# Environmental Monitoring Plan
# Fiscal Year 2016
# Paducah Gaseous Diffusion Plant,
# Paducah, Kentucky

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This document is approved for public release per review by:

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FPDP Classification Support

1-12-16
Date

# Environmental Monitoring Plan
# Fiscal Year 2016
# Paducah Gaseous Diffusion Plant,
# Paducah, Kentucky

Date Issued—January 2016

U.S. DEPARTMENT OF ENERGY
Office of Environmental Management

Prepared by
FLUOR FEDERAL SERVICES, INC.,
Paducah Deactivation Project
managing the
Deactivation Project at the
Paducah Gaseous Diffusion Plant
under Task Order DE-DT0007774

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# ACRONYMS

| | |
|---|---|
| AEC | Atomic Energy Commission |
| AIP | Agreement in Principle |
| ASER | Annual Site Environmental Report |
| BWCS | BWXT Conversion Services, LLC |
| CAP-88 | Clean Air Act Assessment Package-88 |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| *CFR* | *Code of Federal Regulations* |
| DOD | U.S. Department of Defense |
| DOE | U.S. Department of Energy |
| DQO | data quality objective |
| ED | effective dose |
| EDE | effective dose equivalent |
| EM | environmental monitoring |
| EMP | Environmental Monitoring Plan |
| EMS | Environmental Management System |
| EPA | U.S. Environmental Protection Agency |
| ERPP | Environmental Radiation Protection Program |
| FFA | Federal Facility Agreement |
| FPDP | Fluor Federal Services, Inc., Paducah Deactivation Project |
| FY | fiscal year |
| GSA | General Services Administration |
| ISMS | Integrated Safety Management System |
| *KAR* | *Kentucky Administrative Regulation* |
| KDOW | Kentucky Division of Water |
| KDWM | Kentucky Division of Waste Management |
| KPDES | Kentucky Pollutant Discharge Elimination System |
| LATA Kentucky | LATA Environmental Services of Kentucky, LLC |
| MDA | minimum detectable activity |
| MDL | method detection limit |
| MW | monitoring well |
| NESHAP | National Emission Standards for Hazardous Air Pollutants |
| NPDES | National Pollutant Discharge Elimination System |
| O | Order |
| O&M | operation and maintenance |
| OU | operable unit |
| PGDP | Paducah Gaseous Diffusion Plant |
| PQL | practical quantification limit |
| PZ | piezometer |
| QA | quality assurance |
| QAPP | Quality Assurance Project Plan |
| RCRA | Resource Conservation and Recovery Act |
| ROD | record of decision |
| RI | remedial investigation |
| SARA | Superfund Amendments Reauthorization Act |
| SPCC | spill prevention control and countermeasure |
| SSPP | Strategic Sustainability Performance Plan |
| SWMU | solid waste management unit |
| TED | total effective dose |

| | |
|---|---|
| TLD | thermoluminescent dosimeter |
| USEC | United States Enrichment Corporation |
| WKWMA | West Kentucky Wildlife Management Area |
| WMP | Watershed Monitoring Program |

# EXECUTIVE SUMMARY

This Paducah Site Environmental Monitoring Plan (EMP) for fiscal year (FY) 2016 is intended to document the rationale, sampling frequency, parameters, and analytical methods for environmental monitoring (EM) activities at the Paducah Site and provide information on site characteristics, environmental pathways, dose assessment methodologies, and quality assurance management.

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

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

Sampling frequencies and sampling parameters that were modified for a sampling program that was permit-driven or collected as a result of a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) or Resource Conservation and Recovery Act (RCRA) decision document were changed only if the permit allowed the change. Data collected under existing permits and under CERCLA or RCRA decision documents will continue to be evaluated in FY 2016. 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 2017 EMP. If sampling is modified due to a change in a sampling approach or by physical limitations, such as a dry well, then those conditions will be documented in the assessment file for that given project.

Until 2013, the United States Enrichment Corporation (USEC) enriched uranium at the Paducah Site to supply nuclear fuel to electric utilities worldwide. In 2014, the U.S. Department of Energy (DOE) began the process of planning for lease termination and facility transfer from USEC to Fluor Federal Services, Inc., Paducah Deactivation Project (FPDP). FPDP's responsibilities include facility modification and infrastructure optimization (including stabilization and deactivation of GDP facilities at the Paducah Site). In October 2014, USEC terminated its lease with DOE. DOE retains ownership of all facilities and retains responsibility for managing the disposition of legacy waste material and environmental cleanup.

Changes to the sampling programs reflected in the FY 2016 EMP include, but are not limited to, the following actions, which are described later in more detail.

- **Water Level Measurements and Inspections.** Groundwater wells will continue to be inspected and evaluated for depth to water on an annual basis; however, the timing of the event has been changed within the FY 2016 EMP. The measurements and inspections will be conducted annually during the second quarter of the calendar year. This is a change in cycle compared to the last year's EMP. The wells consistently have been inspected and evaluated for water level measurements in the third quarter of each calendar year. In order to evaluate temporal effects to the groundwater levels, the water level measurements and the inspections are being moved to the second quarter of the calendar year of 2016.

- **Northeast Plume.** Monitoring well (MW) numbers identified in regulatory documents as MWs associated with the Northeast Plume Optimization Project were added to the well inventory list in

Appendix B, with the status listed as "Planned." Parameters and sampling frequency will be included in the FY 2017 EMP. Sampling per regulatory commitments will be conducted during FY 2016, as required by regulatory documents.

- **Solid Waste Management Unit (SWMU) 4.** MW numbers identified in regulatory documents as MWs associated with the SWMU 4 project were added to the well inventory list in Appendix B, with the status listed as "Planned." Parameters and sampling frequency will be included in the FY 2017 EMP. Sampling per regulatory commitments will be conducted during FY 2016, as required by regulatory documents. Additionally, some piezometers (PZs) were installed as part of the SWMU 4 investigation. Those PZs also were added to Appendix B. As this active project concludes, these PZs are scheduled to be abandoned. Updates to the status of these PZs will be noted in the FY 2017 EMP.

- **SWMU 1.** MW numbers identified in regulatory documents as MWs associated with the SWMU 1 project were added to the well inventory list in Appendix B, with the status listed as "Planned." Parameters and sampling frequency will be included in the FY 2017 EMP. Sampling per regulatory commitments will be conducted during FY 2016, as required by regulatory documents.

- **Southwest Plume.** MW numbers identified in regulatory documents as MWs associated with the Southwest Plume project were added to the well inventory list in Appendix B, with the status listed as "Planned." Parameters and sampling frequency will be included in the FY 2017 EMP. Sampling per regulatory commitments will be conducted during FY 2016, as required by regulatory documents.

- **Water Policy Boundary Monitoring Program.** R384 was eliminated from the program. R384 was included in the FY 2015 EMP; however, the well could not be sampled during FY 2015 because of lack of occupancy/electrical power at the property. Because the property is expected to be vacated in the future, R384 was removed from the sampling campaign for FY 2016. Other wells in the vicinity are sampled; therefore, a replacement well was not deemed necessary for an effective monitoring program of the water policy boundary.

- **Environmental Radiation Protection Program—Effluent and Surface Water Runoff.** Radiological parameters were added to the upstream background location, L29A, and just downstream of the Paducah Site, L30. These locations are in the Ohio River. The sampling frequency for L306 was changed from annually to quarterly. Additionally, the timing of the sampling will be managed in a manner where the upstream locations (including background locations) will be sampled a week prior to the sampling location at Cairo, Illinois, L306. This is an effort to make a comparison of water quality as the surface water moves to the downstream location at Cairo.

- **External Gamma Radiological Monitoring Program.** For the FY 2016 EMP, one change was made to the external gamma radiological monitoring program. Thermoluminescent dosimeter (TLD) TLD-55, which was located near C-410, has been discontinued due to the decontamination and decommissioning of the facility. There now are 64 TLD locations at Paducah Gaseous Diffusion Plant.

# 1. INTRODUCTION

## 1.1 PURPOSE

This Paducah Site Environmental Monitoring Plan (EMP) for fiscal year (FY) 2016 is intended to document the rationale, sampling frequency, parameters, and analytical methods for environmental monitoring (EM) activities at the Paducah Site and provide information on site characteristics, environmental pathways, dose assessment methodologies, and quality assurance (QA) management. Guidance for EM is included in U.S. Department of Energy (DOE) Order (O) 436.1, *Departmental Sustainability*; DOE O 458.1, *Radiation Protection of the Public and the Environment*; DOE/HDBK-1216-2015, *Environmental Radiological Effluent Monitoring and Environmental Surveillance* (DOE 2015a), hereinafter identified as the Radiological Guide; and Commonwealth of Kentucky and federal regulations that implement federal environmental laws. The Radiological Guide establishes the elements of a radiological effluent monitoring and environmental surveillance program considered acceptable to DOE, in support of DOE O 458.1.

DOE O 436.1, *Departmental Sustainability*, was approved by DOE on May 5, 2011. It canceled DOE O 450.1A, *Environmental Protection Program*, and DOE O 430.2B, *Department of Energy, Renewable Energy and Transportation Management*. The development of DOE O 436.1 required sites to incorporate activities and programs to meet the goals of the Strategic Sustainability Performance Plan (SSPP), which are specified in Executive Order 13514. 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. Overall, the implementation of this Paducah EMP for FY 2016 will aid in planning for environmental remediation and monitoring efforts at the site and in meeting the goals of DOE O 436.1 and DOE O 458.1.

This EMP also supports permit requirements and supplements the ongoing Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) remedial investigations (RIs) being conducted at the Paducah Site. In accordance with the Paducah Site Management Plan, currently there are five defined CERCLA operable units (OUs)—surface water, groundwater, soils, burial grounds, and decontamination and decommissioning—that require investigation (DOE 2015b). This EMP is integrated with each OU investigation and/or remedial action 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 and gaseous discharges to the environment. Environmental surveillance is the direct measurement or the collection and analysis of ambient air, surface water, groundwater, sediment, and other media.

Until 2013, the United States Enrichment Corporation (USEC) enriched uranium at the Paducah Site to supply nuclear fuel to electric utilities worldwide. In 2014, DOE began the process of planning for lease

termination and facility transfer from USEC to Fluor Federal Services, Inc., Paducah Deactivation Project (FPDP). FPDP's responsibilities include facility modification and infrastructure optimization (including stabilization and deactivation of gaseous diffusion plant facilities at the Paducah Site). In October 2014, USEC terminated its lease with DOE. DOE retains ownership of all facilities and retains responsibility for managing the disposition of legacy waste material and environmental cleanup.

FPDP assumed management of the facilities at the end of the USEC lease period. LATA Environmental Services of Kentucky, LLC, (LATA Kentucky) continued with the scope of the environmental remediation contract until the end of their contract period, July 26, 2015. At the end of LATA Kentucky's contract period, FPDP assumed the LATA Kentucky scope of work and continued with the sampling strategies that were specified in the FY 2015 EMP.

In order for DOE and its remediation contractor, FPDP, to meet or exceed compliance with applicable environmental, public health, and resource protection requirements cost-effectively, the EMP is evaluated and modified, as appropriate. These modifications may include adjusting the number of monitoring wells (MWs) that are sampled, changing sampling frequency of certain activities, or eliminating parameters to avoid duplication of data. As a contractor for DOE at the Paducah Site, FPDP 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 2015c). 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-by-walking-around. At a minimum, a management assessment of a sampling activity mandated by a permit will be conducted on a quarterly basis.

Operational sampling included in the Title V air permit is considered outside the scope of the EMP. FPDP will implement the appropriate operational sampling, depending on the operations that will continue at the site now that transition to FPDP has been completed. While this EMP addresses liquid effluent monitoring from the depleted uranium hexafluoride conversion facility ($DUF_6$), which is operated by BWXT Conversion Services, LLC, (BWCS) this EMP does not address gaseous effluent monitoring that is conducted by BWCS in support of their air permit.

## 1.3 RATIONALE

The rationale for EM activities at the Paducah Site for FY 2016 is premised by the understanding that sampling frequency, sampling parameters, and analytical methods must be sufficient to meet regulatory and contractual requirements and support appropriate DOE orders and guidance cost-effectively.

Data collected under existing permits, National Emission Standards for Hazardous Air Pollutants (NESHAP) Management Plan (LATA Kentucky 2013), and under CERCLA or Resource Conservation and Recovery Act (RCRA) decision documents will continue to be evaluated in FY 2016. 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 2016, 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 2017 Paducah Site EMP. If sampling is modified due to a change in a sampling approach or by physical limitations, such as a dry well, then those conditions will be documented in the assessment file for that given project.

Changes to the sampling programs reflected in the FY 2016 EMP include, but are not limited to, the following actions, which are described in more detail in Appendix C.

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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 2015)]. 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 2015)] and 3.5 miles south of the Ohio River (Figure 1). The facility is on approximately 1,350 acres with controlled access. Roughly 650 acres of the reservation are enclosed within a fenced security area. An uninhabited buffer zone of at least 400 yd surrounds the entire fenced area. During World War II, the Kentucky Ordnance Works was operated in an area southwest of the plant on what is now a wildlife management area. Three small communities are located within 3 miles of the DOE property boundary at PGDP: Heath and Grahamville to the east and Kevil to the southwest. The closest commercial airport is Barkley Regional Airport, approximately 5 miles to the southeast. The population within a 50-mile radius of PGDP is about 534,000. Within a 10-mile radius of PGDP, the population is about 89,000 (ESRI 2012).

### 1.4.2 Site Background Information

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

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

In 1950, the U.S. Department of Defense (DOD) and DOE's predecessor, the Atomic Energy Commission (AEC), began efforts to expand fissionable material production capacity. As part of this effort, the National Security Resources Board was instructed to designate power areas within a strategically safe area of the United States. Eight government-owned sites initially were selected as

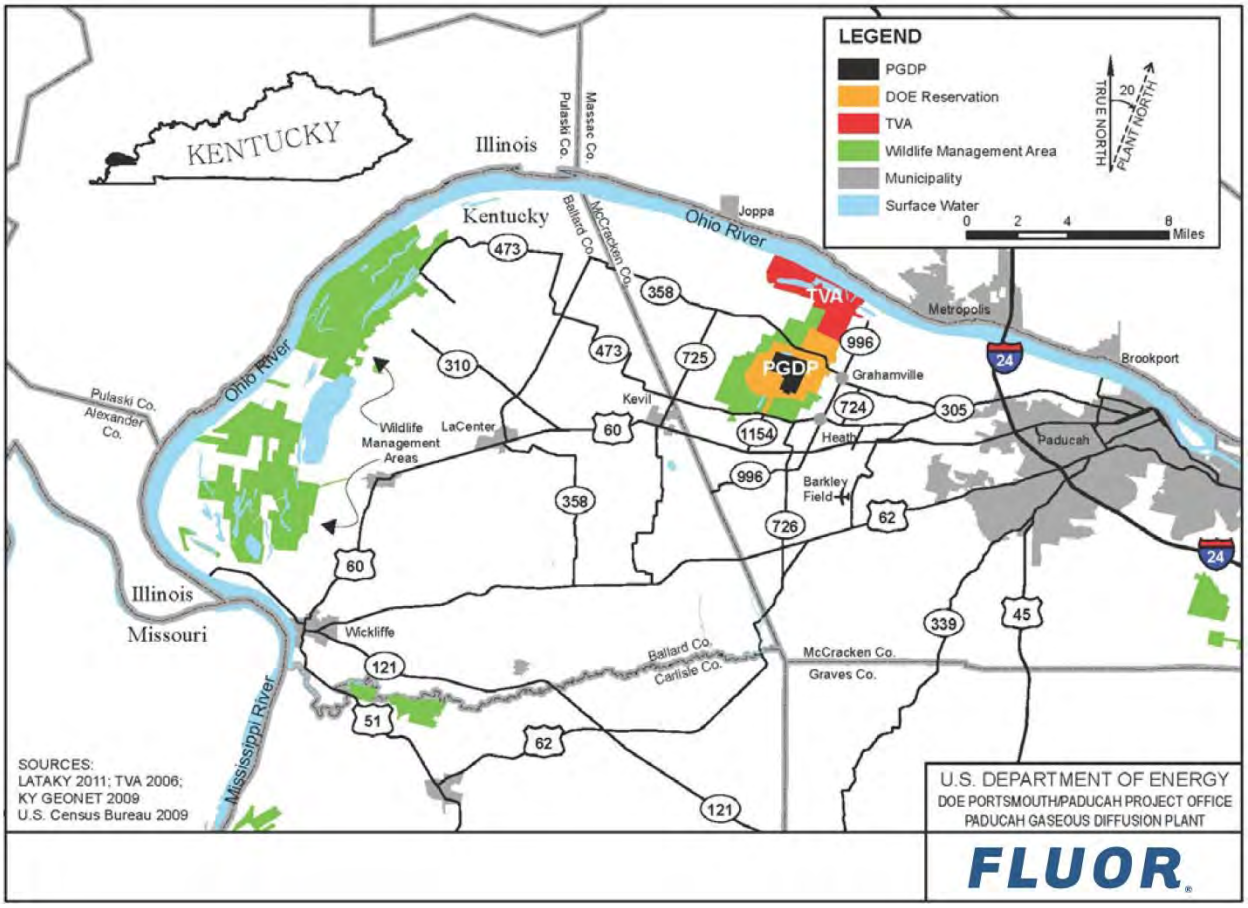


**Figure 1. Location of the Paducah Site**

candidate areas. In October 1950, as a result of joint recommendations from DOD, U.S. Department of State, and AEC, President Harry S. Truman directed AEC to expand further production of atomic weapons. One of the principal facets of this expansion program was the provision for a new gaseous diffusion plant. On October 18, 1950, AEC approved the Paducah Site for uranium enrichment operations and formally requested the Department of the Army to transfer the site from GSA to AEC. Of the 7,566 acres acquired by the AEC, 1,361 acres subsequently were transferred to the Tennessee Valley Authority (Shawnee Fossil Plant Site), and approximately, 2,700 acres were conveyed to the Commonwealth of Kentucky for wildlife conservation and for recreational purposes [West Kentucky Wildlife Management Area (WKWMA)].

Although construction of PGDP was not complete until 1954, production of enriched uranium began in 1952. Recycled uranium from nuclear reactors was introduced into the PGDP enrichment cascades in 1953 and continued through 1964. In 1964, cascade feed material was switched solely to virgin-mined uranium. Use of recycled uranium resumed in 1969 and continued through 1976. In 1976, the practice of recycling uranium feed material from nuclear reactors was halted and never resumed. During the recycling time periods, Paducah received approximately 100,000 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 technetium-99 (Tc-99). The majority of the Pu-239 and Np-237 was separated out during the initial chemical conversion to uranium hexafluoride ($UF_6$). Concentrations of transuranics (e.g., Pu-239 and Np-237) and Tc-99 are believed to have been deposited on internal surfaces of process equipment and in waste products.

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

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

## 1.5 PLAN OBJECTIVES

The main objectives of this EMP are as follows:

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

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

- Provide data for use in the ASER, 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 is called a reference location and is defined as an area unaffected by releases from PGDP. The area could, however, be impacted by the operation of other industrial or commercial facilities. When no standards or criteria exist for contaminants that may have an impact on human health or the environment, comparisons to concentrations at reference locations can be made to determine if concentrations are significantly higher near the Paducah Site boundary.

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# 2. EFFLUENT MONITORING

Effluent monitoring is the collection and analysis of samples or measurements of liquid and gaseous effluents to quantify and officially report chemical and radiological contaminants, assess radiation exposures of the public, provide a means to control effluents at or near the point of discharge, and demonstrate compliance with applicable standards and permit requirements. Effluent monitoring is initiated to demonstrate compliance with one or more federal or Commonwealth of Kentucky regulations, permit conditions, or environmental commitments made in environmental impact statements, environmental assessments, DOE Orders and guides, or other official documents. Table 1 lists the various routine effluent monitoring activities performed at the Paducah Site. This table includes monitoring of liquid effluents, but it does not include gaseous effluents by BWCS operations or FPDP. BWCS and FPDP conduct gaseous effluent 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. No other DOE operations at the Paducah Site require an air permit. 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, K006, K008, K009, K010) | 5 | Weekly |
| Outfall (K002, K004,[c] K011, K012, K013, K015, K016, K017, K019, K020) | 10 | Monthly |
| Outfall Toxicity (K001, K002, K006, K008, K009, K010, K011, K012, K013, K015, K016, K019, K020) | 13 | Quarterly |
| Outfall Toxicity (K017) | 1 | Monthly |
| ***Leachate*** | | |
| C-746-S&T Landfills | 1 | As required and annually |
| C-746-U Landfill | 1 | As required and annually |
| C-404 Landfill | 1 | As required |

[a] One location, L154, is permitted for both the C-746-S&T Landfills and for the C-746-U Landfill. Totals represent this location for each landfill, as shown in the applicable permits. 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.
**NOTE:** Sampling locations and frequencies are detailed in Appendix C.

The primary statute governing the monitoring of effluents to surface water is the Clean Water Act (with the exception of radionuclides), which requires the issuance of a National Pollutant Discharge Elimination System (NPDES) permit.[1] EPA has delegated the administration of the NPDES Program to the Kentucky

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

Division of Water (KDOW) KPDES Program. The KPDES permits require radiological monitoring at the permitted outfalls for reporting purposes only.

Sampling and analytical methods meet the requirements described in 40 *CFR* § 136 or the KPDES permits. 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 trends in effluents.

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

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

The preceding requirements are addressed as follows.

- Appendix C of this document lists all effluent monitoring locations. Appendix C specifies sampling and field measurements, as well as analytical method information. Appendix C also lists the sampling frequency at each location and the required analytical parameters, analytical method, and required reporting limits (as applicable). Additionally, Appendix C specifies the sampling driver for each

sampling program (e.g., permit, CERCLA decision document). Generally, data collected as part of this document not only meets permit and CERCLA decision requirements, it also provides data sets that may be used in future CERCLA decision documents.

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

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

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

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

**Physical/Chemical/KPDES.** KPDES is the regulatory program administered by KDOW for discharge of wastewaters to the waters of the Commonwealth of Kentucky. The DOE Paducah Site KPDES permits (KY0004049 and KY0102083) establish monitoring requirements for the discharge of effluent and surface water runoff. The two KPDES permits include the permit that was issued by KDOW to DOE and DOE's previous remediation contractor, LATA Kentucky, and the permit issued by KDOW to USEC. KDOW currently is reviewing the permit renewal applications submitted for both KPDES permits (KY0004049 and KY0102083) and has indicated its intent to issue a combined permit in early 2016.

The permits define 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 permits require monthly radiological analyses at the outfall locations (Figure C.12); however, the Commonwealth of Kentucky did not apply limits to radiological components of the liquid effluent.

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

**Program Implementation Procedures.** The FPDP EM manager (or designee) is responsible for implementing all relevant aspects of the EMP. In that role, the FPDP EM manager reports through a line organization to the manager of projects 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 (e.g., the C-612 Northwest Plume Groundwater Treatment System, Northeast Plume Alternate Treatment Unit, C-617 Lagoon effluent, C-611 Water Treatment Plant, and the C-616 Wastewater Treatment Facility). The intent of monitoring is to assess compliance with Commonwealth of Kentucky and federal regulations, permits, and DOE Orders and to assess the impact of DOE operations on the local environment.

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

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

### 2.1.2 Leachate

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

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

## 2.2 AIRBORNE

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

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

# 3. METEOROLOGICAL MONITORING

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

## 3.1 CHEMICAL EMISSIONS

DOE operations may have airborne chemical emissions from various sources, such as CERCLA remedial actions, as well as fugitive emissions. Projects requiring dispersion modeling have purchased meteorological data from accredited meteorological measuring stations that are in close proximity to the site.

## 3.2 RADIOLOGICAL EMISSIONS

Operations at the Paducah Site may have airborne radiological emissions from various sources, such as CERCLA remedial actions, deactivation activities, $DUF_6$ conversion activities, as well as fugitive emissions. Modeling to demonstrate compliance with NESHAP regulations is conducted using the Clean Air Act Assessment Package-88 (CAP-88). In accordance with the NESHAP Management Plan (LATA Kentucky 2013), Meteorological data utilized for CAP-88 are compiled from historical data from the on-site meteorological tower. Other dose modeling software such as RESRAD-OFFSITE or RESRAD-BIOTA may be used with appropriate meteorological data sets.

The Paducah site ceased operation of an on-site meteorological 60 m tower in 1993. The last meteorological data set from the on-site tower is a five-year stability array distribution used for CAP-88.

Emissions from Paducah Site operations historically have contributed little dose to the public. The CAP-88 model estimated dose modeled in previous ASERs also has been much lower than the regulatory safe public dose standard of 10 mrem per year to any individual.

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# 4. ENVIRONMENTAL SURVEILLANCE

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

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

DOE activities must be conducted to ensure that radionuclides contained in liquid effluents do not cause private or public drinking water systems to exceed an annual dose of 4 mrem per year per 40 *CFR* § 141, which is more limiting than DOE O 458.1 limit of 10 mrem per year. For monitoring of public drinking water systems, 40 *CFR* § 141 allows for environmental surveillance data to be used in the vicinity of nuclear facilities. The nearest downstream public water withdrawal location is Cairo, Illinois, located on the Ohio River. To avoid potential readings from other sources that may be found in the Ohio River, the plant effluents can be evaluated against the 4 mrem per year standard within the Bayou and Little Bayou Creek systems prior to confluence with the Ohio River. Compliance demonstrated within the creeks shows compliance to 40 *CFR* § 141 for the nearest public drinking water system. The public is protected from contaminants in groundwater that would be accessed by private drinking water systems (i.e., wells) because of the measures provided in support of the Water Policy Box (see Figures. C.8 and C.9).

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

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

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

**Table 2. Routine Environmental Surveillance**

| Program | Number of Locations | Sampling Frequency | Sample Type | Parameters |
|---|---|---|---|---|
| ***Groundwater*** | | | | |
| Surveillance | 24 | Annually | Grab | See Appendix C |
| Surveillance | 101 | Biennially (Sampled FY 2015—will be sampled in FY 2017) | Grab | See Appendix C |
| Surveillance Geochemical | 38 | Every 3 years (Sampled FY 2013—will be sampled in FY 2016) | Grab | See Appendix C |
| C-746-S&T Landfills | 25[a] | Quarterly | Grab | See Appendix C |
| C-746-U Landfill | 21[a] | Quarterly | Grab | See Appendix C |
| C-404 Landfill | 9 | Semiannually | Grab | See Appendix C |
| C-746-K Landfill | 3 | Semiannually | Grab | See Appendix C |
| Northeast Plume | 14 | Semiannually | Grab | See Appendix C |
| Northeast Plume | 5 | Quarterly | Grab | See Appendix C |
| Northwest Plume | 33 | Semiannually | Grab | See Appendix C |
| C-400 | 9 | Quarterly | Grab | See Appendix C |
| C-400 | 8 | Semiannually | Grab | See Appendix C |
| Water Policy Boundary—NW | 20 | Quarterly | Grab | See Appendix C |
| Water Policy Boundary—NE | 9 | Annually | Grab | See Appendix C |
| Residential Carbon Filter System | 1 | Semiannually | Grab | See Appendix C |
| | | | | |
| ***Surface Water and Seeps*** | | | | |
| Surface Water and Seeps | 20 | Quarterly | Grab | See Appendix C |
| Surface Water—ERPP | 6/2 | Quarterly/Annually | Grab | See Appendix C |
| C-613 Sediment Basin | 1 | Quarterly | Grab | See Appendix C |
| | | | | |
| ***Sediment*** | | | | |
| Sediment | 14 | Semiannually | Grab | See Appendix C |
| Sediment—ERPP | 6 | Annually | Grab | See Appendix C |
| | | | | |
| ***Ambient Air*** | 9 | Weekly/Quarterly | N/A | See Appendix C |
| | | | | |
| ***Meteorologic***[b] | N/A | N/A | N/A | N/A |
| ***Environmental TLDs*** | 64 | Quarterly | Continuous | External Gamma |

[a] Four of the same wells are cited in both C-746-U and C-746-S&T Landfills permits. For these totals, the wells are counted for both programs. Also, for the C-746-S&T Landfills locations, the count of 25 wells includes 2 wells that are measured only for water level. The number of locations sampled for analytical laboratory parameters is 23 locations.

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

## 4.1 GROUNDWATER

### 4.1.1 Introduction

The Paducah Site, located in the Jackson Purchase region of western Kentucky, lies within the northern tip of the Mississippi Embayment portion of the Gulf Coastal Plain Province. The stratigraphic sequence in the region consists of Cretaceous, Tertiary, and Quaternary sediment unconformably overlying Paleozoic bedrock. The *Report of the Paducah Gaseous Diffusion Plant Groundwater Investigation Phase III* (Clausen et al. 1992) discusses geology and hydrogeology of the Paducah Site in detail. Additional information regarding the geology and hydrogeology at the Paducah Site is covered in the *Update of the Paducah Gaseous Diffusion Plant Sitewide Groundwater Flow Model* (PRS 2010) for PGDP. The most recent groundwater contaminant plume maps were developed in 2015 and are contained in *Trichloroethene and Technetium-99 Groundwater Contamination in the Regional Gravel Aquifer for Calendar Year 2014 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (LATA Kentucky 2015a).

### 4.1.2 Rationale and Design Criteria

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

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

The following addresses specific laws, regulations, and orders.

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

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

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

**Agreement in Principle Sampling.** The Agreement in Principle (AIP) provides sampling and inspection of the differing monitoring programs. The oversight includes inspections (including MW inspections and surface water area inspections), sample analysis, statistical analysis of sample results, and data quality. KDWM AIP personnel conduct independent groundwater 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.** The FFA among DOE, EPA, and the Commonwealth of Kentucky states that sampling of residential wells is required for those wells potentially affected by migration of the Northeast and Northwest Plumes. Another 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 operable units at the Paducah Site, as well as the sampling under this EMP.

The *Action Memorandum for the Water Policy at Paducah Gaseous Diffusion Plant* (Water Policy) (DOE 1994) stipulated the need to ensure that residential landowners whose well water was contaminated by PGDP sources were provided with water (DOE 1995; DOE 1993). The Water Policy was established in accordance with the Administrative Consent Order, following an Engineering Evaluation/Cost Analysis, and was written to document the preferred alternative addressing the need for protection of human health due to the presence of groundwater contamination originating from the Paducah Site. As soon as possible after contamination was found in local residential water supply wells, the affected households were supplied with bottled water. Construction of water mains allowed access to water lines for homes in the affected area. This was accomplished as a non-time-critical removal action under CERCLA. The Action Memorandum provided the sampling strategy only at the time the document was prepared and referred future sampling to the Sampling and Analysis Plan Addendum, which previously was superseded by the EMP. Currently, 29 wells are sampled in support of action (Figures C.8 and C.9).

