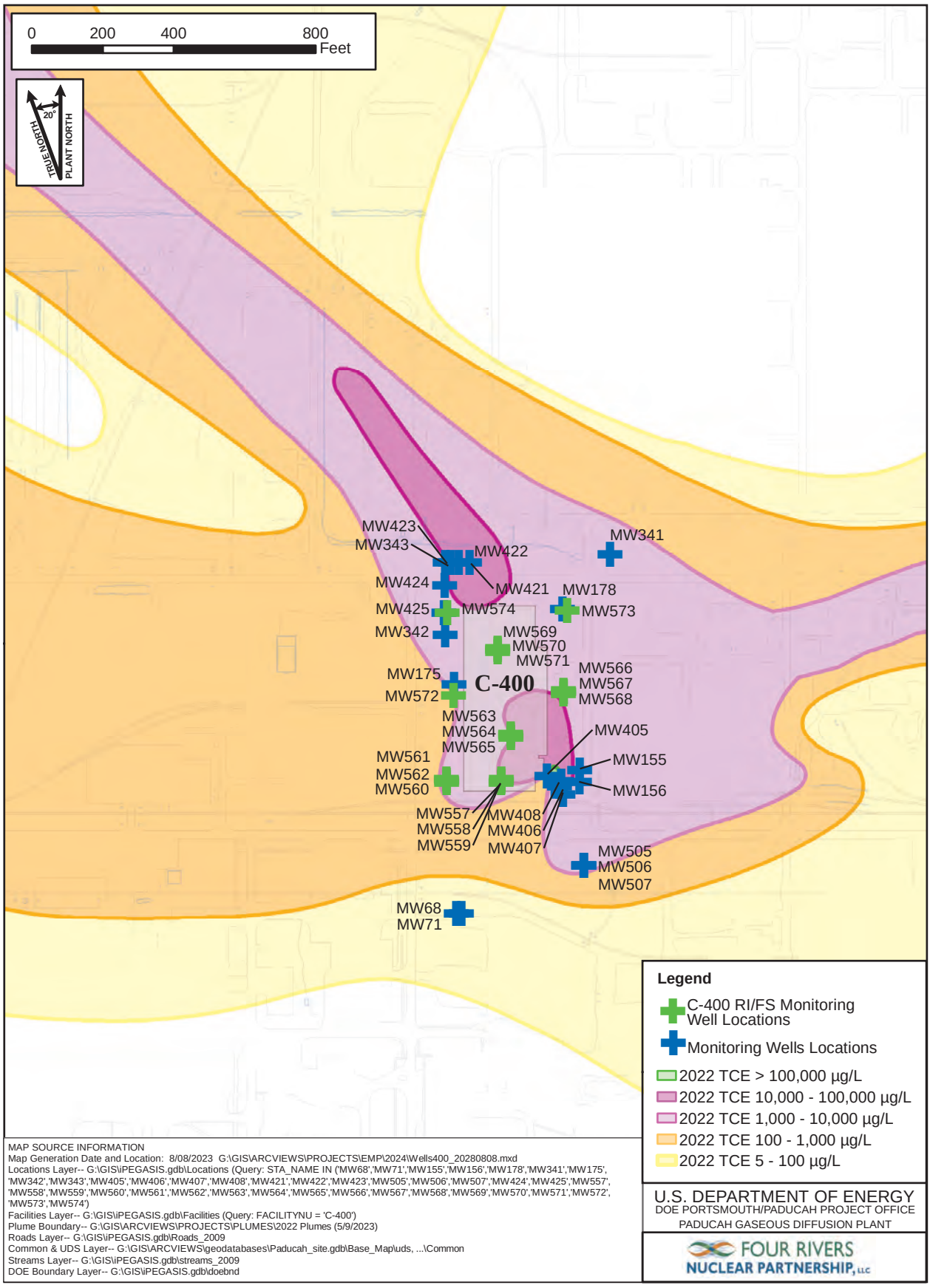


**Figure C.6. C-400 Monitoring Wells with TCE Plume Shown**

## 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:** Sampling frequencies and parameters were not modified for this sampling program for FY 2024.

Table C.13 provides a listing of MWs, and Table C.14 provides the analytical parameters. Locations are shown on Figure C.7.

**Table C.13. SWMU 1 Wells**

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

**Table C.14. SWMU 1 Analytical Parameters**

| | | | |
|---|---|---|---|
| **Volatiles—Method 8260D** | | | |
| 1,1-Dichloroethene | *trans*-1,2-Dichloroethene | Vinyl Chloride | |
| *cis*-1,2-Dichloroethene | Trichloroethene | | |
| **Field Parameters** | | | |
| Barometric Pressure | Depth to Water | Eh* (approx) | Temperature |
| Conductivity | Dissolved Oxygen | pH | Turbidity |

*Oxidation-reduction potential calibrated as Eh.

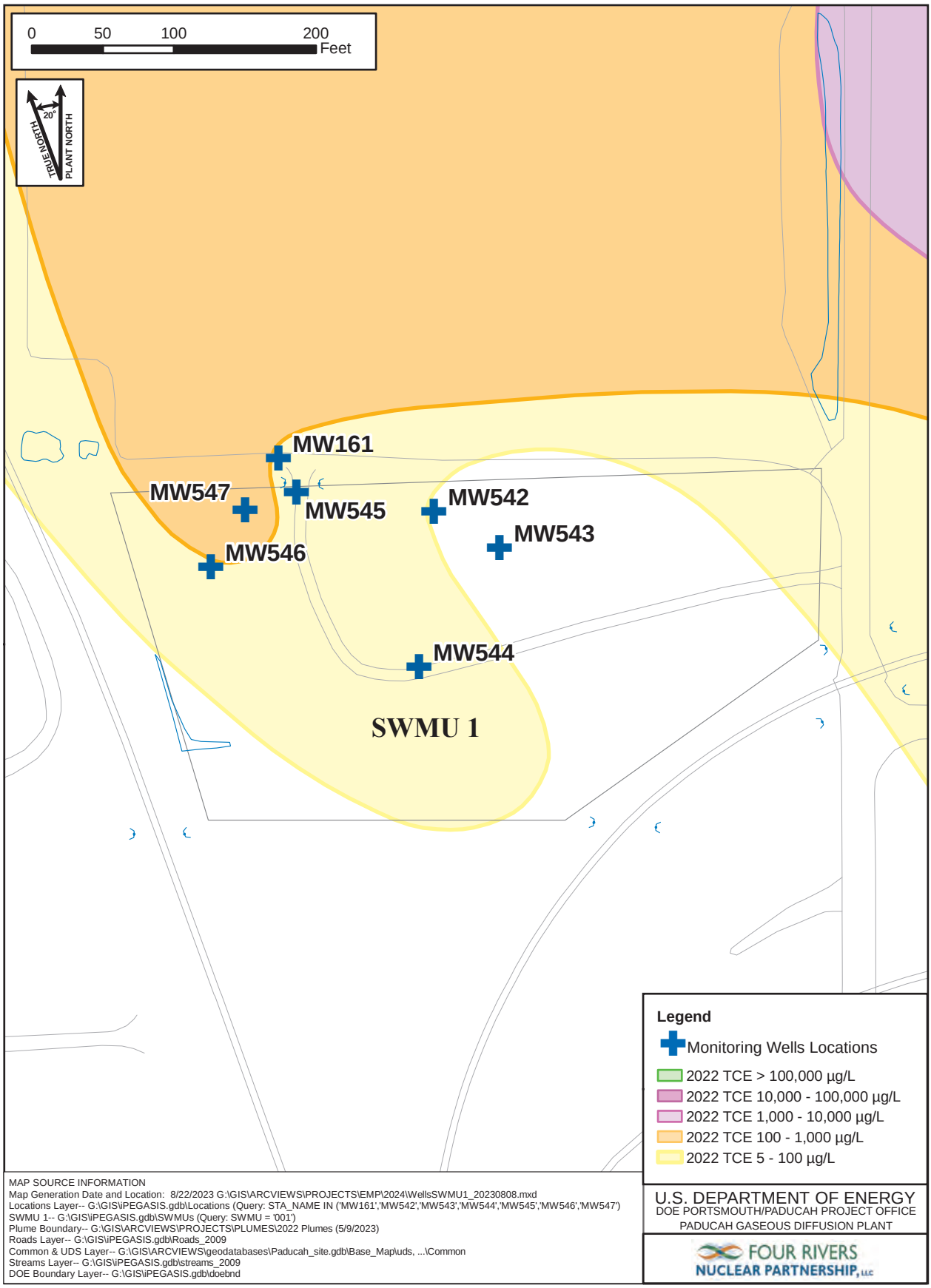


**Figure C.7. SWMU 1 Monitoring Wells with TCE Plume Shown**

## C.2.6 SWMU 211-A PERFORMANCE AND LONG-TERM MONITORING WELLS

**SWMU 211-A Wells**

**Frequency:** Semiannually

**Driver:** The MWs are required to be sampled by the *Remedial Action Work Plan for SWMU 211-A Enhanced In Situ Bioremediation for Volatile Organic Compound Sources to the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-2443&D2, December 2021, and the *Certified for Construction Remedial Design Report for SWMU 211-A for Volatile Organic Compound Sources to the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-2435&D2, December, 2019.

**Reported:** CERCLA Five-Year Reviews and ASER

**Rationale:** MW sampling will be conducted to assess the performance of the remedial action. Post-implementation sampling and analysis is intended to achieve three main goals:

1. Assess the passive ongoing bioremediation in the subsurface;
2. Assess the zero-valent iron for continued volatile organic compound (VOC) reduction; and
3. Assess continued reduction of TCE and degradation products such that VOC migration from contaminated subsurface soils in the treatment areas of SWMU 211-A do not result in the exceedance of MCLs in the RGA over time as EISB degrades TCE in the UCRS.

**Comments:** Sampling of SWMU 211-A performance and long-term wells will begin near the end of the second quarter of FY 2024. Performance and long-term MWs will be sampled semiannually from FY 2024 to FY 2028. Beginning in FY 2029, performance MWs will be sampled semiannually and long-term MWs will be sampled annually.

Table C.15 and Table C.16 provide a listing of performance monitoring wells and long-term monitoring wells, respectively. Table C.17 provides the analytical parameters. Performance and long-term monitoring well locations are shown on Figure C.8.

**Table C.15. SWMU 211-A Performance Wells**

| **Semiannual Wells (18)** | | | | | |
|---|---|---|---|---|---|
| PW001 | PW004 | PW007 | PW010 | PW013 | PW016 |
| PW002 | PW005 | PW008 | PW011 | PW014 | PW017 |
| PW003 | PW006 | PW009 | PW012 | PW015 | PW018 |

**Table C.16. SWMU 211-A Long-Term Wells**

| **Semiannual Wells (10)** | | | | |
|---|---|---|---|---|
| MW203[a] | MW576 | MW578 | MW580 | MW582 |
| MW575 | MW577 | MW579 | MW581 | MW586 |

[a] MW203 is also sampled in support of Environmental Surveillance Monitoring.

**Table C.17. SWMU 211-A Analytical Parameters**

| | | | |
|---|---|---|---|
| **Volatiles—Method 8260D** | | | |
| 1,1,1-Trichloroethane | 1,4-Dioxane | Carbon tetrachloride | Methylcyclohexane |
| 1,1,2,2-Tetrachloroethane | 2-Butanone | Chlorobenzene | Methylene chloride |
| 1,1,2-Trichloroethane | 2-Chloroethyl vinyl ether | Chloroethane | o-Xylene |
| 1,1-Dichloroethane | 2-Hexanone | Chloroform | Styrene |
| 1,1-Dichloroethene[a] | 4-Methyl-2-pentanone | Chloromethane | tert-Butyl methyl ether |
| 1,2,3-Trichlorobenzene | Acetone | *cis*-1,2-Dichloroethene[a] | Tetrachloroethene |
| 1,2,4-Trichlorobenzene | Acrolein | *cis*-1,3-Dichloropropene | Toluene |
| 1,2-Dibromo-3-chloropropane | Acrylonitrile | Cyclohexane | *trans*-1,2-Dichloroethene[a] |
| 1,2-Dibromoethane | Benzene | Dibromochloromethane | *trans*-1,3-Dichloropropene |
| 1,2-Dichlorobenzene | Bromochloromethane | Dichlorodifluoromethane | Trichloroethene[a] |
| 1,2-Dichloroethane | Bromodichloromethane | Ethylbenzene | Trichlorofluoromethane |
| 1,2-Dichloropropane | Bromoform | Isopropylbenzene | Trichlorotrifluoroethane |
| 1,3-Dichlorobenzene | Bromomethane | m,p-Xylene | Vinyl chloride[a] |
| 1,4-Dichlorobenzene | Carbon disulfide | Methyl acetate | Xylenes, Total |
| **Miscellaneous-Method RSK-175 Modified** | | | |
| Methane[b] | Ethane[b] | Ethene[b] | |
| **Total Organic Carbon—Method 9060A** | | | |
| Total Organic Carbon[b] | | | |
| **Bacteria—Method quantitative polymerase chain reaction** | | | |
| *Dehalococcoides ethenogene*[c] | | | |
| **Field Parameters** | | | |
| Barometric Pressure | Depth to Water | Eh[d] (approx) | Temperature |
| Conductivity | Dissolved Oxygen | pH | Turbidity |

[a] Long-term MWs will be analyzed for these volatile parameters and field parameters only.
[b] Analytical parameters for performance MWs.
[c] Analytical parameter for performance MWs: PW002, PW003, PW017, and PW018 only.
[d] Oxidation-reduction potential calibrated as Eh.

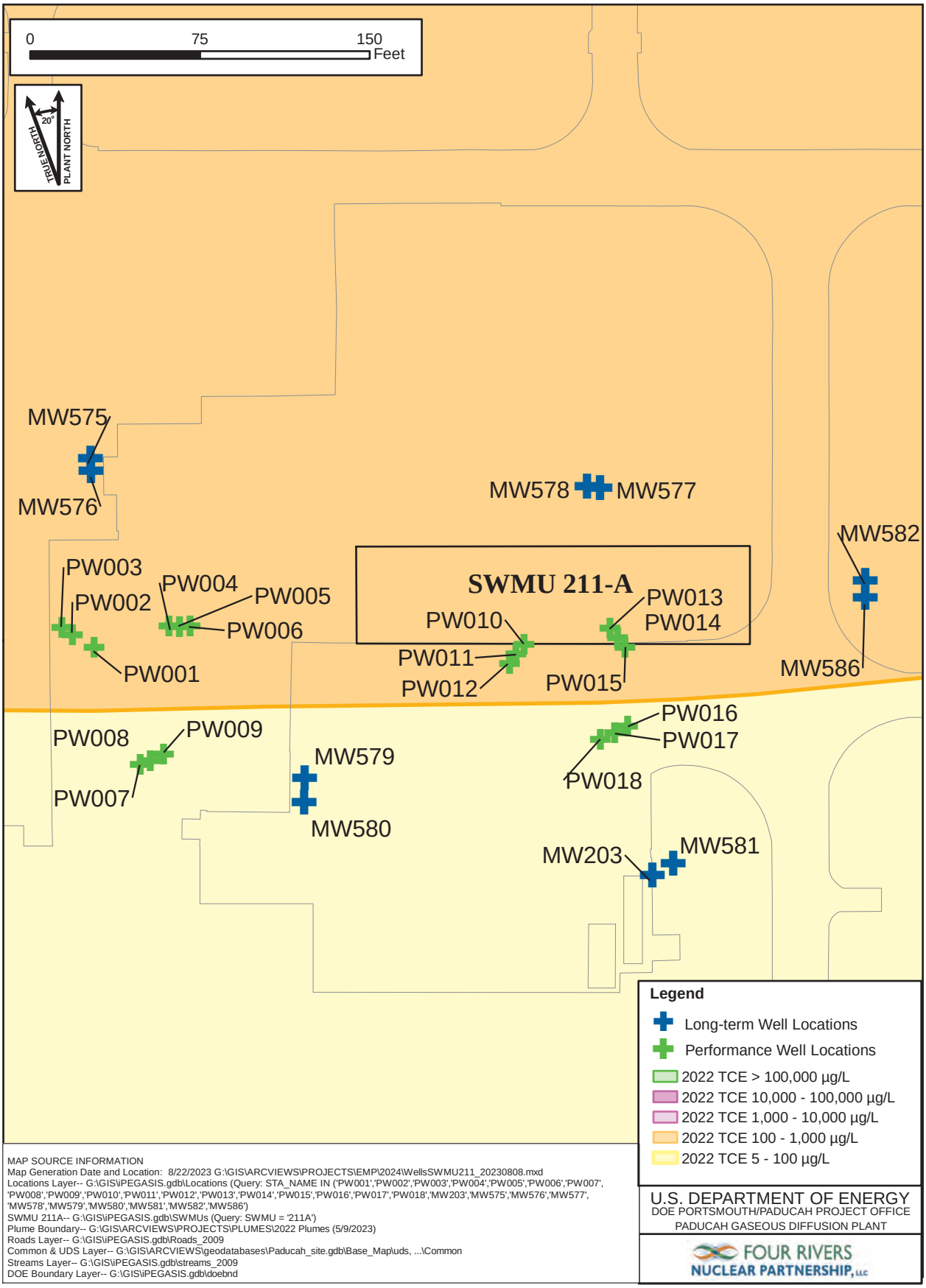


**Figure C.8. SWMU 211-A Long-term and Performance Monitoring Wells with TCE Plume Shown**

## C.2.7 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.

Per the *Memorandum of Agreement for Resolution of Informal Dispute Concerning U.S. Environmental Protection Agency and Kentucky Department for Environmental Protection Requirements for Additional Actions or Modifications Regarding the CY 2018 Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, *DOE/LX/07-2426&D2*, July 2020, the Operation and Maintenance Plans for the Northeast and Northwest Plumes were revised to incorporate elements of Water Policy boundary monitoring conducted under the EMP. The following are the revised plans.

- *Operation and Maintenance Plan for the Northeast Plume Containment System Interim Remedial Action at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-2470&D1, November 2021

- *Operation and Maintenance Plan for the Northwest Plume Groundwater System Interim Remedial Action at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-2469&D2, October 2021

**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.18, C.19, and C.20).

Reviews of the data generated through this program may warrant changes to the Water Policy Box [see Figure C.9 (northwest wells) and Figure C.10 (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.

The Groundwater Strategy project is evaluating the extent of TCE and groundwater flow trends near the east and west boundaries of the Water Policy Box. Manual water level measurements and pressure transducer measurements in specific MWs will be used to

measure the potentiometric surface and seasonal changes in the potentiometric surface. MWs planned for pressure transducer deployment are included in Appendix B.

Tc-99 was removed from the list of sampling parameters for all wells under this program in FY 2019, except MW432, based on monitoring results and conceptual site models indicating that Tc-99 is not present at levels of concern in the areas of residential wells. However, based on the *Memorandum of Agreement for Resolution of Informal Dispute Concerning U.S. Environmental Protection Agency and Kentucky Department for Environmental Protection Requirements for Additional Actions or Modifications Regarding the CY 2018 Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, *DOE/LX/07-2426&D2*, July 2020, and *Operation and Maintenance Plan for the Northwest Plume Groundwater System Interim Remedial Action at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-2469&D2, October 2021, Tc-99 is analyzed for wells in the Northwest Plume portion of the Water Policy Box as noted in Table C.18, with the exception of those residential wells noted for TCE analysis only.

A Water Policy Box reduction evaluation report was submitted to DOE in 2021 with the recommendation to continue with the current Water Policy monitoring program.

As part of the Groundwater Strategy project and the Water Policy Box evaluation, residential wells along Bethel Church Road and Ogden Landing Road were evaluated to determine if they were able to be sampled. Residential wells that are accessible are sampled for TCE only.

In order for samples to be collected from the residential and monitoring wells in this program, license agreements have to be in place with the property owners.

In FY 2019, the analytical method for uranium isotopes was changed from alpha spectroscopy to inductively coupled plasma mass spectroscopy in order to obtain a lower detection limit.

In FY 2022, vinyl chloride was detected above the MCL in residential well R40 samples collected by KDWM Agreement in Principle and DOE. Multiple sampling events were conducted at R40 in FY 2022 and the pump and tubing were replaced in the well. After the pump and tubing were replaced and additional samples were collected, vinyl chloride was not detected above the MCL. In order to continue evaluating conditions at the well, R40 will continue to be sampled quarterly for TCE and degradation products in FY 2024.

Additionally, in support of the Paducah Site Groundwater Strategy Project, MW20 will be sampled quarterly in FY 2024.

**Table C.18. Northwestern Wells**

| | | | | | | |
|---|---|---|---|---|---|---|
| **Quarterly (21)** | | | | | | |
| R2 | R26 | MW20 | MW146 | MW201 | MW427 | MW435 |
| R13 | R53 | MW106A | MW194 | MW202 | MW432 | MW441 |
| R14 | R245 | MW134 | MW199 | MW426 | MW433 | MW452 |
| **Quarterly (2)** | | | | | | |
| R10[a] | R40[b] | | | | | |

[a] This residential well will only be sampled for TCE.
[b] This residential well will only be sampled for the volatiles suite.

**Table C.19. Northeastern Wells**

| | | | |
|---|---|---|---|
| **Annually (7)** | | | |
| R9 | R21 | R90 | R302 |
| R20 | R83 | R114 | |

**Table C.20. Residential Analytical Parameters—Northwest and Northeast Analytical Parameters**

| | | |
|---|---|---|
| **Field Parameters** | | |
| Barometric Pressure | Dissolved Oxygen | pH |
| Conductivity | Eh[d] (approx.) | Temperature |
| Depth to Water[a] | | |
| **Radionuclides—Method ASTM C 1345-08M unless noted** | | |
| Uranium-234 | Uranium-235 | Uranium-238 |
| **Technetium-99[b]—TC-02-RC M[c]** | | |
| **Volatiles—Method 8260D** | | |
| 1,1-Dichloroethene[e] | *trans*-1,2-Dichloroethene[e] | Vinyl Chloride[e] |
| *cis*-1,2-Dichloroethene[e] | Trichloroethene | |

[a] As applicable.
[b] Analytical parameter for wells in the Northwest Plume portion of the Water Policy Box (northwestern wells only), except for the two residential wells R10 and R40.
[c] Bolded parameters are analyzed by different method than specified in header.
[d] Oxidation-reduction potential calibrated as Eh.
[e] Analytical parameters for R40 only.