The EMP also supplements the Paducah CERCLA RIs and ongoing remedial actions. Currently, there are five defined CERCLA OUs (i.e., surface water, groundwater, soils, burial grounds, and decontamination and decommissioning) that have been, or will be, investigated under the FFA. The EMP is integrated with each operable unit investigation to provide collection of optimal data sets.

**C-400 Program.** Sampling of MWs provides a meaningful tool for evaluating the downgradient dissolved-phase contamination in the Northwest Plume and the efficacy of the C-400 Interim Remedial Action (Figure C.7). MWs are required to be sampled by the *Remedial Action Work Plan for the Interim Remedial Action for the Volatile Organic Compound Contamination at the C-400 Cleaning Building* (DOE 2011). Additional sampling requirements are documented in PPPO-02-452-09, "Response to Letter from Kentucky Division of Waste Management Regarding Baseline Groundwater Sample Collection at the Northwest Corner of the C-400 Building," July 8, 2009.

**FFA Requirement and Operation and Maintenance (O&M) Plan for the Northwest and Northeast Plume Programs.** In order to monitor the nature and extent of groundwater contamination and to evaluate any cyclic trends in water quality that may affect contaminant migration, 33 wells are required to be sampled for the Northwest Plume (Figure C.6) and 16 for the Northeast Plume (Figure C.5), according to their respective O&M Plans.

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

#### 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 permits SW07300014 and SW07300015. The groundwater is monitored utilizing a total of 25 MWs near the two landfills (Figure C.2). 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 permitted (SW0730045), contained landfill; 21 MWs (Figure C.2) are monitored quarterly for organic, inorganic, and radiological parameters. Additional analytical information is found in Appendix C. Sampling and monitoring of treatment systems are not captured within this document because they are part of the daily operations of the landfill.

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

**C-404 Landfill.** The C-404 Hazardous Waste Landfill is currently subject to post-closure monitoring under EPA Hazardous Waste Permit KY8-890-008-982. The C-404 Hazardous Waste Landfill currently is being monitored under detection monitoring (semiannual sampling) according to permit requirements, including Attachment E of the permit, "Groundwater Monitoring." The groundwater is monitored utilizing nine MWs (Figure C.3). There are six downgradient and three upgradient compliance point wells. Per the permit, sample aliquots shall be withdrawn in the following order: volatiles, total metals, and radionuclides. Remaining permit requirements may follow the radionuclide sample collection. Samples are to be collected twice a year: January through March as one sampling event and July through September as the second event. Results from the January through March event are reported to KDWM by May 30 and results from the July through September event are reported to KDWM by November 30.

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

All groundwater wells (MWs, PZs, etc.) will be inspected annually during the second quarter of the calendar year. This is a change in cycle compared to the last year's EMP. The wells consistently have been inspected and evaluated for water level measurements in the third quarter of each calendar year. In order to evaluate temporal effects to the groundwater levels, the water level measurements and the inspections will be moved to the second quarter of calendar year 2016. The wells will be inspected for the condition of the Kentucky Groundwater Data Repository identification, the outer casing, the concrete pad, the bumper posts, painting, the well cap, the lettering and numbers, lock and hasp, well access, vegetation control, and well fittings and tubing. Items will be repaired, as necessary. The wells will be inspected annually for excessive sedimentation by performing a depth sounding at each MW. If a well is found no longer to meet the requirements of 401 *KAR* 34:060, the well will be abandoned in accordance with 401 *KAR* 6:350 and the Hazardous Waste Permit. If a replacement well is needed, it will be installed in accordance with 401 *KAR* 6:350 and the requirements of the Hazardous Waste Permit.

**C-746-K Landfill.** Sampling of three MWs (Figure C.4) is conducted to evaluate the potential impact of historical waste disposal activities at the C-746-K Landfill on the groundwater quality parameters, which are analyzed semiannually, as identified in Appendix C. The Record of Decision (ROD) for Waste Area Groups 1 and 7 (DOE 1997) discussed sampling that was being conducted at the time of the ROD development; however, the ROD allowed for modifications to the sampling strategy with documentation of the strategy in a Sampling and Analysis Plan addendum, which was replaced by the EMP. Sampling of these wells is not required by a permit, but is conducted in support of the FFA CERCLA investigation and RCRA facility investigations according to the FFA. Additional analytical information is found in Appendix C. An inspection of MW301, as part of the routine well maintenance program, identified an issue with the casing of the well. An evaluation was conducted to assess repair to the casing, and it was found that it would not be cost-effective for repair. A review of the data suggested that MW300 data is sufficient and that there is no value added in replacing MW301. MW301 was abandoned in August 2014.

#### 4.1.2.2 Surveillance monitoring program

**Environmental Surveillance (Annual and Biennial Monitoring) Program.** In order to monitor the nature and extent of groundwater contamination and to monitor groundwater quality, 97 nonbackground MWs are sampled biennially and 24 are monitored annually, as shown in Appendix C (Figure C.10). Sampling of these MWs is not driven by a permitted process, but is conducted in support of the FFA CERCLA investigations, as well as DOE O 436.1. The inclusion of these MWs in this program does not exclude them from other sampling programs. For ease of review, Appendix B of this document contains a well inventory list, which acts as a crosswalk for each MW and sampling program.

The sampling frequency for this program was modified in the FY 2011 EMP. The sampling frequency was modified from a quarter/semiannual basis to an annual/biennial basis. This modification was justified by an evaluation of the data collected over the last 10 years, which showed that there have not been significant changes that merited the need for sampling as frequently. The 25 MWs that were selected to be monitored annually were selected based on their location within the plumes. The 101 MWs that were selected to be monitored biennially were sampled in FY 2015; therefore, these wells will not be sampled in FY 2016. These MWs are included in Appendix C; however, they are shaded and denoted as not included in the FY 2016 sampling campaign.

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

**Environmental Surveillance (Geochemical Monitoring) Program.** In order to monitor the effects of natural attenuation of groundwater contamination and to monitor groundwater quality, 39 MWs are to be sampled every 3 years. 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 will be sampled in FY 2016 as part of the triennial basis sampling strategy.

### 4.1.3 Extent and Frequency of Monitoring

Appendix B provides information for all wells used at the Paducah Site, as well as residential wells located off-site. The groundwater sampling frequency and parameters, which are identified in Appendix C, are reviewed annually. The information detailed in Appendix C is the planning document for all monitoring and lists sites to be monitored, the governing program(s), MWs, parameters, analytical methods, required reporting limits (as applicable), and the sampling frequency.

### 4.1.4 Program Implementation Procedures

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

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

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

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

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

(d) Implementation schedules for the protection practices;

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

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

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

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

## 4.2 SURFACE WATER/SEDIMENT ENVIRONMENT

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

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

The Environmental Surveillance Watershed Monitoring Program at the Paducah Site for surface water and sediment has 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 permits 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. Data collected provide documentation of limited surface water impacts related to the site.

### 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, either off-site or upstream of the Paducah Site. 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

Surface water is sampled on a quarterly basis for PCBs and TCE at 19 locations upstream and downstream from Paducah Site operations (Figure C.15), as specified in KPDES permit (KY0004049). One seep location in Little Bayou Creek is sampled quarterly for TCE. Surface water monitoring at 19 locations for PCBs is specified by the KPDES permit.

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

#### 4.2.2.2 Sediment program

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

### 4.2.3 Program Implementation Procedures

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

## 4.3 TERRESTRIAL ENVIRONMENT

Woodlands, meadows, and cultivated fields dominate the rural landscape around the DOE Reservation. Immediately adjacent to the DOE Reservation is WKWMA, which is used by a considerable number of hunters, trappers, and anglers each year. Hunting and trapping activities may include such wildlife as

rabbit, deer, quail, raccoon, squirrel, dove, turkey, waterfowl, and beaver. Additionally, the Kentucky Department of Fish and Wildlife Resources sponsors field hunting trials for dogs within the WKWMA.

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

### 4.3.1 Rationale and Design Criteria

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

#### 4.3.1.1 Soils

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

#### 4.3.1.2 Animal products

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

#### 4.3.1.3 Food crops and vegetation

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

The Paducah Site estimates doses from food crops to the receptors based on these estimated airborne emissions. See Section 4.3.1 for air modeling information.

#### 4.3.1.4 Wildlife

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

## 4.4 EXTERNAL GAMMA RADIATION

The Paducah Site conducts routine surveillance of external gamma radiation exposure to monitor any effects due to past releases of radionuclides and current operations involving radioactive sources (e.g., depleted uranium hexafluoride cylinder management). Historical monitoring has shown that the external gamma radiation dose from routine DOE operations at the Paducah Site boundary is under 5 mrem per year ED (individual) and 100 person-rem per year ED (collective dose for exposed population). Routine surveillance of external gamma radiation with TLD monitors is conducted as a conservative measure to provide data to model direct external radiation from sources located on-site consistent with DOE O 458.1. Area gamma and neutron TLD monitoring near cylinder yards has been in place in previous years to meet 10 *CFR* § 835 requirements. To reduce the duplication of monitoring locations along the security fence, DOE O 458.1, environmental gamma TLD program, and the 10 *CFR* § 835, area TLD monitoring program, were combined. The neutron monitoring provides data to determine if there is any potential neutron dose from cylinders to members of the public. This program is contained within the FPDP radiological control organization.

### 4.4.1 Objectives

A primary objective is to calculate the ED of the maximally exposed individual member of the public.

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

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

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

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

### 4.4.2 Rationale and Design Criteria

The External Gamma 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 gamma radiation dose monitoring using TLDs. Devices of this type are capable of measuring exposure resulting from gamma radiation and are used throughout the industry to perform EM.

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

### 4.4.3 Extent and Frequency of Monitoring

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

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

Environmental gamma detection TLDs are located at 64 locations, including inside the PGDP security fence, PGDP perimeter, outfalls, ditches, and background locations (Figure C.17). TLDs 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 for External Gamma Radiation Monitoring, as well as in the ASER.

## 4.5 AMBIENT AIR

DOE complies with 40 *CFR* § 61, Subpart H, to control airborne emissions of radionuclides. This compliance includes evaluation of activities that have potential radionuclide emissions. For any activities that meet the definition of construction under 40 *CFR* § 61, Subpart A, or any activities such as fabrication, erection, or installation of a new building or structure within a facility that emits radionuclides, the potential emissions must be evaluated against the NESHAP requirements. If the EDE caused by all emissions from the new construction or modification within an existing facility is less than 1% of the standard prescribed in Section 61.92, then an application for approval under Section 61.07 or notification of startup under Section 61.09 does not need to be filed, per Section 61.96. The EDE shall be calculated in accordance with 40 *CFR* § 61, Subpart H.

DOE has identified several areas as potential fugitive and diffuse sources. Based on prior health physics data and historical ambient air monitoring, it is unlikely that any of these potential sources are significant; however, in accordance with methods utilized at other DOE facilities, DOE utilized ambient air monitoring data to verify levels of radionuclides in off-site ambient air. Ambient air data collected at sites surrounding the plant capture radionuclides from all sources, including fugitive and diffuse, as described in the Paducah Site NESHAP Management Plan, PAD-REG-1017. Historically, the Kentucky Cabinet for Health and Family Services (Radiation Health Branch) conducted this ambient air monitoring for the Paducah Site through grants from DOE. Beginning in July 2012, DOE began self-performing the air monitoring program and compared results with Kentucky Radiation and Health Branch. The results from the period of duplicate monitoring indicated comparable, consistent results. The network is comprised of nine air monitoring stations, including one background station (Figure C.18). Additional analytical information is found in Appendix C. Air monitoring data are reviewed and included in the NESHAP report and ASER.

Emissions from Paducah Site operations and any fugitive emissions historically have contributed little, if any, dose to the public. The ambient air concentration of radionuclides usually is below the detection ability of the ambient air stations. Since 2000, most of the ambient air monitoring stations have not detected any airborne radionuclides. The few detection results recorded have been below the 40 *CFR* § 61, Appendix E, Table 2, safe dose values. The CAP-88 model estimated dose reported in previous ASERs also has been much lower than the regulatory safe public dose standard of 10 mrem per year.

## 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

Biological monitoring of receiving streams at the Paducah Site was initiated in 1987 and has been revised periodically in response to results and permit requirements. While the KPDES permit (KY0004049) outlines requirements of the biological monitoring program, the KPDES permit (KY0004049) also requires that biological monitoring design and rationale be presented in the *Bayou Creek and Little Bayou Creek Watershed Monitoring Plan, Paducah Gaseous Diffusion Plant,* PAD-PROJ-0003 (WMP) (LATA Kentucky 2011a).

The site's WMP was modified in FY 2011. This modification eliminated the requirement for biological monitoring in the creeks surrounding the site. Because measured concentrations associated with radionuclides of concern at the Paducah Site in fish are low and there is an overall downward trend in the concentration of contaminants found at the Paducah Site due to remediation efforts, assessment of this pathway is not performed. The WMP requires that the watershed monitoring consist of the toxicity analysis conducted at the outfalls, as required by the KPDES permit (KY0004049). The toxicity analysis at the outfalls is discussed in Appendix C of this EMP. The justification for this elimination presented in the KPDES permit (KY0004049) is that, over the years, the watersheds have been extensively sampled to the point that further collection of aquatic organisms could result in a deleterious effect on the aquatic community; therefore, biological sampling no longer is required.

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# 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 maximally exposed individual 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 2015d). The Risk Methods Document states that during the DQO process for a specific project, risk analyses will be used to identify qualitatively the preliminary chemicals of potential concern, receptors that may be exposed to contaminants, locations at which exposure may occur, and pathways by which contaminants may reach these locations. This information will be used to develop the conceptual site model against which the new data collected can be compared. Exposure factors will be based on information contained in the Risk Methods Document or in consultation with project teams for site-specific parameters. In addition to the dose assessments in support of the ASER, individual projects also may perform dose assessments to establish bounding scenarios to ensure that any future public radiological exposures are maintained within the limits established in DOE Orders. The assumptions and parameters used in these project-specific assessments are found within the individual project technical derivations.

## 5.1 CONFORMANCE WITH STANDARDS FOR PUBLIC DOSE CALCULATIONS

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

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

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

## 5.2 MAJOR CONSIDERATIONS

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

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

| | |
|---|---|
| **Releases to water** | Remain dissolved or suspended in water<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.

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 in 1990. 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 information was compared to modeling results to identify the maximally exposed individual. Demographic data were obtained from the Bureau of the Census to document characteristics of the people who live near the site. As part of the management of the Water Policy, property surrounding the Paducah Site is evaluated annually to ensure that there have been no changes to property ownership.

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

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

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

Models and computer codes for evaluating public exposures to released radionuclides are codified or approved for use by DOE and selected based on (1) the applicability of the model to the situation being evaluated, (2) the degree to which the model has been documented and verified, and (3) the availability of the data needed to implement the model.

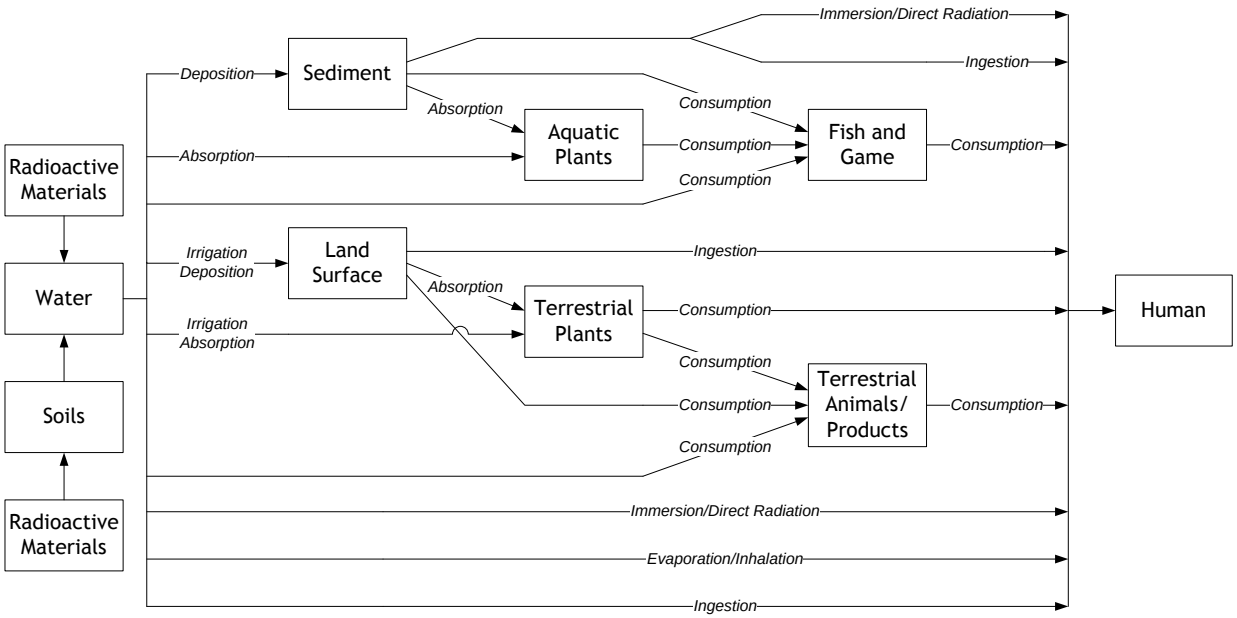


**Figure 2. Possible Pathways between Radioactive Material Released to the Water and Humans**

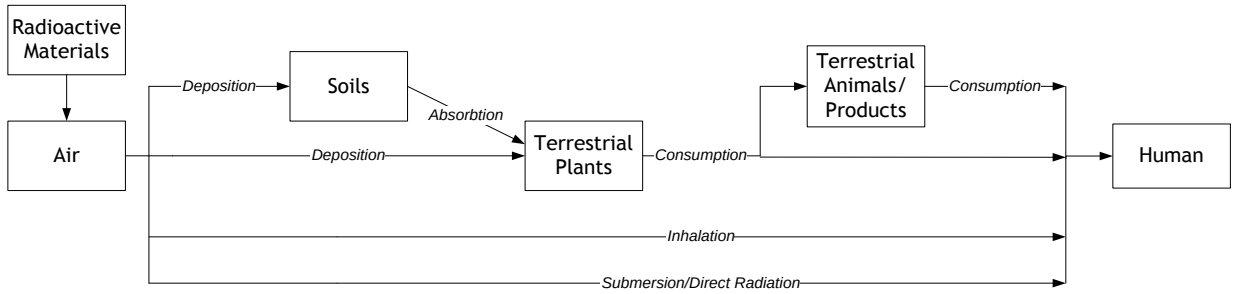


**Figure 3. Possible Pathways between Radioactive Materials Released to the Air and Humans**

## 5.3 TRANSPORT MODELS

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

### 5.3.1 Atmospheric Transport

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

Dose calculations on atmospheric releases are described in Section 5.4.1.

### 5.3.2 Water Transport

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

## 5.4 ENVIRONMENTAL PATHWAY MODELS

This section describes the methodologies that are used to characterize mechanisms for human uptake and exposure to the radiological contaminant concentrations described in Section 5.3. As in Section 5.3, both modeling and sampling are used to obtain contaminant concentrations in media and foods to which humans may be exposed. In addition, environmental gamma radiation exposure is measured through a TLD 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 directives. The DOE contribution to airborne radioactivity from DOE operations at the Paducah Site normally is too low to be detected in the presence of natural background radiation in the environment; therefore, as required under 40 *CFR* § 61, Subpart H, potential doses to the public from point sources also are calculated with a dispersion model. This model calculates how measured quantities of released radionuclides mix with the atmosphere, where they travel, and where they could deposit. Once the dispersion is calculated, population data and concentration/dose conversion factors are used to calculate individual and population doses. These doses include exposure from all the pathways represented in Figure 3, although the primary route of exposure is inhalation. The ambient air monitoring data collected from the ambient air monitoring network are used to assess the impact of emissions of all point and fugitive sources.

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

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

### 5.4.2 Contaminants in Water

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

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

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

Surface water is not used for drinking or irrigation near the plant. In 1990, a survey of surface water and groundwater users in the vicinity of the Paducah Site was conducted to determine the number of residents using water wells within a 4-mile radius and to determine the number of surface water intakes on the Ohio River within 15 miles downstream of the plant. No residents or businesses that responded to the survey questionnaire reported using a private surface water intake on the Ohio River, Bayou Creek, or Little Bayou Creek for any part of their water supply. Private groundwater wells were the major water supply for residents surrounding the Paducah Site. Most residents reported using water from their residential wells for drinking, irrigation, and domestic uses. As part of the management of the Water Policy, property surrounding the Paducah Site is evaluated annually to ensure there have been no changes to property ownership.

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

Dose calculations are made for the drinking water pathway if measurable concentrations of radionuclides are found in water samples collected from drinking water systems. Cairo, Illinois, about 36 miles downstream on the Ohio River, has the nearest drinking water intake to the plant. The dose to a resident from drinking water ingestion is evaluated based on environmental surveillance data, which includes a sample taken at Cairo, Illinois. If site environmental surveillance data is insufficient to meet the requirements of 40 *CFR* § 141 and DOE Order 458.1, additional samples may be taken at the water intake of the drinking water system. Members of the public (adult) are assumed to ingest 2.5 liters per day of drinking water per the Risk Methods Document (DOE 2015d).

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

### 5.4.3 Contaminants in Sediment

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

External irradiation from contaminated sediment in Little Bayou Creek is a pathway of potential importance. Sediment is known to contain uranium isotopes, Np-237 and Pu-239. Radionuclides deposited on the shores of rivers or creeks may accumulate over a period of time, leading to external irradiation of persons standing on contaminated surfaces. The amount of the nuclides built up on the shoreline depends on the concentration in the water, the depth of deposit, and the length of the period of buildup. The dose to persons depends on the time spent near the contaminants. This exposure time is expected to be minimal because signs are posted in this area stating that prolonged exposure could result in a dose above background.

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

## 5.5 CONTAMINANTS IN SOIL

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

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

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

## 5.6 CONTAMINANTS IN OR ON FOOD CROPS

A portion of the airborne radionuclides is estimated to be deposited in soil and on food crops where they may be absorbed into food crops. These food crops then may be ingested by the public. The Paducah Site estimates doses from food crops to the receptors based on these estimated airborne emissions. AIRDOS-EPA computer code contained in the latest version of CAP-88, which implements a steady-state, Gaussian plume, atmospheric dispersion model, is used to calculate environmental

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

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

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

## 5.7 CONTAMINANTS IN TERRESTRIAL ANIMALS AND FISH

Contaminants may accumulate in animals from eating contaminated feed, drinking contaminated water, and breathing contaminated air. Contaminants may accumulate in fish when they eat contaminated foods and equilibrate with surrounding waters. Indirect pathways for human exposure to contaminants in animals and fish are eating meat and fish. Because both measured concentrations and bioconcentration factors associated with radionuclides of concern at the Paducah Site in animals and fish are low, assessments of these pathways are not performed.

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

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

During the 20-year period of deer harvesting at the site, dose assessments from the ingestion of deer meat were performed using measured concentrations of contaminants. In 2011, an evaluation was conducted of the data sets from the years of deer harvesting events (LATA Kentucky 2011b). As a result of this review, the deer harvest was eliminated because of a downward trend and a continued lack of detection in the results, as well as an overall downward trend in the concentration of contaminants found at the Paducah Site due to remediation efforts. The elimination of the deer harvest program was documented in the FY 2012 EMP and is not referenced in Appendix C.

**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.

## 5.8 INTERNAL DOSIMETRY MODELS

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

## 5.9 RADIATION DOSE TO AQUATIC AND TERRESTRIAL BIOTA

Compliance with DOE-STD-1153-2002, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota*, regarding the absorbed dose rate limit to native organisms (e.g., invertebrates, fish, raccoons, and muskrats) is demonstrated using generally accepted methods of dose calculation. Current practice estimates absorbed doses by multiplying measured radionuclide concentrations in surface waters by internationally recognized, organism-specific dose rate factors for external and internal exposures (NRCC 1983) and summing the external and internal contributions. Results from this study are included in the ASER.

## 5.10 REPORTS AND RECORDS

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

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

# 6. REPORTS

## 6.1 INTRODUCTION

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

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

## 6.2 REPORTING REQUIREMENTS

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

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

**Table 4. Applicable Reporting Requirements**

| Reporting | Due Date | Source of Requirement | Requirement |
|---|---|---|---|
| ASER | October 1 | DOE O 231.1B and DOE O 458.1 (and ERPP) | All DOE facilities that conduct significant environmental protection programs shall prepare an ASER for DOE. The report must provide a comprehensive review of the environmental surveillance programs, status of environmental compliance, and effluent data for nonradioactive pollutants. |
| Annual NESHAP Compliance Report | June 30 | NESHAP 40 *CFR* § 61 Subpart H | Reporting shall include results from monitoring of radionuclide emissions to the ambient air, as well as, required dose calculations. Ambient air monitoring data are included in the NESHAP reports for assessment of fugitive and diffuse emission sources. |
| Discharge Monitoring Report | Monthly and Quarterly | Clean Water Act | Discharge Monitoring Reports are required for compliance with KPDES permits (KY0004049 and KY0102083). |

**Table 4. Applicable Reporting Requirements (Continued)**

| Reporting | Due Date | Source of Requirement | Requirement |
|---|---|---|---|
| Toxicity Report | Monthly for K017 and Quarterly for Remaining Outfalls | Clean Water Act | Toxicity reports are required for compliance with KPDES permits (KY0004049 and KY0102083). |
| Annual PCB Document | July 1 | 40 *CFR* § 761.180 | The Annual PCB Document is required for PCBs in use and PCB wastes. |
| SARA Section 313 | June 1 | SARA Title III | Covered facilities (see above) shall report to EPA and the Commonwealth of Kentucky, all environmental releases of specified toxic chemicals that are manufactured, processed, or otherwise used in excess of specified thresholds. |
| SARA Section 312 | March 1 | SARA Title III | Annual Hazardous Chemical Inventory Report. |
| C-746-U Landfill Compliance Monitoring Report | Quarterly | 401 *KAR* 47:130 | This report is required in accordance with landfill solid waste permit SW07300045. |
| Landfill Quarterly Operating Report | Quarterly | 401 *KAR* 47:130 | This report is required in accordance with landfill solid waste permit SW07300014, SW07300015, and SW07300045. |
| C-746-S&T Landfills Compliance Monitoring Report | Quarterly | 401 *KAR* 47:130 | This report is required in accordance with landfill solid waste permits SW07300014 and SW07300015. |
| Semiannual C-404 Landfill Groundwater Monitoring Report | May, November | 401 *KAR* 34:060 | This report is required in accordance with Paducah hazardous waste permit KY8-890-008-982. |
| Environmental Monitoring Plan | October 1 Annually | DOE O 436.1 DOE O 458.1 (and ERPP) | Requires a plan to ensure the site's sustainability; characterize the exposures and doses to individuals and to the population; and evaluate the potential impacts to the biota in the vicinity of DOE activity. |
| Groundwater Protection Plan | Three Years; Last Updated May 2015 | 401 *KAR* 5:037 | Requires a plan to ensure protection for all current and future uses of groundwater and to prevent groundwater pollution. |
| Best Management Practices Plan | Five Years; Last Updated March 2015 | KPDES permit (KPDES permit is required by the Clean Water Act) | This plan is required by KPDES permits (KY0004049 and KY0102083). |
| Spill Prevention Control and Countermeasure (SPCC) Plan | Three Years; Last Updated November 2014 | 40 *CFR* § 112 | Requires regulated facilities to prepare and implement a SPCC. The purpose of a SPCC Plan is to form a comprehensive spill prevention program that minimizes the potential for discharges. |
| Annual External Gamma Monitoring Report | March 1 | DOE O 458.1 (and ERPP) | This report estimates the external gamma dose on an annual basis; summary info also is included in the ASER. |
| FFA Semiannual Report | April 30 October 30 | FFA | This report is required by the FFA. Data generated in many of the sampling programs referenced in Appendix C are reported in this report. |

# 7. REFERENCES


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# APPENDIX A

# PADUCAH PERMIT SUMMARY

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

| Permit Type | Issuer | Expiration Date | Permit Number | Permittee | Transition Action Required |
|---|---|---|---|---|---|
| **AIR** | | | | | |
| Title V Air Permit | Kentucky Division of Air Quality | 2/25/2020 | V-14-012R1 | Fluor Federal Services, Inc. (FFS) | No Action |
| **WATER** | | | | | |
| Kentucky Pollutant Discharge Elimination System (KPDES) | Kentucky Division of Water (KDOW) | 10/31/2011[a] | KY0004049 | U.S. Department of Energy (DOE), LATA Environmental Services of Kentucky, LLC, (LATA Kentucky) and B&W Conversion Services, LLC | Change LATA Kentucky to FFS Transfer Agreement Transfer Form DEP 7032-CO |
| KPDES | KDOW | 3/31/2013[b] | KY0102083 | DOE/FFS | No Action |
| Permit to Withdraw Public Water | KDOW | N/A | 0900 | FFS | No Action |
| Water Treatment Registration (Public Water System) | KDOW | N/A | PWS No. 0732457 | FFS | No Action |
| **SOLID WASTE** | | | | | |
| C-746-S Residential Landfill (Closed) | Kentucky Division of Waste Management (KDWM) | 11/04/2016 | SW07300014 | DOE/LATA Kentucky | Change LATA Kentucky to FFS per 401 *KAR* 47:130 § 1, Transfer of Permits Submit FFS delegations |
| C-746-T Inert Landfill (Closed) | KDWM | 11/04/2016 | SW07300015 | DOE/LATA Kentucky | Change LATA Kentucky to FFS per 401 *KAR* 47:130 § 1, Transfer of Permits Submit FFS delegations |
| C-746-U Solid Waste Landfill | KDWM | 11/04/2016 | SW07300045 | DOE/LATA Kentucky | Change LATA Kentucky to FFS per 401 *KAR* 47:130 § 1, Transfer of Permits Submit FFS delegations |

## U.S. DEPARTMENT OF ENERGY PERMIT SUMMARY FOR THE PADUCAH GASEOUS DIFFUSION PLANT (CONTINUED)

| Permit Type | Issuer | Expiration Date | Permit Number | Permittee | Transition Action Required |
|---|---|---|---|---|---|
| **RCRA** | | | | | |
| Hazardous Waste Facility Operating Permit | KDWM | 8/22/2025 | KY8-890-008-982 | DOE/LATA Kentucky | Change LATA Kentucky to FFS per 401 *KAR* 3 § 1, Transfer of Permits Submit FFS delegations |
| Hazardous and Solid Waste Amendments (HSWA) Portion of the RCRA Permit | EPA | 04/23/2016 | KY8-890-008-982 | DOE/LATA Kentucky | Change LATA Kentucky to FFS Transfer Letter/Agreement |

[a] The renewal application for KPDES permit KY0004049 was filed with KDOW in May 2011. The requirements in the current permit will be followed until issuance of the renewed permit.
[b] The renewal application for KPDES permit KY0102083 was filed with KDOW in October 2002. The requirements in the current permit will be followed until issuance of the renewed permit.