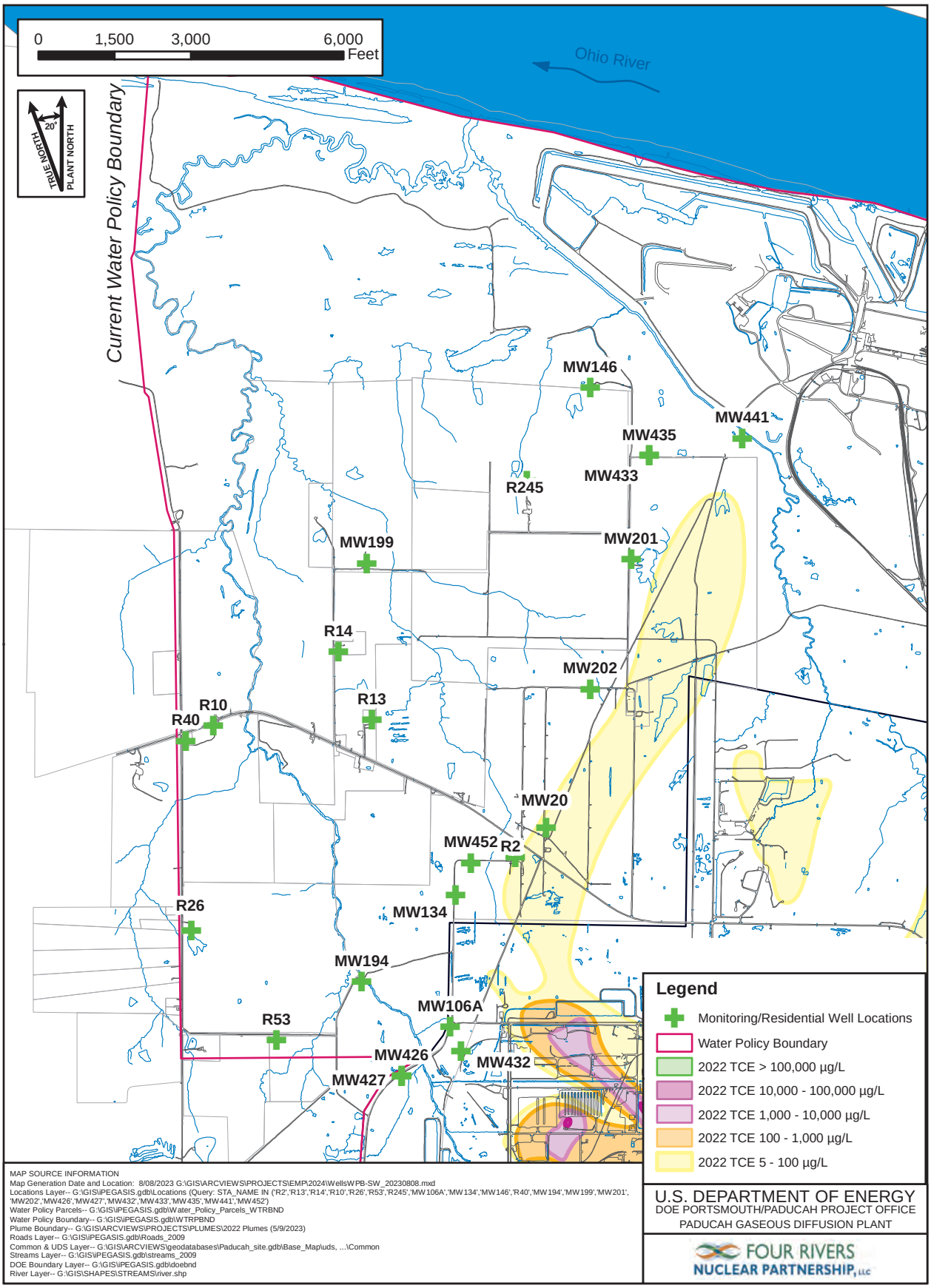


**Figure C.9. Water Policy Boundary Monitoring Wells, Northwest with TCE Plume Shown**

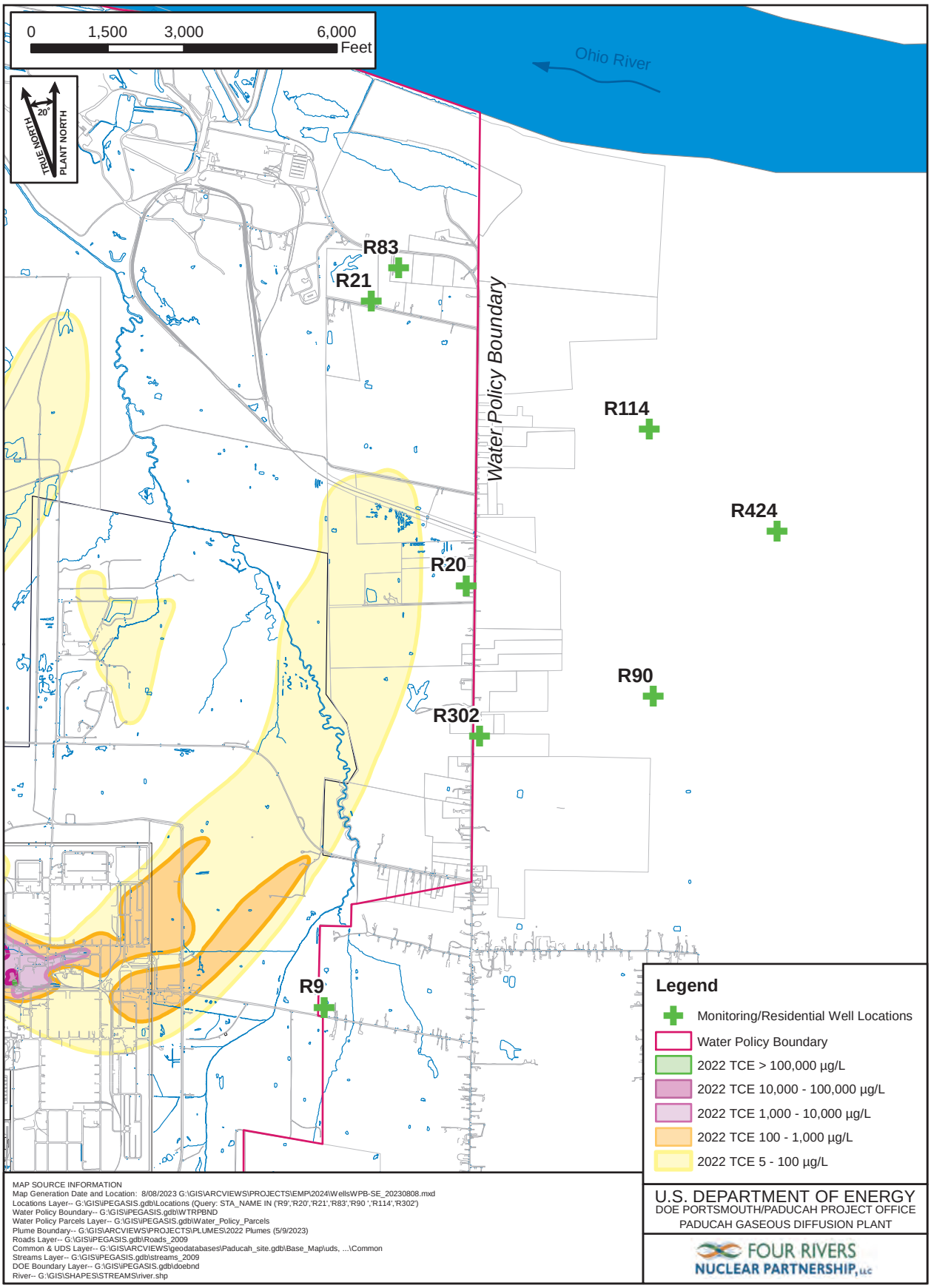


**Figure C.10. Water Policy Boundary Monitoring Wells, Northeast with TCE Plume Shown**

## C.2.8 CARBON FILTER TREATMENT SYSTEM

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

**Driver:** License agreement with landowner

**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. A license agreement with the landowner stipulates the terms of this arrangement.

Sampling will be conducted for Tc-99 and TCE because they are contaminants of potential concern in groundwater from DOE activities. 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, Tc-99 sampling frequency was reduced from monthly to semiannual to verify the Tc-99 is below reporting limits. A review of the FY 2021 Tc-99 data did not indicate a need for increased radionuclide analysis; therefore, no changes in sample strategy were made.

Tables C.21 and C.22 identify carbon filter treatment system well and carbon filter treatment system analytical parameters, respectively. Location is shown on Figure C.10.

**Table C.21. Carbon Filtration System (1)**

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

**Table C.22. Carbon Filtration System Analytical Parameters**

| | | |
|---|---|---|
| **Field Parameters**[a] | | |
| Conductivity | Eh[b] (approx) | Temperature |
| Dissolved Oxygen | pH | |
| **Radionuclides—Method TC-02-RC M** | | |
| Technetium-99 | | |
| **Volatiles—Method 8260D** | | |
| Trichloroethene | | |
| **Miscellaneous—Method SM 9223** | | |
| Total Coliform | | |

[a] Field parameters will only be measured for Port 1 direct groundwater samples.
[b] Oxidation-reduction potential calibrated as Eh.

## C.2.9 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 2023; therefore, they will be sampled in FY 2025.

In support of groundwater modeling efforts at the site, McNairy MWs are sampled semiannually.

MW152 was abandoned in October 2018 in order for the Tennessee Valley Authority to construct a new process water basin. Another location has been selected for installation of a new well once construction activities have been completed. This new well will be MW583 and will be included in the annual sampling program once it has been installed.

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.

Per the *Memorandum of Agreement for Resolution of Informal Dispute Concerning U.S. Environmental Protection Agency and Kentucky Department for Environmental Protection Requirements for Additional Actions or Modifications Regarding the CY 2018 Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, *DOE/LX/07-2426&D2*, July 2020, the *Operation and Maintenance Plan for the Northeast Plume Containment System Interim Remedial Action at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-2470&D1, November 2021, was revised to incorporate elements of Water Policy boundary monitoring conducted under the EMP. MW100, MW150, MW409, MW410, MW411, MW473, MW474, MW475, and MW476 are sampled in support of the Environmental Surveillance program and also are sampled in support of Water Policy boundary monitoring.

Based on TCE and Tc-99 trends, the sampling frequency for MW445, MW447, MW448, and MW450 is being changed from biennial to annual, and the sampling frequency for MW486A is being changed from biennial to semiannual. Additionally, in support of the Paducah Site Groundwater Strategy Project, MW326, MW327, and MW330 will be sampled quarterly in FY 2024.

Tables C.23 and C.24 identify MWs and analytical parameters, respectively. Locations are shown on Figure C.11.

**Table C.23. Surveillance Wells (132)**

| | | | | | |
|---|---|---|---|---|---|
| **Biennial (68)** | | | | | |
| MW67 | MW174 | MW333 | MW416 | MW467[d] | MW487[d,g] |
| MW76 | MW193[d] | MW337 | MW417 | MW468[d] | MW489[g] |
| MW86 | MW200[g] | MW338 | MW432 | MW473[d,f,g] | MW490[g] |
| MW89 | MW201[d,g] | MW341 | MW435[d] | MW474[d,f,g] | MW493 |
| MW92 | MW202[d,g] | MW343 | MW439[d] | MW475[d,f,g] | MW494 |
| MW95A | MW205 | MW404: Port 4 | MW442[g] | MW476[d,f,g] | MW495 |
| MW106A[d] | MW226 | MW405: Port 5 | MW443[g] | MW478 | MW496 |
| MW146[d] | MW227 | MW406: Port 5 | MW444[g] | MW479 | MW548[b] |
| MW148[d,g] | MW260 | MW407: Port 4 | MW451[g] | MW480 | |
| MW149[d,g] | MW262 | MW408: Port 5 | MW452[g] | MW481 | |
| MW163 | MW328 | MW414 | MW465[d] | MW482 | **Background (1)** |
| MW168 | MW329 | MW415 | MW466[d] | MW485[d,g] | MW103 |
| **Annual (41)** | | | | | |
| MW68[a] | MW182 | MW252[d,g] | MW419 | MW463[d] | MW483[d,g] |
| MW71[a] | MW186 | MW253A[d,g] | MW445 | MW464[d] | MW484[d,g] |
| MW99[d] | MW187 | MW261 | MW447 | MW469[d] | MW488[g] |
| MW100[d,f] | MW191[d] | MW345 | MW448[g] | MW470[d] | MW491 |
| MW125[g] | MW203 | MW346 | MW450[g] | MW471[d] | MW492 |
| MW139 | MW236[g] | MW347 | MW453[g] | MW472[d] | |
| MW161 | MW240[g] | MW418 | MW454[g] | MW477[d] | **Background (1)** |
| MW169 | | | | | MW150[f,g] |
| **Semiannual (18)** | | | | | |
| MW98 | MW121[e,g] | MW135 | MW247[e] | MW410[c,f,g] | MW549[b] |
| MW102[e] | MW122[e] | MW197 | MW356[e] | MW411[c,f,g] | MW550[b] |
| MW120[e] | MW133[e] | MW239[e,g] | MW409[c,f,g] | MW486A[d,g] | MW551[b] |
| **Quarterly (6)** | | | | | |
| MW326[h] | MW327[h] | MW330[h] | MW354 | MW403: Port 3 | MW431[d] |

Shading indicates MWs are not scheduled to be sampled this FY.

[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 TCE only to evaluate Northeast Plume migration. These wells previously were included in the Northeast Plume monitoring section as being sampled semiannually for TCE only.

[d] These wells will not be sampled for Tc-99 based on a recommendation in the Technical Memorandum provided to DOE by EarthCon, Consultants, Inc.

[e] If these McNairy MWs produce enough water for sampling, samples will be collected for volatiles, Tc-99, and uranium as a metal.

[f] These MWs also are sampled in support of Water Policy boundary monitoring.

[g] MWs located on private property or Kentucky Department of Fish and Wildlife Resources property.

[h] These MWs will be sampled in FY 2024 in support of the Paducah Site Groundwater Strategy Project.

**Table C.24. Environmental Surveillance and Analytical Parameters**

| Biennial, Annual, Semiannual, and Quarterly | | | |
|---|---|---|---|
| **Field Parameters** | | | |
| Barometric Pressure | Depth to Water | pH | Temperature |
| Conductivity | Dissolved Oxygen | Eh[a] (approx) | Turbidity |
| **Radionuclides—Method TC-02-RC M** | | | |
| Technetium-99 | | | |
| **Metals—Method 6020B[b]** | | | |
| Uranium | | | |
| **Volatiles—Method 8260D** | | | |
| 1,1,1-Trichloroethane | Benzene | *cis*-1,2-Dichloroethene | Toluene |
| 1,1,2-Trichloroethane | Bromodichloromethane | Dimethylbenzene, Total[c] | *trans*-1,2-Dichloroethene |
| 1,1-Dichloroethane | Carbon Tetrachloride | Ethylbenzene | Trichloroethene |
| 1,1-Dichloroethene | Chloroform | Tetrachloroethene | Vinyl Chloride |
| 1,2-Dichloroethane | | | |

[a] Oxidation-reduction potential calibrated as Eh.
[b] Uranium analysis is only required on the eight McNairy MWs sampled semiannually and MW326, MW327, and MW330 sampled quarterly as noted in Table C.20.
[c] Xylenes

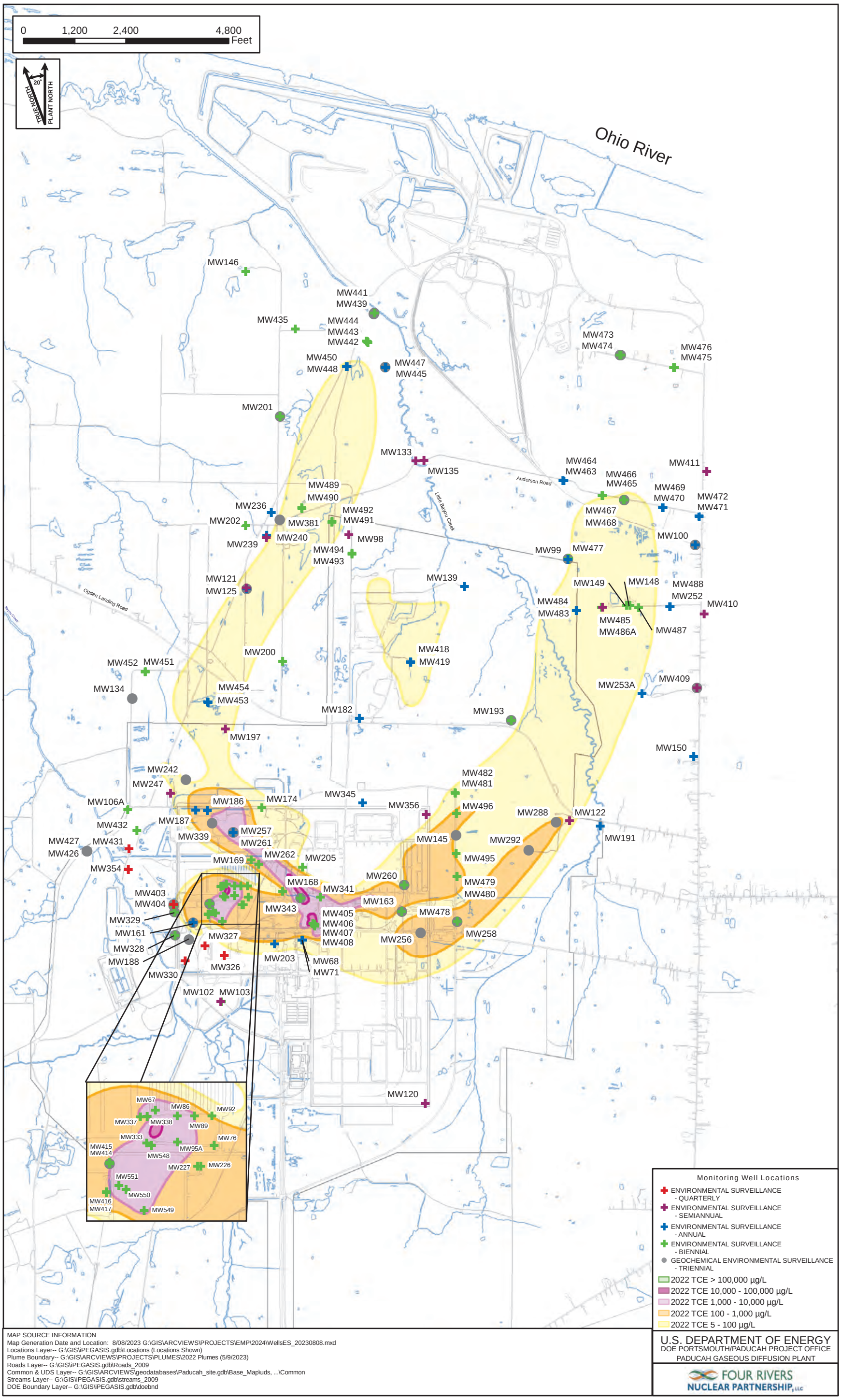


**Figure C.11. Environmental Surveillance Groundwater Monitoring Wells with TCE Plume Shown**

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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 2022; therefore, they will not be sampled in FY 2024.

MW152 was abandoned in October 2018 in order for the Tennessee Valley Authority to construct a new process water basin. Another location has been selected for installation of a new well once construction activities have been completed. This new well will be MW583 and will be included in this sampling program once it has been installed.

Tables C.25 and C.26 show MWs and analytical parameters, respectively. Locations are shown on Figure C.11.

**Table C.25. Surveillance Geochemical Wells (37)**

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

Shading indicates MWs are not scheduled to be sampled this FY.
[a] MWs located on private property or Kentucky Department of Fish and Wildlife Resources property.

**Table C.26. Surveillance Geochemical Triennial Analytical Parameters**

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

*Oxidation-reduction potential calibrated as Eh.
Bolded parameters are analyzed by different method than specified in header.

# 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 SW07300014, SW07300015, SW07300045, Technical Attachment 24, which includes the surface water monitoring plans.

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

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

**Comments:** Sampling frequencies and sampling parameters were not modified for this sampling program for FY 2024 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.27 and C.28 show landfill surface water locations and landfill surface water parameters, respectively. Locations are shown on Figure C.12.

**Table C.27. 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.28. Landfill Surface Water Parameters**

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

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

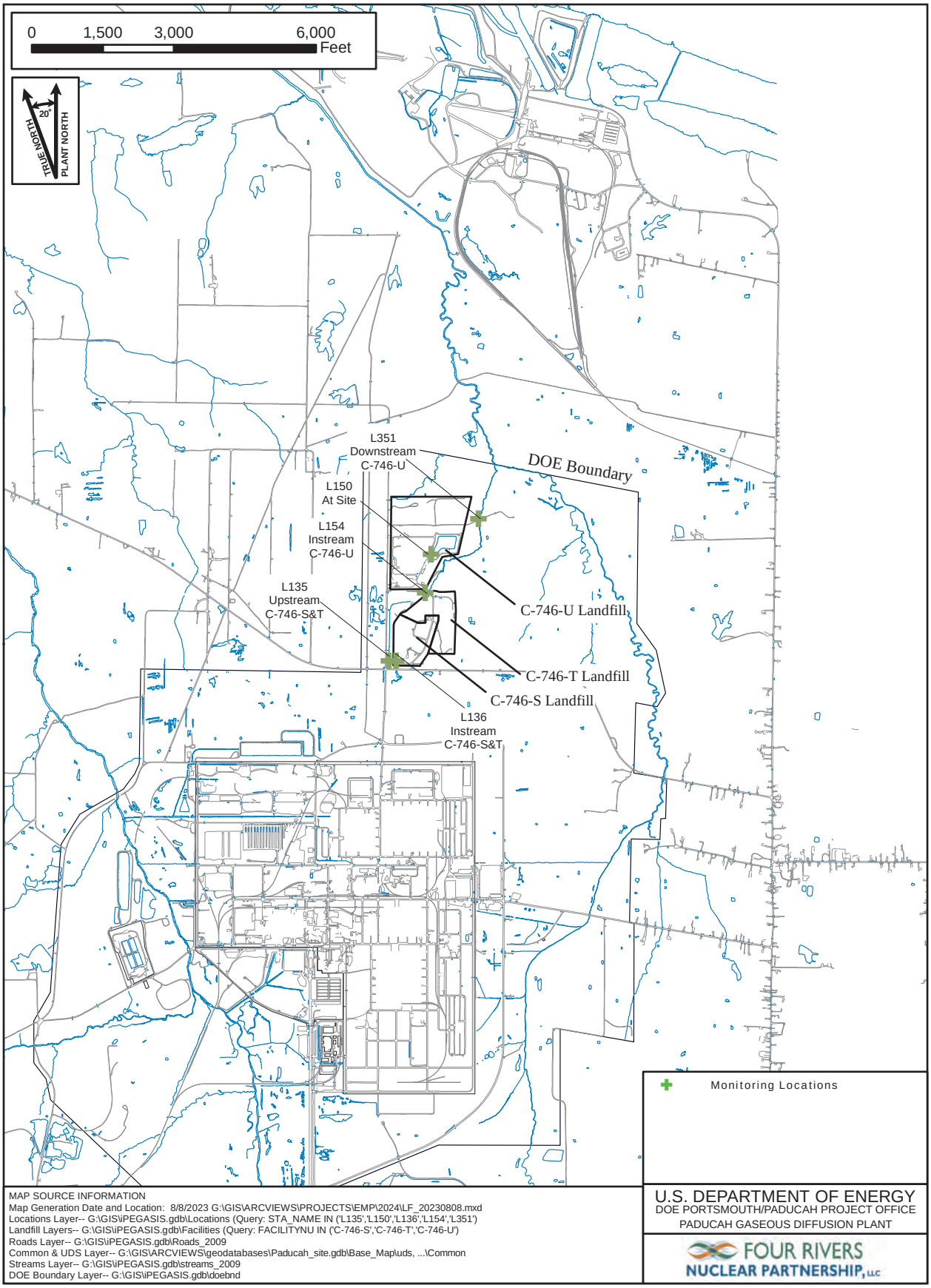


**Figure C.12. Landfill Surface Water Locations**

**Kentucky Pollutant Discharge Elimination System Outfall Sampling**

**Frequency:** Weekly, Monthly, and Quarterly

**Driver:** KPDES permit for PGDP, permit number KY0004049, 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, and became effective September 1, 2017. A permit dated October 12, 2017, changed the co-permittee from FPDP to FRNP. This permit expired on August 30, 2022, but was administratively continued while KDOW processed the KPDES permit renewal application. KDOW issued the new KPDES permit in December 2022, and the new permit became effective on February 1, 2023. The current permit expires on January 31, 2028.

**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.29 shows the KPDES outfall sampling locations, frequency of sampling, and parameters required by permit KY0004049. Locations are shown on Figure C.13.

**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/LX/07-2470&D1, November 2021, and the *Remedial Action Work Plan for the Optimization of the Northeast Plume Interim Remedial Action at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-1280&D2/R3/A1, July 2018.

**Reported:** Semiannual FFA Progress Report and ASER

**Rationale:** Monitor effluent from the Northeast Plume containment system.

**Comments:** Table C.30 shows the frequency of sampling and parameters required for this CERCLA outfall (C001).

Sampling frequencies and sampling parameters were not modified for this sampling program for FY 2024.

**Table C.29. KY0004049 Permit**
**KPDES Outfall Sampling Locations, Frequency, and Parameters**

| Analysis-Method | Frequency of Sampling at KPDES Locations D—Daily; W—Weekly; M—Monthly; Q—Quarterly | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **K001** | **K002** | **K004** | **K006** | **K008** | **K009** | **K010** | **K011** | **K012** | **K013** | **K015** | **K016** | **K017** | **K019[a]** | **K020** |
| Flow (Mgd)—Field | D | M | 2/M[b] | 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[c] | | | M | | | | | | | | | | |
| PCBs (µg/L)—608.3 | W | M | | | M | M | M | M | M | M | M | M | M | M | M |
| Trichloroethene (µg/L)—624.1 | W | M | | | M | M | M | M | M | M | M | M | M | M | M |
| Total Phosphorus (mg/L)—365.4 | W | | | M[c] | M | M[c] | | | | | M[c] | M[c] | M[c] | | |
| 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 ($TU_A$)[d]—2000.0/2002.0 | | | | | | | | | | | | | Q | | |

**Table C.29. KY0004049 Permit**
**KPDES Outfall Sampling Locations, Frequency, and Parameters (Continued)**

| Analysis-Method | Frequency of Sampling at KPDES Locations D—Daily; W—Weekly; M—Monthly; Q—Quarterly | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **K001** | **K002** | **K004** | **K006** | **K008** | **K009** | **K010** | **K011** | **K012** | **K013** | **K015** | **K016** | **K017** | **K019[a]** | **K020** |
| Chronic Toxicity ($TU_C$)[e]—1000.0/1002.0 | Q | | | | | | Q | Q[f] | | | | | | | |
| Total Recoverable Copper (µg/L)—200.8 | | M | | | | | | | | | | | | | |
| Total Recoverable Zinc (µg/L)—200.8 | | | | | | | | | | M | | | M | | |
| Technetium-99 (pCi/L)—TC-02-RC M | Q | M | | | M | M | M | M | M | M | M | M | M | M | M |
| Hardness (as mg/L $CaCO_3$)—SM 2340 C | | M | | | | | | | | M | | | M | | |
| $BOD_5$ (mg/L)—SM 5210 B | | | 2/M | | | | | | | | | | | | |
| Total Recoverable Mercury (µg/L)-1631E | | | | | M[c] | | | | | | | | | | |
| pH—Field | W | M | | M | M | M | M | M | M | M | M | M | M | M | M |

[a] K019 is sampled when the C-746-U Landfill sedimentation pond is discharged through the outfall.
[b] Per the KPDES permit, flow is measured from grab samples collected at K004. Pursuant to the Water Treatment Registration, PWS No. 0732457, for sewage discharge in operating a sewage treatment plant, monthly flow information is documented by the Utilities organization and is reported to KDOW.
[c] Monitoring for this analysis added with KPDES Permit KY0004049, effective date February 1, 2023.
[d] Acute toxicity sampling requires two discrete grab samples collected approximately 12 hours apart. A different lab method is used for each species.
[e] 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.
[f] Monitoring for K011 is required only when the effluent from the C-617 Lagoon is discharged through the outfall.

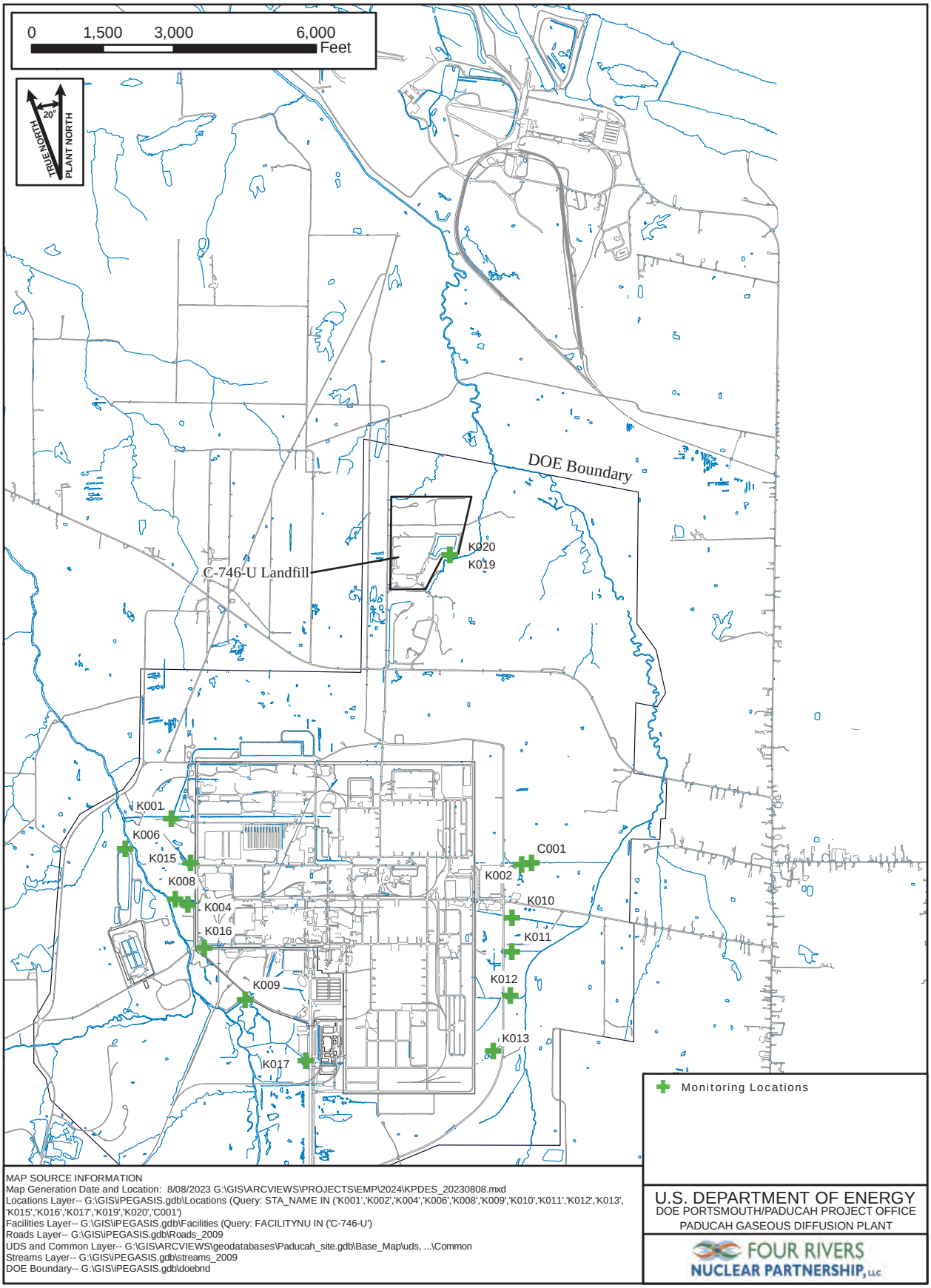


**Figure C.13. KPDES and CERCLA Outfall Sampling Locations**

**Table C.30. C001 Outfall Sampling Frequency and Parameters**

| Analysis-Method | Frequency of Sampling at C001 Outfall<br>W—Weekly; Q—Quarterly |
|---|---|
| | **C001** |
| Flow (Mgd)—Field | W |
| Total Suspended Solids (mg/L)—160.2 | W |
| Oil & Grease (mg/L)—1664A | W |
| Total Residual Chlorine (mg/L)—Field | W |
| Temperature (°F)—Field | W |
| Trichloroethene (mg/L)—624.1 | W |
| 1,1-Dichloroethene (mg/L)—624.1 | W |
| Chronic Toxicity ($TU_C$)[a]—1000.0/1002.0 | Q |
| Technetium-99 (pCi/L)—TC-02-RC M[b] | Q |
| pH—Field | W |

[a] Chronic toxicity sampling requires three 24-hour composite samples. A different lab procedure is used for each species.
[b] Technetium-99 is required under the Remedial Action Work Plan for the Northeast Plume.

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

**Frequency:** Monthly

**Driver:** DOE Order 458.1

**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 Chg 4 (LtdChg) went into effect on September 15, 2020 and was implemented in FY 2021. DOE Order 458.1 requires compliance in accordance with DOE-STD-1196-2022, *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). Settleable solids are analyzed for the Environmental Radiation Protection Program (ERPP) outfall locations, with the exception of Outfall 020. Parameters required to determine alpha and beta activity on settleable solids per Section 6.10.7 of DOE-HDBK-1216-2015 Change Notice 1 are noted in Table C.28. These results will be compared to the sediment background data to evaluate if the radionuclide concentration exceeds the standard. At the completion of FY 2024, further evaluations of total suspended solids (TSS) in relation to the alpha and beta activity of the settleable solids will be performed in order to determine a TSS value that can be used to demonstrate compliance to DOE Order 458.1 for the overall presence of total solids in the effluent.

Table C.31 lists the sampling locations, frequencies, and parameters. Locations are shown on Figure C.14.

## Table C.31. 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 | M | | | |
| Cesium-137 (pCi/L)—901.1 | | | M | M | | | | | | M | M | | | |
| Neptunium-237 (pCi/L)—1475-00 M | 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 | M | | | |
| Plutonium-239/240 (pCi/L)—PU-11-RC M | M | | M | M | M | M | M | M | | M | M | | | |
| Technetium-99 (pCi/L)—TC-02-RC M | M | | M | | | | | | | | | | | |
| Thorium-230 (pCi/L)—Th-01-RC M | M | | M | M | M | M | M | M | | M | M | | | |
| *Non-Settleable Solids (mg/L)—SM 2540 D | M | M | M | M | M | M | M | M | M | M | M | M | M | |
| *Total Suspended Solids (mg/L)—SM 2540 D | M | M | M | M | M | M | M | M | M | M | M | M | M | |
| *Settleable Solids (mg/L)—SM 2540 F | M | M | M | M | M | M | M | M | M | M | M | M | M | |
| *Alpha activity on the filtered material from Total Suspended Solids (pCi/g) )—9310 | M | M | M | M | M | M | M | M | M | M | M | M | M | |
| *Beta activity on the filtered material from Total Suspended Solids (pCi/g) )—9310 | M | M | M | M | M | M | M | M | M | M | M | M | M | |
| *Alpha activity on the filtered material from Non-Settleable Solids (pCi/g) )—9310 | M | M | M | M | M | M | M | M | M | M | M | M | M | |
| *Beta activity on the filtered material from Non-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 | M |
| Uranium-235 (pCi/L)—U-02-RC M | 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 | M |

NOTE: Samples are being collected from locations near the outfalls listed in KPDES permit KY0004049.

*Results are used to determine the alpha and beta activity on settleable solids per Section 6.10.7 of DOE-HDBK-1216-2015 Change Notice 1. The alpha and beta activity on settleable solids will be calculated project.

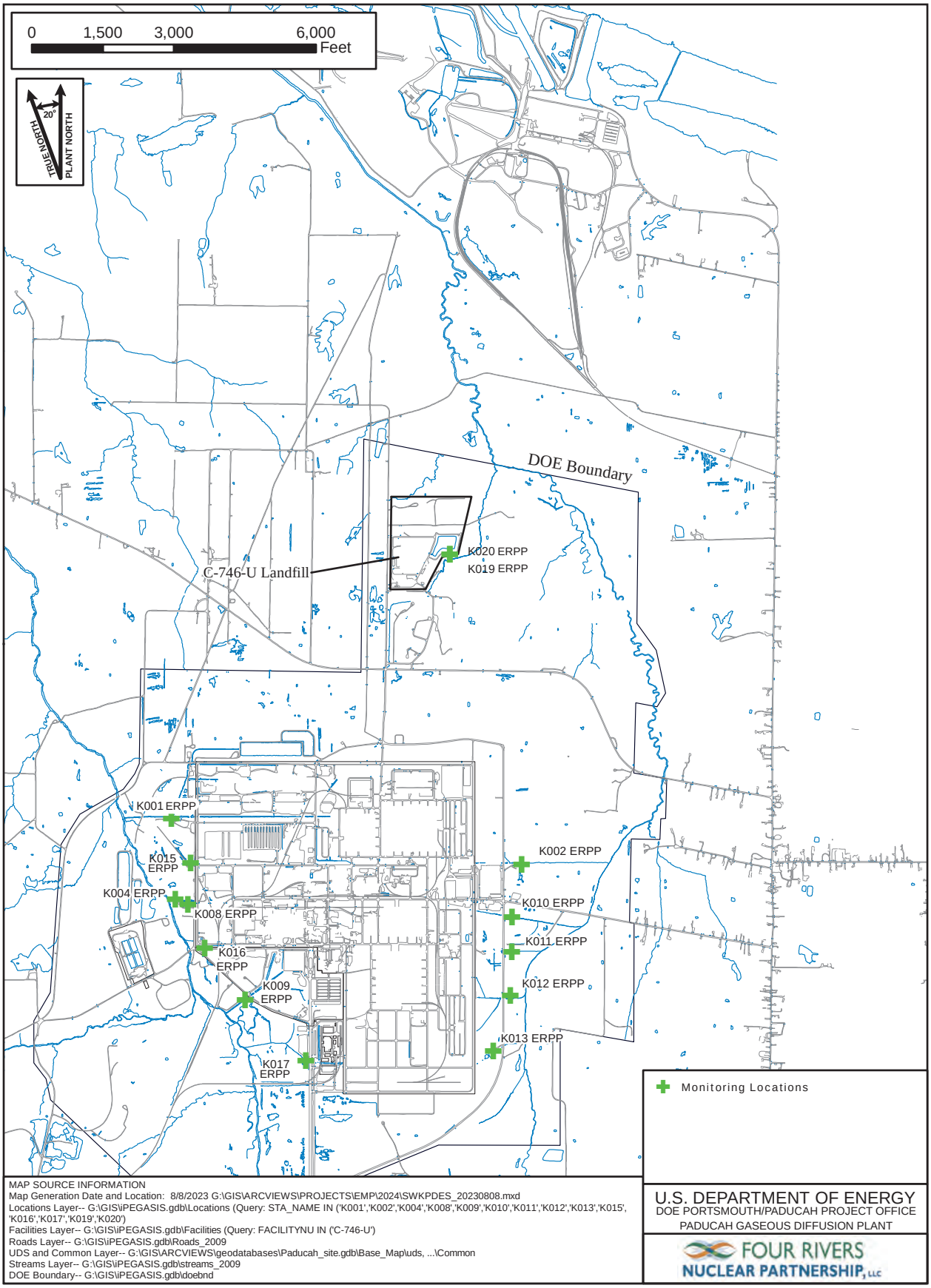


**Figure C.14. Surface Water Monitoring near KPDES Outfalls**

### 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 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 Operation and Maintenance Plan, a sample is to be collected each quarter to confirm the pH and TSS field measurements.

**Comments:** Table C.32 provides a listing of the analytical parameters. Location of the C-613 Sediment Basin is shown on Figure C.15.

Sampling frequencies and sampling parameters were not modified for this sampling program for FY 2024.

**Table C.32. C-613 Sediment Basin Quarterly Water Parameters**

| | |
|---|---|
| **Miscellaneous—Method 160.2** | |
| Total Suspended Solids | |
| **Field Parameters** | |
| pH | Turbidity |

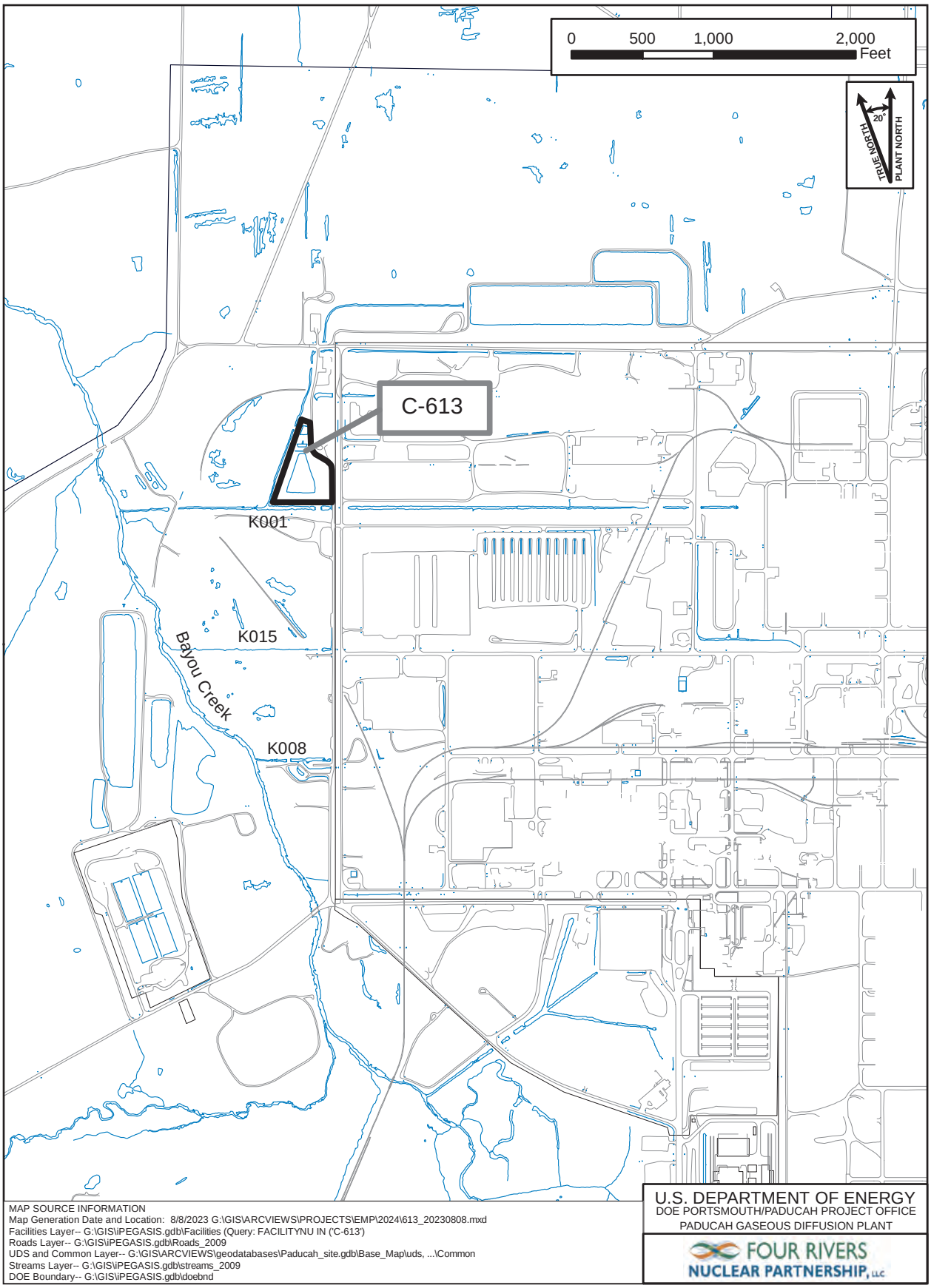


**Figure C.15. C-613 Sediment Basin**

## 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 Change Notice 1. 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.

Background location L1 was chosen to support data comparisons of data generated as part of this program, as well as the ERPP Effluent and Surface Water Runoff program outlined in Section C.3.2.

Settleable solids are analyzed for the background and public water sources locations. Parameters required to determine alpha and beta activity on settleable solids per Section 6.10.7 of DOE-HDBK-1216-2015 Change Notice 1 are noted in Table C.36. These results will be compared to the sediment background data to evaluate if the radionuclide concentration exceeds the standard. At the completion of FY 2024, further evaluations of TSS in relation to the alpha and beta activity of the settleable solids will be performed in order to determine a TSS value that can be used to demonstrate compliance to DOE Order 458.1 for the overall presence of total solids in the effluent.

The previous KPDES permit required that 19 in-stream surface water locations be sampled quarterly for PCBs and TCE. The current KPDES permit, permit number KY0004049, does not require this sampling; therefore this sampling program was modified in FY 2018 to include only locations near C-746-K Landfill (C746K-5 and C746KTB1A) 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 2024 to determine if any changes are needed. L14 was added to the quarterly ERPP sampling program in FY 2018 to include monitoring upstream of the C-746-S&T and C-746-U Landfills. During sampling in FY 2018, it was determined that the sample should be collected downstream of L14 in order to obtain enough flow to collect a sample. The location is L14DWN.

In support of the Groundwater Strategy project, quarterly walkdowns of a portion of Little Bayou Creek will be performed. If any new seeps are found, samples will be collected and analyzed for TCE only.

Table C.33 details the surface water and seep sampling locations. Tables C.34 and C.35 detail the surface water and seep sampling analytical parameters. Tables C.36 through C.39 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.16.

**Table C.33. Surface Water and Seep Quarterly Sampling Locations (3)**

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

*Unable to obtain flow rates.

**Table C.34. 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** | | |
| 1,1-Dichloroethene | *cis*-1,2-Dichloroethene | *trans*-1,2-Dichloroethene |
| Trichloroethene | Vinyl Chloride | |

*See Table C.30 for locations where flow rates are not collected.

**Table C.35. Seep Location Quarterly Analytical Parameters**

| | |
|---|---|
| **Volatiles—Method 624.1** | |
| Trichloroethene | |
| **Field Measurements** | |
| pH | Dissolved Oxygen |
| Temperature | Conductivity |

**Table C.36. Surface Water—ERPP Little Bayou Creek Locations and Quarterly Analytical Parameters (3)**

| **Locations** | | |
|---|---|---|
| L10 | L14DWN | L241 |
| **Radionuclides—Method U-02-RC M unless noted** | | |
| **Alpha Activity—9310** | | Uranium-234 |
| **Beta Activity—9310** | | Uranium-235 |
| **Technetium-99—TC-02-RC M** | | Uranium-238 |
| Uranium | | |

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

**Table C.37. Surface Water—ERPP Bayou Creek Location and Quarterly Analytical Parameters (1)**

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

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

**Table C.38. Surface Water—ERPP North-South Diversion Ditch Location and Quarterly Analytical Parameters (1)**

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

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

**Table C.39. Surface Water—ERPP Background and Nearest Public Water Source Location and Quarterly/Annual Analytical Parameters (4)**

| **Locations** | |
|---|---|
| | Annually L1 (BG) and L30 (BG to PWS)<br>Quarterly L29A (BG) and L306 (PWS at Cairo, Illinois) |
| **Radionuclides—Method U-02-RC M unless noted** | |
| **Alpha Activity—9310** | **Cesium-137—901.1** |
| **Beta Activity—9310** | **Technetium-99—TC-02-RC M** |
| **Americium-241—AM-05-RC M** | Uranium |
| **Neptunium-237—1475-00 M** | Uranium-234 |
| **Plutonium-238—PU-11-RC M** | Uranium-235 |
| **Plutonium-239/240—PU-11-RC M** | Uranium-238 |
| **Thorium-230—Th-01-RC M** | ***Alpha activity on the filtered material from** Total Suspended Solids (pCi/g)—9310 |
| ***Alpha activity on the filtered material from** Non-Settleable Solids (pCi/g)—9310 | ***Beta activity on the filtered material from** Total Suspended Solids (pCi/g)—9310 |
| ***Beta activity on the filtered material from** Non-Settleable Solids (pCi/g)—9310 | |
| **Miscellaneous—Methods as follows** | |
| ***Non-Settleable Solids—SM 2540 D** | |
| ***Total Suspended Solids—SM 2540 D** | |
| ***Settleable Solids—SM 2540 F** | |

BG = Background locations
PWS = Public Water Source locations
*Results are used to determine the alpha and beta activity on settleable solids per Section 6.10.7 of DOE-HDBK-1216-2015 Change Notice 1. The alpha and beta activity on settleable solids will be calculated by the EM project.
Bolded parameters are analyzed by different method than specified in header.

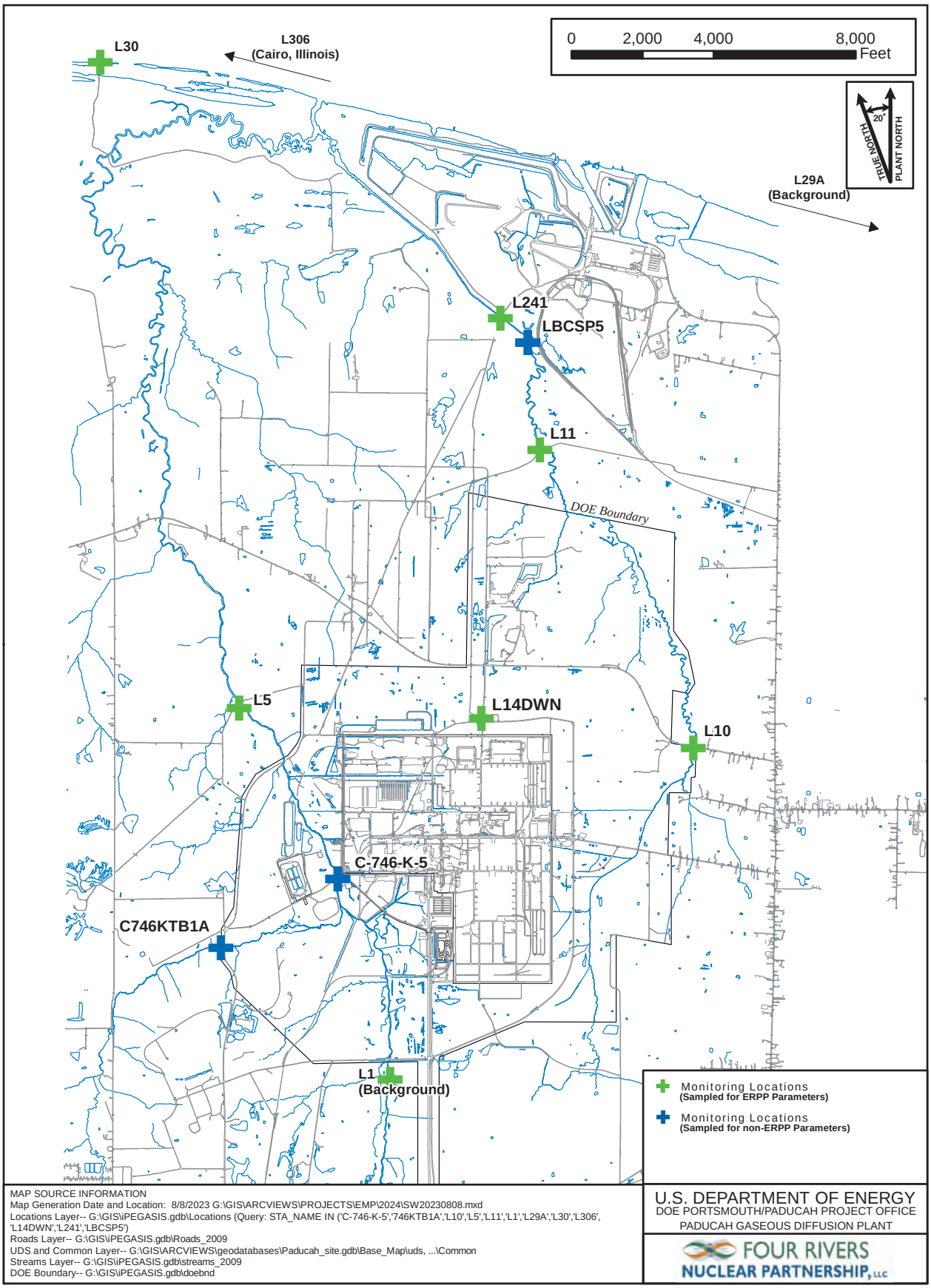


**Figure C.16. Surface Water and Seep Monitoring Locations**

**Sediment Monitoring**

**Frequency:** Semiannually (PCBs) and Annually (Radionuclides)

**Driver:** Acquisition of PCB data for future "Impaired Waters of Kentucky" discussions. 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 Change Notice 1. 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 the Paducah Site effluent monitoring. Sampling for radionuclides will occur annually.

During FY 2022, the background sediment location along Massac Creek, S28, was no longer safely accessible due to road construction and design changes to the highway that provided access for sampling. A new background location, S29, was established along Massac Creek to replace S28.

Table C.40 details sediment sampling locations and parameters. Table C.41 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 2024 in order to evaluate action levels for PCBs in sediment. Locations are shown on Figure C.17.