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

| Agreement | Effective Date | Expiration Date | Entities |
|---|---|---|---|
| TSCA FFCA (Toxic Substances Control Act Federal Facility Compliance Agreement) | 02/1992 | To be determined | EPA and DOE |
| FFCA Agreed Order/Site Treatment Plan | 09/1997 | 2015 | 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 |

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# APPENDIX B

# WELL PROGRAM INVENTORY

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# ACRONYMS

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

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Table B.1 includes 336 monitoring wells (MWs) 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 |
| MW6 | Unknown | AB 88 | NA | NA | NA | NA |
| MW7 | UCRS | AB 94 | NA | NA | NA | NA |
| MW8 | RGA | AB 94 | NA | NA | NA | NA |
| MW9 | RGA | AB 94 | NA | NA | NA | NA |
| MW10 | RGA | AB | NA | NA | NA | NA |
| MW11 | UCRS | AB 94 | NA | NA | NA | NA |
| MW12 | RGA | AB 94 | NA | NA | NA | NA |
| MW13 | UCRS | AB 94 | NA | NA | NA | NA |
| MW14 | UCRS | AB 94 | NA | NA | NA | NA |
| MW15 | RGA | AB 94 | NA | NA | NA | NA |
| MW16 | UCRS | AB 94 | NA | NA | NA | NA |
| MW17 | RGA | AB 94 | NA | NA | NA | NA |
| MW18 | UCRS | AB 94 | NA | NA | NA | NA |
| MW19 | RGA | AB 94 | NA | NA | NA | NA |
| MW20 (also R4) | RGA | Current | KDFWR | NA | A | A |
| MW21 | RGA | AB 94 | NA | NA | NA | NA |
| MW22 | RGA | AB 94 | NA | NA | NA | NA |
| MW23 | Porters Creek Clay Well | AB 94 | NA | NA | NA | NA |
| MW24 | Porters Creek Clay Well | AB 94 | NA | NA | NA | NA |
| MW25 | Porters Creek Clay Well | AB 94 | NA | NA | NA | NA |
| MW26 | Porters Creek Clay Well | AB 94 | NA | NA | NA | NA |
| MW27 | Porters Creek Clay Well | AB 94 | NA | NA | NA | NA |
| MW28 | UCRS | AB 94 | NA | NA | NA | NA |
| MW29 | UCRS | AB 94 | NA | NA | NA | NA |
| MW30 | UCRS | AB 94 | NA | NA | NA | NA |
| MW31 | UCRS | AB 94 | NA | NA | NA | NA |
| MW32 | UCRS | AB 94 | NA | NA | NA | NA |
| MW33 | UCRS | AB | NA | NA | NA | NA |
| MW34 | UCRS | AB 94 | NA | NA | NA | NA |
| MW35 | UCRS | AB 94 | NA | NA | NA | NA |
| MW36 | UCRS | AB 94 | NA | NA | NA | NA |
| MW37 | UCRS | AB 94 | NA | NA | NA | NA |
| MW38 | RGA | AB 94 | NA | NA | NA | NA |
| MW39 | RGA | AB 94 | NA | NA | NA | NA |
| MW40 | 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 |
|---|---|---|---|---|---|---|
| MW41 | RGA | AB 94 | NA | NA | NA | NA |
| MW42 | RGA | AB 94 | NA | NA | NA | NA |
| MW43 | RGA | AB 94 | NA | NA | NA | NA |
| MW44 | RGA | AB 94 | NA | NA | NA | NA |
| MW45 | RGA | AB 87 | NA | NA | NA | NA |
| MW46 | RGA | AB 94 | NA | NA | NA | NA |
| MW47 | UCRS | AB 94 | NA | NA | NA | NA |
| MW48 | RGA | AB 94 | NA | NA | NA | NA |
| MW49 | UCRS | AB 94 | NA | NA | NA | NA |
| MW50 | RGA | AB 94 | NA | NA | NA | NA |
| MW51 | RGA | AB 94 | NA | NA | NA | NA |
| MW52 | RGA | AB 94 | NA | NA | NA | NA |
| MW53 | RGA | AB 94 | NA | NA | NA | NA |
| MW54 | RGA | AB 94 | NA | NA | NA | NA |
| MW55 | RGA | AB 87 | NA | NA | NA | NA |
| MW56 | UCRS | AB 87 | NA | NA | NA | NA |
| MW57 | UCRS | AB 94 | NA | NA | NA | NA |
| MW58 | UCRS | AB 90 | NA | NA | NA | NA |
| MW59 | RGA | AB | NA | NA | NA | NA |
| MW60 | UCRS | AB | NA | NA | NA | NA |
| MW61 | RGA | AB | NA | NA | NA | NA |
| MW62 | RGA | AB | NA | NA | NA | NA |
| MW63 | RGA | Current | DOE | GWNWSA | A | A |
| MW64 | UCRS | Current | DOE | NS | A | A |
| MW65 | RGA | Current | DOE | GWNWSA | A | A |
| MW66 | RGA | Current | DOE | GWNWSA | A | A |
| MW67 | RGA | Current | DOE | GWESBA, 404G | A, Q | A |
| MW68 | RGA | Current | DOE | NS | A | A |
| MW69 | UCRS | Current | DOE | NS | A | A |
| MW70 | RGA | AB 94 | NA | NA | NA | NA |
| MW71 | RGA | Current | DOE | NS | A | A |
| MW72 | RGA | Current | DOE | NS | A | A |
| MW73 | RGA | Current | DOE | NS | A | A |
| MW75 | UCRS | Current | DOE | NS | A | A |
| MW76 | RGA | Current | DOE | GWESBA, 404G | A, Q | A |
| MW77 | RGA | Current | DOE | NS | A | A |
| MW78 | RGA | Current | DOE | NS | A | A |
| MW79 | RGA | Current | DOE | NS | A | A |
| MW80 | RGA | Current | DOE | NS | A | A |
| MW81 | RGA | Current | DOE | NS | A | A |
| MW82 | UCRS | Current | DOE | NS | A | A |
| MW83 | UCRS | Current | DOE | NS | A | A |
| MW84 | RGA | Current | DOE | 404G | A, Q | A |
| MW85 | UCRS | Current | DOE | 404G | A, Q | A |
| MW86 | RGA | Current | DOE | GWESBA, 404G | A, Q | A |
| MW87 | RGA | Current | DOE | 404G | A, Q | A |
| MW88 | UCRS | Current | DOE | 404G | A, Q | A |
| MW89 | RGA | Current | DOE | GWESBA, 404G | A, Q | A |

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

| Well Number | Screened Zone | Status | Property Where Located | Sampled | Water Level | Inspection |
|---|---|---|---|---|---|---|
| MW90 | RGA | AB 2001 | NA | NA | NA | NA |
| MW90A | RGA | Current | DOE | 404G | A, Q | A |
| MW91 | UCRS | Current | DOE | 404G | A, Q | A |
| MW92 | RGA | Current | DOE | GWESBA, 404G | A, Q | A |
| MW93 | RGA | Current | DOE | 404G | A, Q | A |
| MW94 | UCRS | Current | DOE | 404G | A, Q | A |
| MW95 | RGA | AB 2001 | NA | NA | NA | NA |
| MW95A | RGA | Current | DOE | GWESBA, 404G | A, Q | A |
| MW96 | UCRS | Current | DOE | NS | A | A |
| MW97 | RGA | AB 97 | NA | NA | NA | NA |
| MW98 | RGA | Current | DOE | GWESA | A, Q | A |
| MW99 | RGA | Current | TVA | GWESA, GC | A | A |
| MW100 | RGA | Current | TVA | GWESA, GC | A, Q | A |
| MW102 | McNairy | Current | DOE | NS | A | A |
| MW103 | RGA | Current | DOE | GWESBA | A | A |
| MW104 | UCRS | AB 96 | NA | NA | NA | NA |
| MW105 | RGA | AB | NA | NA | NA | NA |
| MW106 | RGA | AB 2014 | NA | NA | NA | NA |
| MW106A | RGA | Current | DOE | GWESBA, WPB-NW | A | A |
| MW108 | RGA | Current | DOE | NS | A | A |
| MW119 | RGA | AB | NA | NA | NA | NA |
| MW120 | McNairy | Current | DOE | NS | A | A |
| MW121 | McNairy | Current | KDFWR | NS | A | A |
| MW122 | McNairy | Current | DOE | NS | A | A |
| MW123 | RGA | Current | KDFWR | NS | A | A |
| MW124 | RGA | Current | DOE | GWNESA | A | A |
| MW125 | RGA | Current | KDFWR | GWESBA, GC | A, Q | A |
| MW126 | RGA | Current | DOE | GWNESA | A | 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 | RGA | Current | DOE | NS | A | A |
| MW133 | McNairy | Current | TVA | NS | A | A |
| MW134 | RGA | Current | KDFWR | GWESBA, GC, WPB-NW | A | A |
| MW135 | RGA | Current | TVA | GWESBA | A | A |
| MW136 | UCRS | AB | NA | NA | NA | NA |
| MW137 | RGA | Current | TVA | NS | A | A |
| MW138 | UCRS | Current | TVA | NS | A | A |
| MW139 | RGA | Current | DOE | GWESBA | A, Q | A |
| MW140 | McNairy | AB | NA | NA | NA | NA |
| MW141 | RGA | AB 98 | NA | NA | NA | NA |
| MW142 | RGA | AB 98 | NA | NA | NA | NA |
| MW143 | UCRS | AB 98 | NA | NA | NA | NA |
| MW144 | RGA | Current | DOE | NS | A | A |
| MW145 | RGA | Current | DOE | GWNESA, GC | A | A |

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

| Well Number | Screened Zone | Status | Property Where Located | Sampled | Water Level | Inspection |
|---|---|---|---|---|---|---|
| MW146 | RGA | Current | TVA | GWESBA, WPB-NW | A | A |
| MW147 | RGA | Current | TVA | NS | A | A |
| MW148 | RGA | Current | Private—Residential | GWESBA | A | A |
| MW149 | UCRS | Current | Private—Residential | GWESBA | A | A |
| MW150 | RGA | Current | Private—Residential | GWESA | A | A |
| MW151 | Terrace Gravels | Current | Private—Residential | NS | A | A |
| MW152 | RGA | Current | TVA | GWESA, GC | A | A |
| MW153 | UCRS | Current | TVA | NS | A | A |
| MW154 | UCRS | Current | DOE | NS | A | A |
| MW155 | RGA | Current | DOE | 400GQ | A | A |
| MW156 | RGA | Current | DOE | 400GQ | A | A |
| MW157 | UCRS | Current | DOE | NS | A | A |
| MW158 | RGA | AB 99 | NA | NA | NA | NA |
| MW159 | RGA | AB 99 | NA | NA | NA | NA |
| MW160 | UCRS | AB 99 | NA | NA | NA | NA |
| MW161 | RGA | Current | DOE | GWESA, GC | A | A |
| MW162 | UCRS | Current | DOE | NS | A | A |
| MW163 | RGA | Current | DOE | GWESBA, GC | A | A |
| MW164 | UCRS | Current | DOE | NS | A | A |
| MW165 | RGA | AB 2014 | NA | NA | NA | NA |
| MW165A | RGA | Current | DOE | GWNWSA | A, Q | A |
| MW166 | UCRS | Current | DOE | NS | A | A |
| MW167 | UCRS | Current | DOE | NS | A | A |
| MW168 | RGA | Current | DOE | GWESBA | A | A |
| MW169 | RGA | Current | DOE | GWESBA | A | A |
| MW170 | UCRS | Current | DOE | NS | A | A |
| MW171 | UCRS | Current | DOE | NS | A | A |
| MW172 | UCRS | Current | DOE | NS | A | A |
| MW173 | RGA | Current | DOE | GWNWSA | A, Q | A |
| MW174 | UCRS | Current | DOE | GWESBA | A | A |
| MW175 | RGA | Current | DOE | 400GSA | A | A |
| MW176 | UCRS | Current | DOE | NS | A | A |
| MW177 | UCRS | Current | DOE | NS | A | A |
| MW178 | RGA | Current | DOE | NS | A | A |
| MW179 | RGA | AB 2003 | NA | NA | NA | NA |
| MW180 | UCRS | Current | DOE | NS | A | A |
| MW181 | RGA | AB 2000 | NA | NA | NA | NA |
| MW182 | UCRS | Current | DOE | GWESA | A | A |
| 183, Not Installed | NA | NA | NA | NA | NA | NA |
| MW184 | UCRS | AB 98 | NA | NA | NA | NA |
| MW185 | RGA | Current | DOE | NS | A | A |
| MW186 | UCRS | Current | DOE | GWESBA | A | A |
| MW187 | UCRS | Current | DOE | GWESBA | A | A |
| MW188 | RGA | Current | DOE | GC | A | A |
| MW189 | UCRS | Current | DOE | NS | A | A |
| MW190 | UCRS | Current | DOE | NS | A | A |
| MW191 | RGA | Current | DOE | GWESA | A | A |

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

| Well Number | Screened Zone | Status | Property Where Located | Sampled | Water Level | Inspection |
|---|---|---|---|---|---|---|
| MW192 | UCRS | Current | DOE | NS | A | A |
| MW193 | RGA | Current | DOE | GWESBA, GC | A, Q | A |
| MW194 | RGA | Current | KDFWR | GWESBA, WPB-NW | A | A |
| MW195 | UCRS | AB 94 | NA | NA | NA | NA |
| MW196 | Terrace Gravels | Current | DOE | NS | A | A |
| MW197 | RGA | Current | DOE | GWESBA | A, Q | A |
| MW198 | UCRS | Current | DOE | NS | A | A |
| MW199 | RGA | Current | Private—Residential | GWESBA, WPB-NW | A | A |
| MW200 | RGA | Current | KDFWR | GWESBA | A, Q | A |
| MW201 | RGA | Current | KDFWR | GWESBA, GC, WPB-NW | A | A |
| MW202 | RGA | Current | KDFWR | GWESBA, WPB-NW | A | A |
| MW203 | RGA | Current | DOE | GWESA | A | A |
| MW204 | UCRS | Current | DOE | NS | A | A |
| MW205 | RGA | Current | DOE | GWESBA | A | A |
| MW206 | RGA | AB 2014 | NA | NA | NA | NA |
| MW207 | UCRS | Current | DOE | NS | A | A |
| MW208 | UCRS | AB 2012 | NA | NA | NA | NA |
| MW209 | UCRS | Current | DOE | NS | A | A |
| MW210 | UCRS | Current | DOE | NS | A | A |
| MW211 | UCRS | Current | DOE | NS | A | A |
| MW212 | UCRS | Current | DOE | NS | A | A |
| MW213 | UCRS | Current | DOE | NS | A | A |
| MW214 | UCRS | Current | DOE | NS | A | A |
| MW215 | UCRS | Current | DOE | NS | A | A |
| MW216 | UCRS | Current | DOE | NS | A | A |
| MW217 | UCRS | Current | DOE | NS | A | A |
| MW218 | UCRS | Current | DOE | NS | A | A |
| MW219 | UCRS | Current | DOE | NS | A | A |
| MW220 | RGA | Current | DOE | SG | A, Q | A |
| MW221 | RGA | Current | DOE | SG | A, Q | A |
| MW222 | RGA | Current | DOE | SG | A, Q | A |
| MW223 | RGA | Current | DOE | SG | A, Q | A |
| MW224 | RGA | Current | DOE | SG | A, Q | A |
| MW225 | RGA | Current | DOE | NS | A, Q | A |
| MW226 | RGA | Current | DOE | GWESBA, 404G | A, Q | A |
| MW227 | RGA | Current | DOE | GWESBA, 404G | A, Q | A |
| 232, Not Installed | NA | NA | NA | NA | NA | NA |
| MW233 | RGA | Current | KDFWR | GWESA | A | A |
| MW234 | RGA | AB 2002 | NA | NA | NA | NA |
| MW235 | RGA | AB 2002 | NA | NA | NA | NA |
| MW236 | RGA | Current | KDFWR | GWESA | A | A |
| MW237 | UCRS | Current | KDFWR | NS | A | A |
| MW238 | RGA | Current | KDFWR | NS | A | A |
| MW239 | McNairy | Current | KDFWR | NS | A | A |

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

| Well Number | Screened Zone | Status | Property Where Located | Sampled | Water Level | Inspection |
|---|---|---|---|---|---|---|
| MW240 | RGA | Current | KDFWR | GWESA | A | A |
| MW241 | RGA | AB 2003 | NA | NA | NA | NA |
| MW241A | RGA | Current | KDFWR | NS | A | A |
| MW242 | RGA | Current | DOE | GWNWSA, GC | A | A |
| MW243 | RGA | Current | DOE | GWNWSA | A | A |
| MW244 | RGA | Current | DOE | GWNWSA | A | A |
| MW245 | RGA | Current | DOE | GWNWSA | A | A |
| MW246 | UCRS | Current | DOE | NS | A | A |
| MW247 | McNairy | Current | DOE | NS | A | A |
| MW248 | RGA | Current | DOE | GWNWSA | A | A |
| MW249 | RGA | Current | DOE | NS | A | A |
| MW250 | RGA | Current | DOE | GWNWSA | A | A |
| PZ251 | UCRS | Current | DOE | NS | A | A |
| MW252 | RGA | Current | Private—Residential | GWESA | A | A |
| MW253 | RGA | Current | Private—Residential | GWESA | A | A |
| 254, Not Installed | NA | NA | NA | NA | NA | NA |
| MW255 | RGA | Current | DOE | GWNEQ | A | A |
| MW256 | RGA | Current | DOE | GWNEQ, GC | A | A |
| MW257 | RGA | Current | DOE | GC | A | A |
| MW258 | RGA | Current | DOE | GWNEQ, GC | A | A |
| 259, Not Installed | NA | NA | NA | NA | NA | NA |
| MW260 | RGA | Current | DOE | GWESBA, GC | A | A |
| MW261 | RGA | Current | DOE | GWESA, GC | A | A |
| MW262 | RGA | Current | DOE | GWESBA | A | A |
| MW263 | RGA | AB 2003 | NA | NA | NA | NA |
| MW264 | RGA | AB 2003 | NA | NA | NA | NA |
| MW265 | RGA | AB 2000 | NA | NA | NA | NA |
| MW266 | RGA | AB 2003 | NA | NA | NA | NA |
| MW267 | RGA | AB 2003 | NA | NA | NA | NA |
| MW268 | RGA | AB 2002 | NA | NA | NA | NA |
| MW269 | RGA | AB 2002 | NA | NA | NA | NA |
| MW270 | RGA | AB 2000 | NA | NA | NA | NA |
| MW271 | RGA | AB 2002 | NA | NA | NA | NA |
| MW272 | RGA | AB 2002 | NA | NA | NA | NA |
| MW273 | RGA | AB 2002 | NA | NA | NA | NA |
| MW274 | RGA | AB 2002 | NA | NA | NA | NA |
| MW275 | RGA | AB 2002 | NA | NA | NA | NA |
| MW276 | RGA | AB 2002 | NA | NA | NA | NA |
| MW277 | RGA | AB 2000 | NA | NA | NA | NA |
| MW283 | RGA | Current | DOE | GWNESA | A | A |
| MW284 | RGA | Current | DOE | NS | A | A |
| 285, Not Installed | NA | NA | NA | NA | NA | NA |
| 286, Not Installed | NA | NA | NA | NA | NA | NA |
| MW288 | RGA | Current | DOE | GWNEQ, GC | A | A |
| MW291 | RGA | Current | DOE | GWNESA | A | A |
| MW292 | RGA | Current | DOE | GWNEQ, GC | A | A |
| MW293 | RGA | AB 2003 | NA | NA | NA | NA |
| MW293A | RGA | Current | DOE | GWNESA | A | A |

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

| Well Number | Screened Zone | Status | Property Where Located | Sampled | Water Level | Inspection |
|---|---|---|---|---|---|---|
| MW294 | RGA | AB 2003 | NA | NA | NA | NA |
| MW294A | RGA | Current | DOE | NS | A | A |
| 295, Not Installed | NA | NA | NA | NA | NA | NA |
| 296, Not Installed | NA | NA | NA | NA | NA | NA |
| 297, Not Installed | NA | NA | NA | NA | NA | NA |
| 298, Not Installed | NA | NA | NA | NA | NA | NA |
| 299, Not Installed | NA | NA | NA | NA | NA | NA |
| MW300 | Terrace Gravels | Current | DOE | KG | A | A |
| MW301 | Terrace Gravels | AB 2014 | NA | NA | NA | NA |
| MW302 | Terrace Gravels | Current | DOE | KG | A | A |
| MW303 | Terrace Gravels | AB 94 | NA | NA | NA | NA |
| MW304 | Terrace Gravels | Current | DOE | NS | A | A |
| MW305 | Eocene | Current | DOE | GWESBA | A | A |
| MW306 | Eocene | Current | DOE | NS | A | A |
| MW307 | Eocene | Current | DOE | NS | A | A |
| MW308 | Eocene | Current | DOE | NS | A | A |
| MW309 | Terrace Gravels | Current | DOE | NS | A | A |
| MW310 | Terrace Gravels | Current | DOE | NS | A | A |
| MW311 | Terrace Gravels | Current | DOE | NS | A | A |
| MW312 | UCRS | Current | DOE | NS | A | A |
| MW313 | UCRS | Current | DOE | NS | A | A |
| MW314 | UCRS | Current | DOE | NS | A | A |
| MW315 | UCRS | Current | DOE | NS | A | A |
| MW316 | UCRS | Current | DOE | NS | A | A |
| MW317 | Terrace Gravels | Current | DOE | NS | A | A |
| MW318 | Terrace Gravels | Current | DOE | NS | A | A |
| 319, Not Installed | NA | NA | NA | NA | NA | NA |
| 320, Not Installed | NA | NA | NA | NA | NA | NA |
| 321, Not Installed | NA | NA | NA | NA | NA | NA |
| 322, Not Installed | NA | NA | NA | NA | NA | NA |
| 323, Not Installed | NA | NA | NA | NA | NA | NA |
| 324, Not Installed | NA | NA | NA | NA | NA | NA |
| MW325 | RGA | Current | DOE | NS | A | A |
| MW326 | RGA | Current | DOE | NS | A | A |
| MW327 | RGA | Current | DOE | NS | A | A |
| MW328 | RGA | Current | DOE | GWESBA, GC | A | A |
| MW329 | RGA | Current | DOE | GWESBA, GC | A | A |
| MW330 | RGA | Current | DOE | NS | A | A |
| MW333 | RGA | Current | DOE | GWESBA, 404G | A, Q | A |
| MW337 | RGA | Current | DOE | GWESBA, 404G | A, Q | A |
| MW338 | RGA | Current | DOE | GWESBA, 404G | A, Q | A |
| MW339 | RGA | Current | DOE | GWNWSA, GC | A | A |
| MW340 | RGA | Current | DOE | GWNWSA | A | A |
| MW341 | RGA | Current | DOE | GWESBA | A | A |
| MW342 | RGA | Current | DOE | 400GSA | A | A |
| MW343 | RGA | Current | DOE | GWESBA, 400GSA, GC | A | A |
| MW344 | Terrace Gravels | Current | DOE | KG | A | A |

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

| Well Number | Screened Zone | Status | Property Where Located | Sampled | Water Level | Inspection |
|---|---|---|---|---|---|---|
| MW345 | Rubble Zone | Current | DOE | GWESA | A | A |
| MW346 | Rubble Zone | Current | DOE | NS | A | A |
| MW347 | Rubble Zone | Current | DOE | NS | A | A |
| MW352 | RGA | AB 2002 | NA | NA | NA | NA |
| MW353 | RGA | Current | DOE | NS | A, Q | A |
| MW354 | RGA | Current | DOE | GWESBA | A | A |
| MW355 | RGA | Current | DOE | GWNWSA | A | A |
| MW356 | RGA | Current | DOE | GWESBA | A | A |
| MW357 | URGA | Current | DOE | UG | A, Q | A |
| MW358 | LRGA | Current | DOE | UG | A, Q | A |
| MW359 | UCRS | Current | DOE | UG | A, Q | A |
| MW360 | URGA | Current | DOE | UG | A, Q | A |
| MW361 | LRGA | Current | DOE | UG | A, Q | A |
| MW362 | UCRS | Current | DOE | UG | A, Q | A |
| MW363 | URGA | Current | DOE | UG | A, Q | A |
| MW364 | LRGA | Current | DOE | UG | A, Q | A |
| MW365 | UCRS | Current | DOE | UG | A, Q | A |
| MW366 | URGA | Current | DOE | UG | A, Q | A |
| MW367 | LRGA | Current | DOE | UG | A, Q | A |
| MW368 | UCRS | Current | DOE | UG | A, Q | A |
| MW369 | URGA | Current | DOE | UG/SG | A, Q | A |
| MW370 | LRGA | Current | DOE | UG/SG | A, Q | A |
| MW371 | UCRS | Current | DOE | UG | A, Q | A |
| MW372 | URGA | Current | DOE | UG/SG | A, Q | A |
| MW373 | LRGA | Current | DOE | UG/SG | A, Q | A |
| MW374 | UCRS | Current | DOE | UG | A, Q | A |
| MW375 | UCRS | Current | DOE | UG | A, Q | A |
| MW376 | LRGA | Current | DOE | UG | A, Q | A |
| MW377 | UCRS | Current | DOE | UG | A, Q | A |
| 378, Not Installed | NA | NA | NA | NA | NA | NA |
| 379, Not Installed | NA | NA | NA | NA | NA | NA |
| MW380 | RGA | Current | KDFWR | NS | A | A |
| MW381 | RGA | Current | KDFWR | GC | A | A |
| 382, Not Installed | NA | NA | NA | NA | NA | NA |
| 383, Not Installed | NA | NA | NA | NA | NA | NA |
| MW384 | URGA | Current | DOE | SG | A, Q | A |
| MW385 | LRGA | Current | DOE | SG | A, Q | A |
| MW386 | UCRS | Current | DOE | SG | A, Q | A |
| MW387 | URGA | Current | DOE | SG | A, Q | A |
| MW388 | LRGA | Current | DOE | SG | A, Q | A |
| MW389 | UCRS | Current | DOE | SG | A, Q | A |
| MW390 | UCRS | Current | DOE | SG | A, Q | A |
| MW391 | URGA | Current | DOE | SG | A, Q | A |
| MW392 | LRGA | Current | DOE | SG | A, Q | A |
| MW393 | UCRS | Current | DOE | SG | A, Q | A |
| MW394 | URGA | Current | DOE | SG | A, Q | A |
| MW395 | LRGA | Current | DOE | SG | A, Q | A |
| MW396 | UCRS | Current | DOE | SG | A, Q | A |

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

| Well Number | Screened Zone | Status | Property Where Located | Sampled | Water Level | Inspection |
|---|---|---|---|---|---|---|
| MW397 | LRGA | Current | DOE | SG | A, Q | A |
| 398, Not Installed | NA | NA | NA | NA | NA | NA |
| 399, Not Installed | NA | NA | NA | NA | NA | NA |
| 400, Not Installed | NA | NA | NA | NA | NA | NA |
| MW401 | RGA | Current | DOE | NS | A | A |
| MW402 | RGA | Current | DOE | NS | A | A |
| MW403 | RGA | Current | DOE | GWESBA, GC | A | A |
| MW404 | RGA | Current | DOE | GWESBA, GC | A | A |
| MW405 | RGA | Current | DOE | GWESBA, 400GQ | A | A |
| MW406 | RGA | Current | DOE | GWESBA, 400GQ | A | A |
| MW407 | RGA | Current | DOE | GWESBA, 400GQ | A | A |
| MW408 | RGA | Current | DOE | GWESBA, 400GQ | A | A |
| MW409 | RGA | Current | Private—Residential | GWESA, GC | A | A |
| MW410 | RGA | Current | Private—Residential | GWESA | A | A |
| MW411 | RGA | Current | Private—Residential | GWESA | A | A |
| 412, Not Installed | NA | NA | NA | NA | NA | NA |
| 413, Not Installed | NA | NA | NA | NA | NA | NA |
| MW414 | RGA | Current | DOE | GWESBA, GC | A, Q | A |
| MW415 | RGA | Current | DOE | GWESBA | A, Q | A |
| MW416 | RGA | Current | DOE | GWESBA | A, Q | A |
| MW417 | RGA | Current | DOE | GWESBA | A | A |
| MW418 | RGA | Current | DOE | GWESA | A, Q | A |
| MW419 | RGA | Current | DOE | GWESA | A, Q | A |
| MW420 | URGA | Current | DOE | 404G | A, Q | A |
| MW421 | RGA | Current | DOE | 400GSA | A | A |
| MW422 | RGA | Current | DOE | 400GSA | A | A |
| MW423 | RGA | Current | DOE | 400GSA | A | A |
| MW424 | RGA | Current | DOE | 400GSA | A | A |
| MW425 | RGA | Current | DOE | 400GSA | A | A |
| MW426 | RGA | Current | DOE | GWESBA, GC, WPB-NW | A | A |
| MW427 | RGA | Current | DOE | GWESBA, GC, WPB-NW | A | A |
| MW428 | RGA | Current | DOE | GWNWSA | A | A |
| MW429 | RGA | AB 2009 | NA | NA | NA | NA |
| MW429 A | RGA | Current | DOE | GWNWSA | A | A |
| MW430 | RGA | Current | DOE | GWNWSA | A | A |
| MW431 | RGA | Current | DOE | GWESBA | A | A |
| MW432 | RGA | Current | DOE | GWESBA, WPB-NW | A | A |
| MW433 | RGA | Current | TVA | GWESBA, WPB-NW | A | A |
| 434, Not Installed | NA | NA | NA | NA | NA | NA |
| MW435 | RGA | Current | TVA | GWESBA, WPB-NW | A | A |
| 436, Not Installed | NA | NA | NA | NA | NA | NA |
| 437, Not Installed | NA | NA | NA | NA | NA | NA |
| 438, Not Installed | NA | NA | NA | NA | NA | NA |
| MW439 | RGA | Current | TVA | GWESBA, GC | A | A |