**Table C.40. Sediment—Location and Semiannual Analytical Parameters Sampling Locations (14)**

| **Locations** | | |
|---|---|---|
| C612 | S1 | S31 |
| C616 | S2 | S32 |
| 746KTB2 | S20 (BG) | S33 |
| K001 | S27 | S34 |
| L194 | S29 (BG) | |
| **PCBs—Method 8082A** | | |
| PCB, Total | PCB-1232 | PCB-1254 |
| PCB-1016 | PCB-1242 | PCB-1260 |
| PCB-1221 | PCB-1248 | |

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

**Table C.41. Sediment—ERPP Location and Annual Analytical Parameters Sampling Locations (6)**

| **Locations** | | |
|---|---|---|
| S1 | S20 (BG) | S33 |
| S2 | S27 | S34 |
| **Radionuclides—Method U-02-RC M unless noted** | | |
| **Alpha Activity—9310** | **Plutonium-238—PU-11-RC M** | **Technetium-99—TC-02-RC M** |
| | **Plutonium-239/240—PU-11-RC** | |
| **Beta Activity—9310** | **M** | Uranium |
| **Americium-241—AM-05-RC M** | **Thorium-230—Th-01-RC M** | Uranium-234 |
| **Neptunium-237—1475-00 M** | **Cesium-137—HASL 300 4.5.2.3** | Uranium-235 |
| | | Uranium-238 |

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

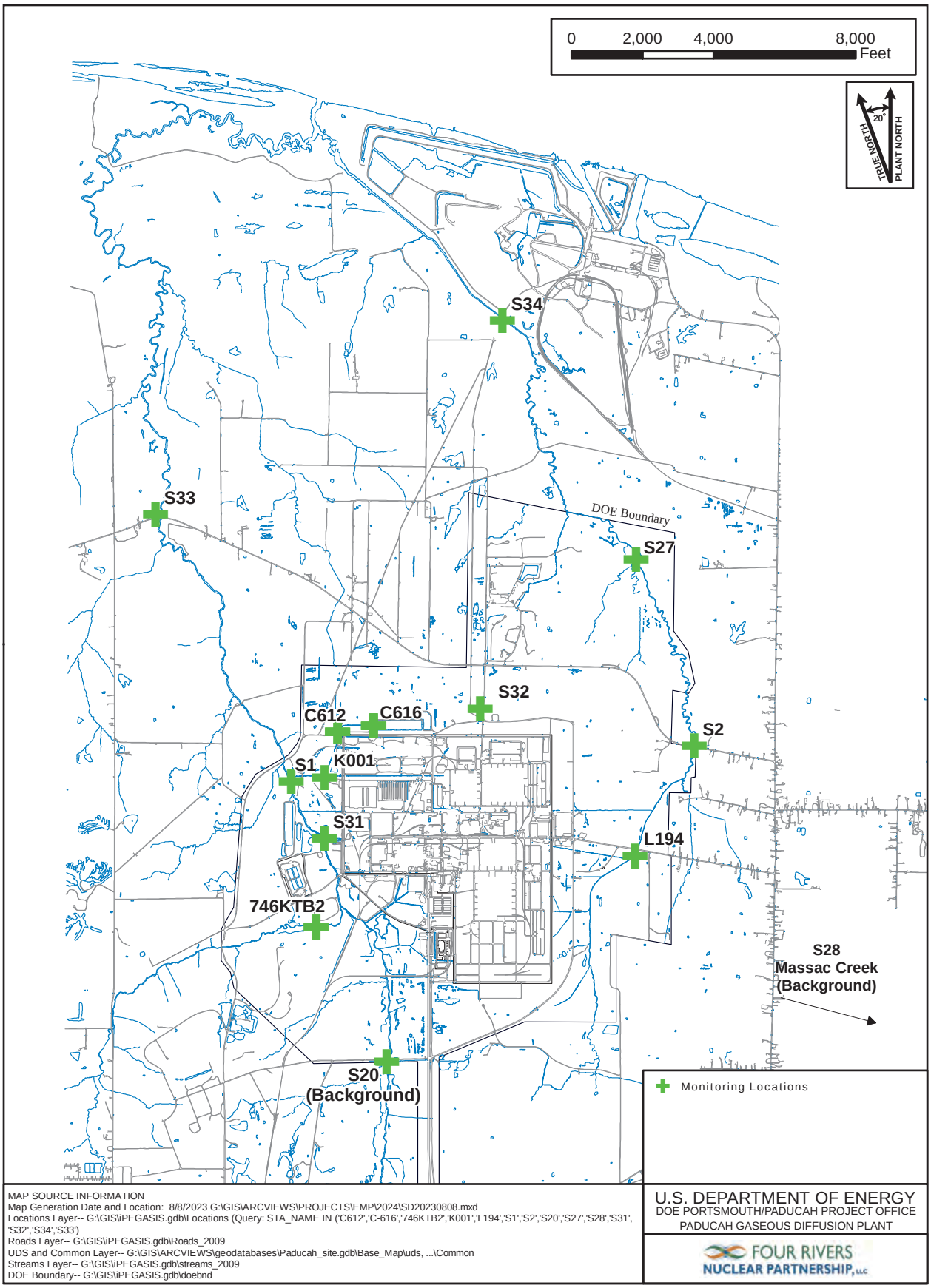


**Figure C.17. Sediment Sampling Locations**

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# C.4. LANDFILL LEACHATE SAMPLING

**C-746-S and C-746-U Landfills Leachate Monitoring**

**Frequency:** Annually

**Driver:** Solid Waste Landfill Permit SW07300014, SW07300015, SW07300045, issued by KDWM.

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

**Rationale:** Solid Waste Landfill Permit SW07300014, SW07300015, SW07300045.

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

Sampling frequencies and sampling parameters were not modified for this sampling program in FY 2024 because it is permit driven.

Annual leachate parameters for C-746-S and C-746-U Landfills are presented in Table C.42.

## Table C.42. C-746-S and C-746-U Landfills Annual Leachate Parameters

| | | | |
|---|---|---|---|
| **Volatiles—Method 624.1 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 8082A** | | | |
| PCB, Total | PCB-1232 | PCB-1248 | PCB-1260 |
| PCB-1016 | PCB-1242 | PCB-1254 | PCB-1268 |
| PCB-1221 | | | |
| **Radionuclides—Method U-02-RC M unless noted** | | | |
| **Alpha Activity—9310** | **Cobalt-60[b]—901.1** | Uranium-235, Dissolved[b] | **Cesium-137, Dissolved[b]—901.1** |
| **Beta Activity—9310** | **Thorium-234[b]—901.1** | Uranium-234, Dissolved[b] | **Cobalt-60, Dissolved[b]—901.1** |
| **Radium-226—AN-1418** | **Americium-241[b]—AM-05-RC M** | Uranium-238, Dissolved[b] | **Thorium-234, Dissolved[b]—901.1** |
| **Strontium-90—905.0 M** | **Neptunium-237[b]—1475-00 M** | Uranium | **Americium-241, Dissolved[b]—AM-05-RC M** |
| **Technetium-99—TC-02-RC M** | **Plutonium-239/240[b]—PU-11-RC M** | Uranium, Dissolved[b] | **Neptunium-237, Dissolved[b]—1475-00 M** |
| **Thorium-230—Th-01-RC M** | Uranium-235[b] | **Dissolved Alpha[b]—9310** | **Plutonium-239/240, Dissolved[b]—PU-11-RC M** |
| **Tritium—906.0 M** | Uranium-234[b] | **Dissolved Beta[b]—9310** | **Thorium-230, Dissolved[b]—Th-01-RC M** |
| **Cesium-137[b]—901.1** | Uranium-238[b] | **Technetium-99, Dissolved[b]—TC-02-RC M** | |
| **Radium-228[c]—904.0M** | **Thorium-232[c]—Th-01-RC M** | | |
| **Metals—Method 6020B unless noted** | | | |
| Aluminum | Lead | Thallium | Cobalt, Dissolved |
| Antimony | Magnesium | Tin[b] | Copper, Dissolved |
| Arsenic | Manganese | Titanium[b] | 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 9056A** | | | |
| Bromide | Fluoride | Nitrate as Nitrogen | Sulfate |
| Chloride | | | |
| **Field Parameters** | | | |
| Conductivity | Eh[d] (approx) | Temperature | pH |
| Dissolved Oxygen | | | |
| **Miscellaneous—Method as follows** | | | |
| **Total Dissolved Solids—160.1** | **Total Organic Halides—9020B** | **Phosphorus[b]—365.4** | **Carbonaceous Biochemical[b] Oxygen Demand—SM 5210 B** |
| **Chemical Oxygen Demand—410.4** | **Total Organic Carbon—9060A** | **Hardness—Total as $CaCO_3$[b]—130.2** | |
| **Cyanide—9012B** | **Oil and Grease[b]—1664A** | **Iodide—300.0** | **Total Suspended Solids[b]—160.2** |

[a] Xylenes

[b] Permit does not require analysis of this parameter. The parameter is analyzed in support of leachate treatment and discharge to KPDES Outfalls 004 and 008 at the C-615 Wastewater Treatment Facility.

[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.

[d] Oxidation-reduction potential calibrated as Eh.

Bolded parameters are analyzed 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 Management Facility Permit, Number KY8-890-008-982.

**Reported:** C-404 Semiannual Groundwater Report and the ASER

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

**Comments:** Sampling frequencies and sampling parameters were not modified for this sampling program in FY 2024 because it is permit driven.

Leachate analytical parameters for C-404 Landfill are presented in Table C.43.

**Table C.43. C-404 Landfill Leachate Analytical Parameters**

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

[a] Cesium is not required by the Hazardous Waste Management Facility Permit, but is requested per management decision.
[b] PCBs are not required by the Hazardous Waste Management Facility Permit for disposal purposes.
[c] Oxidation-reduction potential calibrated as Eh.
Bolded parameters are analyzed by different method than specified in header.

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# 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:** Table C.44 provides a listing of dosimeters. Figure C.18 shows dosimeter monitoring locations.

**Table C.44. Environmental Dosimeters (64)**

| | | | | |
|---|---|---|---|---|
| TLD-1 | TLD-19 | TLD-59 | TLD-72 | TLD-86 |
| TLD-2 | TLD-22 | TLD-60 | TLD-73 | TLD-87 |
| TLD-3 | TLD-25 | TLD-61 | TLD-74 | TLD-88 |
| TLD-4 | TLD-30 | TLD-62 | TLD-75 | TLD-89 |
| TLD-5 | TLD-35 | TLD-63 | TLD-76 | TLD-90 |
| TLD-6 | TLD-37 | TLD-64 | TLD-77 | TLD-91 |
| TLD-7 | TLD-38 | TLD-65 | TLD-78 | TLD-92 |
| TLD-9 | TLD-40 | TLD-66 | TLD-79 | TLD-93 |
| TLD-12 | TLD-46 | TLD-67 | TLD-80 | TLD-94 |
| TLD-13 | TLD-50 | TLD-68 | TLD-81 | TLD-95 |
| TLD-14 | TLD-52 | TLD-69 | TLD-82 | TLD-96 |
| TLD-15 | TLD-53 | TLD-70 | TLD-83 | TLD-97 |
| TLD-16 | TLD-58 | TLD-71 | TLD-84 | |

TLD = thermoluminescent dosimeter

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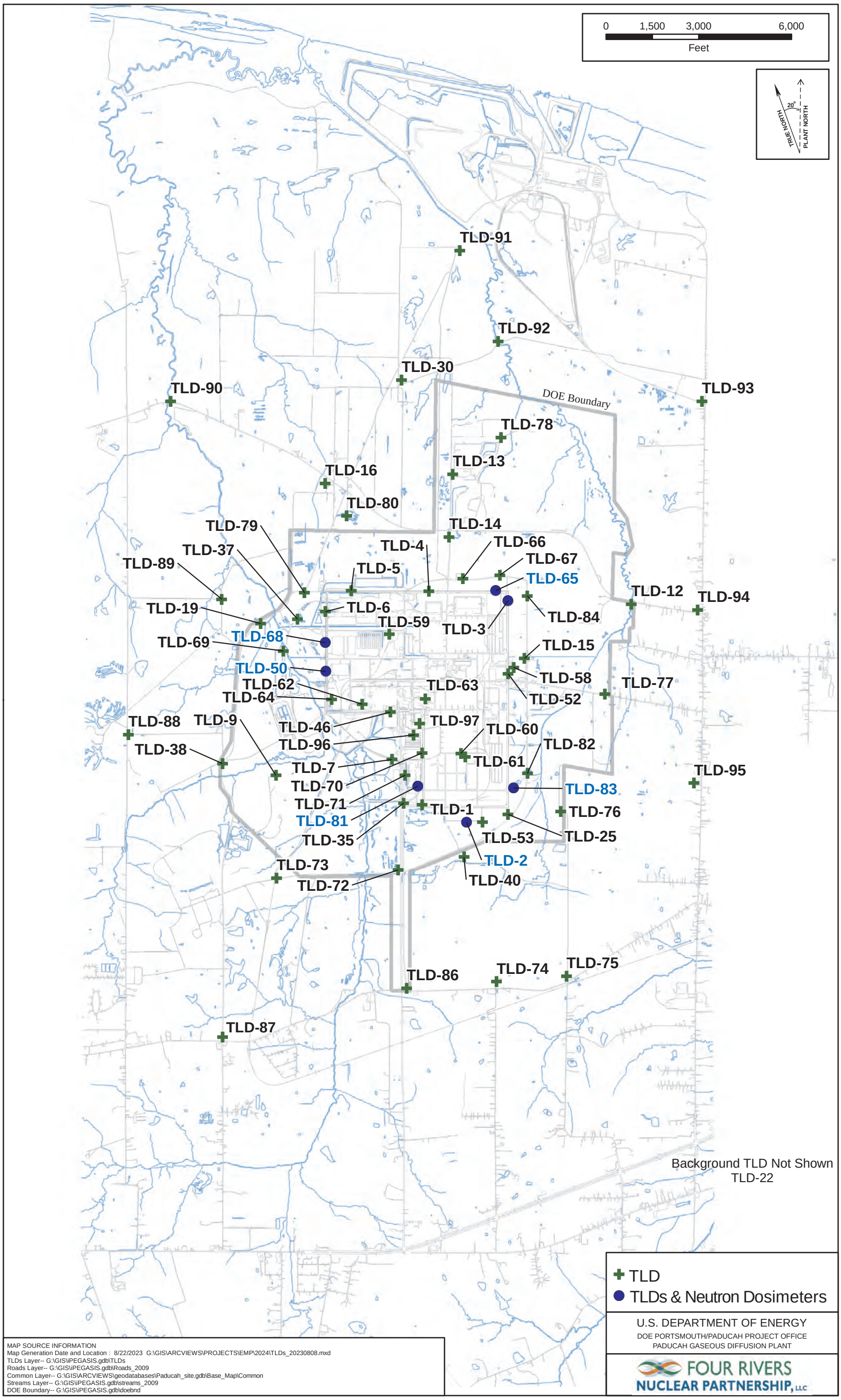


Figure C.18. Environmental Dosimeter Locations

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# C.6. AMBIENT AIR MONITORING

**Frequency:** Weekly and 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*, CP2-EC-0002, October 2019

**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.

Sampling frequencies and sampling parameters were not modified for this sampling program for FY 2024.

Location identifications are found in Table C.45. Filter samples are collected on a weekly basis and analyzed for gross alpha and beta, as shown in Table C.46. 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.47. Locations are shown on Figure C.19.

**Table C.45. Ambient Air Monitoring Locations (9)**

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

BG = Background location

**Table C.46. Ambient Air Monitoring Weekly Analytical Parameters**

| **Radionuclides—Method 9310** | |
|---|---|
| Alpha Activity | Beta Activity |

**Table C.47. Ambient Air Monitoring Quarterly Analytical Parameters**

| **Radionuclides—Methods as follows** | | |
|---|---|---|
| **Americium-241—AM-05-RC M** | **Plutonium-239/240—Pu-11-RC M** | **Uranium-234—U-02-RC M** |
| **Plutonium-238—Pu-11-RC M** | **Technetium-99—Tc-02-RC M** | **Uranium-235—U-02-RC M** |
| **Neptunium-237—1475-00 M** | **Thorium-234/Uranium-238—HASL300 4.5.2.3** | **Uranium-238—U-02-RC M** |

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

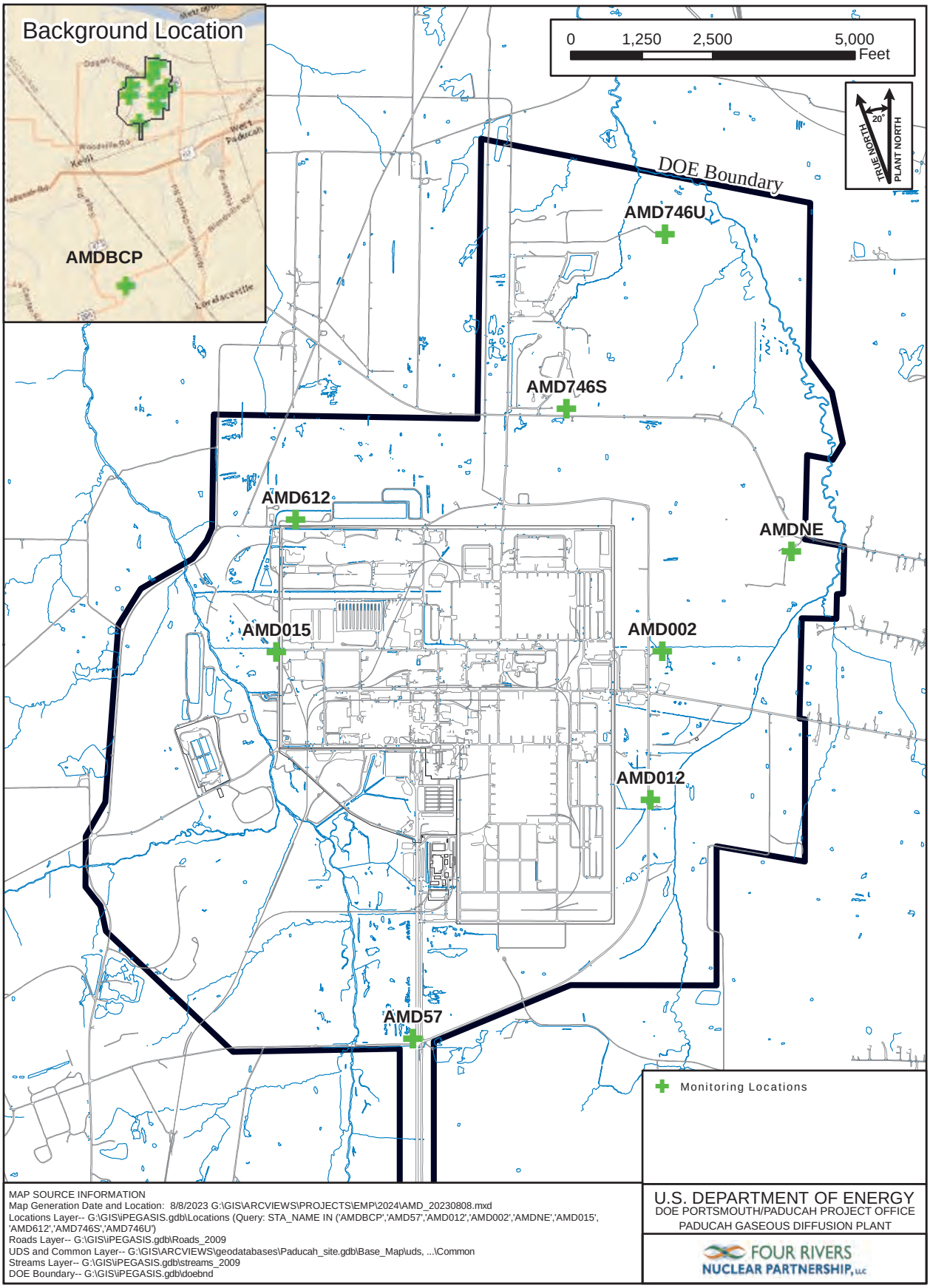


**Figure C.19. DOE Ambient Air Monitoring Stations**

# 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 |
| COC | contaminant of concern |
| COPC | chemical (or radionuclide) of potential concern |
| CPAP | contractor performance assurance program |
| CRQL | contract-required quantitation limit |
| CVAA | cold vapor atomic absorption |
| DOE | U.S. Department of Energy |
| DOECAP | DOE Consolidated Audit Program |
| DQI | Data Quality Indicator |
| DQO | data quality objective |
| ECD | electron capture detector |
| EM | environmental monitoring |
| EMP | Environmental Monitoring Plan |
| EPA | U.S. Environmental Protection Agency |
| ETAS | Enterprise Technical Assistance Services, Inc. |
| FFA | Federal Facility Agreement |
| FID | flame ionization detector |
| FRNP | Four Rivers Nuclear Partnership, LLC |
| FY | fiscal year |
| GC | gas chromatography |
| GC-MS | gas chromatography mass spectrometer |
| HSS&Q | health, safety, support, and quality |
| ICP-AES | inductively coupled plasma atomic emission spectroscopy |
| ICP-MS | inductively coupled plasma mass spectrometer |
| ICP-OES | inductively coupled optical emission spectroscopy |
| KDEP | Kentucky Department for Environmental Protection |
| KPDES | Kentucky Pollutant Discharge Elimination System |
| LCS | laboratory control sample |
| LRGA | Lower Regional Gravel Aquifer |
| MCL | maximum contaminant level |
| MDA | minimum detectable activity |
| MDL | method detection limit |
| MPC | measurement performance criteria |
| MS | matrix spike |
| MSD | matrix spike duplicate |
| MW | monitoring well |
| N/A | not applicable |
| NAL | no action level |
| NDIRD | nondispersive infrared detector |
| O | Order |
| OREIS | Oak Ridge Environmental Information System |
| PARCCS | precision, accuracy, representativeness, comparability, completeness, and sensitivity |
| PEGASIS | PPPO Environmental Geographic Analytical Spatial Information System |
| PGDP | Paducah Gaseous Diffusion Plant |
| PM | project manager |
| PQL | practical quantitation limit |
| QA | quality assurance |

| | |
|---|---|
| QAPP | Quality Assurance Project Plan |
| QC | quality control |
| RPD | relative percent difference |
| SMO | sample management office |
| SOP | standard operating procedure |
| SVOC | semivolatile organic compound |
| TLD | thermoluminescent dosimeter |
| TOC | total organic carbon |
| TPD | training position description |
| UCRS | Upper Continental Recharge System |
| UPS | United Parcel Service |
| URGA | Upper Regional Gravel Aquifer |
| UFP | Uniform Federal Policy |
| VOC | volatile organic compound |

# 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/07-2490&D1, *Paducah Gaseous Diffusion Plant Programmatic Quality Assurance Project Plan*, April 2023, 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 2024 Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, CP2-ES-0006/FR10. It describes the project-specific quality assurance (QA) 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 standard operating procedures (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 (PM) 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 (SMO) 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 *Paducah Gaseous Diffusion Plant Data Management Plan*, DOE/LX/07-2458&D2; 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, 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]

[1] Project-specific QAPPs contain information concerning implemented field methods. FRNP's Radiological Control Manual (CP2-RP-0002) sets requirements associated with the use and calibration of survey instruments, survey documentation, survey review, and training.

This QAPP does not cover the analysis of the environmental dosimeters for gamma and neutron emissions although the program is detailed with sample locations in Appendix C of the EMP. The analysis of the environmental dosimeters is discussed in the annual External Radiation Monitoring Report. The environmental dosimeters are designed to meet ANSI N545-1975, *Performance, Testing, and Procedural Specifications for Thermoluminescence Dosimetry (Environmental Applications)*, and ANSI/Health Physics Society N13.37-2014 (R2019), *Environmental Dosimetry-Criteria for System Design and Implementation*. Additionally, samples collected in the ambient air monitoring program are not covered in this QAPP. QA information regarding the ambient air monitoring program is provided in CP2-EC-0002, *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.*

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 and identified in the *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, Volume 1. Human Health*, DOE/LX/07-0107&D2/R14/V1 (herein known as RMD) as contaminants of concern (COCs) at the site 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 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 COCs 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:** Contract No. DE-EM0004895
**Contract Title:** Paducah Gaseous Diffusion Plant Paducah Deactivation and Remediation Project
**Work Assignment Number:** Not Applicable (N/A)

**Document Title:** *Environmental Monitoring Quality Assurance Project Plan*

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

**Preparer's Name and Organizational Affiliation:** Evan Clark, Four Rivers Nuclear Partnership, LLC

**Preparer's Address, Telephone Number, and E-mail Address:** 5511 Hobbs Road, Kevil, KY, 42053, Phone (270) 441-6247, evan.clark@pad.pppo.gov

**Preparation Date (Month/Year):** 8/2023

**Document Control Number:** CP2-ES-0006/FR10, Appendix D

| | | |
|---|---|---|
| FRNP Environmental Services Director | BRUCE FORD (Affiliate) Digitally signed by BRUCE FORD (Affiliate) Date: 2023.11.27 12:59:13 -06'00'<br>Signature<br>Bruce Ford | Date:_____ |
| FRNP Environmental Stewardship Manager | BRUCE FORD (Affiliate) Digitally signed by BRUCE FORD (Affiliate) Date: 2023.11.27 12:59:47 -06'00'<br>Signature<br>Bruce Ford, Acting | Date:_____ |
| FRNP Sample Management Office Manager | JAIME MORROW (Affiliate) Digitally signed by JAIME MORROW (Affiliate) Date: 2023.11.27 14:02:44 -06'00'<br>Signature<br>Jaime Morrow | Date:_____ |
| FRNP Quality Assurance/Quality Control Program Manager | JENNIE FREELS (Affiliate) Digitally signed by JENNIE FREELS (Affiliate) Date: 2023.11.27 15:14:24 -06'00'<br>Signature<br>Jennie Freels | Date:_____ |

**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 Workbook*, 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.

   *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, *Volume 1 Human Health*, DOE/LX/07-0107&D2/R14/V1.