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

| Well Number | Screened Zone | Status | Property Where Located | Sampled | Water Level | Inspection |
|---|---|---|---|---|---|---|
| MW440 | RGA | Current | TVA | GWESBA | A | A |
| MW441 | RGA | Current | TVA | GWESBA, GC, WPB-NW | A | A |
| MW442 | RGA | Current | KDFWR | GWESBA | A | A |
| MW443 | RGA | Current | KDFWR | GWESBA | A | A |
| MW444 | RGA | Current | KDFWR | GWESBA | A | A |
| MW445 | RGA | Current | TVA | GWESBA | A | A |
| 446, Not Installed | NA | NA | NA | NA | NA | NA |
| MW447 | RGA | Current | TVA | GWESBA, GC | A | A |
| MW448 | RGA | Current | KDFWR | GWESBA | A | A |
| 449, Not Installed | NA | NA | NA | NA | NA | NA |
| MW450 | RGA | Current | KDFWR | GWESBA | A | A |
| MW451 | RGA | Current | KDFWR | GWESBA | A | A |
| MW452 | RGA | Current | KDFWR | GWESBA, WPB-NW | A | A |
| MW453 | RGA | Current | KDFWR | GWESBA | A | A |
| MW454 | RGA | Current | KDFWR | GWESBA | A | A |
| MW455 | RGA | Current | DOE | GWNWSA | A | A |
| MW456 | RGA | Current | DOE | GWNWSA | A | A |
| MW457 | RGA | Current | DOE | GWNWSA | A | A |
| MW458 | RGA | Current | DOE | GWNWSA | A | A |
| MW459 | RGA | Current | DOE | GWNWSA | A | A |
| MW460 | RGA | Current | DOE | GWNWSA | A | A |
| MW461 | RGA | Current | DOE | GWNWSA | A | A |
| MW462 | RGA | Current | DOE | GWNWSA | A | A |
| MW463 | RGA | Current | TVA | GWESBA | A | A |
| MW464 | RGA | Current | TVA | GWESBA | A | A |
| MW465 | RGA | Current | Private—Residential | GWESA | A | A |
| MW466 | RGA | Current | Private—Residential | GWESA | A | A |
| MW467 | RGA | Current | Private—Residential | GWESBA | A | A |
| MW468 | RGA | Current | Private—Residential | GWESBA, GC | A | A |
| MW469 | RGA | Current | Private—Residential | GWESA | A | A |
| MW470 | RGA | Current | Private—Residential | GWESA | A | A |
| MW471 | RGA | Current | Private—Residential | GWESA | A | A |
| MW472 | RGA | Current | Private—Residential | GWESA | A | A |
| MW473 | RGA | Current | Private—Residential | GWESBA, GC | A | A |
| MW474 | RGA | Current | Private—Residential | GWESBA, GC | A | A |
| MW475 | RGA | Current | Private—Residential | GWESBA | A | A |
| MW476 | RGA | Current | Private—Residential | GWESBA | A | A |
| MW477 | RGA | Current | TVA | GWESBA | A | A |
| MW478 | RGA | Current | DOE | GWESBA | A | A |
| MW479 | RGA | Current | DOE | GWESBA | A | A |
| MW480 | RGA | Current | DOE | GWESBA | A | A |
| MW481 | RGA | Current | DOE | GWESBA | A | A |
| MW482 | RGA | Current | DOE | GWESBA | A | A |
| MW483 | RGA | Current | Private—Residential | GWESBA | A | A |
| MW484 | RGA | Current | Private—Residential | GWESBA | A | A |
| MW485 | RGA | Current | Private—Residential | GWESBA | A | A |
| MW486 | RGA | Current | Private—Residential | GWESBA | A | A |

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

| Well Number | Screened Zone | Status | Property Where Located | Sampled | Water Level | Inspection |
|---|---|---|---|---|---|---|
| MW487 | RGA | Current | Private—Residential | GWESBA | A | A |
| MW488 | RGA | Current | Private—Residential | GWESBA | A | A |
| MW489 | RGA | Current | KDFWR | GWESBA | A | A |
| MW490 | RGA | Current | KDFWR | GWESBA | A | A |
| MW491 | RGA | Current | DOE | GWESBA | A | A |
| MW492 | RGA | Current | DOE | GWESBA | A | A |
| MW493 | RGA | Current | DOE | GWESBA | A | A |
| MW494 | RGA | Current | DOE | GWESBA | A | A |
| MW495 | RGA | Current | DOE | GWESBA | A | A |
| MW496 | RGA | Current | DOE | GWESBA | A | A |
| MW497 | URGA | Current | DOE | GWNWSA | A | A |
| MW498 | LRGA | Current | DOE | GWNWSA | A | A |
| MW499 | URGA | Current | DOE | GWNWSA | A | A |
| MW500 | LRGA | Current | DOE | GWNWSA | A | A |
| MW501 | URGA | Current | DOE | GWNWSA | A | A |
| MW502 | LRGA | Current | DOE | GWNWSA | A | A |
| MW503 | URGA | Current | DOE | GWNWSA | A | A |
| MW504 | LRGA | Current | DOE | GWNWSA | A | A |
| MW505 | RGA | Current | DOE | 400GQ | A | A |
| MW506 | RGA | Current | DOE | 400GQ | A | A |
| MW507 | RGA | Current | DOE | 400GQ | A | A |
| MW508 | RGA | AB 2014 | DOE | GWSWP | A | A |
| MW509 | RGA | AB 2014 | DOE | GWSWP | A | A |
| MW510 | RGA | AB 2014 | DOE | GWSWP | A | A |
| MW511[a] | RGA | Current | DOE | GWSWP | A | A |
| MW512[a] | RGA | Current | DOE | GWSWP | A | A |
| MW513[a] | RGA | Current | DOE | GWSWP | A | A |
| MW514[a] | RGA | Current | DOE | GWSWP | A | A |
| MW515[a] | RGA | Current | DOE | GWSWP | A | A |
| MW516[a] | RGA | Current | DOE | GWSWP | A | A |
| MW517 (PZ)[b] | RGA | Current | DOE | GWSWMU4 | A | A |
| MW518 (PZ)[b] | RGA | Current | DOE | GWSWMU4 | A | A |
| MW519 (PZ)[b] | RGA | Current | DOE | GWSWMU4 | A | A |
| MW520 (PZ)[b] | RGA | Current | DOE | GWSWMU4 | A | A |
| MW521 (PZ)[b] | RGA | Current | DOE | GWSWMU4 | A | A |
| MW522 (PZ)[b] | RGA | Current | DOE | GWSWMU4 | A | A |
| MW523 (PZ)[b] | RGA | Current | DOE | GWSWMU4 | A | A |
| MW524 | RGA | Planned | DOE | GWNEQ | A | A |
| MW525 | RGA | Planned | DOE | GWNEQ | A | A |
| MW526 | RGA | Planned | DOE | GWNEQ | A | A |
| MW527 | RGA | Planned | DOE | GWNEQ | A | A |
| MW528 | RGA | Planned | DOE | GWNEQ | A | A |
| MW529 | RGA | Planned | DOE | GWNEQ | A | A |
| MW530 | RGA | Planned | DOE | GWNEQ | A | A |
| MW531 | RGA | Planned | DOE | GWNEQ | A | A |
| MW532 | RGA | Planned | DOE | GWNEQ | A | A |
| MW533 | RGA | Planned | DOE | GWNEQ | A | A |
| MW534 | RGA | Planned | DOE | GWNEQ | A | A |

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

| Well Number | Screened Zone | Status | Property Where Located | Sampled | Water Level | Inspection |
|---|---|---|---|---|---|---|
| MW535 | RGA | Planned | DOE | GWNEQ | A | A |
| MW536 | RGA | Planned | DOE | GWNEQ | A | A |
| MW537 | RGA | Planned | DOE | GWNEQ | A | A |
| MW538 | RGA | Planned | DOE | GWNEQ | A | A |
| MW539 | RGA | Planned | DOE | GWNEQ | A | A |
| MW540 | RGA | Planned | DOE | GWNEQ | A | A |
| MW541 | RGA | Planned | DOE | GWNEQ | A | A |
| MW542 | RGA | Planned | DOE | GWSWMU1 | A | A |
| MW543 | RGA | Planned | DOE | GWSWMU1 | A | A |
| MW544 | RGA | Planned | DOE | GWSWMU1 | A | A |
| MW545 | RGA | Planned | DOE | GWSWMU1 | A | A |
| MW546 | RGA | Planned | DOE | GWSWMU1 | A | A |
| MW547 | RGA | Planned | DOE | GWSWMU1 | A | A |
| MW548 | RGA | Planned | DOE | GWSWMU4 | A | A |
| MW549 | RGA | Planned | DOE | GWSWMU4 | A | A |
| MW550 | RGA | Planned | DOE | GWSWMU4 | A | A |
| MW551 | RGA | Planned | DOE | GWSWMU4 | A | A |
| MW552 | RGA | Planned | DOE | GWSWMU4 | A | A |
| R2 | Unknown | Current | Private—Residential | WPB-NW | A | FYR |
| R9 | Unknown | Current | Private—Residential | WPB-NE | A | FYR |
| R13 | Unknown | Current | Private—Residential | WPB-NW | A | FYR |
| R14 | Unknown | Current | Private—Residential | WPB-NW | A | FYR |
| R20 | RGA | Current | Private—Residential | WPB-NE | A | FYR |
| R21 | Unknown | Current | Private—Residential | WPB-NE | A | FYR |
| R26 | Unknown | Current | Private—Residential | WPB-NW | A | FYR |
| R53 | Unknown | Current | Private—Residential | WPB-NW | A | FYR |
| R83 | Unknown | Current | Private—Residential | WPB-NE | A | FYR |
| R90 | Unknown | Current | Private—Residential | WPB-NE | A | Outside Water Policy |
| R114 | Unknown | Current | Private—Residential | WPB-NE | A | Outside Water Policy |
| R245 | Unknown | Current | Private—Residential | WPB-NW | A | FYR |
| R294 | RGA | Current | Private—Residential | WPB-NE | A | FYR |
| R302 | RGA | Current | Private—Residential | WPB-NE | A | FYR |
| R387 | RGA | Current | Private—Residential | WPB-NE | A | Outside Water Policy |
| R424 | RGA | Current | Private—Residential | CARB | NS | Outside Water Policy |

[a] MWs associated with Southwest Plume project. Sampling per regulatory commitments will be conducted under this project during FY2016.
[b] PZs associated with SWMU 4 project. These PZs are scheduled to be abandoned as this project concludes.
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. Those residential wells outside of the water policy box may be accessed by the landowner.

# WATER LEVELS

Water level measurements are divided into two programs: (1) measurement of water levels at wells that support potentiometric surface map development in relation to the permitted landfills (measured quarterly); and (2) measurement of water levels at wells of remaining wells (measured annually). The remaining wells are defined as those remaining wells from Appendix B of this Environmental Monitoring Plan. Wells associated with the potentiometric surface maps at the permitted landfills are measured within as short a time period as possible, not to exceed a three-day period. (Note: Wells denoted as "commitment wells" are those wells formally agreed upon to be measured, but are not listed specifically in the permit. Wells denoted as "noncommitment wells" are measured as a best management practice.) All remaining wells are measured on an annual basis. In fiscal year 2016, the remaining wells will be measured between July 1 and August 30 by Fluor Federal Services, Inc., Paducah Deactivation Project. This is a change in cycle compared to the FY 2015 EMP. The wells have been consistently inspected and evaluated for water level measurements in the third quarter of each calendar year. In order to evaluate temporal effects to the groundwater levels, the water level measurements and the inspections will be moved to the second quarter of the calendar year of 2016.

## WATER LEVELS IN SUPPORT OF PERMITTED LANDFILLS

| C-404 Landfill Quarterly Water Levels (9) Permitted Wells |
|---|
| MW84 |
| MW85 |
| MW87 |
| MW88 |
| MW90A |
| MW91 |
| MW93 |
| MW94 |
| MW420 |
| **Commitment Wells (7)[a]** |
| MW67 |
| MW76 |
| MW227 |
| MW333 |
| MW337 |
| MW414 |
| MW416 |
| **Noncommitment Wells (7)** |
| MW86 |
| MW89 |
| MW92 |
| MW95A |
| MW226 |
| MW338 |
| MW415 |

| C-746-U Landfill Quarterly Water Levels (21) Permitted Wells | |
|---|---|
| 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)** | |
| MW 98 | MW173 |
| MW100 | MW193 |
| MW125 | MW197 |
| MW139 | MW200 |
| MW165A | |

| C-746-S&T Landfills Quarterly Water Levels (25) Permitted Wells |
|---|
| MW220 |
| MW221 |
| MW222 |
| MW223 |
| MW224 |
| MW225[c] |
| MW353[c] |
| MW384 |
| MW385 |
| MW386 |
| MW387 |
| MW388 |
| MW389 |
| MW390 |
| MW391 |
| MW392 |
| MW393 |
| MW394 |
| MW395 |
| MW396 |
| MW397 |
| MW369[b] |
| MW370[b] |
| MW372[b] |
| MW373[b] |
| **Noncommitment Wells (3)** |
| MW353 |
| 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 permitted wells. Although these wells are not identified in the permit, the obtained water level measurement data will be reported to Kentucky Division of Waste Management as part of the semiannual report.

[b] Wells are cited in both the C-746-U Landfill permit and the C-746-S&T Landfill permit.

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

# APPENDIX C

# ENVIRONMENTAL SAMPLING FREQUENCY AND PARAMETERS

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# CONTENTS

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# FIGURES

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# TABLES

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# ACRONYMS

| | |
|---|---|
| ASER | Annual Site Environmental Report |
| BWCS | B&W Conversion Services, LLC |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| COPC | chemical of potential concern |
| DOE | U.S. Department of Energy |
| EM | environmental monitoring |
| EMP | Environmental Monitoring Plan |
| ERPP | Environmental Radiation Protection Program |
| FFA | Federal Facility Agreement |
| FPDP | Fluor Federal Services, Inc., Paducah Deactivation Project |
| FY | fiscal year |
| KDWM | Kentucky Division of Waste Management |
| KPDES | Kentucky Pollutant Discharge Elimination System |
| MCL | maximum contaminant level |
| MW | monitoring well |
| PGDP | Paducah Gaseous Diffusion Plant |
| RFI | Resource Conservation and Recovery Act Facility Investigation |
| ROD | record of decision |
| TLD | thermoluminescent dosimeter |
| TSS | total suspended solids |

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# C.1. INTRODUCTION

Three-hundred thirty-six monitoring wells (MWs) are active and monitored as part of the Environmental Monitoring (EM) Program. Active wells are either in an analytical sampling program or may be evaluated only for water level measurements. This appendix shows a summary of each analytical sampling program. Figure C.1 shows the locations of each MW that is included in an analytical sampling program.

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

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

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

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

A brief summary of changes that have been made from the fiscal year (FY) 2015 to the FY 2016 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 2016. 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 2017 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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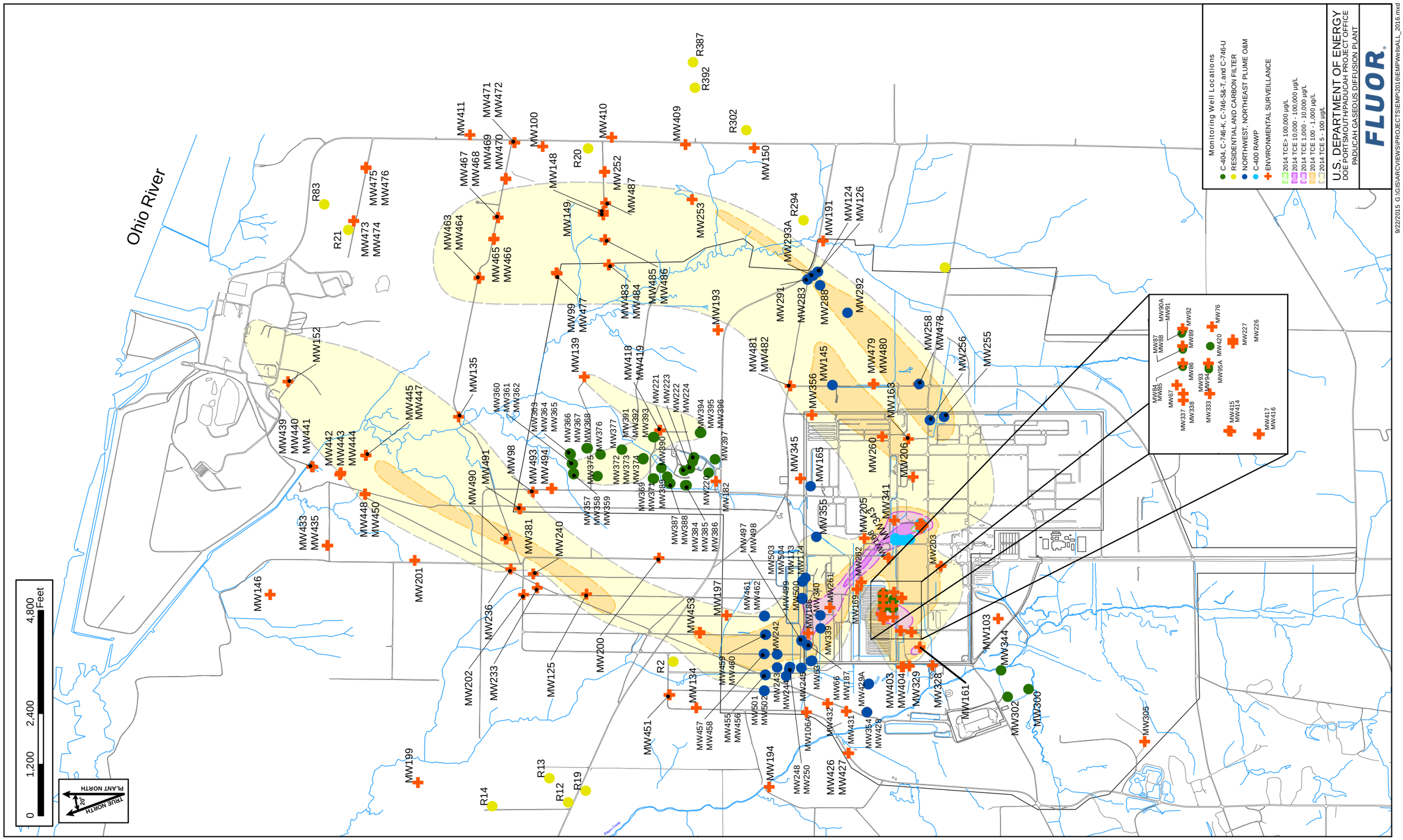


**Figure C.1. Monitoring Wells Sampled under the EMP**

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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 environmental monitoring and reporting 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) Fluor Federal Services, Inc., Paducah Deactivation Project (FPDP) 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 the *Monitoring Well Maintenance Implementation Plan for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, CP2-ES-0024.

Specified methods found in Appendix C are EPA-approved methods, as applicable. In some instances, such as with radionuclides, EPA-approved methods are unavailable. For this EMP, the currently used laboratory's analytical procedure is noted as the method of choice. If an analysis is conducted at another laboratory during FY 2016, an equivalent procedure will be used upon approval by the environmental monitoring and reporting manager.

## C.2.1 GROUNDWATER MONITORING PROGRAM FOR LANDFILL OPERATIONS

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

**Frequency:** Quarterly

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

**Reported:** Quarterly Compliance Monitoring Reports, as required by the permits 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 permits.

**Comments:** The current solid waste landfill permits expire on November 4, 2016.

For all three solid waste permits, SW07300014, SW07300015, and SW07300045, the reporting requirement for maximum contaminant level (MCL) is as follows: "If the analysis

of the groundwater sample results indicates contamination [i.e., a statistical or MCL exceedance] as specified in 401 *KAR* 48:300 Section 8(1), the owner or operator shall notify the cabinet within (forty-eight) 48 hours of receiving the results and shall arrange to split sample no later than ten (10) days from the receipt of the results [401 *KAR* 48:300 Section 7]."

C-746-S and C-746-T Landfills permits were consolidated in the 1990s into a single permit. MW sampling is performed and reported collectively. Per Technical Attachment 25, to the permits for C-746-S, C-746-T, and C-746-U Landfills, sample collection order is specified. The order is as follows: volatiles (including total organic halides), dissolved gases and total organic carbon, semivolatile organics, metals and cyanide, water quality cations and anions, and radionuclides. If samples are being collected at a location where it is anticipated that sample volume is not adequate, then the order of collection will be volatiles followed by radionuclides.

Data collected under this program will be evaluated. Based on trending results, if changes are deemed appropriate, they will be proposed via a permit modification and reflected in the FY 2017 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.2.

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

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

[a] The total number of permitted wells associated with the C-746-S&T Landfills is 25; however, two of these wells (MW225, MW353) are permitted only for water level measurement. The total number of analytically measured wells, therefore, is 23.

[b] Wells are sampled with the C-746-U Landfill; 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.2. C-746-U Landfill Wells (21)**

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

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

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

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

[a] Xylenes

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

[c] Permit does not require analysis of radium-228 and thorium-232. These parameters are analyzed for information purposes only in support of the C-746-U Landfill assessment.

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

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

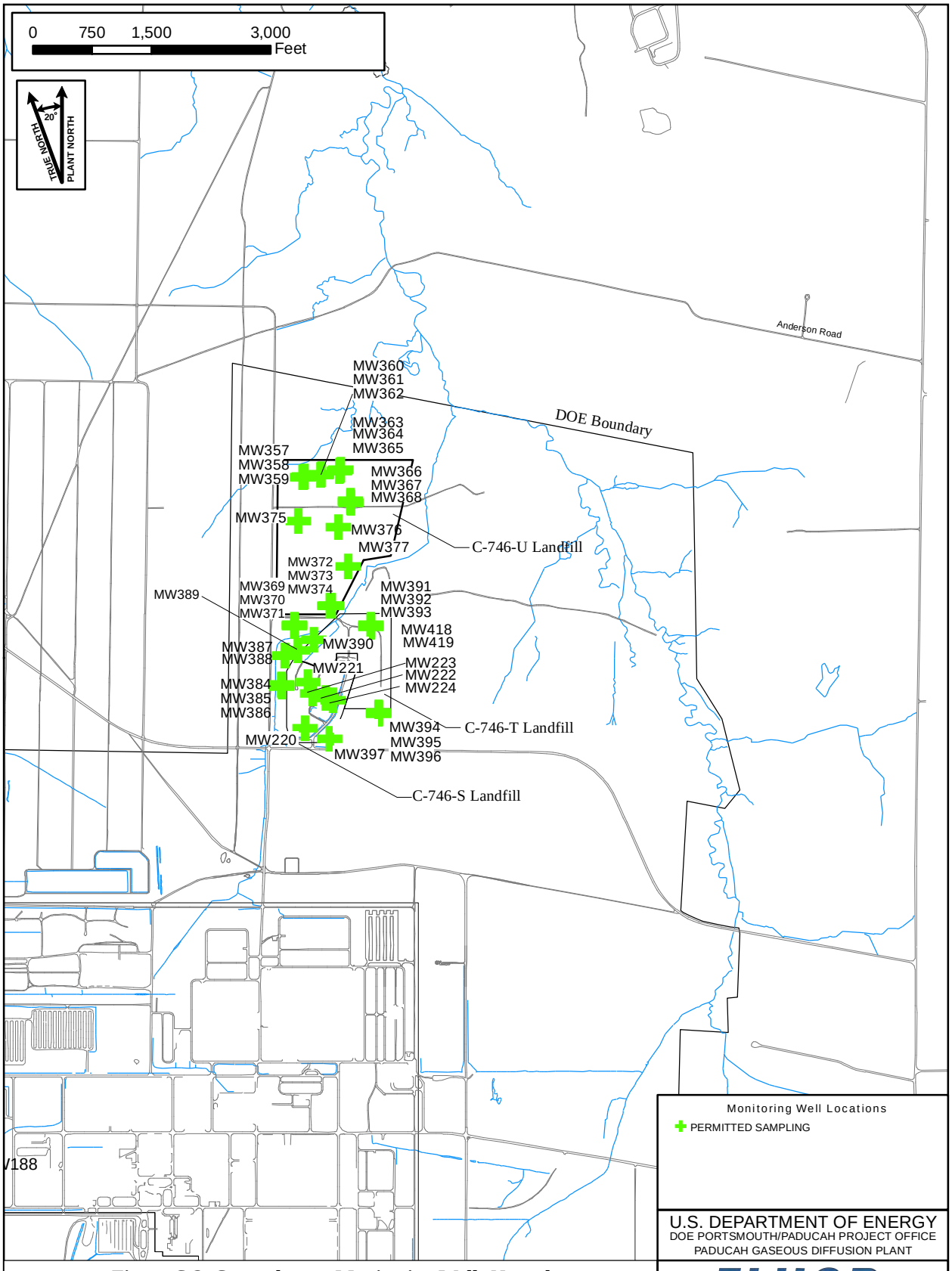


**Figure C.2. Groundwater Monitoring Wells Near the C-746-S, T, and U Landfills**

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

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

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

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

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

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

Sampling frequencies and sampling parameters were not modified for this sampling program in FY 2016. Data collected under this program were evaluated.

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

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

A listing of MWs for the C-404 Landfill is presented in Table C.4 and the analytical parameters are presented in Table C.5. Locations are shown on Figure C.3.

**Table C.4. C-404 Landfill Wells**

| | | | |
|---|---|---|---|
| **C-404 Landfill Wells (9)** | | | |
| MW84 | MW88 | MW91 | MW94 |
| MW85 | MW90A | MW93 | MW420 |
| MW87 | | | |
| **Opted to Sample—Not Committed to KDWM (11)[a]** | | | |
| **TCE, Tc-99, and Field Parameters** | | | |
| MW67 | MW89 | MW226[b] | MW337[b] |
| MW76 | MW92 | MW227[b] | MW338[b] |
| MW86 | MW95A | MW333[b] | |

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

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

| | | | |
|---|---|---|---|
| **Volatiles—Method 8260B** | | | |
| Trichloroethene | | | |
| **Metals—6020 unless noted** | | | |
| Arsenic | Lead | Uranium | Lead, Dissolved |
| Cadmium | Manganese | Arsenic, Dissolved | **Mercury, Dissolved—7470A** |
| Chromium | **Mercury—7470A** | Cadmium, Dissolved | Selenium, Dissolved |
| Iron | Selenium | Chromium, Dissolved | Uranium, Dissolved |
| **Field Parameters** | | | |
| Barometric Pressure | Depth to Water | Redox | Temperature |
| Conductivity | Dissolved Oxygen | pH | Turbidity |
| **Radionuclides—Method U-02-RC unless noted** | | | |
| **Technetium-99—TC-02-RC** | Uranium-234 | Uranium-235 | Uranium-238 |
| **Miscellaneous—Method as follows*** | | | |
| **Sulfide—SM 4500-S (2-)D** | **Sulfite—SM 4500-SO3 (2-)B** | **Sulfate—9056** | **Total Organic Carbon—9060** |

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

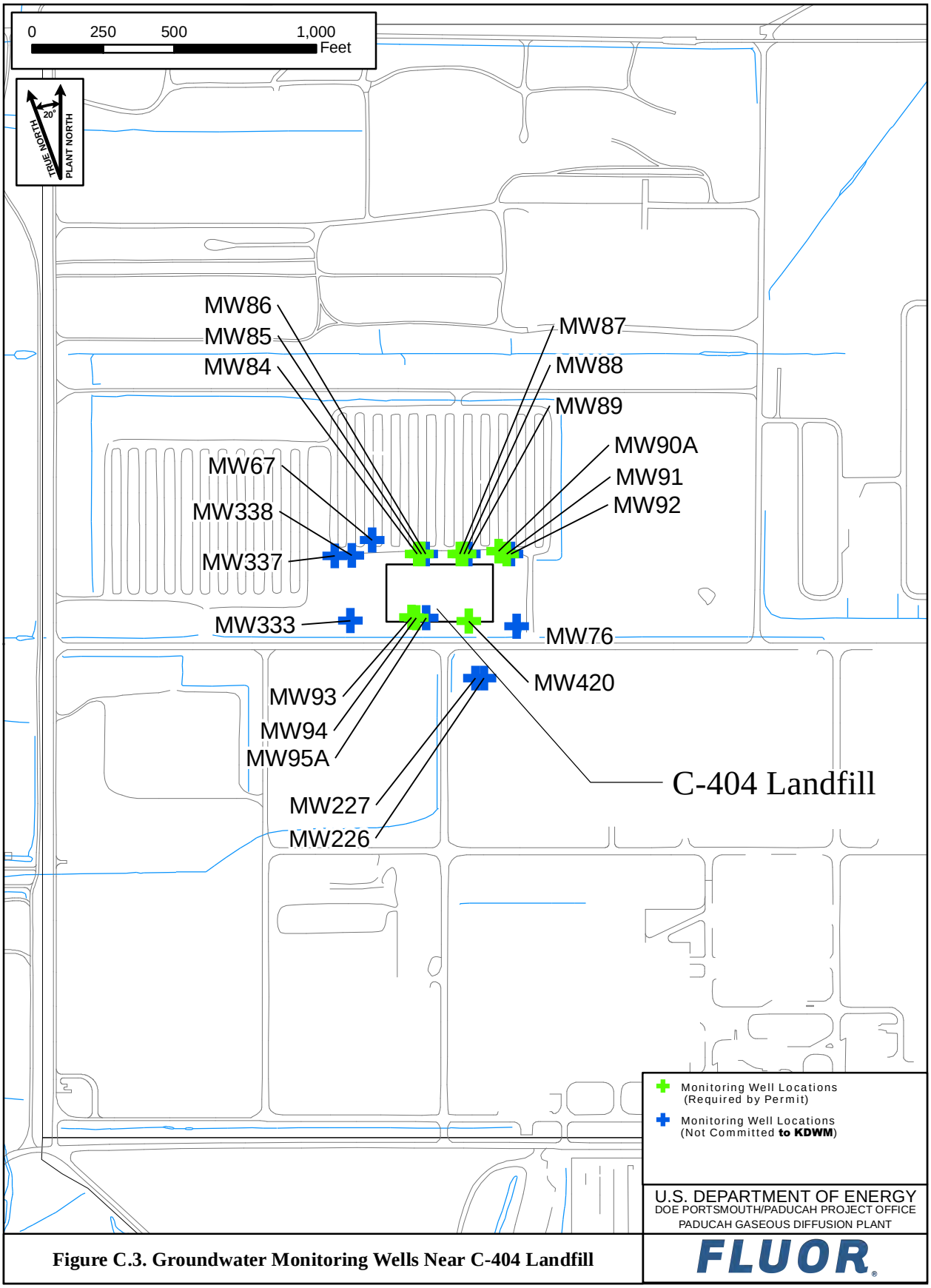


**Figure C.3. Groundwater Monitoring Wells Near C-404 Landfill**

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**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 2016.

Tables C.6 and C.7 provide a listing of landfill wells and analytical parameters, respectively. Locations are shown on Figure C.4.

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

| | | |
|---|---|---|
| MW300 | MW302 | MW344 |

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

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

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

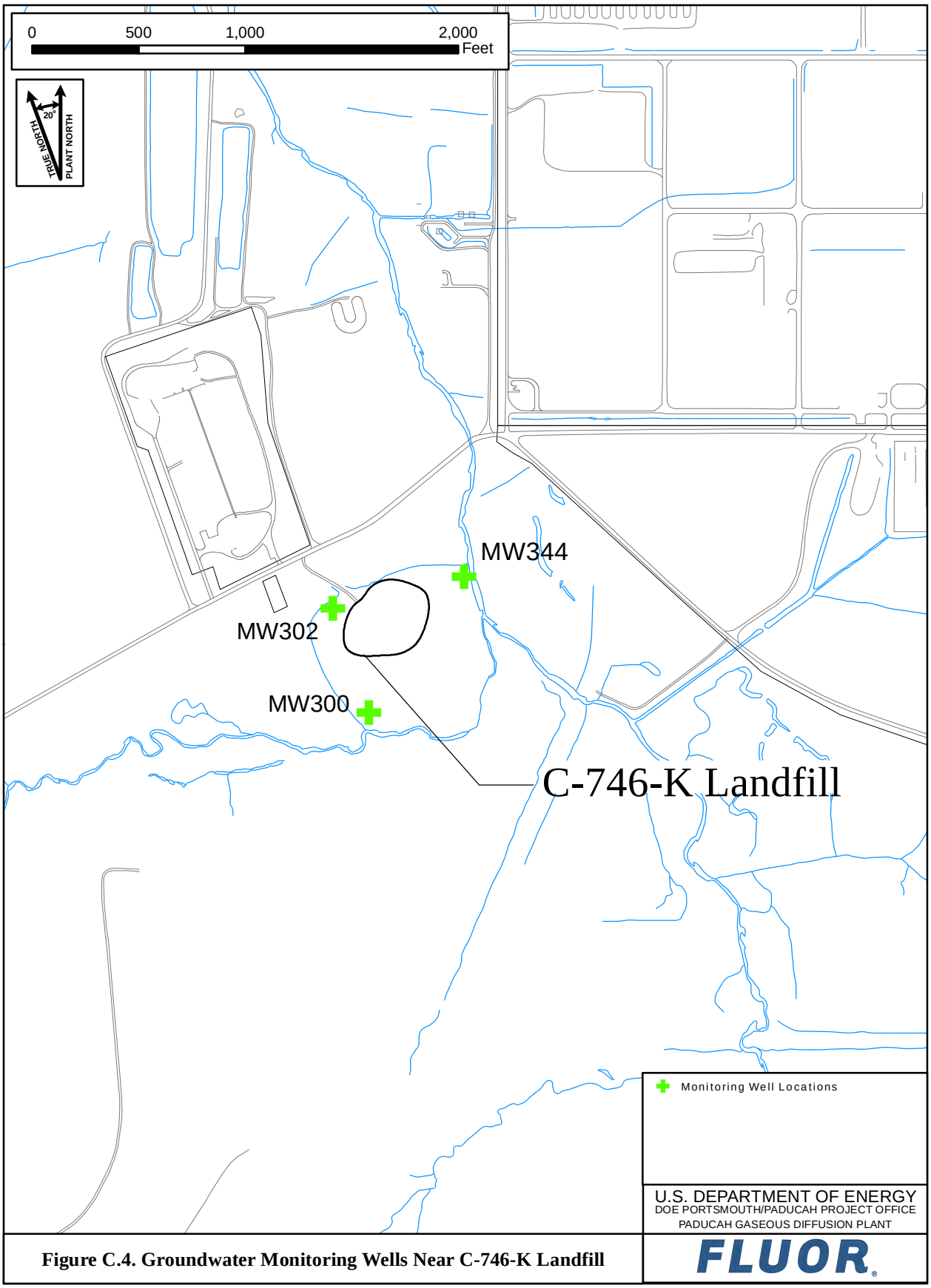


**Figure C.4. Groundwater Monitoring Wells Near C-746-K Landfill**

## C.2.2 NORTHEAST PLUME OPERATIONS AND MAINTENANCE PROGRAM

**Northeast Plume Monitoring**

**Frequency:** Quarterly and Semiannually

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

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

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

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

Sampling frequencies and sampling parameters were not modified for this sampling program for FY 2016.

The Northeast Plume extraction well system is undergoing an optimization. New extraction wells will be installed in new locations closer to the site due to the decreasing concentration of contaminants at their current locations. This optimization program will include two new extraction wells, EW234 and EW235, and up to 18 MWs. The MW identification numbers have been added to Appendix B with a status of "Planned." As the MWs are installed, they will be sampled, as required, and details will be included in the FY 2017 EMP.

Table C.8 provides a listing of MWs sampled semiannually and the associated parameters. Table C.9 provides a listing of MWs sampled quarterly and the associated parameters. Locations are shown on Figure C.5.

**Table C.8. Northeast Plume Semiannual Wells and Parameters**

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

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

[b] Xylenes

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

**Table C.9. Northeast Plume Quarterly Wells and Parameters**

| | | | |
|---|---|---|---|
| **Quarterly Wells (5)** | | | |
| MW255 | MW258 | MW288 | MW292 |
| MW256 | | | |
| **Quarterly Analytical Parameters** | | | |
| **Radionuclides—Method TC-02-RC** | | | |
| Technetium-99 | | | |
| **Field Parameters** | | | |
| Barometric Pressure | Depth to Water | Redox | Temperature |
| Conductivity | Dissolved Oxygen | pH | Turbidity |

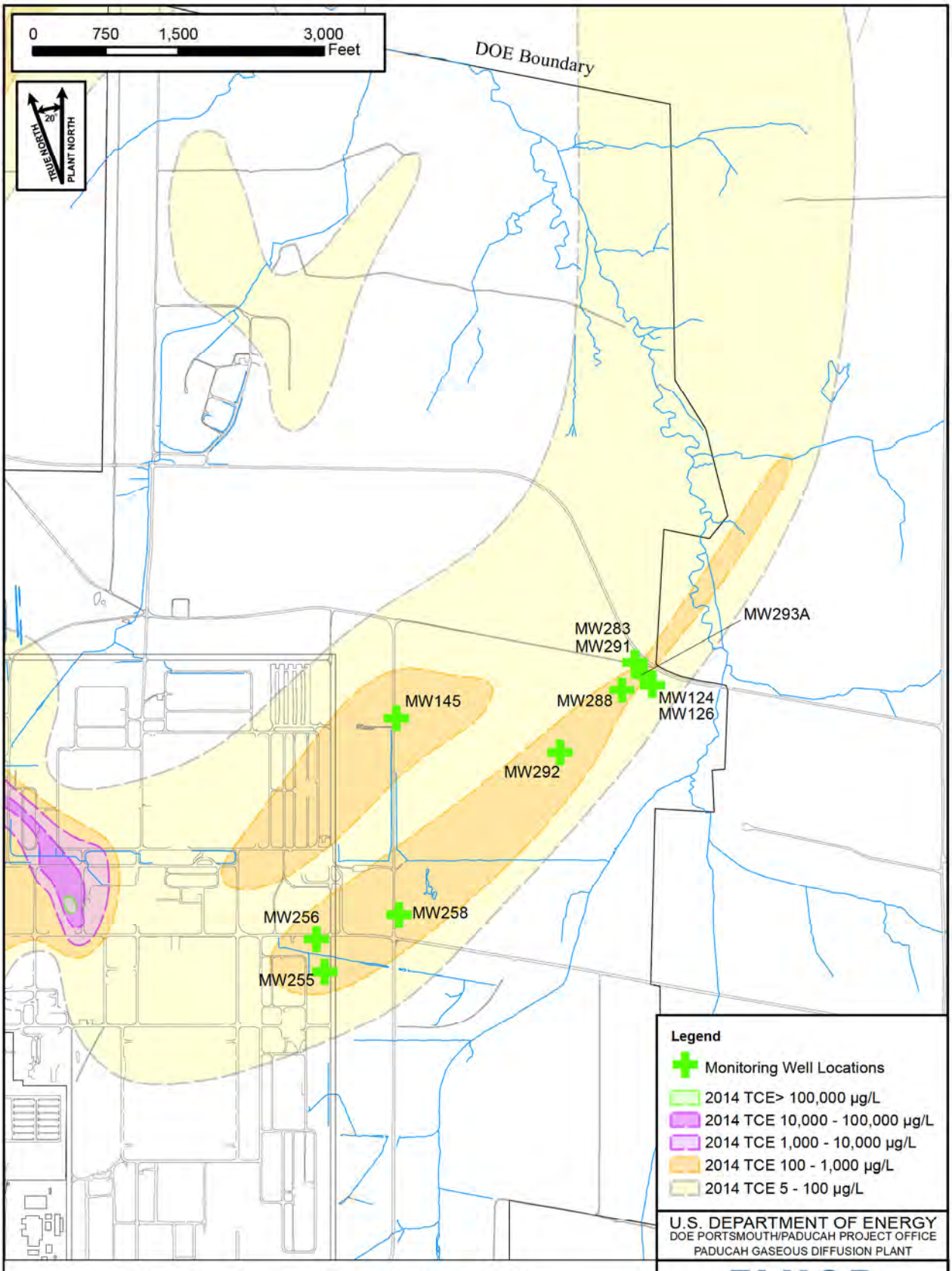


**Figure C.5. Northeast Plume Monitoring Wells**

## C.2.3 NORTHWEST PLUME OPERATIONS AND MAINTENANCE PROGRAM

**Northwest Plume Monitoring**

**Frequency:** Semiannually

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

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

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

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

Sampling frequencies and sampling parameters were not modified for this sampling program for FY 2016.

Table C.10 provides a listing of MWs and the associated parameters, and Table C.11 provides the analytical parameters. Locations are shown on Figure C.6.

**Table C.10. Northwest Plume Wells**

| **Semiannual Wells (33)** | | | | | |
|---|---|---|---|---|---|
| MW63 | MW243 | MW340 | MW456 | MW461 | MW500 |
| MW65 | MW244 | MW355 | MW457 | MW462 | MW501 |
| MW66 | MW245 | MW428 | MW458 | MW497 | MW502 |
| MW165A | MW248 | MW429A | MW459 | MW498 | MW503 |
| MW173 | MW250 | MW430 | MW460 | MW499 | MW504 |
| MW242 | MW339 | MW455 | | | |

**Table C.11. Northwest Plume Analytical Parameters**

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

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

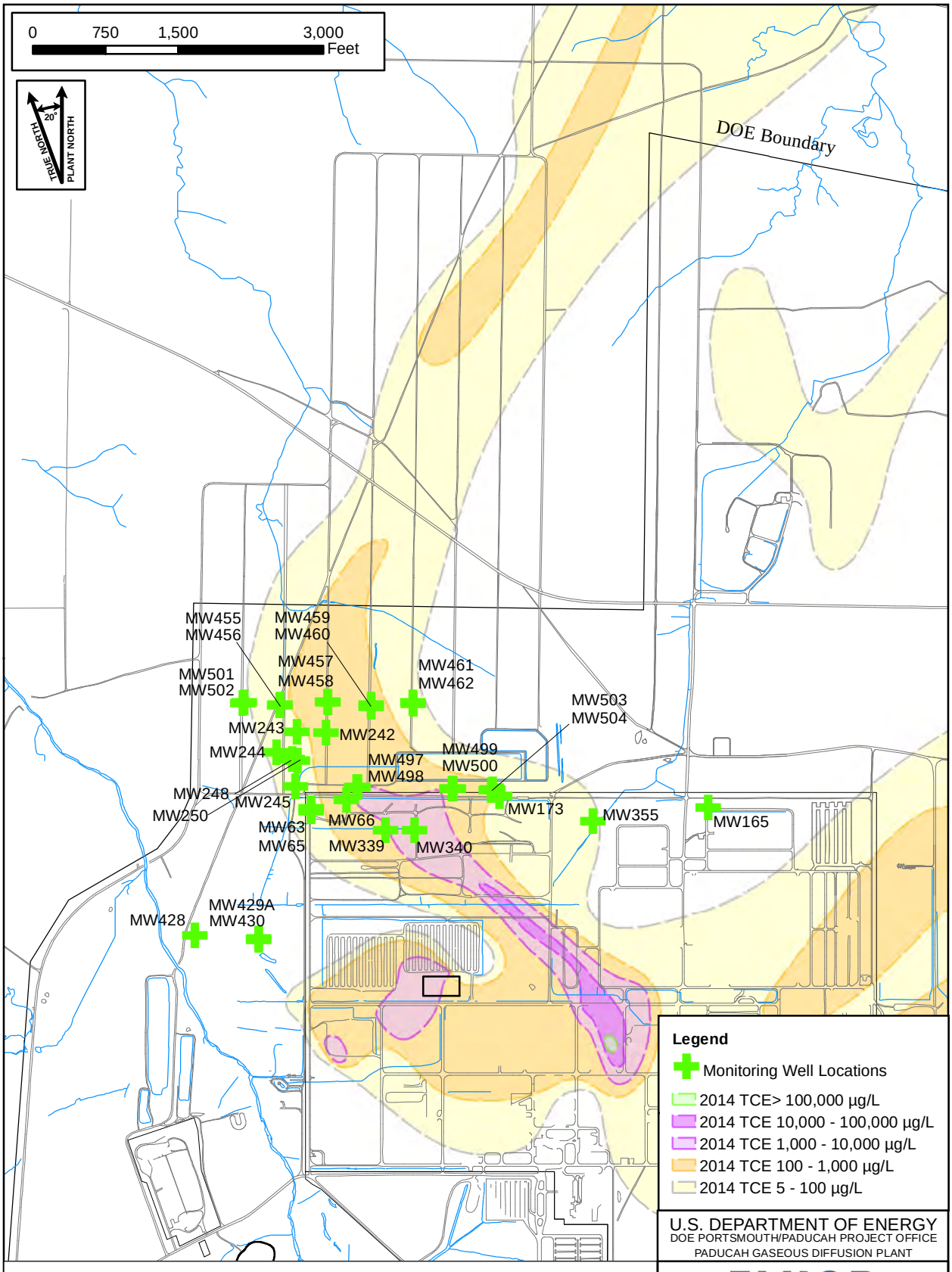


**Figure C.6. Northwest Plume Monitoring Wells**

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9/17/2015

### C.2.4 C-400 MONITORING WELLS

**C-400 Wells**

**Frequency:** Quarterly and Semiannually

**Driver:** The MWs are required to be sampled by the *Remedial Action Work Plan for the Interim Remedial Action for the Volatile Organic Compound Contamination at the C-400 Cleaning Building at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/LX/07-0004&D2/R2/A1/R2.

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

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

**Comments:** Sampling frequencies and sampling parameters were not modified for this sampling program for FY 2016.

Table C.12 provides a listing of the C-400 MWs, and Table C.13 provides the analytical parameters for these MWs. Locations are shown on Figure C.7.

**Table C.12. C-400 Monitoring Wells (17)**

| | | |
|---|---|---|
| **Quarterly Wells (9)** | | |
| MW155 | MW406: Port 5 | MW505 |
| MW156 | MW407: Port 4 | MW506 |
| MW405: Port 5 | MW408: Port 5 | MW507 |
| **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 | |

**Table C.13. C-400 Monitoring Wells Analytical Parameters**

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

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

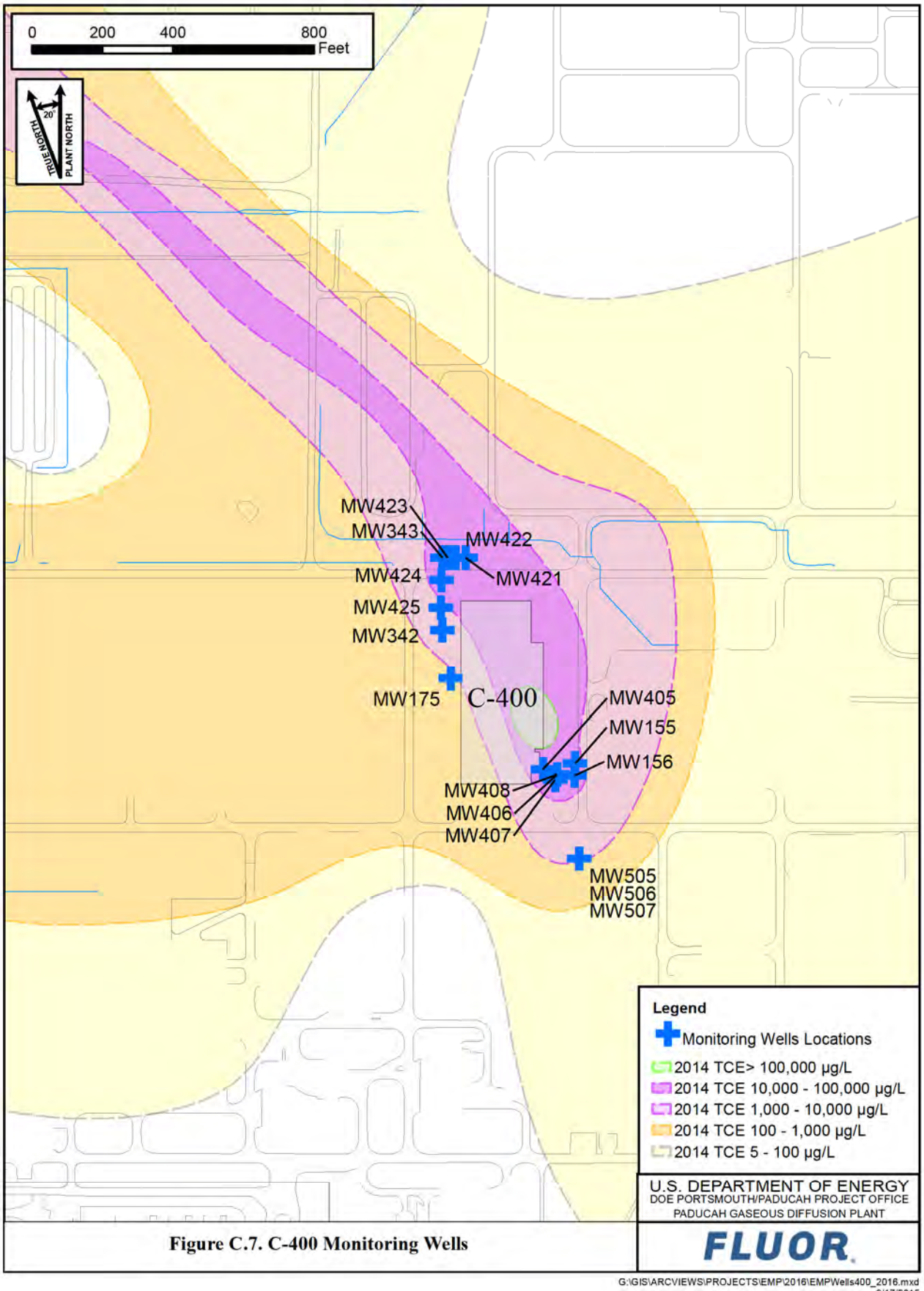


**Figure C.7. C-400 Monitoring Wells**

## C.2.5 WATER POLICY BOUNDARY MONITORING PROGRAM

**Frequency:** Quarterly and Annually

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

**Reported:** Residential well data will be reported to the landowner on an annual basis and may be reported in the ASER. Monitoring wells, regardless if located on private property or on DOE property, will be reported only 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.14, C.15, and C.16).

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

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

R384 was eliminated from the program. R384 was included in the FY 2015 EMP; however, the well could not be sampled during FY 2015 because of lack of occupancy/electrical power at the property. Because the property is expected to be vacated in the future, R384 was removed from the sampling campaign for FY 2016. Other wells in the vicinity are sampled; therefore, a replacement well was not deemed necessary for an effective monitoring program of the water policy boundary.

**Table C.14. Northwestern Wells**

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

**Table C.15. Northeastern Wells**

| **Annually (9)** | | | | |
|---|---|---|---|---|
| R9 | R21 | R90 | R294 | |
| R20 | R83 | R114 | R302 | R387 |

**Table C.16. Residential Analytical Parameters—Northwest and Northeast Analytical Parameters**

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

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

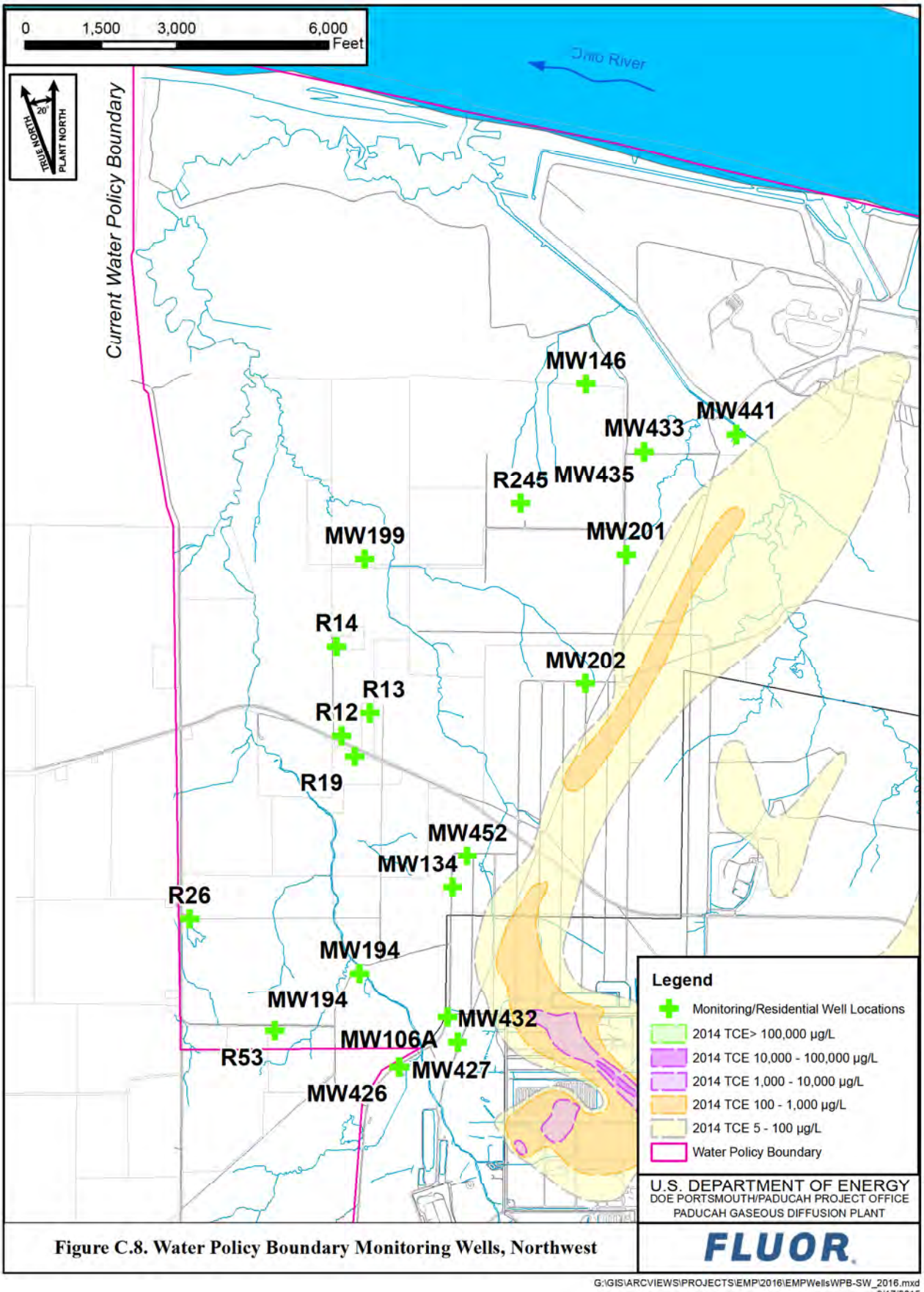


**Figure C.8. Water Policy Boundary Monitoring Wells, Northwest**

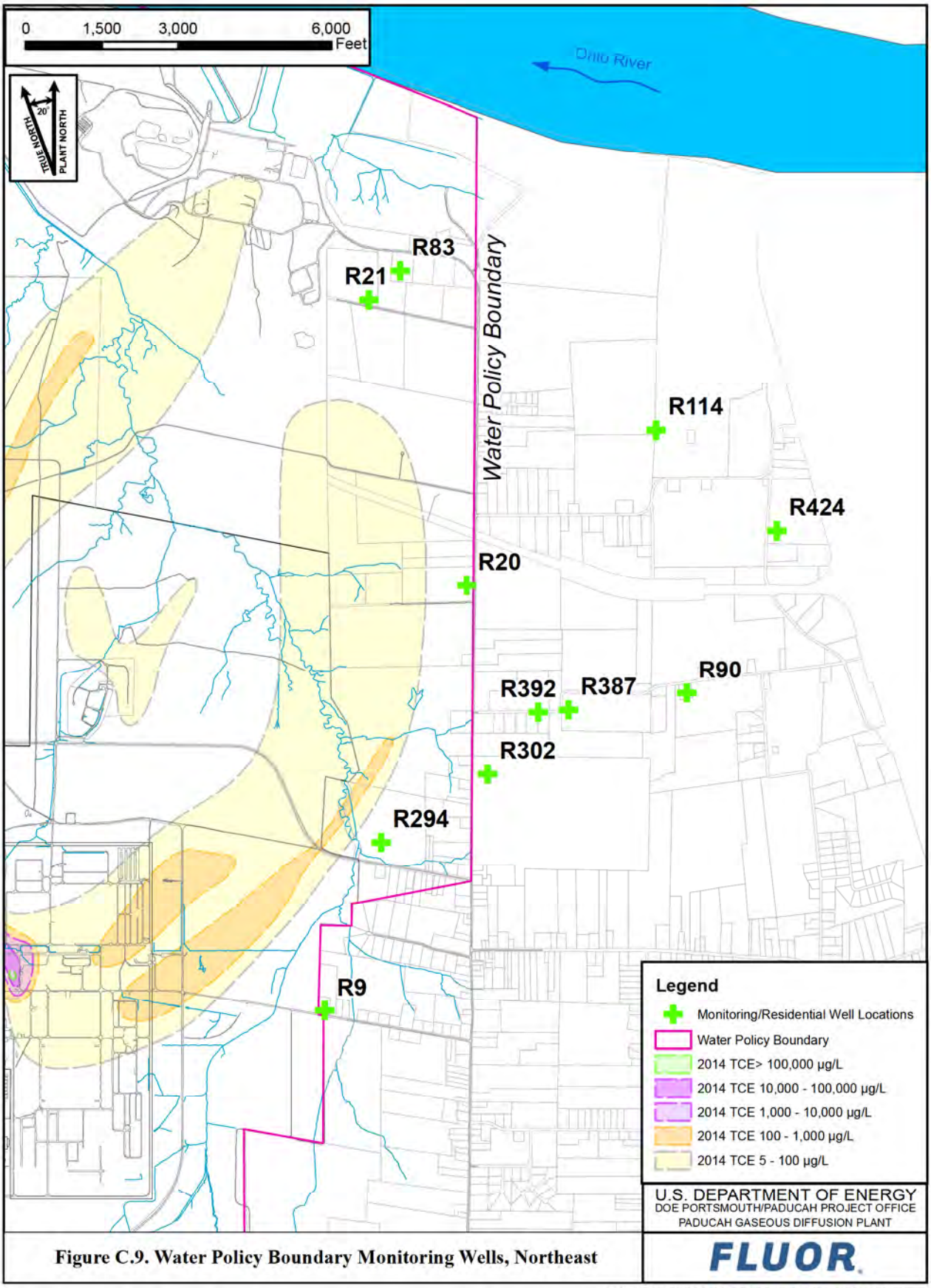


**Figure C.9. Water Policy Boundary Monitoring Wells, Northeast**

### C.2.6 CARBON FILTER TREATMENT SYSTEM

**Frequency:** Semiannually (two events per each semiannual event)

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

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

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

DOE Order 458.1 requires that contractors implement radiation protection for persons consuming water from a drinking water system operated by DOE or its contractors equivalent to 40 *CFR* § 141. Provisions of 40 *CFR* § 141 allow for environmental surveillance to be used for reduced sampling requirements. Review of the historical analytical data at this location indicates minimal risk and reduced monitoring is appropriate; therefore sampling for radiological parameters has been reduced from the specified frequencies in DOE Order 458.1. Parameters required by 40 *CFR* § 141 are beta emitters, tritium, and strontium-90 (Sr-90). Tc-99 is the only radiological parameter in this group that is a contaminant of potential concern in groundwater from DOE activities; however, based on reviews of the groundwater modeling and historical data, the groundwater at this location is not impacted by site operations. Based on these conditions, Tritium and Sr-90 will not be sampled, nor will alpha activity or beta activity be analyzed; and Tc-99 sampling frequency will be reduced from the monthly requirement to semiannual requirement to verify the Tc-99 is below reporting limits. A review of the FY 2015 Tc-99 did not indicate a need for increased radionuclide analysis; therefore, no changes in sample strategy were made.

Tables C.17 and C.18 identify carbon filter treatment system well and carbon filter treatment system analytical parameters, respectively. Location is shown on Figure C.9.

**Table C.17. Carbon Filtration System (1)**

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

**Table C.18. Carbon Filtration System Analytical Parameters**

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

## C.2.7 ENVIRONMENTAL SURVEILLANCE GROUNDWATER MONITORING PROGRAM

**Environmental Surveillance Monitoring**

**Frequency:** Annually and Biennially

**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 2015; therefore, they will not be sampled in FY 2016. Those MWs are included in Table C.19, but are shaded and noted to indicate that sampling will not be conducted in FY 2016.

Sampling frequencies and sampling parameters were not modified for this sampling program for FY 2016.

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.

An inspection of MW106 and MW206, as part of the routine well maintenance program, identified an issue with the pumps. MW106 was abandoned in August 2014, and a replacement well (MW106A) was installed in October 2014. MW206 also was abandoned in August 2014, but no replacement was installed.

Tables C.19 and C.20 identify MWs and analytical parameters, respectively. Locations are shown on Figure C.10.