   *Paducah Gaseous Diffusion Plant Programmatic Quality Assurance Project Plan*, DOE/LX/07-2490&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; Kentucky Department for Environmental Protection (KDEP) (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 8, 2023—Data Quality Objective (DQO) Session

**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(s):** |
|---|---|
| *Paducah Gaseous Diffusion Plant Data Management Plan*, DOE/LX/07-2458&D2 | September 2021 |
| *Paducah Gaseous Diffusion Plant Programmatic Quality Assurance Project Plan, Paducah, Kentucky*, DOE/LX/07-2409&D1 | February 2017 |
| *Paducah Gaseous Diffusion Plant Programmatic Quality Assurance Project Plan, Paducah, Kentucky*, DOE/LX/07-2421&D1 | April 2018 |
| *Paducah Gaseous Diffusion Plant Programmatic Quality Assurance Project Plan, Paducah, Kentucky*, DOE/LX/07-2439&D1 | April 2019 |
| *Paducah Gaseous Diffusion Plant Programmatic Quality Assurance Project Plan, Paducah, Kentucky*, DOE/LX/07-2446&D1 | April 2020 |
| *Paducah Gaseous Diffusion Plant Programmatic Quality Assurance Project Plan, Paducah, Kentucky*, DOE/LX/07-2459&D1 | April 2021 |
| *Paducah Gaseous Diffusion Plant Programmatic Quality Assurance Project Plan, Paducah, Kentucky*, DOE/LX/07-2479&D1 | March 2022 |
| *Paducah Gaseous Diffusion Plant Programmatic Quality Assurance Project Plan, Paducah, Kentucky,* DOE/LX/07-2490&D1 | April 2023 |

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

7. List organizational partners (stakeholders) and connection with lead organization:
   U.S. Environmental Protection Agency (EPA) Region 4 [Federal Facility Agreement (FFA) member]; KDEP (regulates hazardous and solid waste landfills, effluent discharge permits, FFA member)

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

9. Table 1 provides a crosswalk of required QAPP elements.

   This QAPP includes 26 combined worksheets that are required based on UFP-QAPP guidance, as updated by the optimized worksheet guidance (37 total worksheets). Worksheets #10 and #17 have been omitted because the problem definitions are described in detail within the body of the EMP, of which this QAPP is an appendix. Each of these worksheets has been reviewed to ensure the accuracy of the information presented in this QAPP.

**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 Summary | 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 |

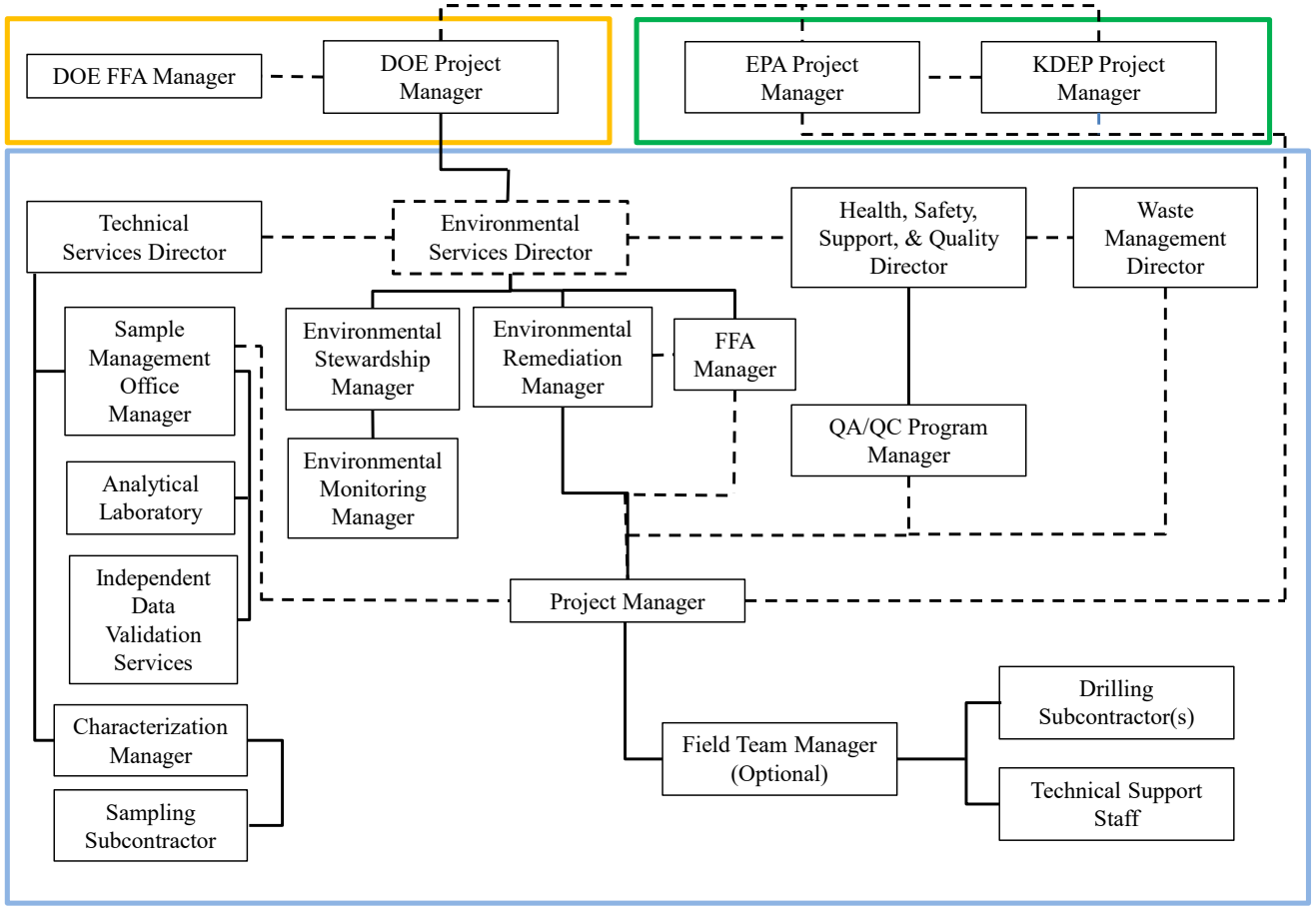
**QAPP Worksheets #3 and #5.**
**Project Organization and QAPP Distribution**

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 this worksheet and submit page changes to the document holders. Alternatively, as with other changes to the approved project-specific QAPP, personnel changes may be tracked and included as an attachment to the QAPP. Managers are responsible for distribution to their staffs.

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 | April Ladd | (270) 441-6843 | april.ladd@pppo.gov | 1 |
| Project Manager | DOE | Rich Bonczek | (859) 219-4051 | rich.bonczek@pppo.gov | 2 |
| FFA Manager | DOE | April Ladd | (270) 441-6843 | april.ladd@pppo.gov | 3 |
| Environmental Services Director | FRNP | Bruce Ford | (270) 441-5357 | bruce.ford@pad.pppo.gov | 4 |
| Environmental Stewardship Manager | FRNP | Bruce Ford, Acting | (270) 441-5357 | bruce.ford@pad.pppo.gov | 5 |
| Environmental Radiation Protection | FRNP | Kevin Funke | (270) 557-8009 | kevin.funke@pad.pppo.gov | 6 |
| FFA Manager | FRNP | LeAnne Garner | (270) 441-5436 | leanne.garner@pad.pppo.gov | 7 |
| QA/Quality Control (QC) Program Manager | FRNP | Jennie Freels | (270) 441-5407 | jennie.freels@pad.pppo.gov | 8 |
| SMO Manager | FRNP | Jaime Morrow | (270) 441-5508 | jaime.morrow@pad.pppo.gov | 9 |

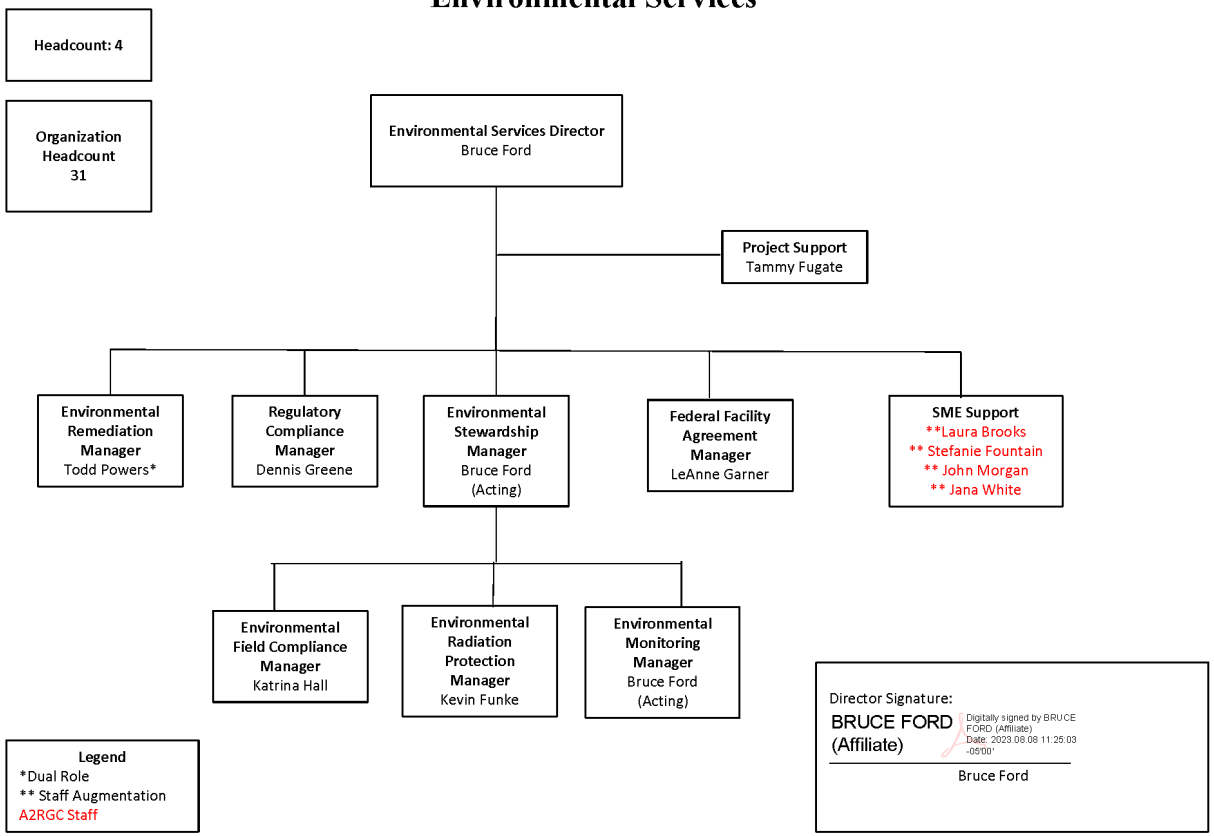
**QAPP Worksheets #3 and #5. (Continued)**
**Project Organization and QAPP Distribution**




Note: DOE personnel are in Orange Box, Regulatory personnel are in Green Box, and DOE Prime Contractor personnel are in Blue Box.

**QAPP Worksheets #3 and #5. (Continued)**
**Project Organization and QAPP Distribution**

## Environmental Services



**QAPP Worksheets #4, #7, and #8.**
**Personnel Qualifications and Sign-Off Sheet**

**ORGANIZATION: Four Rivers Nuclear Partnership, LLC**

| Name | Project Title/Role | Education/Experience | Specialized Training/Certifications | Signature/Date* |
|---|---|---|---|---|
| Bruce Ford | Environmental Services Director | > 4 years relevant work experience | No specialized training or certification. See Training Position Description (TPD). | |
| Bruce Ford, Acting | Environmental Stewardship Manager | > 4 years relevant work experience | No specialized training or certification. See TPD. | |
| Jaime Morrow | SMO Manager | > 4 years relevant work experience | No specialized training or certification. See TPD. | |
| Chris Skinner | Characterization Sampling Lead | > 4 years relevant work experience | No specialized training or certification. See TPD. | |
| Matthew Richardson | Data Validator | Bachelor degree plus relevant experience | No specialized training or certification. | Follows FRNP data validation plans |
| Kevin Funke | Environmental Radiation Protection | > 4 years relevant work experience | No specialized training or certification. See TPD. | |

**ORGANIZATION: Laboratory**

| Name | Project Title/Role | Education/Experience | Specialized Training/Certifications | Signature/Date* |
|---|---|---|---|---|
| Laboratory Project Manager | Analytical Laboratory Project Manager | > 4 years relevant work experience | No specialized training or certification. See TPD. | Follows the laboratory statement of work |

*Signature indicates personnel have read and agree to implement this QAPP as written.

## QAPP Worksheet #6.
## Communication Pathways

**NOTE**: Formal communication across company or regulatory boundaries occurs via letter. Other forms of communication, such as e-mail, telephone calls, meetings, etc., will occur throughout the project. Regular project communication among DOE, the Site Contractor, and the regulatory agencies concerning project progress is expected. Deviations from the EMP/QAPP will be communicated upward through the chain of command to regulatory agencies using communication tools commensurate with the issue.

| Communication Driver | Organization | Name | Contact Information | Procedure (timing, pathway, documentation, etc.) |
|---|---|---|---|---|
| Regulatory agency interface | DOE, EPA, KDEP | DOE PM: Rich Bonczek;<br>EPA Remedial PM:<br>Victor Weeks;<br>KDEP PM: April Webb | rich.bonczek@pppo.gov<br>weeks.victor@epa.gov<br><br>april.webb@ky.gov | Formal communication among DOE, EPA, and KDEP. |
| Field progress reports | FRNP | FRNP Environmental Services Director: Bruce Ford | bruce.ford@pad.pppo.gov | Formal communication between DOE and contractor for the Environmental Monitoring Project. |
| Stop work due to safety issues | FRNP | FRNP Environmental Services Director: Bruce Ford and FRNP HSS&Q Director: Duke Moscon | bruce.ford@pad.pppo.gov<br><br>duke.moscon@pad.pppo.gov | FRNP will communicate work stoppages to DOE PM as required by procedure. |
| QAPP changes during project execution | FRNP | FRNP Environmental Services Director: Bruce Ford and FRNP Quality Assurance/Quality Control Program Manager: Jennie Freels | bruce.ford@pad.pppo.gov<br><br>jennie.freels@pad.pppo.gov | Obtain approval from DOE PM. Submit QAPP amendments to DOE, KDEP, and EPA. |
| Field corrective actions | FRNP | FRNP Environmental Services Director: Bruce Ford | bruce.ford@pad.pppo.gov | Field corrective actions will need to be approved by FRNP Project Director and communicated to the DOE, EPA, and KDEP PMs. |
| Analytical laboratory interface | FRNP | FRNP SMO Manager: Jaime Morrow | jaime.morrow@pad.pppo.gov | Communication between FRNP and analytical laboratory. |

**QAPP Worksheet #6. (Continued)**
**Communication Pathways**

| Communication Driver | Organization | Name | Contact Information | Procedure (timing, pathway, documentation, etc.) |
|---|---|---|---|---|
| Laboratory quality control variances | Contracted Laboratory | Laboratory PM: Valerie Davis (GEL), Cody Medley (Pace), Daniel Kocher (EMSL) | vsd@gel.com<br>cody.medley@pacelabs.com<br>dkocher@emsl.com | Notify FRNP SMO. FRNP SMO will notify FRNP PM to determine corrective actions. |
| Analytical corrective actions | Contracted Laboratory, FRNP | Laboratory PM: Valerie Davis (GEL), Cody Medley (Pace), Daniel Kocher (EMSL)<br>FRNP SMO Manager: Jaime Morrow | vsd@gel.com<br>cody.medley@pacelabs.com<br>dkocher@emsl.com<br>jaime.morrow@pad.pppo.gov | Notify FRNP SMO. FRNP SMO will notify the project. |
| Data verification issues (e.g., incomplete records) | A2RGC, LLC, FRNP | Data Validator: Matthew Richardson,<br>FRNP SMO Manager: Jaime Morrow | mrichardson@geosyntec.com<br><br>jaime.morrow@pad.pppo.gov | Data verification issues will be reported to the FRNP SMO. |
| Data validation issues (e.g., noncompliance with procedures) | A2RGC, LLC, FRNP | Data Validator: Matthew Richardson,<br>FRNP SMO Manager: Jaime Morrow | mrichardson@geosyntec.com<br><br>jaime.morrow@pad.pppo.gov | Issues with data quality will be reported to the FRNP SMO. |

NOTE: This QAPP is position-based with names of the current positions presented. In the event the contractor changes and the position titles change, DOE will notify EPA and KDEP of the change.

**QAPP Worksheet #9.**
**Project Planning Session Summary**

Project scoping is the key to the success of any project and is part of the systematic planning process. The preparation of this QAPP included review of past documents produced and planning meetings to establish the objectives of the project. It was determined that a formal DQO session was needed for the FY 2024 EMP. The worksheet identifies participants who discussed the sampling strategy in the DQO session held on August 8, 2023.

**Name of Project:** Environmental Monitoring Plan Fiscal Year 2024
**Date of Session:** August 8, 2023
**Scoping Session Purpose:** Identify sampling strategies of EM programs

| Position Title | Affiliation | Name | Phone # | E-mail Address | Project Role |
|---|---|---|---|---|---|
| Project Manager | DOE | Rich Bonczek | (859) 219-4051 | rich.bonczek@pppo.gov | Project Management |
| Scientist | Enterprise Technical Assistance Services, Inc. (ETAS) | Tracy Taylor | (270) 441-6866 | tracy.taylor@pppo.gov | Subject Matter Expert |
| Scientist | ETAS | Jennifer Johnson | (270) 441-6846 | jennifer.johnson@pppo.gov | Subject Matter Expert |
| Scientist | ETAS | Martin Clauberg | (865) 259-7155 | martin.clauberg@pppo.gov | Subject Matter Expert |
| Environmental Services Director | FRNP | Bruce Ford | (270) 441-5357 | bruce.ford@pad.pppo.gov | Environmental Services Director |
| Water Policy Coordinator | FRNP | Megan Mulry | (270) 441-5705 | megan.mulry@pad.pppo.gov | Water Policy |
| Regulatory Compliance Manager | FRNP | Dennis Greene | (270) 441-5071 | dennis.greene@pad.pppo.gov | Regulatory Compliance |
| Environmental Radiation Protection Manager | FRNP | Kevin Funke | (270) 557-8009 | kevin.funke@pad.pppo.gov | Environmental Radiation Protection |
| SMO Manager | FRNP | Jaime Morrow | (270) 441-5508 | jaime.morrow@pad.pppo.gov | SMO |
| Scientist | FRNP | Bryan Clayton | (270) 441-5412 | bryan.clayton@pad.pppo.gov | Subject Matter Expert |
| Scientist | FRNP | Valarie Crabtree | (270) 441-6317 | valarie.crabtree@pad.pppo.gov | Subject Matter Expert |
| Scientist | FRNP | Evan Clark | (270) 441-6247 | evan.clark@pad.pppo.gov | Subject Matter Expert |
| Scientist | Geosyntec Consultants | Sarah Cronk | (865) 291-4689 | Sarah.cronk@pad.pppo.gov | Subject Matter Expert |
| Scientist | FRNP | Ken Davis | (270) 441-5049 | ken.davis@pad.pppo.gov | Subject Matter Expert |

**QAPP Worksheet #9. (Continued)**
**Project Planning Session Summary**

**Notes/comments:** Discussed proposed changes to sampling programs in Appendix C for FY 2024 EMP and that the draft EMP would be submitted to DOE for review by September 1, 2023.

**Consensus decisions made:** Submit draft FY 2024 EMP by August 31, 2023, for DOE review and comment.

**Action items:**

| Action | Responsible Party | Due Date |
|---|---|---|
| Submit draft FY 2024 EMP | Evan Clark and Ken Davis | 9/1/2023 |
| | | |

**QAPP Worksheet #11.**
**Project/Data Quality Objectives**

**Step 1. State the Problem:**

Problem Statement: Determine environmental monitoring requirements set forth by the following drivers:

DOE O 436.1, Departmental Sustainability
DOE O 450.1A, Environmental Protection Program
DOE O 458.1, Radiation Protection of the Public and the Environment
DOE-HDBK-1216-2015 Change Notice 1, Environmental Radiological Effluent Monitoring and Environmental Surveillance
Kentucky Permits
CERCLA Actions
FFA

Problem Approach:

- The planning team will review plans, regulations, DOE Orders, and permits to determine monitoring requirements.
- Planning Team: DOE and FRNP
- Determine Resources:
  - Schedule: Implement FY 2024 EMP, October 1, 2023
  - Budget: Based upon scope
  - Personnel: FRNP

**Step 2: Identify the Goal of the Study**

Obtain data to:

- Demonstrate compliance (effluent, rad dose, etc.)
- Demonstrate effectiveness of chosen remedy (Pump & Treat, etc.)
- Provide for modeling efforts (groundwater surveillance)
- Identify potential adverse environmental impacts; supporting Integrated Safety Management System through an Environmental Management System

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).

**QAPP Worksheet #11.**
**Project/Data Quality Objectives**

**Step 3. Identify Information Inputs:**

Identify Information Inputs (What Information Do We Need)

- Permit or decision document specifies parameters and frequency for demonstration of compliance and remedy effectiveness
- Models and historical data sets provide for data needs

**Step 4. Identify the Boundaries of the Study:**

Permits, chosen remedies, and modeling are ongoing until permit modifications or final remedies are chosen or demonstrated.

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



**Step 5. Develop the Analytical Approach:**

Identify methods, parameters, project action limits, method detection limits (MDLs), sample locations, sample frequencies.

Required list of analytes is 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.

**Step 6. Specify Performance or Acceptance Criteria:**

Data needs to meet the measurement quality objective and data quality indicators established by the systematic planning process consistent with procedures and plans *Quality Assured Data*, CP3-ES-5003; *Environmental Monitoring Data Management Implementation Plan at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, CP2-ES-0063; and *Developing, Implementing, and Maintaining Data Management Implementation Plans*, CP3-ES-1003.

Obtained data may:

- Provide data for use in the Annual Site Environmental Report
- 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
- Provide a mechanism for long-term data collection needs under the FFA

EMP does not address reports or modeling development or a show of noncompliance. Example: An exceedance at a Kentucky Pollutant Discharge Elimination System (KPDES) outfall does not indicate an objective within the EMP was not met.

**Step 7. Develop the Detailed Plan for Obtaining Data:**

- Procedures and Plans
- Analytical Methods
- Statements of Work
- DOE Consolidated Audit Program (DOECAP) Laboratories
- *Environmental Monitoring Data Management Implementation Plan at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, CP2-ES-0063/FR2A
- Paducah Project Environmental Measurements System, Oak Ridge Environmental Information System (OREIS), Portsmouth/Paducah Project Office Environmental Geographic Analytical Spatial Information System (PEGASIS)

**QAPP Worksheet #12-A.**
**Measurement Performance Criteria (PCBs, Sediment)**

| | |
|---|---|
| **Matrix** | Sediment |
| **Analytical Group**[a] | PCBs |
| **Concentration Level** | Low |

| Sampling Procedure[b] | Analytical Method/SOP[c,d] | Data Quality Indicators (DQIs) | Measurement Performance Criteria (MPC) | QC Sample and/or Activity Used to Assess Measurement Performance | QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A) |
|---|---|---|---|---|---|
| See Worksheet #21 | SW-846-8082 See Worksheet #23 | Precision—Lab | RPD—≤ 25% | Laboratory Duplicates | A |
| | | Precision | RPD—≤ 35% | Field Duplicates | S |
| | | Accuracy | RPD—≤ 40% | Dual column analysis | A |
| | | Accuracy/Bias | % recovery[e] | 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[f] | 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.
[a] If information varies within an analytical group, separate by individual analyte.
[b] Reference number from QAPP Worksheet #21.
[c] Reference number from QAPP Worksheet #23.
[d] Appendix C contains the version of the analytical method to be used.
[e] 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.
[f] Completeness is calculated by two methods:

- As the number of valid analytical results reported divided by the number of analytical results planned, multiplied by 100 to obtain the percentage.
- As the number of valid analytical results reported divided by the number of analytical results requested, multiplied by 100 to obtain the percentage.

**QAPP Worksheet #12-B.**
**Measurement Performance Criteria (Radionuclides, Sediment)**

| | |
|---|---|
| **Matrix** | Sediment |
| **Analytical Group**[a] | Radionuclides (uranium,[b] uranium-234, uranium-235, uranium-238) |
| **Concentration Level** | Low |

| **Sampling Procedure**[c] | **Analytical Method/SOP**[d,e] | **Data Quality Indicators (DQIs)** | **Measurement Performance Criteria (MPC)** | **QC Sample and/or Activity Used to Assess Measurement Performance** | **QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)** |
|---|---|---|---|---|---|
| See Worksheet #21 | Alpha spectroscopy[f] See Worksheet #23 | Precision—Lab | RPD—≤ 25% | Laboratory Duplicates | A |
| | | Precision | RPD—≤ 50% | Field Duplicates | S |
| | | Accuracy/Bias | % recovery[g] | 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[h] | 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.
[a] If information varies within an analytical group, separate by individual analyte.
[b] The total uranium listed represents the total of the uranium isotopes that is analyzed by alpha spectroscopy.
[c] Reference number from QAPP Worksheet #21.
[d] Reference number from QAPP Worksheet #23.
[e] Appendix C contains the version of the analytical method to be used.
[f] 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.
[g] 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.
[h] Completeness is calculated by two methods:

- As the number of valid analytical results reported divided by the number of analytical results planned, multiplied by 100 to obtain the percentage.
- As the number of valid analytical results reported divided by the number of analytical results requested, multiplied by 100 to obtain the percentage.

**QAPP Worksheet #12-C.**
**Measurement Performance Criteria (Radionuclides, Sediment)**

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

| Sampling Procedure[b] | Analytical Method/SOP[c,d] | Data Quality Indicators (DQIs) | Measurement Performance Criteria (MPC) | QC Sample and/or Activity Used to Assess Measurement Performance | QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A) |
|---|---|---|---|---|---|
| See Worksheet #21 | Alpha spectroscopy[e] See Worksheet #23 | Precision—Lab | RPD—≤ 25% | Laboratory Duplicates | A |
| | | Precision | RPD—≤ 50% | Field Duplicates | S |
| | | Accuracy/Bias | % recovery[f] | 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[g] | 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.

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

[b] Reference number from QAPP Worksheet #21.

[c] Reference number from QAPP Worksheet #23.

[d] Appendix C contains the version of the analytical method to be used.

[e] 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.

[f] 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.