**Table C.19. Surveillance Wells (125)**

| | | | | | |
|---|---|---|---|---|---|
| **Biennial (101)[a]** | | | | | |
| MW67 | MW174 | MW338 | MW431 | MW454 | MW485 |
| MW76 | MW186 | MW341 | MW432 | MW463 | MW486 |
| MW86 | MW187 | MW343 | MW433 | MW464 | MW487 |
| MW89 | MW193 | MW354 | MW435 | MW467 | MW488 |
| MW92 | MW197 | MW356 | MW439 | MW468 | MW489 |
| MW95A | MW200 | MW403: Port 3 | MW440 | MW473 | MW490 |
| MW106A | MW201 | MW404: Port 4 | MW441 | MW474 | MW491 |
| MW125 | MW202 | MW405: Port 5 | MW442 | MW475 | MW492 |
| MW134 | MW205 | MW406: Port 5 | MW443 | MW476 | MW493 |
| MW135 | MW226 | MW407: Port 4 | MW444 | MW477 | MW494 |
| MW139 | MW227 | MW408: Port 5 | MW445 | MW478 | MW495 |
| MW146 | MW260 | MW414 | MW447 | MW479 | MW496 |
| MW148 | MW262 | MW415 | MW448 | MW480 | **Background (4)** |
| MW149 | MW328 | MW416 | MW450 | MW481 | MW103 |
| MW163 | MW329 | MW417 | MW451 | MW482 | MW194 |
| MW168 | MW333 | MW426 | MW452 | MW483 | MW199 |
| MW169 | MW337 | MW427 | MW453 | MW484 | MW305 |
| **Annual (24)** | | | | | |
| MW98 | MW182[b] | MW240 | MW418[b] | MW470 | **Background (1)** |
| MW99 | MW191 | MW252 | MW419[b] | MW471 | MW150 |
| MW100 | MW203 | MW253 | MW465 | MW472 | |
| MW152 | MW233 | MW261 | MW466 | | |
| MW161 | MW236 | MW345 | MW469 | | |

[a] These wells were sampled in FY 2015; therefore, will not be sampled in FY 2016.
[b] These three wells will be sampled for PCBs in addition to the remaining parameters.

**Table C.20. Environmental Surveillance and Analytical Parameters**

| **Annual and Biennial** | | | |
|---|---|---|---|
| **Field Parameters** | | | |
| Barometric Pressure | Depth to Water | pH | Temperature |
| Conductivity | Dissolved Oxygen | Redox | Turbidity |
| **PCBs (MW182, MW418, and MW419)—Method 8082** | | | |
| PCB, Total | PCB-1232 | PCB-1248 | PCB-1260 |
| PCB-1016 | PCB-1242 | PCB-1254 | PCB-1268 |
| PCB-1221 | | | |
| **Radionuclides—Method TC-02-RC** | | | |
| Technetium-99 | | | |
| **Volatiles—Method 8260B** | | | |
| 1,1,1-Trichloroethane | Benzene | *cis*-1,2-Dichloroethene | Toluene |
| 1,1,2-Trichloroethane | Bromodichloromethane | Dimethylbenzene, Total* | *trans*-1,2-Dichloroethene |
| 1,1-Dichloroethane | Carbon Tetrachloride | Ethylbenzene | Trichloroethene |
| 1,1-Dichloroethene | Chloroform | Tetrachloroethene | Vinyl Chloride |
| 1,2-Dichloroethane | | | |

*Xylenes

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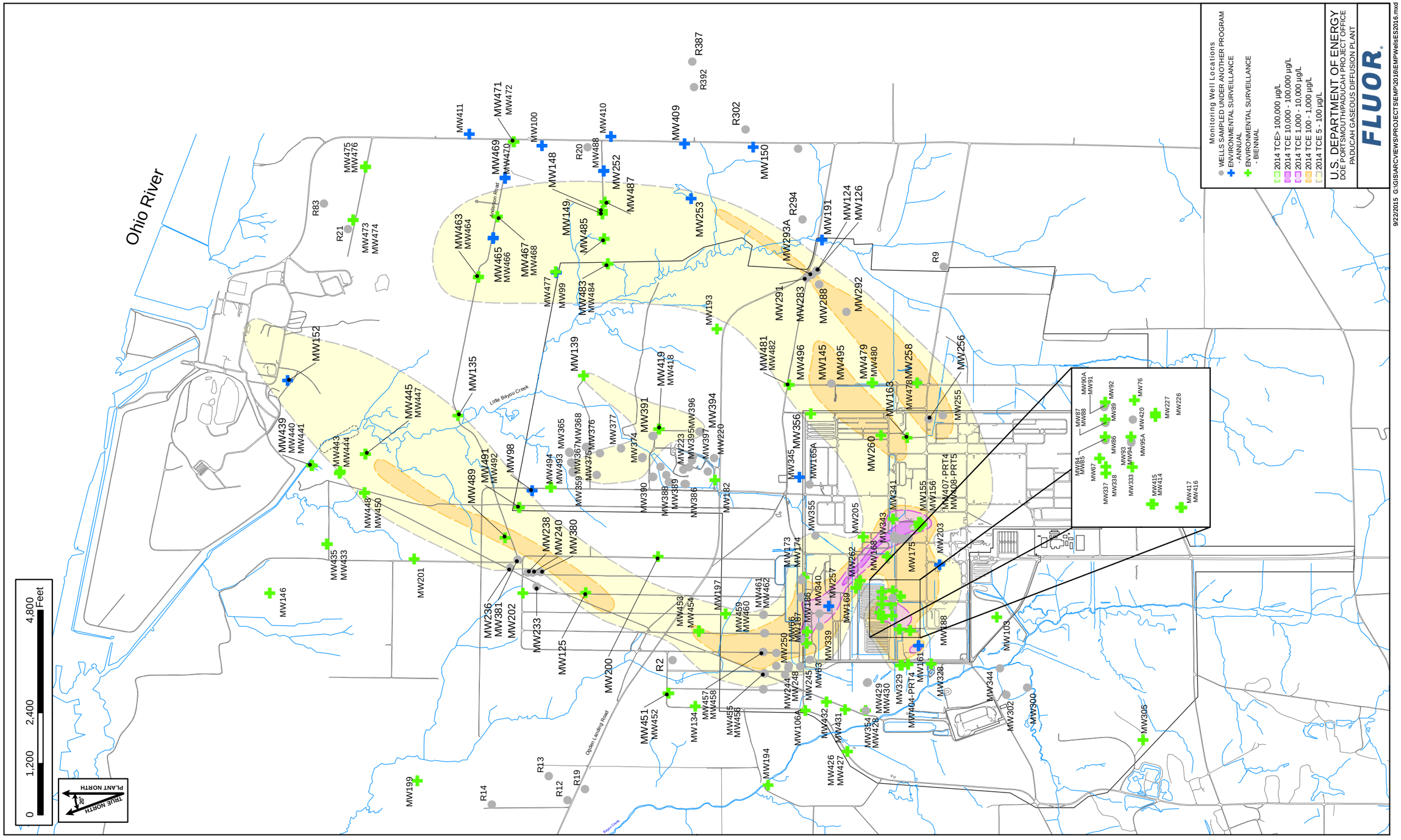


**Figure C.10. Environmental Surveillance Groundwater Monitoring Wells**

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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 2013; therefore, they will be sampled in FY 2016.

Tables C.21 and C.22 show MWs and analytical parameters, respectively. Locations are shown on Figure C.10.

**Table C.21. Surveillance Geochemical Wells (38)**

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

**Table C.22. Surveillance Geochemical Annual Analytical Parameters**

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

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

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

## C.3.1 EFFLUENT WATERSHED MONITORING PROGRAM

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

**Frequency:** Quarterly

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

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

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

**Comments:** Sampling frequencies and sampling parameters were not modified for this sampling program in FY 2016, as it is permit driven.

C-746-S and C-746-T Landfills have independent solid waste permits; however, MW sampling is performed and reported collectively.

Tables C.23 and C.24 show landfill surface water locations and landfill surface water parameters, respectively. Locations are shown on Figure C.11.

**Table C.23. Landfill Surface Water Locations (6)**

| | | |
|---|---|---|
| **C-746-S&T** | | |
| L135 | L136 | L154* |
| **C-746-U** | | |
| L150 | L154[a] | L351 |

*L154 is listed on both the C-746-S&T Landfill and the C-746-U Landfill permits.

**Table C.24. Landfill Surface Water Parameters**

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

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

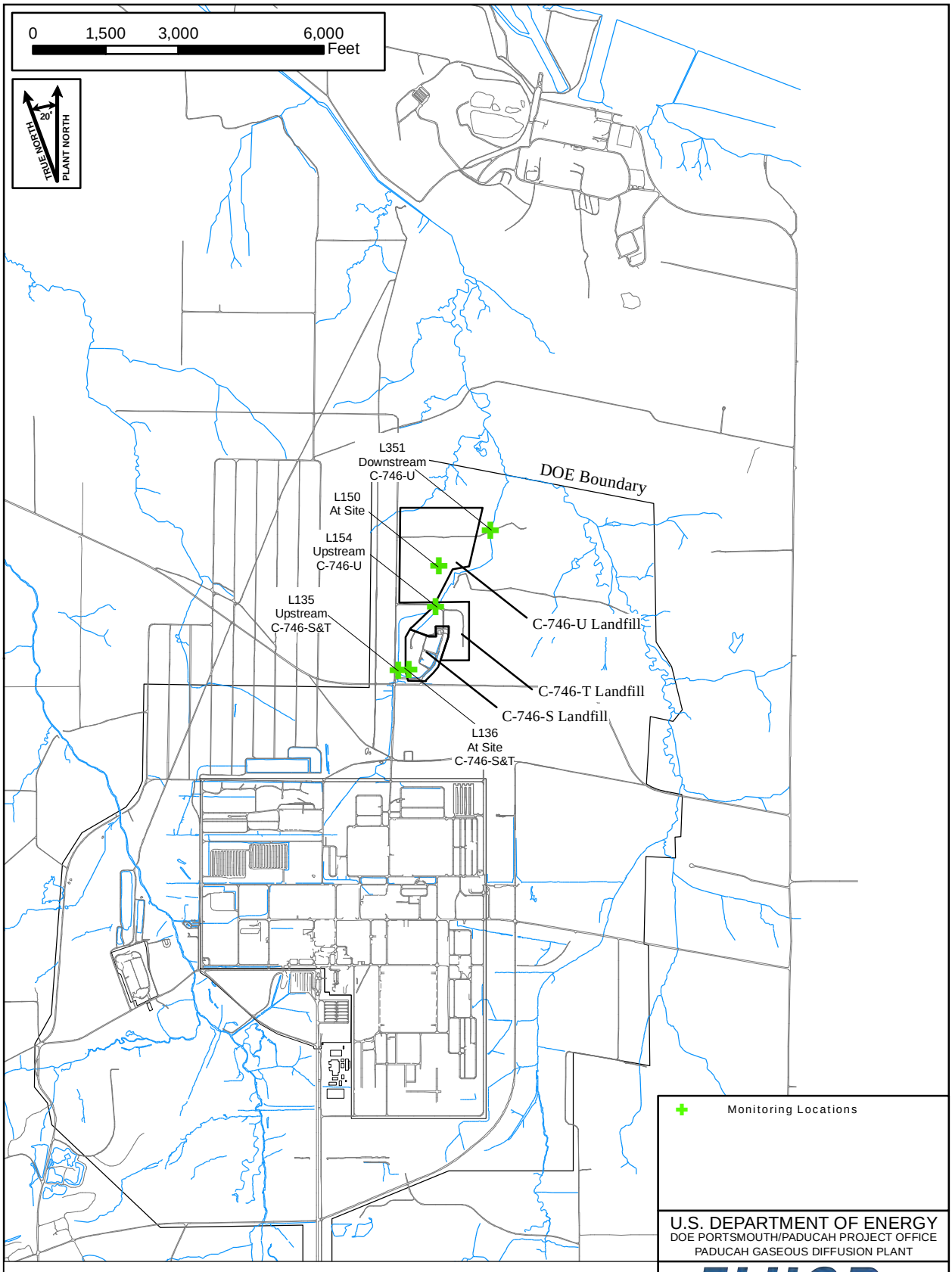


**Figure C.11. Landfill Surface Water Locations**

FIGURE No. EMP\2013\EMPLF_2013.mxd
DATE 09-14-2012

**Kentucky Pollutant Discharge Elimination System Outfall Sampling**

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

**Driver:** Kentucky Pollutant Discharge Elimination System (KPDES) permit for PGDP, permit number KY0004049, which was issued by KDOW to DOE, FPDP, and B&W Conversion Services, LLC, (BWCS) and permit number KY0102083, which was issued by KDOW to FPDP.

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

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

**Comments:** Table C.25 shows the KPDES outfall sampling locations, frequency of sampling, and parameters required by permit KY0004049, permit issued to DOE/FPDP/BWCS Table C.26 shows the KPDES outfall sampling locations, frequency of sampling, and parameters required by permit KY0102083, permit issued to FPDP. Locations are shown on Figure C.12.

Sampling frequencies and sampling parameters were not modified for this sampling program for FY 2016.

Both KPDES permits are expired; however, applications have been submitted and are under review by KDOW. Sampling and reporting specified in the two permits will continue until a new permit is issued by KDOW.

**Table C.25. KY0004049 Permit (DOE/FPDP/BWCS)**
**KPDES Outfall Sampling Locations, Frequency, and Parameters**

| Analysis-Method | Frequency of Sampling at KPDES Locations D—Daily; W—Weekly; M—Monthly; Q—Quarterly | | | | |
|---|---|---|---|---|---|
| | **K001** | **K015** | **K017** | **K019** | **K020** |
| Flow (Mgd)—Field | D | M | M | M | M |
| Total Suspended Solids (mg/L)—SM 2540 D | W | M | M | M | M |
| Oil & Grease (mg/L)—1664A | W | M | M | M | M |
| Total Residual Chlorine (mg/L)—Field | W | | | | |
| Temperature (°F)—Field | W | | M | | |
| PCBs (mg/L)—8082 | W | M | M | M | Q |
| Trichloroethene (mg/L)—624 | W | | | | Q |
| Total Phosphorus (mg/L)—365.4 | W | | | | |
| Alpha Activity (pCi/L)—9310 | W | M | M | M | M |
| Beta Activity (pCi/L)—9310 | W | M | M | M | M |
| Uranium (µg/L)—200.8 | W | M | M | M | M |
| Total Recoverable Zinc (µg/L)—6020 | | | M | M | Q |
| Total Recoverable Arsenic (µg/L)—200.8 | | | | | Q |
| Total Recoverable Nickel (µg/L)—200.8 | | | | | Q |
| Nitrates (mg/L N)—300.0 | | | | | Q |
| 1,1,1-Trichloroethane (mg/L)—624 | | | | | Q |
| Chlorides (mg/L)—300.0 | | | | | Q |
| Acute Toxicity ($TU_A$)[a]—2000.0/2002.0 | | Q | | Q | Q |
| Chronic Toxicity ($TU_c$)[b]—1000.0/1002.0 | Q | | M | | |
| Technetium-99 (pCi/L)—TC-02-RC | Q | Q | Q | Q | Q |
| Hardness (as mg/L $CaCO_3$)—SM 2340 B | Q | Q | Q | Q | Q |
| Phosphorous (mg/L)—365.4 | | | | | Q |
| CBOD (mg/L)—SM 5210 B | | | | | Q |
| Dissolved Oxygen (mg/L)—Field | | | | | Q |
| Total Recoverable Iron (µg/L)—200.8 | | Q | | Q | Q |
| Benzo(a)anthracene (µg/L)—8270SIM | | Q | Q | | |
| Benzo(k)fluoranthene (µg/L)—8270SIM | | Q | | | |
| Free Cyanide (µg/L)—9012B[d] | Q | | | | |
| Heptachlor (µg/L)—8081A | Q | Q | Q | | |
| Indeno(1,2,3-cd) pyrene (µg/L)—8270SIM | Q | | | | |
| pH (between 6–9)—Field | W | M | M | W[c] | W[c] |

[a] Acute toxicity sampling requires two grab samples. A different lab method is used for each species.
[b] Chronic toxicity sampling requires three 24-hour composite samples. A different lab method is used for each species.
[c] These effluents are sampled weekly when the C-746-U Landfill leachate/sedimentation pond is discharging to the outfalls.
[d] 9010 is prep method for 9012.

**Table C.26. KY0102083 Permit (FPDP)**
**KPDES Outfall Sampling Locations, Frequency, and Parameters**

| Analysis-Method | Frequency of Sampling at KPDES Locations W—Weekly; M—Monthly; Q—Quarterly | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **K002** | **K004** | **K006** | **K008** | **K009** | **K010** | **K011** | **K012** | **K013** | **K016** |
| Flow (Mgd)—Field | M | 2/M | W | W | W | W | M | M | M | M |
| Total Suspended Solids (mg/L)—SM 2540 D | | | W | | | | | | | |
| Oil & Grease (mg/L)—1664A | M | | W | W | W | W | M | M | M | M |
| Total Residual Chlorine (mg/L)—Field | M | | M | M | M | M | M | M | | |
| Temperature (°F)—Field | M | | | W | W | W | M | M | | |
| PCBs (mg/L)—608 | M | | | M | M | M | M | M | M | M |
| Trichloroethene (mg/L)—624 | M | | | M | M | M | M | M | M | M |
| Total Phosphorus (mg/L)—365.4 | M | | | W | W | W | M | M | | |
| Total Uranium (mg/L)—-200.8 | Q | | | Q | Q | Q | Q | Q | Q | Q |
| Acute Toxicity ($TU_A$)[a]—2000.0/2002.0 | Q | | Q | | | | Q | Q | Q | Q |
| Chronic Toxicity ($TU_c$)[b]—1000.0/1002.0 | | | | Q | Q | Q | | | | |
| Total Recoverable Metals -200.8/245.2[c] | Q | | Q | Q | Q | Q | Q | Q | Q | Q |
| Technetium-99 (pCi/L)—TC-02-RC | Q | | | Q | Q | Q | Q | Q | Q | Q |
| Hardness (as mg/L $CaCO_3$)—SM 2340 B | M | | M | M | M | M | M | M | M | M |
| CBOD (mg/L)—SM 5210 B | | 2/M | | | | | | | | |
| Fecal Coliform Bacteria (#100 ml) | | 2/M | | | | | | | | |
| pH (between 6-9)—Field | W | | W | W | W | W | W | W | M | M |

[a] Only K006 requires two samples 24-hours apart. All other outfalls only require one sample. A different lab method is used for each species.
[b] Chronic toxicity sampling requires three 24-hour composite samples. A different lab method is used for each species.
[c] Total recoverable metals include iron, antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, and zinc.

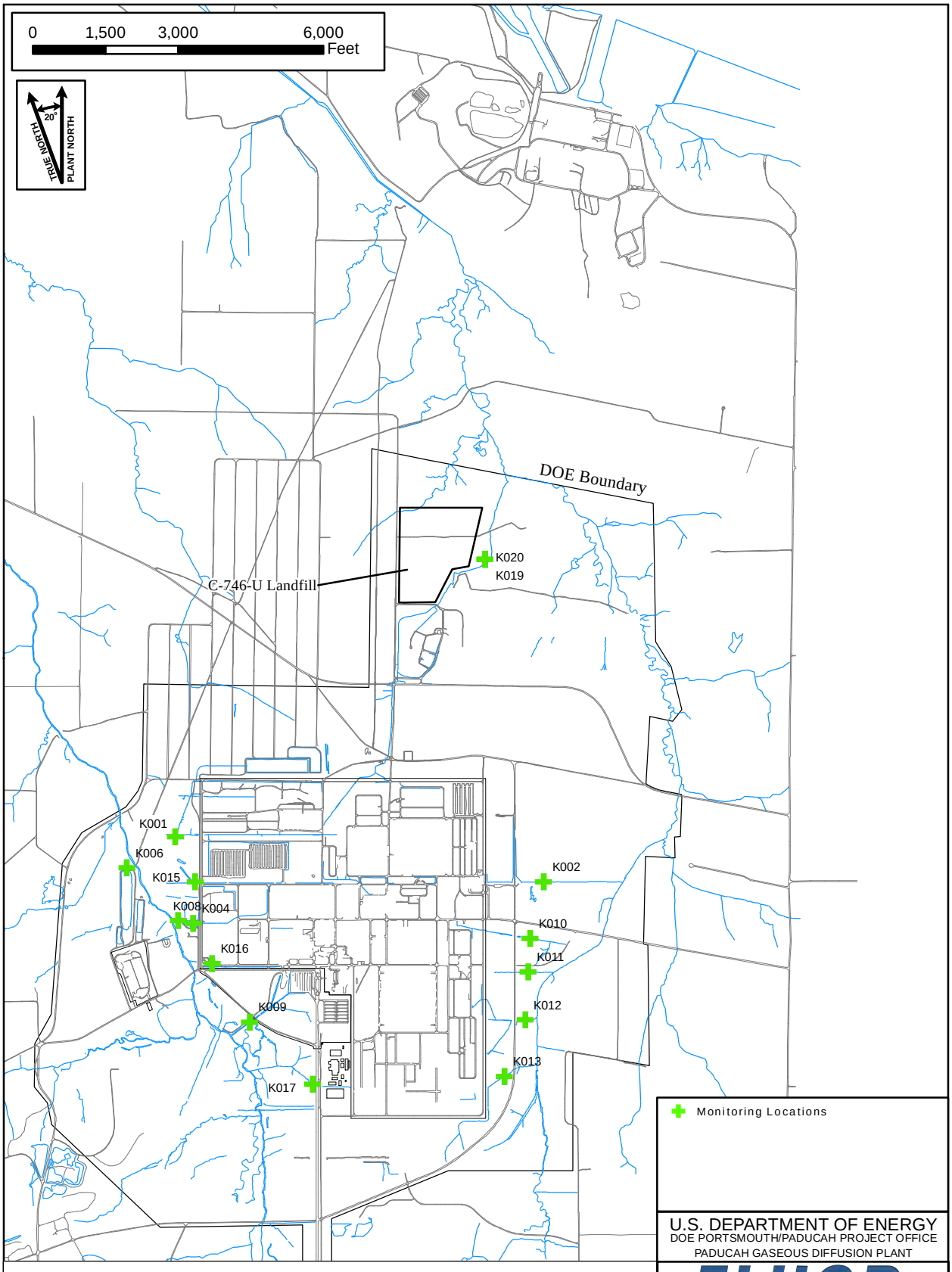


**Figure C.12. KPDES Outfall Sampling Locations**

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8/18/2014

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

**Frequency:** Monthly

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

**Reported:** ASER

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

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

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

Sampling parameters were modified for FY 2016 to be consistent with the Site chemical of potential concern (COPC) list included in Table 2.1 of DOE 2015, *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/R6/V1, U.S. Department of Energy, Paducah, KY, August.

Tables C.27 and C.28 list the sampling location, frequency, and parameter. Locations are shown on Figure C.13.

**Table C.27. ERPP Effluent and Surface Water Runoff**

| Analysis—Method | Analytical Parameters M—Monthly | | | | |
|---|---|---|---|---|---|
| | K001 ERPP | K015 ERPP | K017 ERPP | K019 ERPP | K020 ERPP |
| Alpha activity (pCi/L)—9310 | M | M | M | M | M |
| Beta activity (pCi/L)—9310 | M | M | M | M | M |
| Americium-241—HASL 300 | M | M | | | |
| Cesium-137*—901.1 | | M | | | |
| Neptunium-237 (pCi/L)*—Alpha Spec | M | M | | | |
| Plutonium-238 (pCi/L)*—PU-11-RC | M | M | | | |
| Plutonium-239/240 (pCi/L)*—PU-11-RC | M | M | | | |
| Technetium-99 (pCi/L)*—TC-02-RC | M | M | M | M | M |
| Thorium-230—Th-01-RC | M | M | | | |
| Alpha activity on the filtered material [Settleable Solids (pCi/g)]—9310 | M | M | M | M | |
| Beta activity on the filtered material [Settleable Solids (pCi/g)]—9310 | M | M | M | M | |
| Uranium-234 (pCi/L)*—U-02-RC | M | M | M | M | M |
| Uranium-235 (pCi/L)*—U-02-RC | M | M | M | M | M |
| Uranium-238 (pCi/L)*—U-02-RC | M | M | M | M | M |

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

**Table C.28. ERPP Effluent and Surface Water Runoff**

| Analysis—Method | Analytical Parameters M—Monthly | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | K002 ERPP | K004 ERPP | K008 ERPP | K009 ERPP | K010 ERPP | K011 ERPP | K012 ERPP | K013 ERPP | K016 ERPP |
| Alpha activity (pCi/L)—9310 | M | M | M | M | M | M | M | M | M |
| Beta activity (pCi/L)—9310 | M | M | M | M | M | M | M | M | M |
| Americium-241—HASL 300 | | M | M | M | M | M | M | | M |
| Cesium-137*—901.1 | | M | M | | | | | | M |
| Neptunium-237 (pCi/L)*—Alpha Spec | | M | M | M | M | M | M | | M |
| Plutonium-238 (pCi/L)*—PU-11-RC | | M | M | M | M | M | M | | M |
| Plutonium-239/240 (pCi/L)*—PU-11-RC | | M | M | M | M | M | M | | M |
| Technetium-99 (pCi/L)*— TC-02-RC | M | M | M | M | M | M | M | M | M |
| Thorium-230—Th-01-RC | | M | M | M | M | M | M | | M |
| Alpha activity on the filtered material [Settleable Solids (pCi/g)]—9310 | M | M | M | M | M | M | M | M | M |
| Beta activity on the filtered material [Settleable Solids (pCi/g)]—9310 | 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 |
| Uranium-235 (pCi/L)*—U-02-RC | 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 |

*Sample will be collected, but will not be analyzed unless alpha activity exceeds 14 pCi/L or beta activity exceeds 300 pCi/L.
NOTE: Samples are being collected from locations near the outfalls listed in KPDES permit KY0102083.

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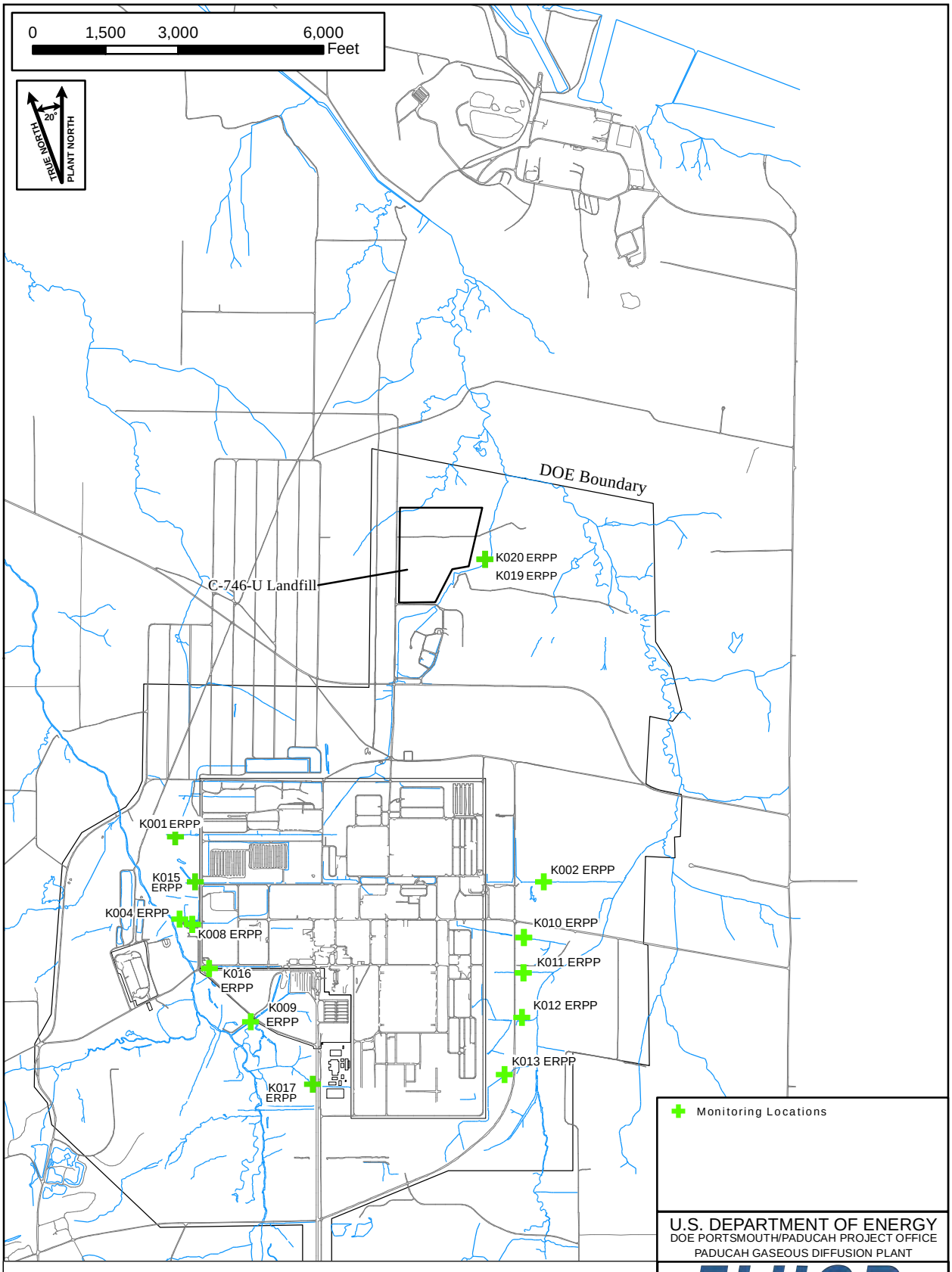


**Figure C.13. Surface Water Monitoring near KPDES Outfalls**

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8/19/2014

### 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:** May be reported to KDWM via electronic mail.

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

**Comments:** Table C.29 provides a listing of the analytical parameters. Location of the C-613 Sediment Basin is shown on Figure C.14.

Sampling frequencies and sampling parameters were not modified for this sampling program for FY 2016.

Split sampling that had been conducted with KDWM during the third quarter of each year was eliminated in FY 2013. This sampling had been conducted for comparison purposes and was not required by the Operations and Maintenance Plan. The sampling is conducted by KDWM during non-discharge operations of the C-613 Sediment Basin. A review of historical data was conducted, and the review found a strong consistency in the data sets. Because no relative change to the data sets is expected due to consistent site operations, this sampling was eliminated.

**Table C.29. C-613 Sediment Basin Quarterly Water Parameters**

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

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

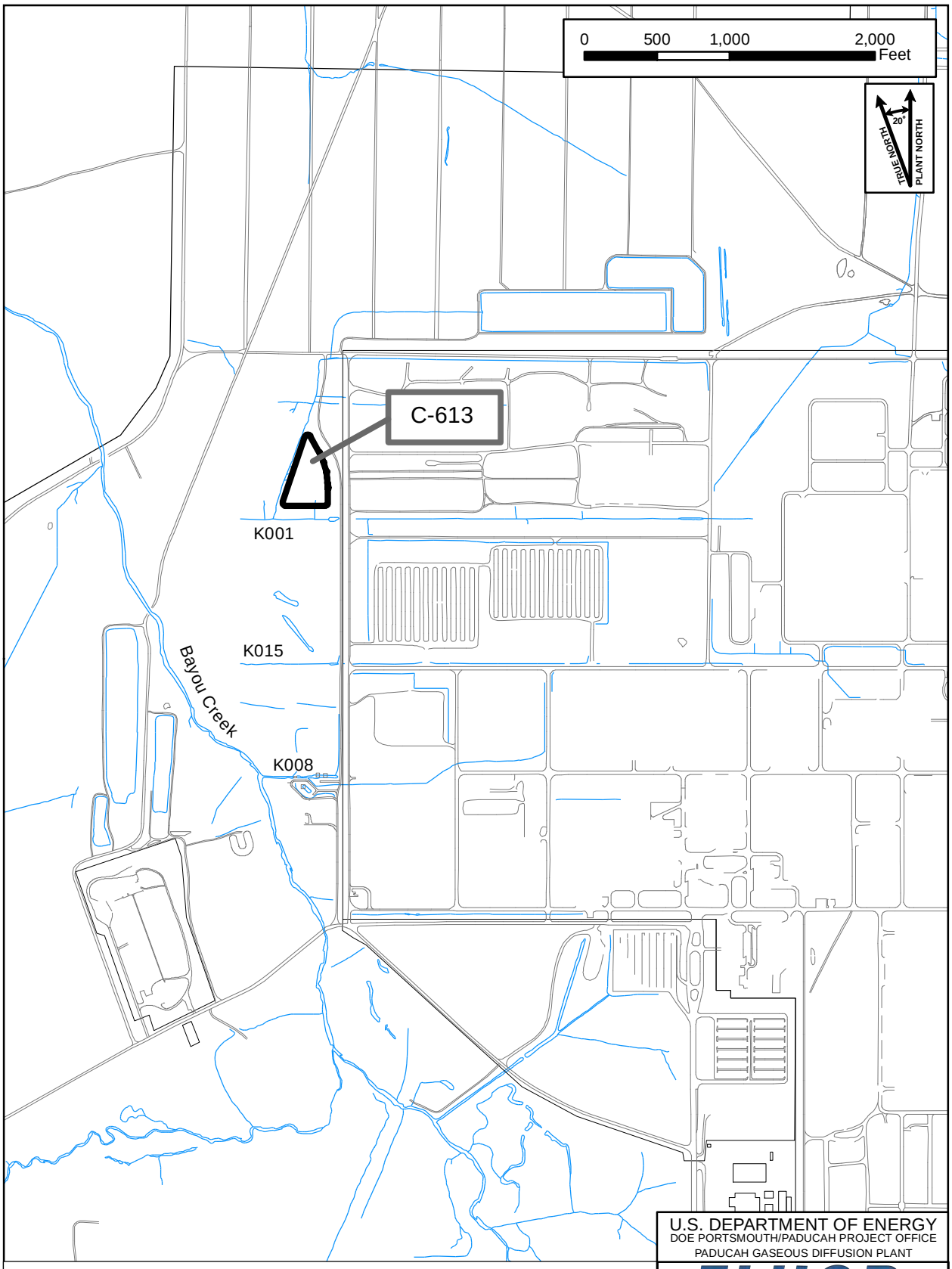


**Figure C.14. C-613 Sediment Basin**

## C.3.4 ENVIRONMENTAL SURVEILLANCE WATERSHED MONITORING PROGRAM

**Surface Water Monitoring**

**Frequency:** Quarterly and Annually

**Driver:** DOE KPDES permit for PGDP, permit number KY0004049, McCracken County, Kentucky requires 19 in-stream surface water locations be sampled quarterly for PCBs and TCE. DOE Order 458.1 requires radiological monitoring.

**Reported:** ASER

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

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

One change was made to the program in FY 2014 EMP. Sampling at L306, Cairo, Illinois, was added to provide additional radiological data at the nearest public drinking water supply. The review of the data did not require the additional sampling; however, the addition is justified due to an increase in the amount of remediation efforts at the site. For the FY 2016 EMP, a change was made in that the L306 location will be sampled quarterly one week following the other sampling locations in an effort to provide a comparison of water quality as the surface water travels to the downstream location, which is located at Cairo, IL.

Also, sampling at L29A, a background location upstream of the Paducah Site, and L30, just downstream of the Paducah Site, located in the Ohio River, have been added to the FY 2016 EMP. L29A and L30 will be sampled for radiological parameters in addition to the other nonradiological parameters. The radiological parameters chosen for analysis will be the same parameter list associated with the Cairo, Illinois, location, L306, and the other upstream background location, L1. See Table C.36 for the listing of parameters.

Table C.30 details surface water and the seep sampling locations. Tables C.31 and C.32 detail the surface water and seep sampling analytical parameters that are driven by the KPDES permit. Tables C.33 through C.36 detail the surface water and seep sampling analytical parameters by location for the ERPP. Sampling to support the ERPP will be conducted on a quarterly basis, with the exception of the background locations (L1 and L30), which will be sampled annually. Locations are shown on Figure C.15.

**Table C.30. Surface Water and Seep Sampling Locations (20)**

| | | |
|---|---|---|
| **Surface Water (19)** | | |
| C612 (SP)* | L194 | L241 |
| C616 | L29A (BG/R)* | L6 |
| C746K-5 | L291 | L64 (BG) |
| C746KTB1A | L30 (R)* | S31 |
| L1 (BG) | L306 (R)* | K001UP |
| L10 | L5 | **Seep (1)** |
| L11 | L12 | LBCSP5* |

BG = Background locations
R = Ohio River locations
SP = Sampling port
*Unable to obtain flow rates.

**Table C.31. Surface Water Quarterly Analytical Parameters**

| | | |
|---|---|---|
| **PCBs—Method 608** | | |
| PCB, Total | PCB-1232 | PCB-1254 |
| PCB-1016 | PCB-1242 | PCB-1260 |
| PCB-1221 | PCB-1248 | PCB-1268 |
| **Field Measurements** | | |
| Alkalinity | Dissolved Oxygen | pH |
| Conductivity | Flow* | Temperature |
| **Volatiles—Method 624** | | |
| Trichloroethene | | |

*See Table C.29 for locations where flow rates are not collected.

**Table C.32. Seep Location Quarterly Analytical Parameters**

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

**Table C.33. Surface Water—ERPP Little Bayou Creek Locations and Quarterly Analytical Parameters**

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

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

**Table C.34. Surface Water—ERPP Bayou Creek Location and Quarterly Analytical Parameters**

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

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

**Table C.35. Surface Water—ERPP North-South Diversion Ditch Location and Quarterly Analytical Parameters**

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

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

**Table C.36. Surface Water—ERPP Background and Nearest Public Water Source Location and Quarterly/Annual Analytical Parameters**

| | |
|---|---|
| **Locations** | |
| Annually L1 and L30<br>Quarterly L29A and L306 (Cairo, Illinois) | |
| **Radionuclides—Method U-02-RC unless noted** | |
| **Alpha Activity—9310** | **Cesium-137*—901.1** |
| **Beta Activity—9310** | **Technetium-99*—TC-02-RC** |
| **Americium-241*—HASL 300** | Uranium* |
| **Neptunium-237*—Alpha Spec** | Uranium-234* |
| **Plutonium-238*—PU-11-RC** | Uranium-235* |
| **Plutonium-239/240*—PU-11-RC** | Uranium-238* |
| **Thorium-230*—Th-01-RC** | |

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

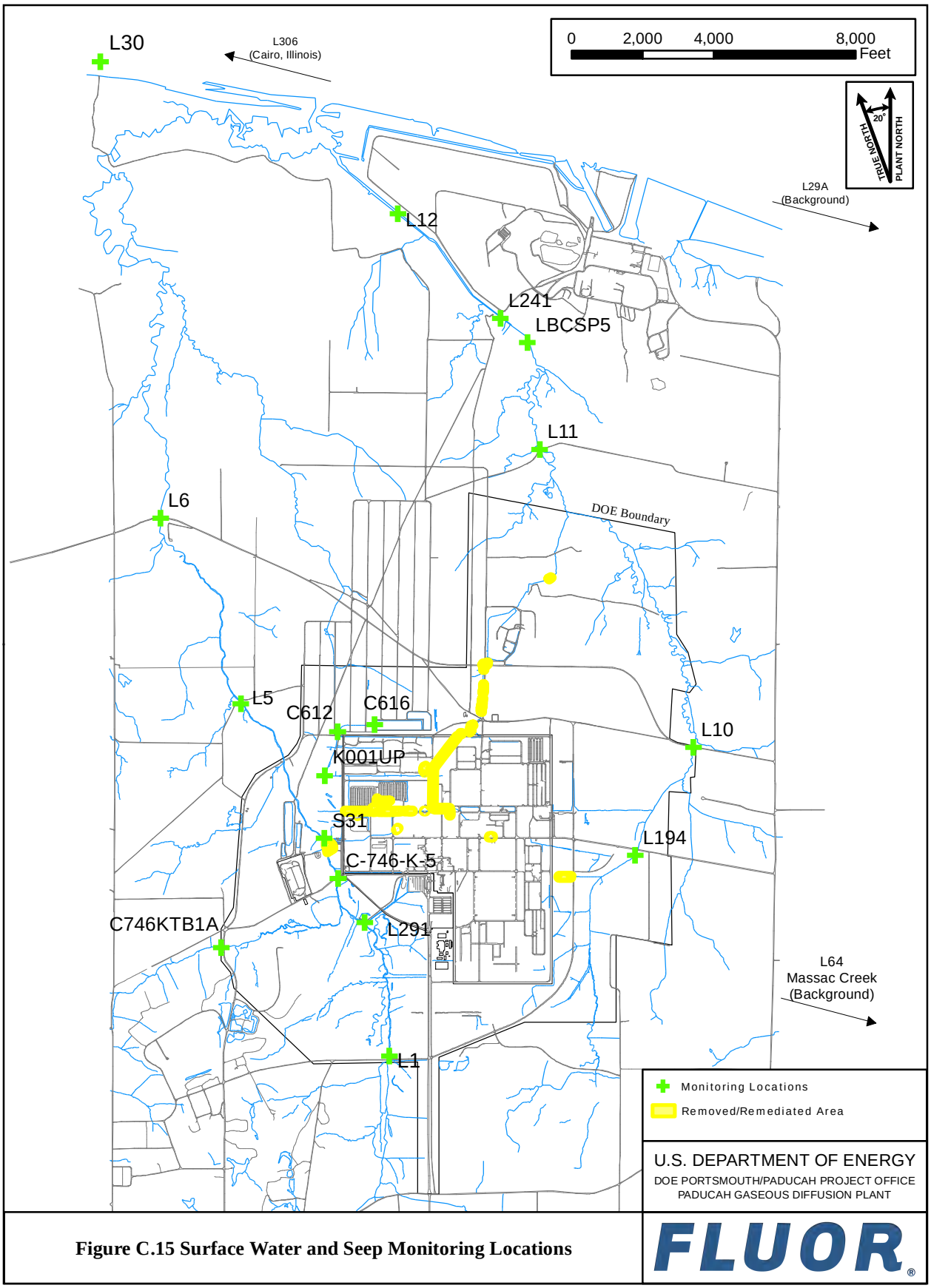


**Figure C.15 Surface Water and Seep Monitoring Locations**

**Sediment Monitoring**

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

**Driver:** DOE KPDES Permit for PGDP, permit number KY0004049, McCracken County, Kentucky requires 14 locations be sampled quarterly for PCBs. DOE Order 458.1 requires radiological monitoring. This radiological monitoring will be conducted on an annual basis.

**Reported:** ASER

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

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

Tables C.37 details sediment sampling locations and parameters driven by the KPDES permit. Tables C.38 details the sediment sampling locations and parameters driven by the ERPP. Sampling parameters were modified for FY 2016 to be consistent with the Site COPC list included in the Risk Methods Document. Locations are shown on Figure C.16.

**Table C.37. Sediment—Location and Semiannual Analytical Parameters Sampling Locations (14)**

| | | |
|---|---|---|
| **Locations** | | |
| C612 | S1 | S31 |
| C616 | S2 | S32 |
| C746KTB2 | S20 (BG) | S33 |
| K001 | S27 | S34 |
| L194 | S28 (BG) | |
| **PCBs—Method 8082** | | |
| PCB, Total | PCB-1232 | PCB-1254 |
| PCB-1016 | PCB-1242 | PCB-1260 |
| PCB-1221 | PCB-1248 | PCB-1268 |

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

**Table C.38. Sediment—ERPP Location and Annual Analytical Parameters Sampling Locations (6)**

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

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

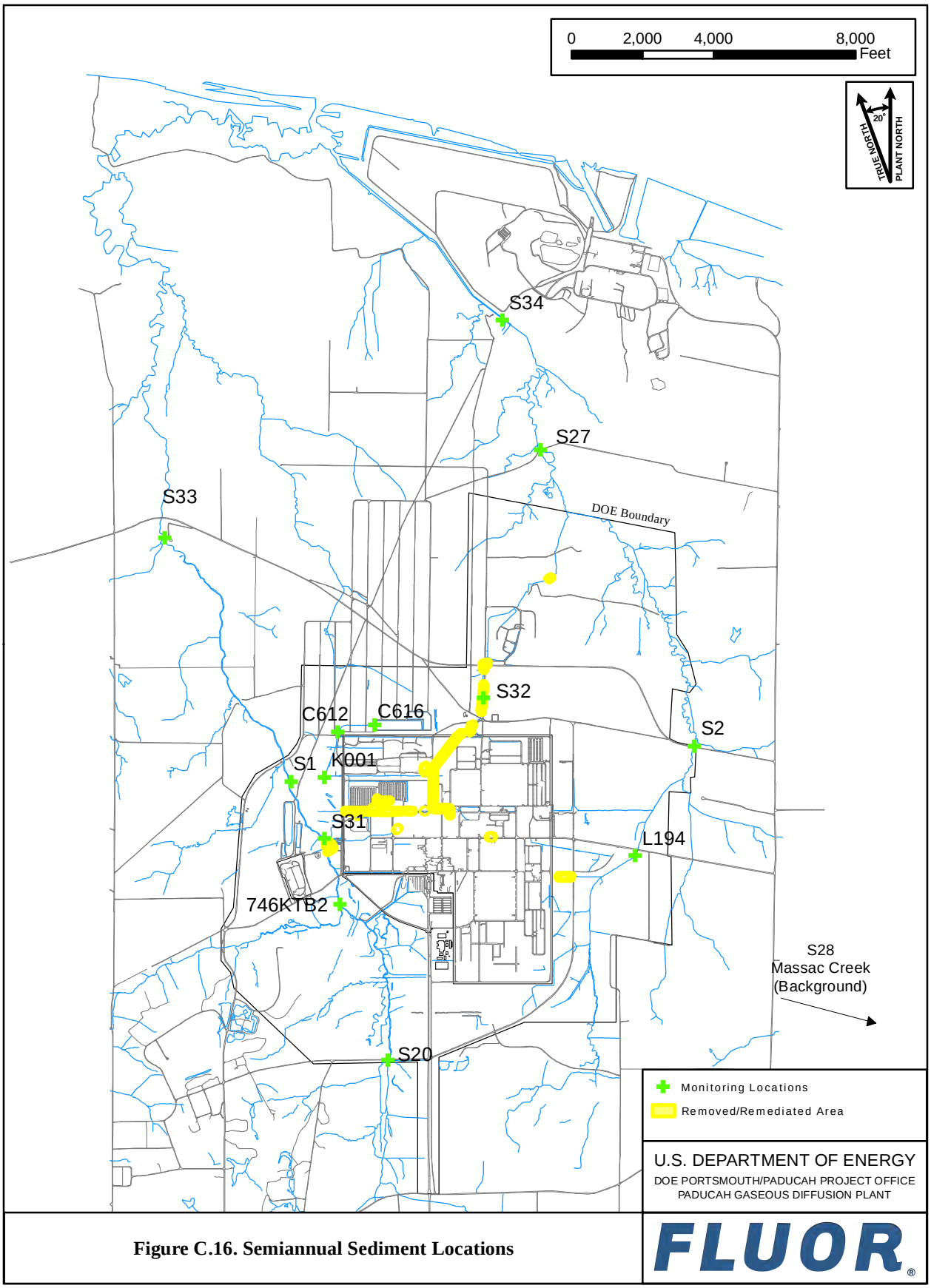


**Figure C.16. Semiannual Sediment Locations**

# C.4. LANDFILL LEACHATE SAMPLING

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

**Frequency:** Annually

**Driver:** C-746-S, C-746-T, and C-746-U Landfill permits issued by KDWM, Permit Numbers SW07300014, SW07300015, and SW07300045, respectively.

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

**Rationale:** Solid waste landfill permits as follows: SW07300014 (C-746-S Landfill), SW07300015 (C-746-T Landfill), and SW07300045 (C-746-U Landfill)

**Comments:** C-746-S and C-746-T Landfills have independent solid waste permits; however, MW sampling is performed and reported collectively.

Annual leachate parameters for C-746-S, C-746-T, and C-746-U Landfills are presented in Table C.39.

## Table C.39. C-746-S&T and C-746-U Landfills Annual Leachate Parameters

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

[a] Xylenes

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

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

**Frequency:** As needed

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

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

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

**Comments:** Leachate analytical parameters for C-404 Landfill are presented in Table C.40.

**Table C.40. C-404 Landfill Leachate Analytical Parameters**

| | | | |
|---|---|---|---|
| **Volatiles—Method 8260B** | | | |
| Trichloroethene | | | |
| **Radionuclides—Method U-02-RC unless noted** | | | |
| **Technetium-99—TC-02-RC** | Uranium-235 | **Plutonium-239/240—PU-11-RC** | **Cesium-137[a]—901.1** |
| Uranium-234 | Uranium-238 | **Thorium-230—Th-01-RC** | **Neptunium-237—Alpha Spec** |
| **PCBs[b]—Method 8082** | | | |
| PCB, Total | PCB-1232 | PCB-1248 | PCB-1260 |
| PCB-1016 | PCB-1242 | PCB-1254 | PCB-1268 |
| PCB-1221 | | | |
| **Metals—Method 6020 unless noted** | | | |
| Barium | Iron | Silver | **Mercury—7470A** |
| Cadmium | Lead | Zinc | Selenium |
| Chromium | Nickel | Arsenic | Uranium |
| Copper | | | |
| **Miscellaneous—Method as follows** | | | |
| **Fluoride—9056** | **Ammonia as Nitrogen—350.1** | | |
| **Field Parameters** | | | |
| pH | Dissolved Oxygen | Redox | Temperature |
| Conductivity | | | |

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

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# C.5. EXTERNAL GAMMA RADIOLOGICAL MONITORING

**Frequency:** Collected continuously and analyzed quarterly; thermoluminescent dosimeters (TLDs) at 64 monitoring locations are changed quarterly for gamma 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:** For the FY 2016 EMP, one change was made to the external gamma radiological monitoring program. TLD-55, which was located near C-410, has been discontinued due to the decontamination and decommissioning of the facility. There now are 64 TLD locations.

Figure C.17 shows TLD monitoring locations.

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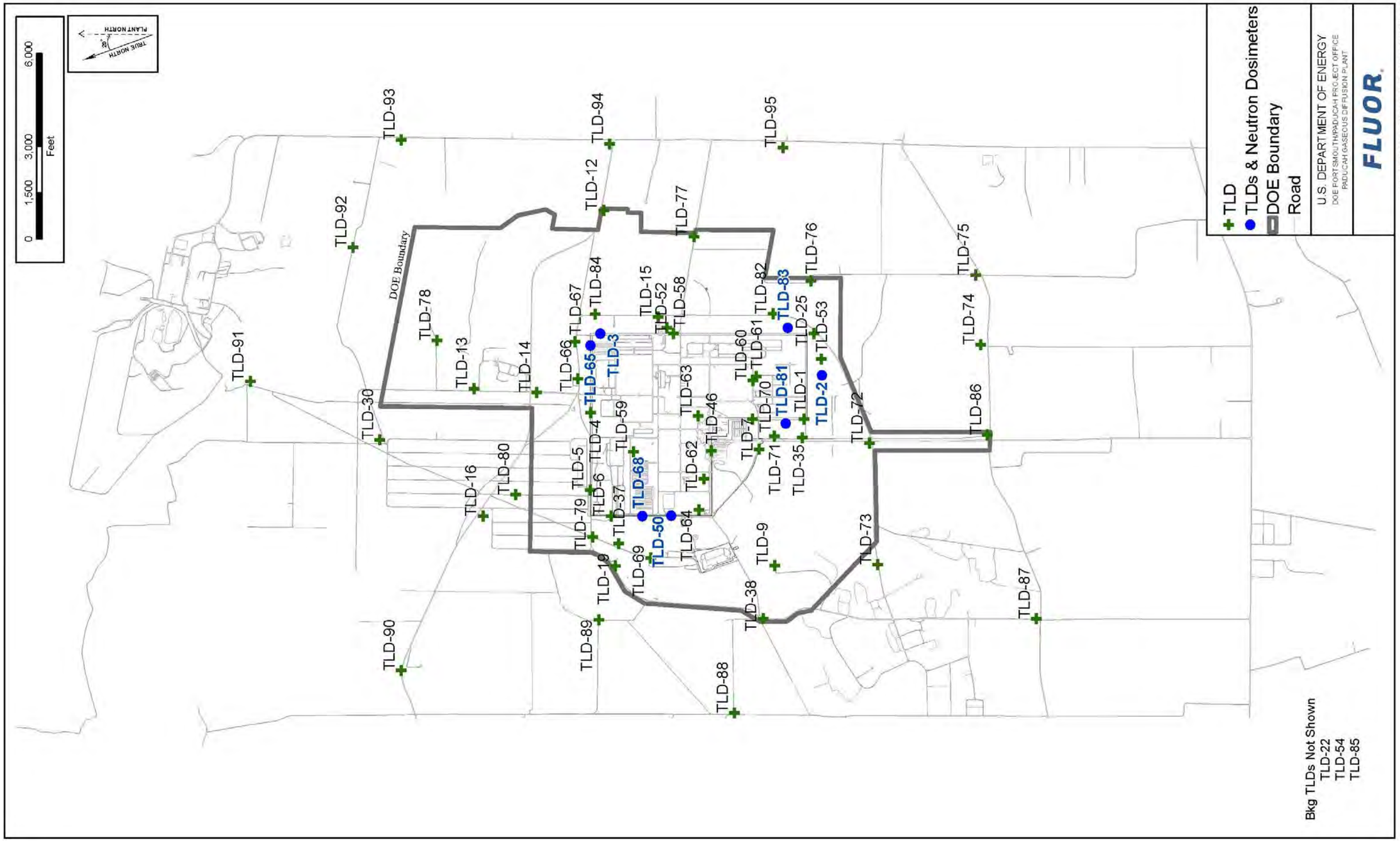


**Figure C.17. TLD Monitoring Locations**

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# C.6. AMBIENT AIR MONITORING

**Frequency:** Weekly/Quarterly

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

**Reported:** NESHAP Annual Report and ASER

**Rationale:** Monitor radionuclide emissions from Paducah Site activities

**Comments:** The ambient air monitoring program has been operated and managed by the Kentucky Cabinet for Health and Family Services since the program was initiated. The EM Program began managing the program on July 1, 2012, using nine solar-powered air monitoring units. Eight of the units are situated on DOE property near the units that the Kentucky Cabinet for Health and Family Services owned and operated. The remaining unit is located off-site near the Kevil community and functions as a collection site to be used for background monitoring.

Location identifications are found in Table C.41. Filter samples are collected on a weekly basis and analyzed for gross alpha and beta, as shown in Table C.42. 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.43. Locations are shown on Figure C.18.

**Table C.41. Ambient Air Monitoring Locations (9)**

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

BG = Background

**Table C.42. Ambient Air Monitoring Weekly Analytical Parameters**

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

**Table C.43. Ambient Air Monitoring Quarterly Analytical**

| **Radionuclides—Methods as follows** | | |
|---|---|---|
| **Americium-241—Gamma Spec** | **Plutonium-239/240—Alpha Spec** | **Uranium-234—6020/Alpha Spec** |
| **Neptunium-237/Protactinium-233—Gamma Spec** | **Technetium-99—LSC** | **Uranium-235—6020/Alpha Spec** |
| **Plutonium-238—Alpha Spec** | **Thorium-234/Uranium-238—Gamma Spec** | **Uranium-238—6020/Alpha Spec** |

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

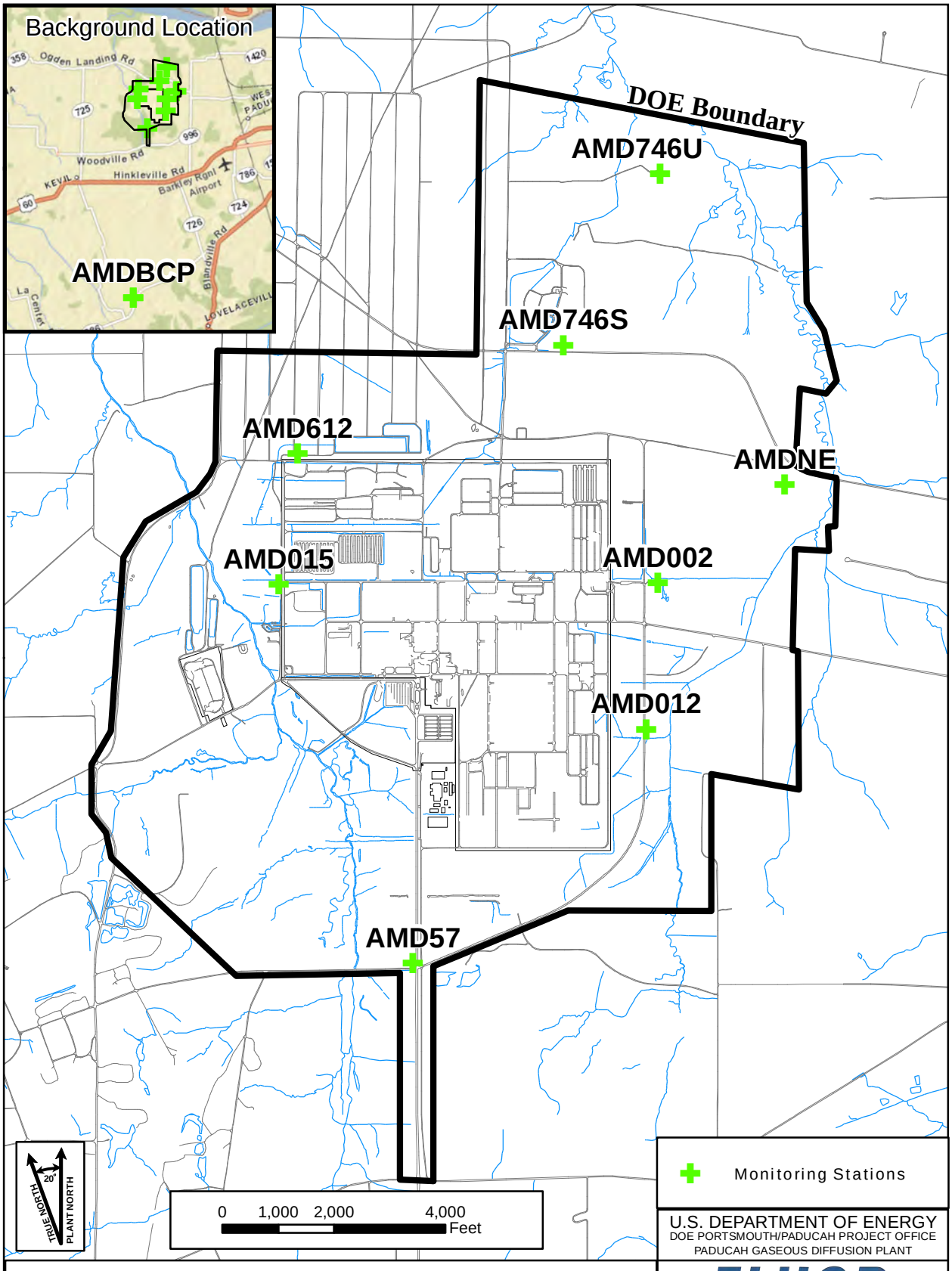


**Figure C.18. COE Ambient Air Monitoring Stations**

FIGURE No. EMP/2013/EMP-AMD_2013.mxd
DATE 09-14-2012

# APPENDIX D

# ENVIRONMENTAL MONITORING QUALITY ASSURANCE PROJECT PLAN

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# CONTENTS



# QAPP WORKSHEETS

# ACRONYMS

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

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# INTRODUCTION

The Environmental Monitoring (EM) Quality Assurance Project Plan (QAPP) has been prepared by Fluor Federal Services, Inc., Paducah Deactivation Project (FPDP) based on the approved programmatic QAPP, DOE/LX/07/1269&D2/R2, *Programmatic Quality Assurance Project Plan*, which was based on the *Uniform Federal Policy for Quality Assurance Project Plans* (UFP-QAPP Manual) guidelines for QAPPs (IDQTF 2005), as updated by the *Optimized UFP-QAPP Worksheets* guidance (IDQTF 2012).

This EM QAPP is Appendix D to the *Environmental Monitoring Plan Fiscal Year 2016*, CP2-ES-0006/R0. It describes the project-specific quality assurance activities that will be conducted to support ongoing monitoring programs of varying media (e.g., groundwater, surface water, air, and sediment) at the site.

This EM QAPP does the following:

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

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

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

This QAPP does not cover the analysis of the thermoluminscent devices (TLDs) for gamma emissions although the program is detailed with sample locations in Appendix C of the EMP. Those analyses are conducted utilizing quality standards set forth and evaluated by the Environment, Safety, and Health organization. Additionally, filters collected in the ambient air monitoring program are not covered in this

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

QAPP. While the ambient air monitoring program, like the TLD environmental monitoring program, are important for overall evaluation of site operations, they are not considered to fit the typical QAPP guidelines and should not be forced into the parameter listing within the QAPP on the sole reason that they are included in Appendix C of the EMP.