[g] Completeness is calculated by two methods:

- As the number of valid analytical results reported divided by the number of analytical results planned, multiplied by 100 to obtain the percentage.
- As the number of valid analytical results reported divided by the number of analytical results requested, multiplied by 100 to obtain the percentage.

**QAPP Worksheet #12-D.**
**Measurement Performance Criteria (Radionuclides, Sediment)**

| | |
|---|---|
| **Matrix** | Sediment |
| **Analytical Group**[a] | Radionuclides (cesium-137) |
| **Concentration Level** | Low |

| **Sampling Procedure**[b] | **Analytical Method/SOP**[c,d] | **Data Quality Indicators (DQIs)** | **Measurement Performance Criteria (MPC)** | **QC Sample and/or Activity Used to Assess Measurement Performance** | **QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)** |
|---|---|---|---|---|---|
| See Worksheet #21 | Gamma spectroscopy[e] See Worksheet #23 | 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[f] | 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.
[a] If information varies within an analytical group, separate by individual analyte.
[b] Reference number from QAPP Worksheet #21.
[c] Reference number from QAPP Worksheet #23.
[d] Appendix C contains the version of the analytical method to be used.
[e] 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.
[f] Completeness is calculated by two methods:

- As the number of valid analytical results reported divided by the number of analytical results planned, multiplied by 100 to obtain the percentage.
- As the number of valid analytical results reported divided by the number of analytical results requested, multiplied by 100 to obtain the percentage.

**QAPP Worksheet #12-E.**
**Measurement Performance Criteria (Radionuclides, Sediment)**

| | |
|---|---|
| **Matrix** | Sediment |
| **Analytical Group**[a] | Radionuclides (technetium-99) |
| **Concentration Level** | Low |

| Sampling Procedure[b] | Analytical Method/SOP[c,d] | Data Quality Indicators (DQIs) | Measurement Performance Criteria (MPC) | QC Sample and/or Activity Used to Assess Measurement Performance | QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A) |
|---|---|---|---|---|---|
| See Worksheet #21 | Liquid scintillation[e] See Worksheet #23 | Precision—Lab | RPD—≤ 25% | Laboratory Duplicates | A |
| | | Precision | RPD—≤ 50% | Field Duplicates | S |
| | | Accuracy/Bias | % recovery[f] | 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[g] | 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.
[a] If information varies within an analytical group, separate by individual analyte.
[b] Reference number from QAPP Worksheet #21.
[c] Reference number from QAPP Worksheet #23.
[d] Appendix C contains the version of the analytical method to be used.
[e] 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.
[f] 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.
[g] Completeness is calculated by two methods:

- As the number of valid analytical results reported divided by the number of analytical results planned, multiplied by 100 to obtain the percentage.
- As the number of valid analytical results reported divided by the number of analytical results requested, multiplied by 100 to obtain the percentage.

**QAPP Worksheet #12-F.**
**Measurement Performance Criteria (VOCs, Water)**

| | |
|---|---|
| **Matrix** | Water/Groundwater |
| **Analytical Group**[a] | Volatile Organic Compounds (VOCs) |
| **Concentration Level** | Low |

| **Sampling Procedure**[b] | **Analytical Method/SOP**[c,d] | **Data Quality Indicators (DQIs)** | **Measurement Performance Criteria (MPC)** | **QC Sample and/or Activity Used to Assess Measurement Performance** | **QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)** |
|---|---|---|---|---|---|
| See Worksheet #21 | SW-846-8260 and EPA-624.1 See Worksheet #23 | Precision—Lab | RPD—≤ 25% | Laboratory Duplicates | A |
| | | Precision | RPD—≤ 25% | Field Duplicates | S |
| | | Accuracy/Bias | % recovery[e] | 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[f] | 90% | Data completeness check | S&A |

PQL = practical quantitation limit; RPD = relative percent difference
[a] If information varies within an analytical group, separate by individual analyte.
[b] Reference number from QAPP Worksheet #21.
[c] Reference number from QAPP Worksheet #23.
[d] Appendix C contains the version of the analytical method to be used.
[e] 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.
[f] Completeness is calculated by two methods:

- As the number of valid analytical results reported divided by the number of analytical results planned, multiplied by 100 to obtain the percentage.
- As the number of valid analytical results reported divided by the number of analytical results requested, multiplied by 100 to obtain the percentage.

**QAPP Worksheet #12-G.**
**Measurement Performance Criteria (Metals, Water)**

| | |
|---|---|
| **Matrix** | Water/Groundwater |
| **Analytical Group**[a] | Metals (all except mercury) |
| **Concentration Level** | Low |

| Sampling Procedure[b] | Analytical Method/SOP[c,d] | Data Quality Indicators (DQIs) | Measurement Performance Criteria (MPC) | QC Sample and/or Activity Used to Assess Measurement Performance | QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A) |
|---|---|---|---|---|---|
| See Worksheet #21 | EPA-200.8/ SW-846-6010/6020 See Worksheet #23 | Precision—Lab | RPD—≤ 20% | Laboratory Duplicates | A |
| | | Precision | RPD—≤ 25% | Field Duplicates | S |
| | | Accuracy/Bias | % recovery[e] | Laboratory Sample Spikes | A |
| | | Accuracy/Bias | RPD = 80-120% | Interference Check Sample | 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[f] | 90% | Data completeness check | S&A |

PQL = practical quantitation limit; RPD = relative percent difference
[a] If information varies within an analytical group, separate by individual analyte.
[b] Reference number from QAPP Worksheet #21.
[c] Reference number from QAPP Worksheet #23.
[d] Appendix C contains the version of the analytical method to be used.
[e] 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.
[f] Completeness is calculated by two methods:

- As the number of valid analytical results reported divided by the number of analytical results planned, multiplied by 100 to obtain the percentage.
- As the number of valid analytical results reported divided by the number of analytical results requested, multiplied by 100 to obtain the percentage.

**QAPP Worksheet #12-H.**
**Measurement Performance Criteria (Mercury, Water)**

| | |
|---|---|
| **Matrix** | Water/Groundwater |
| **Analytical Group**[a] | Metals (Mercury) |
| **Concentration Level** | Low |

| Sampling Procedure[b] | Analytical Method/SOP[c,d] | Data Quality Indicators (DQIs) | Measurement Performance Criteria (MPC) | QC Sample and/or Activity Used to Assess Measurement Performance | QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A) |
|---|---|---|---|---|---|
| See Worksheet #21 | SW-846-7470<br>See Worksheet #23 | Precision—Lab | RPD—≤ 20% | Laboratory Duplicates | A |
| | | Precision | RPD—≤ 25% | Field Duplicates | S |
| | | Accuracy/Bias | % recovery[e] | 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[f] | 90% | Data completeness check | S&A |

PQL = practical quantitation limit; RPD = relative percent difference
[a] If information varies within an analytical group, separate by individual analyte.
[b] Reference number from QAPP Worksheet #21.
[c] Reference number from QAPP Worksheet #23.
[d] Appendix C contains the version of the analytical method to be used.
[e] 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.
[f] Completeness is calculated by two methods:

- As the number of valid analytical results reported divided by the number of analytical results planned, multiplied by 100 to obtain the percentage.
- As the number of valid analytical results reported divided by the number of analytical results requested, multiplied by 100 to obtain the percentage.

**QAPP Worksheet #12-I.**
**Measurement Performance Criteria (PCBs, Water)**

| | |
|---|---|
| **Matrix** | Water/Groundwater |
| **Analytical Group**[a] | PCBs |
| **Concentration Level** | Low |

| **Sampling Procedure**[b] | **Analytical Method/SOP**[c,d] | **Data Quality Indicators (DQIs)** | **Measurement Performance Criteria (MPC)** | **QC Sample and/or Activity Used to Assess Measurement Performance** | **QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)** |
|---|---|---|---|---|---|
| See Worksheet #21 | SW-846-8082 and EPA-608.3 See Worksheet #23 | Precision—Lab | RPD—≤ 25% | Laboratory Duplicates | A |
| | | Precision | RPD—≤ 25% | Field Duplicates | S |
| | | Accuracy | RPD—≤ 40% | Dual column analysis | A |
| | | Accuracy/Bias | % recovery[e] | 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[f] | 90% | Data completeness check | S&A |

PQL = practical quantitation limit; RPD = relative percent difference
[a] If information varies within an analytical group, separate by individual analyte.
[b] Reference number from QAPP Worksheet #21.
[c] Reference number from QAPP Worksheet #23.
[d] Appendix C contains the version of the analytical method to be used.
[e] 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.
[f] Completeness is calculated by two methods:

- As the number of valid analytical results reported divided by the number of analytical results planned, multiplied by 100 to obtain the percentage.
- As the number of valid analytical results reported divided by the number of analytical results requested, multiplied by 100 to obtain the percentage.

**QAPP Worksheet #12-J.**
**Measurement Performance Criteria (Radionuclides, Water)**

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

| **Sampling Procedure**[c] | **Analytical Method/SOP**[d,e] | **Data Quality Indicators (DQIs)** | **Measurement Performance Criteria (MPC)** | **QC Sample and/or Activity Used to Assess Measurement Performance** | **QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)** |
|---|---|---|---|---|---|
| See Worksheet #21 | Alpha spectroscopy[f] See Worksheet #23 | Precision—Lab | RPD—≤ 25% | Laboratory Duplicates | A |
| | | Precision | RPD—≤ 25% | Field Duplicates | S |
| | | Accuracy/Bias | % recovery[g] | 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[h] | 90% | Data completeness check | S&A |

MDA = minimum detectable activity; RPD = relative percent difference

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

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

[c] Reference number from QAPP Worksheet #21.

[d] Reference number from QAPP Worksheet #23.

[e] Appendix C contains the version of the analytical method to be used.

[f] 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.

[g] 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.

[h] Completeness is calculated by two methods:

- As the number of valid analytical results reported divided by the number of analytical results planned, multiplied by 100 to obtain the percentage.
- As the number of valid analytical results reported divided by the number of analytical results requested, multiplied by 100 to obtain the percentage.

**QAPP Worksheet #12-K.**
**Measurement Performance Criteria (Radionuclides, Water)**

| | |
|---|---|
| **Matrix** | Water/groundwater |
| **Analytical Group**[a] | Radionuclides (cesium-137) |
| **Concentration Level** | Low |

| **Sampling Procedure**[b] | **Analytical Method/SOP**[c,d] | **Data Quality Indicators (DQIs)** | **Measurement Performance Criteria (MPC)** | **QC Sample and/or Activity Used to Assess Measurement Performance** | **QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)** |
|---|---|---|---|---|---|
| See Worksheet #21 | Gamma spectroscopy[e] See Worksheet #23 | 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[f] | 90% | Data completeness check | S&A |

MDA = minimum detectable activity; RPD = relative percent difference
[a] If information varies within an analytical group, separate by individual analyte.
[b] Reference number from QAPP Worksheet #21.
[c] Reference number from QAPP Worksheet #23.
[d] Appendix C contains the version of the analytical method to be used.
[e] 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.
[f] Completeness is calculated by two methods:

- As the number of valid analytical results reported divided by the number of analytical results planned, multiplied by 100 to obtain the percentage.
- As the number of valid analytical results reported divided by the number of analytical results requested, multiplied by 100 to obtain the percentage.

**QAPP Worksheet #12-L.**
**Measurement Performance Criteria (Radionuclides, Water)**

| | |
|---|---|
| **Matrix** | Water/Groundwater |
| **Analytical Group**[a] | Radionuclides (technetium-99) |
| **Concentration Level** | Low |

| **Sampling Procedure**[b] | **Analytical Method/SOP**[c,d] | **Data Quality Indicators (DQIs)** | **Measurement Performance Criteria (MPC)** | **QC Sample and/or Activity Used to Assess Measurement Performance** | **QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)** |
|---|---|---|---|---|---|
| See Worksheet #21 | Liquid scintillation[e] See Worksheet #23 | Precision—Lab | RPD—≤ 25% | Laboratory Duplicates | A |
| | | Precision | RPD—≤ 25% | Field Duplicates | S |
| | | Accuracy/Bias | % recovery[f] | 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[g] | 90% | Data completeness check | S&A |

MDA = minimum detectable activity
RPD = relative percent difference
[a] If information varies within an analytical group, separate by individual analyte.
[b] Reference number from QAPP Worksheet #21.
[c] Reference number from QAPP Worksheet #23.
[d] Appendix C contains the version of the analytical method to be used.
[e] 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.
[f] 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.
[g] Completeness is calculated by two methods:

- As the number of valid analytical results reported divided by the number of analytical results planned, multiplied by 100 to obtain the percentage.
- As the number of valid analytical results reported divided by the number of analytical results requested, multiplied by 100 to obtain the percentage.

**QAPP Worksheet #12-M.**
**Measurement Performance Criteria (SVOCs, Water)**

| | |
|---|---|
| **Matrix** | Water/Groundwater |
| **Analytical Group**[a] | Semivolatile Organic Compounds (SVOCs) |
| **Concentration Level** | Low |

| Sampling Procedure[b] | Analytical Method/SOP[c,d] | Data Quality Indicators (DQIs) | Measurement Performance Criteria (MPC) | QC Sample and/or Activity Used to Assess Measurement Performance | QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A) |
|---|---|---|---|---|---|
| See Worksheet #21 | SW-846-8270 See Worksheet #23 | Precision—Lab | RPD—≤ 25% | Laboratory Duplicates | A |
| | | Precision | RPD—≤ 25% | Field Duplicates | S |
| | | Accuracy/Bias | % recovery[e] | 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[f] | 90% | Data completeness check | S&A |

PQL = practical quantitation limit; RPD = relative percent difference
[a] If information varies within an analytical group, separate by individual analyte.
[b] Reference number from QAPP Worksheet #21.
[c] Reference number from QAPP Worksheet #23.
[d] Appendix C contains the version of the analytical method to be used.
[e] 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.
[f] Completeness is calculated by two methods:

- As the number of valid analytical results reported divided by the number of analytical results planned, multiplied by 100 to obtain the percentage.
- As the number of valid analytical results reported divided by the number of analytical results requested, multiplied by 100 to obtain the percentage.

**QAPP Worksheet #12-N.**
**Measurement Performance Criteria (Radionuclides, Water)**

| | |
|---|---|
| **Matrix** | Water/Groundwater |
| **Analytical Group**[a] | Radionuclides/Water Policy (uranium-234, uranium-235, uranium-238) |
| **Concentration Level** | Low |

| **Sampling Procedure**[b] | **Analytical Method/SOP**[c,d] | **Data Quality Indicators (DQIs)** | **Measurement Performance Criteria (MPC)** | **QC Sample and/or Activity Used to Assess Measurement Performance** | **QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)** |
|---|---|---|---|---|---|
| See Worksheet #21 | Inductively coupled plasma-mass spectroscopy[e] See Worksheet #23 | Precision—Lab | RPD—≤ 20% | Laboratory Duplicates | A |
| | | Precision | RPD—≤ 25% | Field Duplicates | S |
| | | Accuracy/Bias | % recovery[f] | 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[g] | 90% | Data completeness check | S&A |

PQL = practical quantitation limit; RPD = relative percent difference

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

[b] Reference number from QAPP Worksheet #21.

[c] Reference number from QAPP Worksheet #23.

[d] Appendix C contains the version of the analytical method to be used.

[e] 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.

[f] 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.

[g] Completeness is calculated by two methods:

- As the number of valid analytical results reported divided by the number of analytical results planned, multiplied by 100 to obtain the percentage.
- As the number of valid analytical results reported divided by the number of analytical results requested, multiplied by 100 to obtain the percentage.

**QAPP Worksheet #13.**
**Secondary Data Uses and Limitations**

| Secondary Data Type | Data Source (Originating Organization, Report Title, and Date) | Data Generator(s) (Originating Org., Data Types, Data Generation/Collection Dates) | How Data Will Be Used | Factors Affecting Reliability and 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. |
| 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. |

NOTE: OREIS is the repository for Paducah Gaseous Diffusion Plant (PGDP) environmental and waste characterization analytical results. OREIS is a limited access database. Environmental data are downloaded from OREIS to PEGASIS periodically (usually on a quarterly basis). The general public can access data in PEGASIS.

**QAPP Worksheets #14 and #16.**
**Project Tasks & Schedule**

| Activity | Responsible Party | Planned Start Date | Planned Completion Date | Deliverable(s) | Deliverable Due Date |
|---|---|---|---|---|---|
| Routine sampling conducted throughout the fiscal year | FRNP | October 1, 2023 | September 30, 2024 | See Appendix C of the EMP for deliverable information | See Appendix C of the EMP for deliverable information. |

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

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 #15F 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 #15I 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 MW 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-I, which specifically addresses the surface water samples required by KPDES permit that have a permit limit associated with the parameter excluding toxicity. The action limits included in worksheets #15A through #15I 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 and Laboratory-Specific Detection/Quantitation Limits (VOCs, Water)**

**Matrix: Water**
**Analyte Group: VOCs**

| VOC | Chemical Abstracts Service (CAS) Number | Project Action Limit/NAL (µg/L) | Project Action Limit Reference[a] | Site COPC?[b] | Laboratory-Specific[c] | |
|---|---|---|---|---|---|---|
| | | | | | PQL (µg/L) | MDL(µg/L) |
| Acrylonitrile | 107-13-1 | 0.052/0.0523 | Tapwater[d]/NAL | Yes | 5 | 1.667 |
| Benzene | 71-43-2 | 5.0/0.455 | MCL/NAL | Yes | 1 | 0.333 |
| Carbon Tetrachloride | 56-23-5 | 5.0/0.455 | MCL/NAL | Yes | 1 | 0.333 |
| Chloroform | 67-66-3 | 80/0.221 | MCL/NAL | Yes | 1 | 0.333 |
| 1,1-Dichloroethene | 75-35-4 | 7.0/28.5 | MCL/NAL | Yes | 1 | 0.333 |
| *cis*-1,2-Dichloroethene | 156-59-2 | 70/3.47 | MCL/NAL | Yes | 1 | 0.333 |
| *trans*-1,2-Dichloroethene | 156-60-5 | 100/6.78 | MCL/NAL | Yes | 1 | 0.333 |
| Ethylbenzene | 100-41-4 | 700/1.50 | MCL/NAL | Yes | 1 | 0.333 |
| Tetrachloroethene | 127-18-4 | 5.0/4.06 | MCL/NAL | Yes | 1 | 0.333 |
| Trichloroethene | 79-01-6 | 5.0/0.283 | MCL/NAL | Yes | 1 | 0.333 |
| Vinyl Chloride | 75-01-4 | 2.0/0.0188 | MCL/NAL | Yes | 1 | 0.333 |

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

| VOC | CAS Number | Project Action Limit/NAL (µg/L) | Project Action Limit Reference[a] | Site COPC?[b] | Laboratory-Specific[c] | |
|---|---|---|---|---|---|---|
| | | | | | PQL (µg/L) | MDL (µg/L) |
| Total Xylenes | 1330-20-7 | 10,000/19.3 | MCL/NAL | Yes | 3 | 1 |
| o-Xylene | 95-47-6 | 19/19.3 | Tapwater[d]/NAL | Yes | 1 | 0.333 |
| m,p-Xylene | 179601-23-1 | 19/19.3[e] | Tapwater[d]/NAL | Yes | 2 | 0.667 |

CAS = Chemical Abstracts Service
COPC = chemical (or radionuclide) of potential concern
MCL = maximum contaminant level (see EPA Regional Screening Levels https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables)
MDL = method detection limit
NAL = no action level for child resident scenario taken from the RMD
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 RMD for the child resident scenario.
[b] Analytes marked with COPC are from Table 2.1 of the RMD and represent the list of chemicals, compounds, and radionuclides compiled from chemicals of potential concern retained as COCs in risk assessments previously performed at PGDP.
[c] The analytical laboratory may not be able to meet the NALs established by the RMD and MCLs reproduced in the RMD. For cases where the PQL is above the PAL/NAL, FRNP will have the laboratory report to the MDL, qualifying the result as estimated. Standard practices for qualifying data will apply for any result reported below the laboratory PQL.
[d] Tapwater—Source: EPA regional screening levels, Tapwater Supporting Table (Target Risk = 1E-6, Hazard Quotient = 0.1) May 2023 (see EPA Regional Screening Levels https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables).
[e] Project action limit for m-Xylene used.

**QAPP Worksheet #15-B.**
**Project Action Limits and Laboratory-Specific Detection/Quantitation Limits (Metals, Water)**

**Matrix: Water**
**Analytical Group: Metals**

| Metal | CAS Number | Project Action Limit/NAL (mg/L) | Project Action Limit Reference[a] | Site COPC?[b] | Laboratory-Specific[c] | |
|---|---|---|---|---|---|---|
| | | | | | PQL (mg/L) | MDL (mg/L) |
| Aluminum | 7429-90-5 | 2.0/2.00 | Tapwater[d]/NAL | Yes | 0.05 | 0.0193 |
| 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 | 0.002 |
| Barium | 7440-39-3 | 2.0/0.377 | MCL/NAL | Yes | 0.004 | 0.00067 |
| Beryllium | 7440-41-7 | 0.0040/0.00246 | MCL/NAL | Yes | 0.0005 | 0.0002 |
| Boron | 7440-42-8 | 0.40/0.399 | Tapwater[d]/NAL | Yes | 0.015 | 0.0052 |
| Cadmium | 7440-43-9 | 0.0050/0.000184 | MCL/NAL | Yes | 0.001 | 0.0003 |
| Chromium (total) | 7440-47-3 | 0.10/2.25[e] | MCL/NAL | Yes | 0.01 | 0.003 |
| Cobalt | 7440-48-4 | 0.0006/0.000601 | Tapwater[d]/NAL | Yes | 0.002 | 0.0003 |
| Copper | 7440-50-8 | 1.3/0.0799 | MCL/NAL | Yes | 0.001 | 0.0003 |
| Iron | 7439-89-6 | 1.4/1.40 | Tapwater[d]/NAL | Yes | 0.1 | 0.033 |
| Lead | 7439-92-1 | 0.015/0.0150 | MCL[f]/NAL | Yes | 0.002 | 0.0005 |
| Manganese | 7439-96-5 | 0.043/0.0434 | Tapwater[d]/NAL | Yes | 0.005 | 0.001 |

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

**Matrix: Water**
**Analytical Group: Metals**

| Metal | CAS Number | Project Action Limit/NAL (mg/L) | Project Action Limit Reference[a] | Site COPC?[b] | Laboratory-Specific[c] | |
|---|---|---|---|---|---|---|
| | | | | | PQL (mg/L) | MDL (mg/L) |
| Mercury | 7439-97-6 | 0.0020/0.000566[g] | MCL/NAL | Yes | 0.0002 | 0.000067 |
| Molybdenum | 7439-98-7 | 0.010/0.00998 | Tapwater[d]/NAL | Yes | 0.001 | 0.0002 |
| Nickel | 7440-02-0 | 0.039/0.0392[g] | Tapwater[d]/NAL | Yes | 0.002 | 0.0006 |
| Selenium | 7782-49-2 | 0.050/0.00998 | MCL/NAL | Yes | 0.005 | 0.002 |
| Silver | 7440-22-4 | 0.0094/0.00941 | Tapwater[d]/NAL | Yes | 0.001 | 0.0003 |
| Thallium | 7440-28-0 | 0.0020/0.000020[g] | MCL/NAL | Yes | 0.002 | 0.0006 |
| Uranium | 7440-61-1 | 0.030/0.000399[g] | MCL/NAL | Yes | 0.0002 | 0.000067 |
| Vanadium | 7440-62-2 | 0.0086/0.00864 | Tapwater[d]/NAL | Yes | 0.02 | 0.0033 |
| Zinc | 7440-66-6 | 0.60/0.600 | Tapwater[d]/NAL | Yes | 0.02 | 0.0033 |

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 RMD
PQL = practical quantitation limit

[a] This QAPP references the MCLs (or EPA screening level for tapwater if no MCL) 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 RMD for the child resident scenario.
[b] Analytes marked with COPC are from Table 2.1 of the RMD and represent the list of chemicals, compounds, and radionuclides compiled from COPCs retained as COCs in risk assessments previously performed at PGDP.
[c] The analytical laboratory may not be able to meet the NALs established by the RMD and MCLs reproduced in the RMD. For cases where the PQL is above the PAL/NAL, FRNP will have the laboratory report to the MDL, qualifying the result as estimated. Standard practices for qualifying data will apply for any result reported below the laboratory PQL.
[d] Tapwater-Source: EPA regional screening levels, Tapwater Supporting Table (Target Risk = 1E-6, Hazard Quotient = 0.1) May 2023 (see EPA Regional Screening Levels https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables).
[e] An NAL is not available for chromium (total); therefore, the NAL for chromium III was used.
[f] The MCL established by the EPA for lead is based on a treatment technique action level of 0.015 mg/L.
[g] The PAL/NAL values were derived for metal salts; the CAS number is presented for the elemental form.

**QAPP Worksheet #15-C.**
**Project Action Limits and Laboratory-Specific Detection/Quantitation Limits (PCBs, Water)**

**Matrix: Water**
**Analytical Group: PCBs**

| PCB | CAS Number | Project Action Limit (µg/L) | Project Action Limit Reference[a] | Site COPC?[b] | Laboratory-Specific[c] | |
|---|---|---|---|---|---|---|
| | | | | | PQLs (µg/L) | MDLs (µg/L) |
| Total PCBs | 1336-36-3 | 0.50/0.0436 | MCL/NAL | Yes | 0.1 | 0.0333 |
| Aroclor-1016 | 12674-11-2 | 0.50[d]/0.140 | MCL/NAL | Yes | 0.1 | 0.0333 |
| Aroclor-1221 | 11104-28-2 | 0.50[d]/0.00471 | MCL/NAL | Yes | 0.1 | 0.0333 |
| Aroclor-1232 | 11141-16-5 | 0.50[d]/0.00471 | MCL/NAL | Yes | 0.1 | 0.0333 |
| Aroclor-1242 | 53469-21-9 | 0.50[d]/0.00785 | MCL/NAL | Yes | 0.1 | 0.0333 |
| Aroclor-1248 | 12672-29-6 | 0.50[d]/0.00785 | MCL/NAL | Yes | 0.1 | 0.0333 |
| Aroclor-1254 | 11097-69-1 | 0.50[d]/0.00785 | MCL/NAL | Yes | 0.1 | 0.0333 |
| Aroclor-1260 | 11096-82-5 | 0.50[d]/0.00785 | MCL/NAL | Yes | 0.1 | 0.0333 |

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 RMD
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 RMD for the child resident scenario. In some cases, the laboratories may not be able to reach detection limits below the NAL. In these cases, the project team will address this issue in the decision process.
[b] Analytes marked with COPC are from Table 2.1 of the RMD and represent the list of chemicals, compounds, and radionuclides compiled from COPCs retained as COCs in risk assessments previously performed at PGDP.
[c] The analytical laboratory may not be able to meet the NALs established by the RMD and MCLs reproduced in the RMD. For cases where the PQL is above the PAL/NAL, FRNP will have the laboratory report to the MDL, qualifying the result as estimated. Standard practices for qualifying data will apply for any result reported below the laboratory PQL.
[d] MCL for Total PCBs.

## QAPP Worksheet #15-D.
## Project Action Limits and Laboratory-Specific Detection/Quantitation Limits (Radionuclides, Water)

**Matrix: Water**
**Analytical Group: Radionuclides**

| Radionuclide | CAS Number | Project Action Limit (pCi/L) | Project Action Limit Reference[a] | Site COPC?[b] | Laboratory-Specific[c] MDAs (pCi//L) |
|---|---|---|---|---|---|
| Americium-241 | 14596-10-2 | 0.0677 | NAL | Yes | 1 |
| Cesium-137[f] | 10045-97-3 | 1.71 | NAL | Yes | 10 (75[d]) |
| Neptunium-237[f] | 13994-20-2 | 0.0783 | NAL | Yes | 1 (8[d]) |
| Plutonium-238 | 13981-16-3 | 0.0156 | NAL | Yes | 1 (4[d]) |
| Plutonium-239 | 15117-48-3 | 0.0603 | NAL | Yes | 1 (4[d]) |
| Plutonium-240 | 14119-33-6 | 0.0318 | NAL | Yes | 1 (4[d]) |
| Technetium-99 | 14133-76-7 | 4 mrem/year-dose[e], 900/19.0 | MCL/NAL | Yes | 25 (50[d]) |
| Thorium-230 | 14269-63-7 | 0.0166 | NAL | Yes | 1 (4[d]) |
| Uranium-234[f] | 13966-29-5 | 124/0.0162 | MCL[g]/NAL | Yes | 1 (17[d]) |
| Uranium-235[f] | 15117-96-1 | 0.466/0.0714 | MCL[g]/NAL | Yes | 1 (18[d]) |
| Uranium-238[f] | 7440-61-1 | 9.99/0.0158 | MCL[g]/NAL | Yes | 1 (19[d]) |

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

[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 RMD for the child resident scenario. In some cases, the laboratories may not be able to reach detection limits below the NAL. In these cases, the project team will address this issue in the decision process.
[b] Analytes marked with COPC are from Table 2.1 of the RMD and represent the list of chemicals, compounds, and radionuclides compiled from COPCs retained as COCs in risk assessments previously performed at PGDP.
[c] Radionuclide parameters will be reported per laboratory SOPs and the U.S. Department of Defense and Department of Energy Consolidated Quality Systems Manual for Environmental Laboratories.
[d] The value in parentheses reflects MDAs requested under the Environmental Radiation Protection Program.
[e] The value derived by the EPA from the 4 mrem/year MCL for Tc-99 is 900 pCi/L (see https://www.epa.gov/sites/default/files/2015-06/documents/compliance-radionuclidesindw.pdf). 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 [search term: 570Z91049]).
[f] PAL/NAL was derived considering the contribution from short-lived decay products.
[g] Based on RMD.

## QAPP Worksheet #15-E.
## Project Action Limits and Laboratory-Specific Detection/Quantitation Limits (Radionuclides, Water)

**Matrix: Water**
**Analytical Group: Radionuclides/Water Policy**

| Radionuclide | CAS Number | Project Action Limit (mg/L) | Project Action Limit Reference[a] | Site COPC?[b] | Laboratory-Specific[c] MDAs (mg/L) |
|---|---|---|---|---|---|
| Uranium-234 | 13966-29-5 | 0.030/0.000399 | MCL[d]/NAL[d] | Yes | 0.000005 |
| Uranium-235 | 15117-96-1 | 0.030/0.000399 | MCL[d]/NAL[d] | Yes | 0.0005 |
| Uranium-238 | 7440-61-1 | 0.030/0.000399 | MCL[d]/NAL[d] | Yes | 0.003 |

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 RMD

[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 RMD for the child resident scenario.
[b] Analytes marked with COPC are from Table 2.1 of the RMD and represent the list of chemicals, compounds, and radionuclides compiled from COPCs retained as COCs in risk assessments previously performed at PGDP.
[c] The analytical laboratory analyzes these parameters by inductively coupled plasma mass spectroscopy. Radionuclide parameters will be reported per laboratory SOPs and the U.S. Department of Defense and Department of Energy Consolidated Quality Systems Manual for Environmental Laboratories.
[d] MCL and NAL for Total Uranium.

## QAPP Worksheet #15-F.
## Project Action Limits and Laboratory-Specific Detection/Quantitation Limits (PCBs, Sediment)

**Matrix: Sediment**
**Analytical Group: PCBs**

| PCB | CAS Number | Project Action Limit (mg/kg) | Project Action Limit Reference[a] | Site COPC?[b] | Laboratory-Specific[c] | |
|---|---|---|---|---|---|---|
| | | | | | PQL (mg/kg) | MDL (mg/kg) |
| Total PCBs | 1336-36-3 | 0.0788 | NAL | Yes | 0.0033 | 0.001099 |
| Aroclor 1016 | 12674-11-2 | 0.206 | NAL | Yes | 0.0033 | 0.001099 |
| Aroclor 1221 | 11104-28-2 | 0.0752 | NAL | Yes | 0.0033 | 0.001099 |
| Aroclor 1232 | 11141-16-5 | 0.0708 | NAL | Yes | 0.0033 | 0.001099 |
| Aroclor 1242 | 53469-21-9 | 0.0791 | 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 RMD
PQL = practical quantitation limit
PCBs = polychlorinated biphenyls

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 RMD for the child resident scenario. In some cases, the laboratories may not be able to reach detection limits below the NAL. In these cases, the project team will address this issue in the decision process.

[b] Analytes marked with COPC are from Table 2.1 of the RMD and represent the list of chemicals, compounds, and radionuclides compiled from COPCs retained as COCs in risk assessments previously performed at PGDP.

[c] The analytical laboratory may not be able to meet the NALs established by the RMD and MCLs reproduced in the RMD. For cases where the PQL is above the PAL/NAL, FRNP will have the laboratory report to the MDL, qualifying the result as estimated. Standard practices for qualifying data will apply for any result reported below the laboratory PQL.

## QAPP Worksheet #15-G.
## Project Action Limits and Laboratory-Specific Detection/Quantitation Limits (Radionuclides, Sediment)

**Matrix: Sediment**
**Analytical Group: Radionuclides**

| Radionuclide | CAS Number | Project Action Limit (pCi/g) | Project Action Limit Reference[a] | Site COPC?[b] | Laboratory-Specific[c] |
|---|---|---|---|---|---|
| | | | | | MDA (pCi/g) |
| Americium-241 | 14596-10-2 | 0.0455 | NAL | Yes | 1 |
| Cesium-137[d] | 10045-97-3 | 0.0395 | NAL | Yes | 0.1 |
| Neptunium-237[d] | 13994-20-2 | 0.0466 | NAL | Yes | 1 |
| Plutonium-238 | 13981-16-3 | 0.0110 | NAL | Yes | 1 |
| Plutonium-239 | 15117-48-3 | 0.0397 | NAL | Yes | 1 |
| Plutonium-240 | 14119-33-6 | 0.00854 | NAL | Yes | 1 |
| Technetium-99 | 14133-76-7 | 112 | NAL | Yes | 5 |
| Thorium-230 | 14269-63-7 | 0.0111 | NAL | Yes | 1 |
| Uranium-234 | 13966-29-5 | 0.0111 | NAL | Yes | 1 |
| Uranium-235[d] | 15117-96-1 | 0.0401 | NAL | Yes | 1 |
| Uranium-238[d] | 7440-61-1 | 0.0109 | NAL | Yes | 1 |

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

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

[a] This QAPP references the NALs established by the RMD and MCLs reproduced in the RMD to support project planning and identify whether lower reporting limits may be needed for some constituents. In some cases, the laboratories may not be able to reach detection limits below the NAL. In these cases, the project team will address this issue in the decision process within the project-specific QAPP.
[b] Analytes marked with COPC are from Table 2.1 of the RMD and represent the list of chemicals, compounds, and radionuclides compiled from COPCs retained as COCs in risk assessments previously performed at PGDP.
[c] The analytical laboratory may not be able to meet the NALs established by the RMD and MCLs reproduced in the RMD. For cases where the MDA is above the PAL/NAL, FRNP will have the laboratory report to the MDL, qualifying the result as estimated. Standard practices for qualifying data will apply for any result reported below the laboratory PQL.
[d] PAL/NAL was derived considering the contribution from short-lived decay products.

**QAPP Worksheet #15-H.**
**Project Action Limits and Laboratory-Specific Detection/Quantitation Limits (KPDES Parameters, Surface Water)**

**Matrix: Surface Water**
**Analyte Group: KPDES permit**

| KPDES Parameters with Permit Limits | CAS Number | Project Action Limit | Outfall | Site COPC?[a] | Laboratory-Specific | |
|---|---|---|---|---|---|---|
| | | | | | PQL | MDL |
| Total Suspended Solids | N/A | 30 mg/L | Outfall 001, Outfall 002, Outfall 004, Outfall 006, Outfall 008, Outfall 009, Outfall 010, Outfall 011, Outfall 012, Outfall 013, Outfall 015, Outfall 016, Outfall 017, Outfall 019, Outfall 020 | No | 5 mg/L | 1 mg/L |
| Oil & Grease | N/A | 10 mg/L | Outfall 001, Outfall 002, Outfall 006, Outfall 008, Outfall 009, Outfall 010, Outfall 011, Outfall 012, Outfall 013, Outfall 015, Outfall 016, Outfall 017, Outfall 019, Outfall 020 | 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 |

**QAPP Worksheet #15-I.**
**Project Action Limits and Laboratory-Specific Detection/Quantitation Limits**

**Matrix: Surface Water**
**Analyte Group: KPDES permit**

| KPDES Parameters with Permit Limits | CAS Number | Project Action Limit | Outfall | Site COPC?* | Laboratory-Specific | |
|---|---|---|---|---|---|---|
| | | | | | PQL | MDL |
| 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, 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-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 | 20 µg/L | 3.5 µg/L |
| Biochemical Oxygen Demand | N/A | 30 mg/L | Outfall 004 | No | 2 mg/L | 1 mg/L |
| Mercury | 7439-97-6 | 0.051 µg/L | Outfall 008 | Yes | 0.005 µg/L | 0.002 µg/L |

*Analytes marked with COPC are from Table 2.1 of the RMD and represent the list of chemicals, compounds, and radionuclides compiled from COPCs retained as COCs in risk assessments previously performed at PGDP.

## QAPP Worksheet #18.
## Sampling Locations and Methods

Worksheet #18 provides information pertaining to sampling planned for this project.

| Sampling Location/ID Number | Matrix | Depth (units) | Analytical Group[a] | Concentration Level[b] | Number of Samples (Identify Field Duplicate %) | Sampling SOP Reference[c] | 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%) | See Worksheet #21 | See Appendix C of the EMP |
| | 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%) | See Worksheet #21 | |
| | Groundwater | UCRS, URGA, LRGA | See Appendix C of the EMP | Varies by location and analyte | See Appendix C of the EMP (Minimum of 5%) | See Worksheet #21 | |

SOP = standard operating procedure
N/A = not applicable
UCRS = Upper Continental Recharge System
URGA = Upper Regional Gravel Aquifer
LRGA = Lower Regional Gravel Aquifer

[a] See Analytical SOP References Table (Worksheet #23).
[b] If historic data provide information on anticipated concentration, that information will be populated on this sheet.
[c] See Field SOP References Table (Worksheet #21).

**QAPP Worksheets #19 and #30.**
**Sample Containers, Preservation, and Hold Times**

Laboratory: GEL Laboratories, LLC, 2040 Savage Road, Charleston, SC 29407, Valerie Davis, vsd@gel.com, (843) 556-8171

Pace Analytical, 12065 Lebanon Road, Mt. Juliet, TN 37122, Cody Medley, cody.medley@pacelabs.com, (615) 773-7549

EMSL Analytical, 200 Route 130 North, Cinnaminson, NJ 08077, Daniel Kocher, dkocher@emsl.com, (856) 303-2557

List any required accreditations/certifications (requirement dependent upon analysis performed): DOECAP, KPDES Wastewater Laboratory Certification. The laboratories supporting the Environmental Monitoring program hold different certifications.

Back-up Laboratory: N/A

Sample Delivery Method: Direct Delivery or Overnight/Federal Express or UPS (United Parcel Service) in accordance with the on-site transportation plan or U.S. Department of Transportation requirements.

| Analyte/ Analyte Group | Matrix | Method/SOP | Accreditation Expiration Date[a] | Container(s) (number, size, & type per sample) | Preservation | Preparation Holding Time | Analytical Holding Time | Data Package Turnaround Time |
|---|---|---|---|---|---|---|---|---|
| VOCs[b] | Water | See Worksheet #23 | 6/2025 | 3 × 40 mL glass VOA vial | HCl pH < 2, 0–6°C, no headspace | N/A | 14 days for preserved | 28 days |
| SVOCs | Water | See Worksheet #23 | 6/2025 | 2 × 1,000 mL amber glass | 0–6°C | 7 days | 40 days | 28 days |
| Metals/ Radionuclides by ICP-MS | Water | See Worksheet #23 | 6/2025 | 1 L plastic | $HNO_3$ pH < 2 | N/A | 180 days | 28 days |
| Mercury | Water | See Worksheet #23 | 6/2025 | N/A | $HNO_3$ pH < 2 | N/A | 28 days | 28 days |
| Anions | Water | See Worksheet #23 | 6/2025 | 125 mL plastic | 0–6°C | N/A | 28 days (2 days for nitrate) | 28 days |
| PCBs | Water | EPA-608.3 | 6/2025 | 2 × 1 L amber glass | 0–6°C | 7 days | 40 days | 28 days |

**QAPP Worksheets #19 and #30. (Continued)**
**Sample Containers, Preservation, and Hold Times**

| Analyte/ Analyte Group | Matrix | Method/SOP | Accreditation Expiration Date[a] | Container(s) (number, size, & type per sample) | Preservation | Preparation Holding Time | Analytical Holding Time | Data Package Turnaround Time |
|---|---|---|---|---|---|---|---|---|
| PCBs | Water | SW846-8082 | 6/2025 | 2 × 1 L amber glass | 0–6°C | N/A | N/A[d] | 28 days |
| Radionuclides | Water | See Worksheet #23 | 6/2025 | 3 × 1 L plastic | $HNO_3$ pH < 2[c] | N/A | 180 days | 28 days |
| Metals by ICP-OES | Water | See Worksheet #23 | 6/2025 | 1 L plastic | $HNO_3$ pH < 2 | N/A | 180 days | 28 days |
| Dissolved Hydrocarbon Gases | Water | See Worksheet #23 | 6/2025 | 3 × 40 mL glass VOA vial | 0–6°C, HCl to pH < 2 | N/A | 14 days | 28 days |
| Total Organic Carbon | Water | See Worksheet #23 | 6/2025 | 250 mL amber glass | 0–6°C, $H_2SO_4$ to pH < 2, zero headspace | N/A | 28 days | 28 days |
| DHC Bacteria | Water | See Worksheet #23 | 1/2024 | 1 L poly bottle with screw cap | Cool < 4°C | N/A | 48 hours | 28 days |
| PCBs | Sediment | See Worksheet #23 | 6/2025 | 250 mL wide-mouth amber glass | 0–6ºC | N/A | N/A[d] | 28 days |
| Radionuclides | Sediment | See Worksheet #23 | 6/2025 | 500 mL wide-mouth plastic straight side | None | N/A | 180 days | 28 days |

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).
HCl = hydrochloric acid; $HNO_3$ = nitric acid
ICP-MS = inductively coupled plasma mass spectrometer
ICP-OES = inductively coupled plasma optical emission spectrometry
[a] Indicates the next FRNP Approved Suppliers List review date.
[b] 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.
[c] Check with specific laboratory conducting analyses to ensure that acidification will not interfere with laboratory procedures.
[d] 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.

**QAPP Worksheet #20.**
**Field Quality Control Sample Summary Table**

This worksheet provides a summary of the types of samples to be collected and analyzed for the project.

| Matrix | Analyte/ Analytical Group | Field Samples | Field Duplicates | Matrix Spikes (MS) | Matrix Spike Duplicates (MSD) | Field Blanks | Equipment Blanks | Trip Blanks | Other | Total # of Analyses |
|---|---|---|---|---|---|---|---|---|---|---|
| Sediment | PCBs | See Appendix C of EMP | 5% | 5% | 5% | 5% | 5% | N/A | N/A | See Appendix C of EMP |
| Sediment | Radionuclides | See Appendix C of EMP | 5% | 5% | 5% | 5% | 5% | N/A | N/A | See Appendix C of EMP |
| Water (Groundwater and Surface Water) | VOCs | See Appendix C of EMP | 5% | 5% | 5% | 5% | 5% | 1 per day or 1 per cooler containing VOC samples | N/A | See Appendix C of EMP |
| Water (Groundwater) | SVOCs | See Appendix C of EMP | 5% | 5% | 5% | 5% | 5% | N/A | N/A | See Appendix C of EMP |
| Water (Groundwater and Surface Water) | Metals | See Appendix C of EMP | 5% | 5% | 5% | 5% | 5% | N/A | N/A | See Appendix C of EMP |
| Water (Groundwater and Surface Water) | PCBs | See Appendix C of EMP | 5% | 5% | 5% | 5% | 5% | N/A | N/A | See Appendix C of EMP |
| Water (Groundwater and Surface Water) | Radionuclides | See Appendix C of EMP | 5% | 5% | 5% | 5% | 5% | N/A | N/A | See Appendix C of EMP |

**QAPP Worksheet #20. (Continued)**
**Field Quality Control Sample Summary Table**

| Matrix | Analyte/ Analytical Group | Field Samples | Field Duplicates | Matrix Spikes (MS) | Matrix Spike Duplicates (MSD) | Field Blanks | Equipment Blanks | Trip Blanks | Other | Total # of Analyses |
|---|---|---|---|---|---|---|---|---|---|---|
| Water (Groundwater) | Dissolved Hydrocarbon Gases | See Appendix C of EMP | 5% | 5% | 5% | 5% | 5% | N/A | N/A | See Appendix C of EMP |
| Water (Groundwater) | Total Organic Carbon | See Appendix C of EMP | 5% | 5% | 5% | 5% | 5% | N/A | N/A | See Appendix C of EMP |
| Water (Groundwater) | DHC | See Appendix C of EMP | 5% | N/A | N/A | N/A | N/A | N/A | N/A | See Appendix C of EMP |

DHC = *Dehalococcoides ethenogens*
PCB = polychlorinated biphenyl
VOC = volatile organic compound
N/A = not applicable
SVOC = semivolatile organic compound

**QAPP Worksheet #21.**
**Project Sampling SOP References Table**

SOPs to be used on this project are summarized below.

| Reference Number | Title and Number[a] Revision Date | Originating Organization[b] | Equipment Type | Modified for Project Work? (Y/N) | Comments |
|---|---|---|---|---|---|
| 1 | CP3-ES-0043, *Temperature Control for Sample Storage* (9/28/2022) | Contractor | Sampling | N | N/A |
| 2 | CP2-WM-0001, *Four Rivers Nuclear Partnership, LLC, Paducah Deactivation and Remediation Project Waste Management Plan* (1/22/2021) | Contractor | N/A | N | N/A |
| 3 | CP2-ES-0026, *Wet Chemistry and Miscellaneous Analyses Data Verification and Validation Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (12/13/2017) | Contractor | N/A | N | N/A |
| 4 | CP2-ES-0811, *Pesticide and PCB Analyses Data Verification and Validation Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (12/13/2017) | Contractor | N/A | N | N/A |
| 5 | CP4-ES-1001, *Transmitting Data to the Paducah Oak Ridge Environmental Information System (OREIS)* (10/5/2022) | Contractor | N/A | N | N/A |
| 6 | CP2-ES-0063, *Environmental Monitoring Data Management Implementation Plan at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (7/10/2019) | Contractor | N/A | N | N/A |
| 7 | CP4-ES-2100, *Groundwater Level Measurement* (4/17/2023) | Contractor | Sampling | N | N/A |
| 8 | CP4-ES-2101, *Groundwater Sampling* (4/19/2023) | Contractor | Sampling | N | N/A |
| 9 | CP3-ES-2203, *Surface Water Sampling* (4/17/2023) | Contractor | Sampling | N | N/A |
| 10 | CP4-ES-2302, *Collection of Sediment Samples Associated with Surface Water* (5/30/2023) | Contractor | Sampling | N | N/A |
| 11 | CP4-ES-0074, *Monitoring Well Inspection and Maintenance* (4/17/2023) | Contractor | Sampling | N | N/A |
| 12 | CP4-ES-2700, *Logbooks and Data Forms* (10/10/2022) | Contractor | N/A | N | N/A |

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

| Reference Number | Title and Number[a] Revision Date | Originating Organization[b] | Equipment Type | Modified for Project Work? (Y/N) | Comments |
|---|---|---|---|---|---|
| 13 | CP4-ES-2702, *Decontamination of Sampling Equipment and Devices* (4/19/2023) | Contractor | Sampling | N | N/A |
| 14 | CP4-ES-2704, *Trip, Equipment, and Field Blank Preparation* (1/11/2023)[c] | Contractor | N/A | N | N/A |
| 15 | CP3-ES-2708, *Chain-of-Custody Forms, Field Sample Logs, Sample Labels, and Custody Seals* (10/4/2022) | Contractor | N/A | N | N/A |
| 16 | CP3-ES-5003, *Quality Assured Data* (4/26/2023) | Contractor | N/A | N | N/A |
| 17 | CP3-ES-5004, *Sample Tracking, Lab Coordination, and Sample Handling* (11/22/2022) | Contractor | N/A | N | N/A |
| 18 | CP4-ES-5007, *Data Management Coordination* (10/25/2022) | Contractor | N/A | N | N/A |
| 19 | CP2-ES-5102, *Radiochemical Analysis Data Verification and Validation Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (12/13/2017) | Contractor | N/A | N | N/A |
| 20 | CP2-ES-5103, *Polychlorinated Dibenzodioxins/Polychlorinated Dibenzofurans Analyses Data Verification and Validation Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (12/13/2017) | Contractor | N/A | N | N/A |
| 21 | CP2-ES-5105, *Volatile and Semivolatile Analyses Data Verification and Validation Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (9/27/2018) | Contractor | N/A | N | N/A |
| 22 | CP2-ES-5107, *Inorganic Analyses Data Validation and Verification Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (7/1/2021) | Contractor | N/A | N | N/A |
| 23 | CP3-ES-1003, *Developing, Implementing, and Maintaining Data Management Plans* (10/4/2022) | Contractor | N/A | N | N/A |
| 24 | CP4-ES-1002, *Submitting, Reviewing, and Dispositioning Changes to the Environmental Databases* (10/5/2022) | Contractor | N/A | N | N/A |

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

[a] SOPs are posted to the FRNP intranet website. 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, the most current version of the SOPs listed will be followed.
[c] The Hazardous Waste Management Facility Permit defines a duplicate as being collected from a single sample collection container or sample mixing container. This SOP defines a duplicate as being collected using the same procedural requirements as the original sample. Duplicates collected from MWs at the C-404 Landfill under the permit will be collected as prescribed in the permit and as prescribed in this SOP.

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

The following is the field equipment to be used on the project.

| 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) | Calibrate at the beginning of the day | Performed monthly and as needed | Measure solutions with known values (National Institute for Standards and Technology traceable buffers and conductivity calibration solutions) | Upon receipt, successful operation | Daily before each use | Per manufacturer's specifications | Recalibrate or service as necessary | Field Team Leader | Manufacturer's specifications |
| Turbidity Meter (Nephthelometer) | Calibrate daily before each use | As needed | Measure solutions with known turbidity standards | Upon receipt, successful operation | Daily before each use | N/A (instrument zeroed) | Manually zero meter or service as necessary and recalibrate | Field Team Leader | Manufacturer's specifications |
| Ferrous Iron Colorimeter | Accuracy check at the beginning of each day | Return to instrument rental for replacement | Measure with standard solution | Upon receipt, successful operation | Check daily before each use | Pass/Fail | Return to rental company for replacement | Field Team Leader | Manufacturer's specifications |
| Colorimeter (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 | Within range of manufacturer's standard | Service by manufacturer or replace | Field Team Leader | Manufacturer's specifications |
| Titrator (for total residual chlorine) | Calibrate to manufacturer's solution weekly | As needed | Measure with standard solution | Upon receipt, successful operation | Weekly | With range of manufacturer's standard | Service by manufacturer or replace | Field Team Leader | Manufacturer's specifications |
| Electron Water Level Meter | N/A | None | Check daily before each use | Upon receipt, successful operation | Check daily before each use | Pass/Fail | Return to rental company for replacement | Field Team Leader | Manufacturer's specifications |
| 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 |
| Colloidal Borescope | N/A | Clean as needed | Ensure aligned with magnetic north | Upon receipt, successful operation | Check daily before each use | Pass/Fail | Service by manufacturer or replace | Field Team Leader | Manufacturer's specifications |

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

| Field Equipment* | Calibration Activity | Maintenance Activity | Testing Activity | Inspection Activity | Frequency | Acceptance Criteria | Corrective Action | Responsible Person | SOP Reference |
|---|---|---|---|---|---|---|---|---|---|
| Magnetic Hand-Held Compass | N/A | None | None | Upon receipt, successful operation | Check daily before each use | Pass/Fail | Service by manufacturer or replace | Field Team Leader | Manufacturer's specifications |
| Pressure Transducer (Data Logger typically used for water level measurement in monitoring wells) | Return to manufacturer annually for calibration | Return to manufacturer for maintenance, as needed | Compare water level reading against reading from electron water level meter | Upon receipt, successful operation | Before each use, as needed | Per manufacturer's specifications | Return to manufacturer for repair or replacement | Field Team Leader | CP4-ES-2100, *Groundwater Level Measurement*/ Manufacturer's specifications |

*Additional equipment may be needed; additional equipment will follow manufacturer's specifications for calibration, maintenance, inspection, and testing. Calibration data will be documented in logbooks consistent with CP4-ES-2700, *Logbooks and Data Forms*.

**QAPP Worksheet #23.**
**Analytical SOP References Table**

| Reference Number* | Title, Revision Date, and/or Number | Definitive or Screening Data | Analytical Group/Matrix | Instrument | Organization Performing Analysis | Modified for Project Work? (Y/N) |
|---|---|---|---|---|---|---|
| SW846-8260/ EPA-624.1 | Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC-MS) | Definitive | VOA (Unless noted below)/Soil and Water | Per SOP | GEL Laboratories, Charleston, SC | N |
| SW846-8270 | SVOCs by GC-MS | Definitive | SVOCs/Water | Per SOP | GEL Laboratories, Charleston, SC | N |
| SW846-8011 | 1,2-Dibromoethane and 1,2-Dibromo-3-Chloropropane by Microextraction and Gas Chromatography | Definitive | VOA (1,2-Dibromo-3-chloropropane)/ Soil and Water | Per SOP | GEL Laboratories, Charleston, SC | N |
| SW846-9056/ EPA-300.0 | Determination of Inorganic Anions by Ion Chromatography | Definitive | Anions/Soil and Water | Per SOP | GEL Laboratories, Charleston, SC | N |
| RSKSOP-175 Modified | RSKSOP-175 | Definitive | VOA (Ethene, Ethane, Methane)/Soil and Water | Per SOP | GEL Laboratories, Charleston, SC | N |
| EPA-410.4 | Determination of Chemical Oxygen Demand by Semi-Automated Colorimetry | Definitive | Miscellaneous (Chemical Oxygen Demand)/Water | Per SOP | GEL Laboratories, Charleston, SC | N |
| EPA-350.1 | Determination of Ammonia Nitrogen by Semi-Automated Colorimetry | Definitive | Miscellaneous (Ammonia as Nitrogen)/Water | Per SOP | GEL Laboratories, Charleston, SC | N |
| SW846-9010/ SW846-9012B | Total and Amenable Cyanide | Definitive | Miscellaneous (Cyanide)/Water | Per SOP | GEL Laboratories, Charleston, SC | N |
| SW846-9040 | pH Electrometric Measurement | Definitive | Miscellaneous (pH—when not as field measurement)/ Water | pH Meter | 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/Matrix | Instrument | Organization Performing Analysis | Modified for Project Work? (Y/N) |
|---|---|---|---|---|---|---|
| SM 5210 B | Standard Method for Biochemical Oxygen Demand | Definitive | Miscellaneous (Carbonaceous Biological Oxygen Demand)/Water | Per SOP | GEL Laboratories, Charleston, SC | N |
| EPA-180.1 | Determination of Turbidity by Nephelometry | Definitive | Miscellaneous (Turbidity—when not as field measurement)/ Water | Per SOP | GEL Laboratories, Charleston, SC | N |
| EPA-130.2/SM 2340 C | Hardness | Definitive | Miscellaneous (Hardness)/ Water | Per SOP | GEL Laboratories, Charleston, SC | N |
| SW846-9060A | Total Organic Carbon | Definitive | Miscellaneous [Total Organic Carbon (TOC)]/Water | Per SOP | GEL Laboratories, Charleston, SC | N |
| EPA-160.1 | Total Dissolved Solids | Definitive | Miscellaneous (Total Dissolved Solids)/Water | Per SOP | GEL Laboratories, Charleston, SC | N |
| EPA-160.2/ SM 2540 D | Total Suspended Solids | Definitive | Miscellaneous (Total Suspended Solids)/Water | Per SOP | GEL Laboratories, Charleston, SC | N |
| SM 2540 B | Solids in Water | Definitive | Miscellaneous (Total Solids)/Water | Per SOP | GEL Laboratories, Charleston, SC | N |
| EPA-365.4 | Phosphorous, Total | Definitive | Miscellaneous (Total Phosphorous)/ Water | 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/Matrix | Instrument | Organization Performing Analysis | Modified for Project Work? (Y/N) |
|---|---|---|---|---|---|---|
| EPA-1631E | Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry | Definitive | Metals/Water | Per SOP | GEL Laboratories, Charleston, SC | N |
| SW846-9020 | Total Organic Halides (TOX) | Definitive | Miscellaneous (Total Organic Halides)/Water | 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)/Water | Per SOP | GEL Laboratories, Charleston, SC | N |
| EPA-310.1 | Alkalinity | Definitive | Miscellaneous (Alkalinity)/ Water | Per SOP | GEL Laboratories, Charleston, SC | N |
| EPA-1664A | Determination of Oil and Grease and Total Petroleum Hydrocarbons in Waste Water | Definitive | Miscellaneous (Oil and Grease)/Water | Per SOP | GEL Laboratories, Charleston, SC | N |
| SW846-6020/ EPA-200.8/ICP-MS | Inductively Coupled Plasma-Mass Spectrometry | Definitive | Metals (Unless noted below)/Soil and Water, Radionuclides (Uranium-234, Uranium-235, Uranium-238)/ Water | Per SOP | GEL Laboratories, Charleston, SC | N |
| SW846-7470/SW846-7471 | Cold Vapor Atomic Absorption | Definitive | Metals (Mercury)/Soil and Water | 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/Matrix | Instrument | Organization Performing Analysis | Modified for Project Work? (Y/N) |
|---|---|---|---|---|---|---|
| SW846-8082/ EPA-608.3 | Polychlorinated Biphenyls (PCBs) by Gas Chromatography | Definitive | PCBs/Soil and Water | Per SOP | GEL Laboratories, Charleston, SC | N |
| SW846-9310/ EPA-900.0 | Gross Alpha and Gross Beta | Definitive | Radionuclides/ Soil and Water | Per SOP | GEL Laboratories, Charleston, SC | N |
| EPA-906.0 | Tritium in Drinking Water | Definitive | Radionuclides/ Water | Per SOP | GEL Laboratories, Charleston, SC | N |
| Gamma Spec** | Gamma Spectrometry | Definitive | Radionuclides (Cesium-137)/ Soil and Water | Per SOP | GEL Laboratories, Charleston, SC | N |
| Gas Flow Proportional** | Gas Flow Proportional | Definitive | Radionuclides (Strontium-90)/ Soil and Water | Per SOP | GEL Laboratories, Charleston, SC | N |
| Liquid Scintillation** | Tc-99 by Liquid Scintillation | Definitive | Radionuclides/ Soil and Water | 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)/Soil and Water | Per SOP | GEL Laboratories, Charleston, SC | N |
| Census-TBD | Dehaloccoides Bacteria | Screening | Bacteria | TBD | EMSL, Cinnaminson, NJ | Y |

**QAPP Worksheet #23. (Continued)**
**Analytical SOP References Table**

| Reference Number* | Title, Revision Date, and/or Number | Definitive or Screening Data | Analytical Group/Matrix | Instrument | Organization Performing Analysis | Modified for Project Work? (Y/N) |
|---|---|---|---|---|---|---|
| SW846-6010/EPA-200.8/ICP-OES | Inductively Coupled Plasma-Optical Emission Spectroscopy | Definitive | Water | Per SOP | GEL Laboratories, Charleston, SC | N |
| qPCR for DHC Bacteria and key functional genes—TBD | DHC Bacteria | Screening | Water | Per SOP | EMSL Analytical, NJ | N |

*Information will be based on laboratory used. Analysis will be by the most recent revision.
**Analytical methods for radiochemistry parameters are laboratory specific.
ICP-MS = inductively coupled plasma mass spectrometer

**QAPP Worksheet #24.**
**Analytical Instrument Calibration Information**

Laboratories used by FRNP are participants in DOECAP. In the fall of 2017, DOECAP began providing certification of environmental laboratories through third party organizations. If not in DOECAP, laboratories are audited by contractors for compliance with DOECAP program requirements. As such, laboratory equipment and instruments used for quantitative measurements are calibrated in accordance with the laboratory's formal calibration program as summarized in the SOPs. The laboratory is responsible for maintaining instrument calibration information per their QA Plan including control charts established for all instrumentation.

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. 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.

## 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. Laboratory(s) contracted will participate in DOECAP, with the exception of the laboratory used to support acute and chronic toxicity analysis in support of the KPDES permit. This laboratory is a KPDES Wastewater Laboratory 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; FID = flame ionization 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 Worksheets #26 and #27.**
**Sample Handling, Custody, and Disposal**

Sampling Organization: Sampling Teams/DOE Prime Contractor and Subcontractors

Laboratory: See Worksheets #19 and #30

Method of sample delivery (shipper/carrier): Direct Delivery or Overnight/Federal Express or UPS in accordance with the on-site transportation plan or U.S. Department of Transportation requirements.

Number of day from reporting until sample disposal: 3 months

| Activity | Organization and title or position of person responsible for the activity | SOP reference |
|---|---|---|
| Sample labeling | Sampling Teams/DOE Prime Contractor and Subcontractors | CP3-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* |
| Chain of custody form completion | Sampling Teams/DOE Prime Contractor and Subcontractors | CP3-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* |
| Packaging | Sampling Teams/DOE Prime Contractor and Subcontractors | CP3-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* |
| Shipping coordination | SMO/DOE Prime Contractor | CP3-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* |
| Sample receipt, inspection, & log-in | Sample Management/Contracted Laboratory | Contracted Laboratory SOP |
| Sample custody and storage | Sample Management/Contracted Laboratory | Contracted Laboratory SOP |
| Sample disposal | Sample Management/Contracted Laboratory | Contracted Laboratory SOP |

## QAPP Worksheet #28-A.
## QC Samples Table (Aqueous)

| |
|---|
| **Matrix: Aqueous Samples** |
| **Analytical Group/Concentration Level:** VOCs, Metals, PCBs, RADs |
| **Sampling SOP:** See Worksheet #21 |
| **Analytical Method/SOP Reference:** See Worksheet #23 |
| **Sampler's Name/Field Sampling Organization:** GEO Consultants |
| **Analytical Organization:** See Worksheet #23 |
| **No. of Sample Locations:** See Appendix C of the EMP |

| QC Sample | Frequency/Number[a] | 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[b] | 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[b] | Verify results; reanalyze | | | Contamination—Accuracy/bias | See procedure CP3-ES-5003, *Quality Assured Data* |
| Equipment blank | Minimum 5% | ≤ CRQL[b] | 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 | | | Accuracy/Precision | See procedure CP3-ES-5003, *Quality Assured Data* |
| Laboratory spiked blanks [laboratory control sample (LCS)] | 1 per analytical batch | See data validation plans CP2-ES-0026, -0811, -5102, -5105, -5107 | Check calculations and instrument; reanalyze affected samples | | | Contamination—Accuracy/bias | See procedure CP3-ES-5003, *Quality Assured Data* |

**QAPP Worksheet #28-A. (Continued)**
**QC Samples Table (Aqueous)**

| QC Sample | Frequency/Number[a] | 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 QA (or QC) samples | See data validation plans CP2-ES-0811, -5105 | Check calculations and instrument; reanalyze affected samples | | Accuracy | See procedure CP3-ES-5003, *Quality Assured Data* |
| Internal standards | All samples and standards | See data validation plans CP2-ES-5105 and 5107 | Check calculations and instrument; reanalyze affected samples | | Accuracy | See procedure CP3-ES-5003, *Quality Assured Data* |
| Field duplicate[c] | Minimum 5% | See data validation plans CP2-ES-0026, -0811, -5102, -5105, -5107 | Data reviewer will place qualifiers on samples affected | Project | Homogeneity/ Precision | Specific RPD defined for each group in Worksheet 12. |
| 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 separations 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* |

[a] The number of QC samples is listed on Worksheet #20.

[b] Unless dictated by project-specific parameters, ≤ contract-required quantitation limit (CRQL).

[c] The Hazardous Waste Management Facility Permit defines a duplicate as being collected from a single sample collection container or sample mixing container. CP4-ES-2704, *Trip, Equipment, and Field Blank Preparation*, defines a duplicate as being collected using the same procedural requirements as the original sample. Duplicates collected from MWs at the C-404 Landfill under the permit will be collected as prescribed in the permit and as prescribed in the SOP.

## QAPP Worksheet #28-B.
## QC Samples Table (Sediment)

| |
|---|
| **Matrix: Sediments** |
| **Analytical Group/Concentration Level:** VOCs, Metals, PCBs, Radionuclides |
| **Sampling SOP:** See Worksheet #21 |
| **Analytical Method/SOP Reference:** See Worksheet #23 |
| **Sampler's Name/Field Sampling Organization:** GEO Consultants |
| **Analytical Organization:** GEL Laboratories |
| **No. of Sample Locations:** See Appendix C of the EMP |

| QC Sample | Frequency/Number[a] | 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[b] | 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[b] | Verify results; reanalyze | | Contamination—Accuracy/bias | See procedure CP3-ES-5003, *Quality Assured Data* |
| Equipment blank | Minimum 5% | ≤ CRQL[b] | 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 | | Accuracy/Precision | See procedure CP3-ES-5003, *Quality Assured Data* |
| Laboratory spiked blanks (LCS) | 1 per analytical batch | See data validation plans CP2-ES-0026, -0811, -5102, -5105, -5107 | Check calculations and instrument; reanalyze affected samples | | Contamination—Accuracy/Bias | See procedure CP3-ES-5003, *Quality Assured Data* |

**QAPP Worksheet #28-B. (Continued)**
**QC Samples Table (Sediment)**

| QC Sample | Frequency/Number[a] | 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 QA (or QC) samples | See data validation plans CP2-ES-0811, -5105 | Check calculations and instrument; reanalyze affected samples | | Accuracy | See procedure CP3-ES-5003, *Quality Assured Data* |
| Internal standards | All sample blanks and QA samples | See data validation plans CP2-ES-5102, -5107 | Check calculations and instrument; reanalyze affected samples | | Accuracy | See procedure CP3-ES-5003, *Quality Assured Data* |
| Field duplicate | Minimum 5% | See data validation plans CP2-ES-0026, -0811, 5102, -5105, -5107 | Data reviewer will place qualifiers on samples affected | Project | Homogeneity/ Precision | Specific RPD defined for each group in Worksheet #12 |
| 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 separations 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* |

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

## QAPP Worksheet #29.
## Project Documents and Records Table

This worksheet describes how information will be collected, verified, and stored. Its purpose is to support data completeness, data integrity, and ease of retrieval.

| Sample Collection and Field Records | | | |
|---|---|---|---|
| **Record** | **Generation** | **Verification** | **Storage location/archival** |
| Field Logbook or Data Sheets | Field Team | Field Team Leader | Project File |
| Chain-of-Custody Forms | Field Team | Field Team Leader | Project File |
| Air Bills | Contract Laboratory | Contract Laboratory | Project File |
| Equipment Calibration Forms | Field Team | Field Team Leader | Project File |
| Deviations | Project Manager | Project Director | Project File |
| Corrective Action Reports | Project Manager | Project Director | Project File |
| Correspondence | Project Manager | Project Director | Project File |

| Project Assessments | | | |
|---|---|---|---|
| **Record** | **Generation** | **Verification** | **Storage location/archival** |
| Field Audit Checklists | Project Manager | Project Director | Project File |
| Data Verification Checklists | SMO/Data Validator | SMO | Project File |
| Data Validation Report | Data Validator | SMO | Project File |
| Data Usability Assessment Report | Data Validator | SMO | Project File |

| Laboratory Records | | | |
|---|---|---|---|
| **Record** | **Generation** | **Verification** | **Storage location/archival** |
| Level IV Laboratory Reports | Laboratory Staff | Laboratory Project Manager | Project File |
| Electronic Data Deliverables | Laboratory Staff | Laboratory Project Manager | Project File |

**QAPP Worksheets #31, #32, and #33.**
**Assessments and Corrective Action**

This worksheet is used to document responsibilities for conducting project assessments, responding to assessment findings and implementing corrective action. Appropriately scheduled assessments (e.g., field sampling technical systems audits at the beginning of sampling) allow management to implement corrective action in a timely manner, thereby correcting nonconformances and minimizing their impact on DQOs/project quality objectives. Assessment checklists should be included in the QAPP or referenced.

**Assessments:**

| Assessment Type | Responsible Party & Organization | Number/Frequency | Estimated Date | Assessment Deliverable | Deliverable Due Date |
|---|---|---|---|---|---|
| Field Sampling | Field Team Leader/ FRNP | Quarterly | To be Determined | As described in CP3-QA-1003, *Management and Self-Assessment* | As described in CP3-QA-1003, *Management and Self-Assessment* |
| Off-site Laboratory Technical Systems Audit | Laboratory Manager/Technical Director | Annually | Annually/Ongoing | Internal Audit Report | Per Individual Laboratory QA Manual |
| Management Review | Project Director/ FRNP | Interim management review following site mobilization; final management review upon completion of fieldwork | Annually | As described in CP3-QA-1003, *Management and Self-Assessment* | As described in CP3-QA-1003, *Management and Self-Assessment* |

**QAPP Worksheets #31, #32, and #33. (Continued)**
**Assessments and Corrective Action**

**Assessment Response and Corrective Action:**

| Assessment Type | Responsibility for responding to assessment findings | Assessment Response Documentation | Time Frame for Response | Responsibility for Implementing Corrective Action | Responsible for monitoring Corrective Action implementation |
|---|---|---|---|---|---|
| Field Sampling | Field Team Leader/FRNP | Field Sampling Corrective Action Response | 24 hours from receipt of memorandum | Field Team Leader/FRNP | Contractor Performance Assurance Program (CPAP) Manager/FRNP |
| Off-site Laboratory Technical Systems Audit | Laboratory Manager/Technical Director | Internal Audit Report Deficiency Memorandum | 7 days following receipt of proficiency testing deficiency report and before analysis field samples | Laboratory Technical Director | QA Manager/FRNP |
| Management Review | Project Director/ FRNP | Management Response | As described in CP3-QA-1003, *Management and Self-Assessment* | As assigned in Management Response | CPAP Manager/FRNP |

**QAPP Worksheet #34.**
**Data Verification and Validation Inputs**

This worksheet is used to list the inputs that will be used during data verification and validation. Data verification is a check that specified activities involved in collecting and analyzing samples have been completed and documented and that the necessary records (objective evidence) are available to proceed to data validation. Data validation is the evaluation of conformance to stated requirements, including those in the contract, methods, SOPs, and the QAPP. Records subject to verification and validation are listed below.

| Item | Description | Verification (Completeness) | Validation (Conformance to Specifications) |
|---|---|---|---|
| **Planning Documents/Records** | | | |
| 1 | Approved QAPP | X | X |
| 2 | Contract | X | X |
| 3 | Field SOPs | X | X |
| 4 | Laboratory SOPs | X | X |
| **Field Records** | | | |
| 5 | Field Logbooks and/or sample data forms | X | X |
| 6 | Equipment calibration records | X | X |
| 7 | Chain-of-Custody forms | X | X |
| 8 | Sampling diagrams/surveys | X | X |
| 9 | Drilling logs | X | X |
| 10 | Geophysics reports | X | X |
| 11 | Relevant correspondence | X | X |
| 12 | Change orders/deviations | X | X |
| 13 | Field audit reports | X | X |
| 14 | Field corrective action reports | X | X |

**QAPP Worksheet #34. (Continued)**
**Data Verification and Validation Inputs**

| Item | Description | Verification (Completeness) | Validation (Conformance to Specifications) |
|---|---|---|---|
| **Analytical Data Package** | | | |
| 15 | Cover sheet (laboratory identifying information) | X | X |
| 16 | Case narrative | X | X |
| 17 | Internal laboratory chain-of-custody | X | X |
| 18 | Sample receipt records | X | X |
| 19 | Sample chronology (i.e., dates and times of receipt, preparation, and analysis) | X | X |
| 20 | Communication records | X | X |
| 21 | Project-specific proficiency testing sample results | X | X |
| 22 | Limit of detection/limit of quantification establishment and verification | X | X |
| 23 | Standards Traceability | X | X |
| 24 | Instrument calibration records | X | X |
| 25 | Definition of laboratory qualifiers | X | X |
| 26 | Results reporting forms | X | X |
| 27 | QC sample results | X | X |
| 28 | Corrective action reports | X | X |
| 29 | Raw data | X | X |
| 30 | Electronic data deliverable | X | X |

## QAPP Worksheet #35.
## Data Verification Procedures

This worksheet documents procedures that will be used to verify project data. Data verification is a completeness check to confirm that required activities were conducted, specified records are present, and the contents of the records are complete.

| Records Reviewed | Requirement Documents | Process Description | Responsible Person/Organization |
|---|---|---|---|
| Field logbook and/or sample data forms | QAPP, Field SOPs | Verify that records are present and complete for each day of field activities. Verify that all planned samples including field QC samples were collected and that sample collection locations are documented. Verify that meteorological data were provided for each day of field activities. Verify that changes/exceptions are documented and were reported in accordance with requirements. Verify that any required field monitoring was performed and results are documented. | Field Team Leader/FRNP—Performs daily review<br><br>SMO/FRNP—Performs review as part of data verification and data assessment |
| Chain-of-custody forms | QAPP, Field SOPs | Verify the completeness of chain-of-custody records. Examine entries for consistency with the field logbook/data form. Check that appropriate methods and sample preservation have been recorded. Verify that the required volume of sample has been collected and that sufficient sample volume is available for QC samples (e.g., MS/MSD). Verify that all required signatures and dates are present. Check for transcription errors. | Field Team Leader/FRNP—Performs daily review<br><br>SMO/FRNP—Performs review as part of data verification and data assessment<br><br>Data Validator/A2RGC, LLC—Performs review as part of data validation |

**QAPP Worksheet #35. (Continued)**
**Data Verification Procedures**

| Records Reviewed | Requirement Documents | Process Description | Responsible Person/Organization |
|---|---|---|---|
| Laboratory deliverables | QAPP | Verify that the laboratory deliverable contains all records specified in the QAPP. Check sample receipt records to ensure sample condition upon receipt was noted, and any missing/broken sample containers were noted and reported according to plan. Compare the data package with the COCs to verify that results were provided for all collected samples. Review the narrative to ensure all QC exceptions are described. Check for evidence that any required notifications were provided to project personnel as specified in the QAPP. Verify that necessary signatures and dates are present. | Laboratory PM/Contract Laboratory—Performs review before data is released<br><br>SMO/FRNP—Performs review part of data verification and data assessment<br><br>Data Validator/A2RGC, LLC—Performs review as part of data validation |
| Audit reports, corrective action reports | QAPP | Verify that all planned audits were conducted. Examine audit reports. For any deficiencies noted, verify that corrective action was implemented according to plan. | CPAP Manager/FRNP |

**QAPP Worksheet #36.**
**Data Validation Procedures**

Data Validator: A2RGC, LLC

Data validation plans are listed in Worksheet #21. These plans also are available on the FRNP intranet website. The fixed-base laboratory will provide data in an Electronic Data Deliverable. Ambient air monitoring data from the weekly and quarterly sampling events will be validated to support National Emission Standards for Hazardous Air Pollutants reporting. Also, 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 the Environmental Monitoring Program. Additionally, the landfill requirements encompass the majority of all types of analyses specified within the Environmental Monitoring Program. Therefore, these programs are considered an adequate representation of Environmental Monitoring data targeted for data validation.

**QAPP Worksheet #37.**
**Data Usability Assessment**

This worksheet documents procedures that will be used to perform the data usability assessment. The data usability assessment is performed at the conclusion of data collection activities, using the outputs from data verification and data validation. It is the data interpretation phase, which involves a qualitative and quantitative evaluation of environmental data to determine if the project data are of the right type, quality, and quantity to support the decisions that need to be made. It involves a retrospective evaluation of the systematic planning process, and, like the systematic planning process, involves participation by key members of the project team. The data usability assessment evaluates whether underlying assumptions used during systematic planning are supported, sources of uncertainty have been accounted for and are acceptable, data are representative of the population of interest, and the results can be used as intended, with the acceptable level of confidence.

Identify personnel (organization and position/title) responsible for participating in the data usability assessment:

Environmental Monitoring Project Manager
Risk Assessor
Data Validator
SMO
Field Team Leader

Describe how the usability assessment will be documented:

Data usability will be documented through validation reports as well as through the data assessment review checklist and comment form included in the data assessment packages. 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.

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.

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

**QAPP Worksheet #37. (Continued)**
**Data Usability Assessment**

document any issues pertaining to the data and to indicate if DQOs 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.

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.