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

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

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

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

**Site Name/Project Name:** Paducah Gaseous Diffusion Plant
**Site Location:** Paducah, Kentucky
**Site Number/Code:** KY8890008982
**Contractor Name:** FPDP
**Contractor Number: Task Order** DE-DT0007774
**Contract Title:** Paducah Gaseous Diffusion Plant Paducah Deactivation Project
**Work Assignment Number:** N/A

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

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

**Preparer's Name and Organizational Affiliation:** Lisa Crabtree, Fluor Federal Services, Inc., Paducah Deactivation Project (FPDP)

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

**Preparation Date (Month/Year):** 1/2016

**Document Control Number:** CP2-ES-0006/R0, Appendix D

FPDP Signature: _____ Date: 1-11-16
Mark J. Duff
Environmental Management, Director

FPDP Signature: _____ Date: 1/11/16
Myrna Espinosa Redfield
Regulatory Affairs Manager

FPDP Signature: Lisa Crabtree Date: 1/11/16
Lisa Crabtree
Environmental Monitoring Project Manager

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

1. Identify guidance used to prepare QAPP:

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

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

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

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

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

   *Paducah Gaseous Diffusion Plant Programmatic Quality Assurance Project Plan*, DOE/LX/07-1269&D2/R2.

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

3. Identify approval entity: DOE

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

5. List dates of scoping sessions that were held: August 2013—Data Quality Objective (DQO) Session with LATA Environmental Services of Kentucky, LLC, (LATA Kentucky) and DOE

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

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

| **Title:** | **Approval Date:** |
|---|---|
| *Data and Documents Management and Quality Assurance Plan for Paducah Environmental Management and Enrichment Facilities,* DOE/OR/07-1595&D2 (DOE 1998) | 10/5/1998 |
| *Paducah Gaseous Diffusion Plant Programmatic Quality Assurance Project Plan, Paducah, Kentucky*, DOE/LX/07-1269&D21R2 (QAPP) | 4/8/2015 |

7. List organizational partners (stakeholders) and connection with lead organization:
EPA Region 4 (FFA member), KDEP (Regulates hazardous and solid waste landfills, effluent discharge permits, FFA member), DOE (Lead Organization), FPDP (DOE Prime Contractor)

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

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

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

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

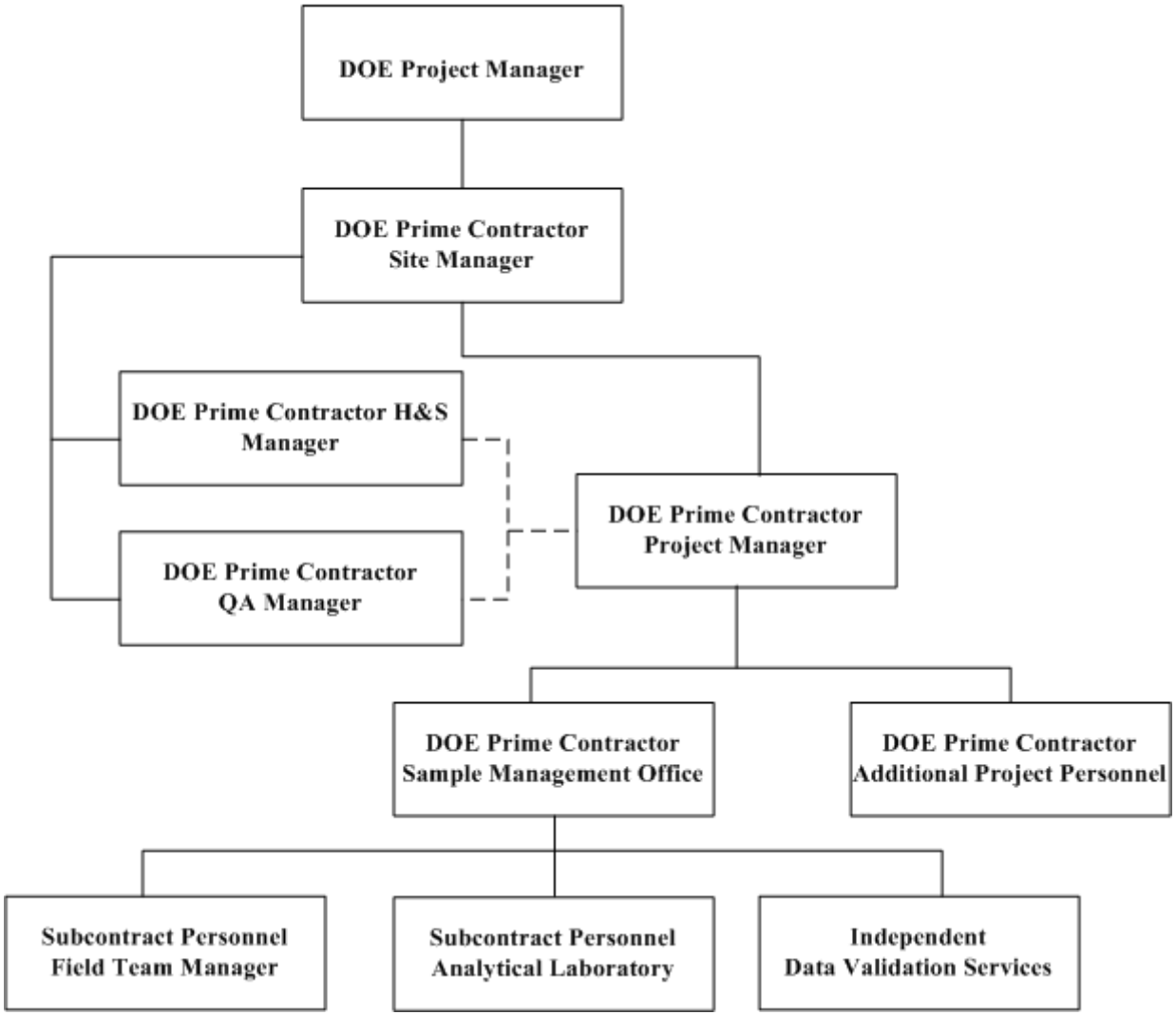
**QAPP Worksheets #3 and #5.**
**Project Organization and QAPP Distribution**

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

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

| Position Title | Organization | QAPP Recipients | Current Telephone Number | Current E-mail Address | Document Control Number |
|---|---|---|---|---|---|
| Paducah Site Lead | DOE | Jennifer Woodard | (270) 441-6820 | jennifer.woodard@lex.doe.gov | 1 |
| Project Manager | DOE | Dave Dollins | (270) 441-6819 | dave.dollins@lex.doe.gov | 2 |
| Director of Environmental Management | FPDP | Mark Duff | (270) 441-5030 | mark.duff@ffspaducah.com | 3 |
| Regulatory Affairs Manager | FPDP | Myrna Redfield | (270) 441-5113 | myrna.redfield@ffspaducah.com | 4 |
| LSRS Project Manager | FPDP | Craig Jones | (270) 441-5114 | craig.jones@ffspaducah.com | 5 |
| Environmental Radiation Protection and Risk Assessment Manager | FPDP | LeAnne Garner | (270) 441-5436 | leanne.garner@ffspaducah.com | 6 |
| FFA Manager | FPDP | Jana White | (270) 441-5185 | jana.white@ffspaducah.com | 7 |
| Quality Manager | FPDP | Jim Quinnette | (270) 441-5656 | jim.quinnette@ffspaducah.com | 8 |
| Environmental Monitoring Project Manager | FPDP | Lisa Crabtree | (270) 441-5135 | lisa.crabtree@ffspaducah.com | 9 |
| Health and Safety Manager | FPDP | Steve Wentzel | (270) 441-6239 | steve.wentzel@ffspaducah.com | 10 |
| Regulatory Compliance Manager | FPDP | Michael Gerle | (270) 441-6680 | michael.gerle@ffspaducah.com | 11 |

**QAPP Worksheet #5-A.**
**Project Level Organizational Chart**



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

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

| Project Position Title | Organization | Specialized Training/Certification, if any | Signature | Date |
|---|---|---|---|---|
| Sample Team Leads | GEO Consultants | Per TPD | | |
| Sample Management Office Manager | FPDP | N/A | | |
| Independent Third-Party Data Validator | Los Alamos Technical Associates, Ohio | N/A | | |
| Environmental Radiation Protection and Risk Assessment Manager | FPDP | N/A | | |

**QAPP Worksheet #7.**
**Personnel Responsibility and Qualifications Table**

**ORGANIZATION: FPDP**

| Name | Position Title Responsible | Organization Affiliation | Responsibilities | Education and Experience Qualifications[1] |
|---|---|---|---|---|
| Craig Jones | Project Manager | FPDP | Overall project responsibility | > 4 years relevant work experience |
| Myrna Redfield | Regulatory Affairs Manager | FPDP | Project environmental compliance responsibility | Bachelor degree plus > 4 years work experience |
| Jana White | FFA Manager | FPDP | Project compliance with the FFA | > 4 years work relevant experience |
| Lisa Crabtree | Environmental Monitoring Project Manager | FPDP | Support project on sampling, data management, and reporting activities | > 4 years relevant work experience |
| Darren Tinsley | Health and Safety Representative | FPDP | Project safety and health responsibility | Bachelor degree plus > 1 year relevant experience |
| Mike Zeiss | Waste Coordinator | FPDP | Overall project waste management responsibility | > 4 years relevant experience |
| James Moore | Data Validator | Independent third party contractor | Performing data validation according to specified procedures | Bachelor degree plus relevant experience |
| Valerie Davis | Analytical Laboratory Project Manager | GEL Laboratories | Sample analysis and data reporting | Bachelor degree plus relevant experience |

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

## QAPP Worksheet #8.
## Special Personnel Training Requirements Table

Personnel are trained in the safe and appropriate performance of their assigned duties in accordance with requirements of work to be performed. This QAPP has been developed as a generalized quality plan. There are no special training requirements other than what normally is required for work at the PGDP site. QAPP development uses a graded approach.

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

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

## QAPP Worksheet #6.
## Communication Pathways

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

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

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

| Communication Drivers | Organizational Affiliation | Position Title Responsible | Organizational Department Manager | Procedure |
|---|---|---|---|---|
| Sampling Requirements | FPDP | Sample Team Leads | Environmental Monitoring | All internal communication regarding field sampling with the FPDP Project Manager. |
| Analytical Laboratory Interface | FPDP | Scientist | Environmental Monitoring | All communication between FPDP and analytical laboratory. |
| Waste Management Requirements | FPDP | Waste Coordinator | Waste Management | All internal communication regarding project waste management with FPDP Project Manager. |
| Environmental Compliance Requirements | FPDP | Regulatory Compliance Manager | Regulatory Affairs Manager | All internal correspondence regarding environmental requirements and compliance with the FPDP Project Manager. |
| Subcontractor Requirements (if applicable) | FPDP | Subcontract Administrator | Business Manager | All correspondence between the project and subcontractors, if applicable. |
| Health and Safety Requirements | FPDP | Health and Safety Representative | Health and Safety Manager | All internal communication regarding safety and health requirements with the FPDP Project Manager. |

**QAPP Worksheet #9.**
**Project Scoping Session Participant Sheet**

Project scoping is the key to the success of any project and is part of the systematic planning process. For this QAPP, this included review of past documents produced and previous years DQO sessions. It was determined that a formal DQO session was not needed for the FY 2016 EMP because an extensive DQO session was held for the FY 2014 EMP. The FY 2015 data does not indicate that significant changes need to be made to the individual sampling programs, with the exception of the annual radiological analyses performed for the ERPP background locations. This strategy was discussed with DOE based on the data presented in the 2014 ASER. The worksheet identifies participants who discussed the sampling strategy in the DQO session held on August 1, 2013.

**Name of Project:** Environmental Monitoring Plan Fiscal Year 2014
**Date of Session:** August 1, 2013
**Scoping Session Purpose:** Identify sampling strategies of EM programs

| Position Title | Affiliation | Name | Phone # | E-mail Address | Project Role |
|---|---|---|---|---|---|
| Project Manager | Department of Energy | Cynthia Zvonar | 859-219-4066 | cynthia.zvonar@lex.doe.gov | Project Management |
| Facility Representative/ Health Physicist | Department of Energy | Don Dihel | 270-441-6824 | donald.dihel@lex.doe.gov | Subject Matter Expert |
| Risk Analyst | Department of Energy | Rich Bonczek, Ph.D. | 859-219-4051 | rich.bonczek@lex.doe.gov | Subject Matter Expert |
| Sample/Data Management Manager | LATA Kentucky | Lisa Crabtree | 270-441-5135 | lisa.crabtree@lataky.com | Laboratory requirements |
| Environmental Monitoring and Reporting Program Manager | LATA Kentucky | Kelly Layne | 270-441-5217 | kelly.layne@lataky.com | Project Management |
| Senior Project Manager | Pro2Serve | Tracey Duncan | 270-461-6803 | tracey.duncan@lex.doe.gov | Subject Matter Expert |

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

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

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

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

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

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

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

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

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

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

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

**QAPP Worksheet #12-D.**
**Measurement Performance Criteria**

| | |
|---|---|
| **Matrix** | Sediment |
| **Analytical Group**[1] | PCBs |
| **Concentration Level** | Low |

| Sampling Procedure[2] | Analytical Method/SOP[3, 4] | Data Quality Indicators (DQIs) | Measurement Performance Criteria | QC Sample and/or Activity Used to Assess Measurement Performance | QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A) |
|---|---|---|---|---|---|
| CP4-ES-2302, *Collection of Sediment Samples Associated with Surface Water* | SW846-8082 | Precision—Lab | RPD–≤ 25% | Laboratory Duplicates | A |
| | | Precision | RPD–≤ 35% | Field Duplicates | S |
| | | Accuracy/Bias | % recovery[6] | Laboratory Sample Spikes | A |
| | | Accuracy/Bias-Contamination | No target compounds > PQL | Method Blanks/Instrument Blanks | A |
| | | Accuracy/Bias-Contamination | No target compounds > PQL | Field Blanks | S |
| | | Accuracy/Bias-Contamination | No target compounds > PQL | Equipment Rinseates | S |
| | | Completeness[5] | 90% | Data completeness check | S&A |

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

**QAPP Worksheet #12-E.**
**Measurement Performance Criteria**

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

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

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

**QAPP Worksheet #12-F.**
**Measurement Performance Criteria**

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

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

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

## QAPP Worksheet #12-G.
## Measurement Performance Criteria

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

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

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

**QAPP Worksheet #12-H.**
**Measurement Performance Criteria**

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

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

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

## QAPP Worksheet #12-K.
## Measurement Performance Criteria

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

| Sampling Procedure[2] | Analytical Method/SOP[3, 4] | Data Quality Indicators (DQIs) | Measurement Performance Criteria | QC Sample and/or Activity Used to Assess Measurement Performance | QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A) |
|---|---|---|---|---|---|
| CP4-ES-2101, *Groundwater Sampling*0" and CP4-ES-2203, *Surface Water Sampling* | SW846-8260 and EPA-624 | Precision—Lab | RPD–≤ 25% | Laboratory Duplicates | A |
| | | Precision | RPD–≤ 25% | Field Duplicates | S |
| | | Accuracy/Bias | % recovery[6] | Laboratory Sample Spikes | A |
| | | Accuracy/Bias-Contamination | No target compounds > PQL | Method Blanks/Instrument Blanks | A |
| | | Accuracy/Bias Contamination | No target compounds > PQL | Field Blanks | S |
| | | Accuracy/Bias Contamination | No target compounds > PQL | Trip Blanks | S |
| | | Accuracy/Bias Contamination | No target compounds > PQL | Equipment Rinseates | S |
| | | Completeness[5] | 90% | Data completeness check | S&A |

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

## QAPP Worksheet #12-L.
## Measurement Performance Criteria

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

| Sampling Procedure[2] | Analytical Method/SOP[3, 4] | Data Quality Indicators (DQIs) | Measurement Performance Criteria | QC Sample and/or Activity Used to Assess Measurement Performance | QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A) |
|---|---|---|---|---|---|
| CP4-ES-2101, *Groundwater Sampling*, and CP4-ES-2203, *Surface Water Sampling* | EPA-200.8/ SW846-6010/6020 | Precision—Lab | RPD–≤ 20% | Laboratory Duplicates | A |
| | | Precision | RPD–≤ 25% | Field Duplicates | S |
| | | Accuracy/Bias | % recovery[6] | Laboratory Sample Spikes | A |
| | | Accuracy/Bias-Contamination | No target compounds > PQL | Method Blanks/Instrument Blanks | A |
| | | Accuracy/Bias-Contamination | No target compounds > PQL | Field Blanks | S |
| | | Accuracy/Bias-Contamination | No target compounds > PQL | Equipment Rinseates | S |
| | | Completeness[5] | 90% | Data completeness check | S&A |

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

## QAPP Worksheet #12-M.
## Measurement Performance Criteria

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

| Sampling Procedure[2] | Analytical Method/SOP[3, 4] | Data Quality Indicators (DQIs) | Measurement Performance Criteria | QC Sample and/or Activity Used to Assess Measurement Performance | QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A) |
|---|---|---|---|---|---|
| CP4-ES-2101, *Groundwater Sampling*, and CP4-ES-2203, *Surface Water Sampling* | SW846-7470 | Precision—Lab | RPD–≤ 20% | Laboratory Duplicates | A |
| | | Precision | RPD–≤ 25% | Field Duplicates | S |
| | | Accuracy/Bias | % recovery[6] | Laboratory Sample Spikes | A |
| | | Accuracy/Bias-Contamination | No target compounds > PQL | Method Blanks/Instrument Blanks | A |
| | | Accuracy/Bias-Contamination | No target compounds > PQL | Field Blanks | S |
| | | Accuracy/Bias-Contamination | No target compounds > PQL | Equipment Rinseates | S |
| | | Completeness[5] | 90% | Data completeness check | S&A |

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

## QAPP Worksheet #12-N.
## Measurement Performance Criteria

| | |
|---|---|
| **Matrix** | Water/Groundwater and Surface Water |
| **Analytical Group**[1] | PCBs and Heptachlor |
| **Concentration Level** | Low |

| Sampling Procedure[2] | Analytical Method/SOP[3, 4] | Data Quality Indicators (DQIs) | Measurement Performance Criteria | QC Sample and/or Activity Used to Assess Measurement Performance | QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A) |
|---|---|---|---|---|---|
| CP4-ES-2101, *Groundwater Sampling*, and CP4-ES-2203, *Surface Water Sampling* | SW-846-8082/ EPA 608 and SW-846-8081 | Precision—Lab | RPD–≤ 25% | Laboratory Duplicates | A |
| | | Precision | RPD–≤ 25% | Field Duplicates | S |
| | | Accuracy/Bias | % recovery[6] | Laboratory Sample Spikes | A |
| | | Accuracy/Bias-Contamination | No target compounds > PQL | Method Blanks/Instrument Blanks | A |
| | | Accuracy/Bias-Contamination | No target compounds > PQL | Field Blanks | S |
| | | Accuracy/Bias-Contamination | No target compounds > PQL | Equipment Rinseates | S |
| | | Completeness[5] | 90% | Data completeness check | S&A |

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

## QAPP Worksheet #12-O.
## Measurement Performance Criteria

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

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

MDA = minimum detectable activity; RPD = Relative Percent Difference

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

[2] Reference number from QAPP Worksheet #21.

[3] Reference number from QAPP Worksheet #23.

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

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

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

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

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

**QAPP Worksheet #12-P.**
**Measurement Performance Criteria**

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

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

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

**QAPP Worksheet #12-Q.**
**Measurement Performance Criteria**

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

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

MDA = minimum detectable activity; RPD = Relative Percent Difference

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

[2] Reference number from QAPP Worksheet #21.

[3] Reference number from QAPP Worksheet #23.

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

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

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

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

**QAPP Worksheet #13.**
**Secondary Data Criteria and Limitations Table**

| Secondary Data | Data Source (Originating Organization, Report Title, and Date) | Data Generator(s) (Originating Org., Data Types, Data Generation/Collection Dates) | How Data Will Be Used | Limitations on Data Use |
|---|---|---|---|---|
| OREIS Database | Various | Various | Data will be used to determine the nature and extent of sediment, surface water, and groundwater contamination. | Data have been verified, assessed, and validated (if validation is required). Rejected data will not be used if there is sufficient time to resample and obtain a result that will not be rejected during validation. All data are assessed based on *Quality Assured Data*, CP3-ES-5003. |
| Historical Documentation | Various | Various | Information will be used as guidance on related project work. | Information from historical documents will be limited to the available documentation as it relates to a specific project. Use of historical data may be limited based on how long ago the data were collected and whether site conditions have changed since data collection. |

**QAPP Worksheet #14.**
**Summary of Project Tasks***

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

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

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

- QC samples—Worksheets #20 and #28
- Equipment calibration—Worksheets #22 and #24
- Data review/validation—Worksheets #34, #35, #36, and #37

**Secondary Data:** See Worksheet #13

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

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

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

**Data Review Tasks:** Data review tasks, including selection of data sets for validation by a third-party independent validator(s), will be per procedure CP3-ES-5003, *Quality Assured Data*, and CP2-ES-0063, *Environmental Monitoring Data Management Plan at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky.* Groundwater data from the quarterly sampling events at the C-746-U and C-746-S&T Landfills and the semiannual sampling events at the C-404 Landfill will be validated. The groundwater data to be validated was chosen because groundwater comprises the majority of the media collected by EM. Additionally, the landfill requirements encompass the majority of all types of analyses specified within the EM program. Therefore, these programs are considered an adequate representation of EM data targeted for data validation. An evaluation will be conducted to determine if less data validation should be performed on the C-746-U, C-746-S&T, and C-404 Landfills and the validation moved to other EM sampling programs in FY 2016. Validation will follow FPDP validation plans.

*It is understood that SOPs are contractor specific.

**QAPP Worksheet #16.**
**Project Schedule/Timeline Table**

| Activities | Organization | Dates | | Deliverable | Deliverable Due Date |
|---|---|---|---|---|---|
| | | Anticipated Date(s) of Initiation | Anticipated Date of Completion | | |
| Routine sampling conducted throughout the fiscal year | FPDP | October 1, 2015 | September 30, 2016 | See Appendix C of the EMP for deliverable information | See Appendix C of the EMP for deliverable information, as well as the Appendix J of the DOE/FPDP contract for deliverable due date information |

## QAPP Worksheet #15.
## Reference Limits and Evaluation Table

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

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

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

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

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

| VOCs | CAS Number | Project Action Limit/NAL (µg/L) | Project Action Limit Reference[a] | Site COPC?[b] | Laboratory-Specific | |
|---|---|---|---|---|---|---|
| | | | | | PQLs (µg/L) | MDLs (µg/L) |
| Acrylonitrile | 107-13-1 | 0.0523 | NAL | Yes | 5 | 1.5 |
| Benzene | 71-43-2 | 5/0.453 | MCL/NAL | Yes | 1 | 0.3 |
| Carbon tetrachloride | 56-23-5 | 5/0.452 | MCL/NAL | Yes | 1 | 0.3 |
| Chloroform | 67-66-3 | 80/0.221 | MCL/NAL | Yes | 1 | 0.3 |
| 1,1-Dichloroethene | 75-35-4 | 7/28.3 | MCL/NAL | Yes | 1 | 0.3 |
| 1,2-Dichloroethane | 107-06-2 | 5/0.171 | MCL/NAL | Yes | 1 | 0.3 |
| *cis*-1,2-Dichloroethene | 156-59-2 | 70/3.56 | MCL/NAL | Yes | 1 | 0.3 |
| Ethylbenzene | 100-41-4 | 700/1.49 | MCL/NAL | Yes | 1 | 0.3 |
| Tetrachloroethene | 127-18-4 | 5/3.95 | MCL/NAL | Yes | 1 | 0.3 |
| Trichloroethene | 79-01-6 | 5/0.281 | MCL/NAL | Yes | 1 | 0.3 |
| Vinyl Chloride | 75-01-4 | 2/0.0187 | MCL/NAL | Yes | 1 | 0.3 |

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

| VOCs | CAS Number | Project Action Limit/NAL (µg/L) | Project Action Limit Reference[a] | Site COPC?[b] | Laboratory-Specific | |
|---|---|---|---|---|---|---|
| | | | | | PQLs (µg/L) | MDLs (µg/L) |
| Total Xylenes | 1330-20-7 | 19.2 | NAL | Yes | 3 | 0.3 |
| o-Xylene | 95-47-6 | 19.2 | NAL | Yes | 1 | 0.3 |
| m-Xylene | 108-38-3 | 19.3 | NAL | Yes | 2 | 0.3 |
| p-Xylene | 106-42-3 | 19.3 | NAL | Yes | 2 | 0.3 |

CAS = Chemical Abstracts Service
COPC = chemical of potential concern
MCL = maximum contaminant level
MDL = method detection limit
NAL = no action level for child resident scenario from the Risk Methods Document (DOE 2015d)
PQL = practical quantitation limit
VOC = volatile organic compound

[a] This QAPP references the MCLs (if available) to support project planning and identify whether lower reporting limits may be needed for some constituents. The worksheet also lists the NALs established by the Risk Methods Document (DOE 2015d) for the child resident scenario.
[b] Analytes marked with COPC are from Table 2.1 of the Risk Methods Document (DOE 2015d) and represent the list of chemicals, compounds, and radionuclides compiled from chemicals of potential concern retained as contaminants of concern in risk assessments performed at PGDP between 1990 and 2008.

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

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

| Metals | CAS Number | Project Action Limit/NAL (mg/L) | Project Action Limit Reference[a] | Site COPC?[b] | Laboratory-Specific | |
|---|---|---|---|---|---|---|
| | | | | | PQLs (mg/L) | MDLs (mg/L) |
| Aluminum | 7429-90-5 | 1.99 | NAL | Yes | 0.05 | 0.015 |
| Antimony | 7440-36-0 | 0.006/0.000772 | MCL/NAL | Yes | 0.003 | 0.001 |
| Arsenic | 7440-38-2 | 0.010/0.0000516 | MCL/NAL | Yes | 0.005 | 0.0017 |
| Barium | 7440-39-3 | 2/0.37 | MCL/NAL | Yes | 0.002 | 0.0006 |
| Beryllium | 7440-41-7 | 0.004/0.00219 | MCL/NAL | Yes | 0.0005 | 0.0002 |
| Boron | 7440-42-8 | 0.399 | NAL | Yes | 0.015 | 0.004 |
| Cadmium | 7440-43-9 | 0.005/0.000898 | MCL/NAL | Yes | 0.001 | 0.00011 |
| Chromium (total) | 7440-47-3 | 0.1/2.08 | MCL/NAL | Yes | 0.010 | 0.002 |
| Cobalt | 7440-48-4 | 0.000600 | NAL | Yes | 0.001 | 0.0001 |
| Copper | 7440-50-8 | 1.3/0.0798 | MCL/NAL | Yes | 0.001 | 0.00035 |
| Iron | 7439-89-6 | 1.40 | NAL | Yes | 0.1 | 0.033 |
| Lead | 7439-92-1 | 0.015/0.0150 | MCL[c]/NAL | Yes | 0.002 | 0.0005 |
| Manganese | 7439-96-5 | 0.0420 | NAL | Yes | 0.005 | 0.001 |

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

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

| Metals | CAS Number | Project Action Limit/ NAL (mg/L) | Project Action Limit Reference[a] | Site COPC?[b] | Laboratory-Specific | |
|---|---|---|---|---|---|---|
| | | | | | PQLs (mg/L) | MDLs (mg/L) |
| Mercury | 7439-97-6 | 0.002/0.000556 | MCL/NAL | Yes | 0.0002 | 0.000067 |
| Molybdenum | 7439-98-7 | 0.00997 | NAL | Yes | 0.0005 | 0.000165 |
| Nickel | 7440-02-0 | 0.0390 | NAL | Yes | 0.002 | 0.0005 |
| Selenium | 7782-49-2 | 0.05/0.00997 | MCL/NAL | Yes | 0.005 | 0.0015 |
| Silver | 7440-22-4 | 0.00922 | NAL | Yes | 0.001 | 0.0002 |
| Thallium | 7440-28-0 | 0.002/0.0000199 | MCL/NAL | Yes | 0.002 | 0.00045 |
| Uranium[d] | 7440-61-1 | 0.03/0.00598 | MCL/NAL | Yes | 0.0002 | 0.000067 |
| Vanadium[e] | 7440-62-2 | 0.00826 | NAL | Yes | 0.01 | 0.003 |
| Zinc[f] | 7440-66-6 | 0.600 | NAL | Yes | 0.01 | 0.0035 |

CAS = Chemical Abstracts Service
COPC = chemical of potential concern
MCL = maximum contaminant level
MDL = method detection limit
NAL = no action level for child resident scenario from the Risk Methods Document (DOE 2015d)
PQL = practical quantitation limit

[a] This QAPP references the MCLs (if available) to support project planning and identify whether lower reporting limits may be needed for some constituents. The worksheet also lists the NALs established by the Risk Methods Document (DOE 2015d) for the child resident scenario
[b] Analytes marked with COPC are from Table 2.1 of the Risk Methods Document (DOE 2015d) and represent the list of chemicals, compounds, and radionuclides compiled from chemicals of potential concern retained as contaminants of concern in risk assessments performed at PGDP between 1990 and 2008.

[c] The MCL established by the EPA for lead is based on a treatment technique action level of 0.015 mg/L.
[d] The NAL provided is for Uranium (Soluble Salts).
[e] The NAL provided is for Vanadium and Compounds.
[f] The NAL provided is for Zinc and Compounds.

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

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

| PCBs | CAS Number | Project Action Limit (µg/L) | Project Action Limit Reference[a] | Site COPC?[b] | Laboratory-Specific | |
|---|---|---|---|---|---|---|
| | | | | | PQLs (µg/L) | MDLs (µg/L) |
| Aroclor 1016 | 12674-11-2 | 0.140 | NAL | Yes | 0.1 | 0.0333 |
| Aroclor 1221 | 11104-28-2 | 0.00457 | NAL | Yes | 0.1 | 0.0333 |
| Aroclor 1232 | 11141-16-5 | 0.00457 | NAL | Yes | 0.1 | 0.0333 |
| Aroclor 1242 | 53469-21-9 | 0.0390 | NAL | Yes | 0.1 | 0.0333 |
| Aroclor 1248 | 12672-29-6 | 0.0390 | NAL | Yes | 0.1 | 0.0333 |
| Aroclor 1254 | 11097-69-1 | 0.0390 | NAL | Yes | 0.1 | 0.0333 |
| Aroclor 1260 | 11096-82-5 | 0.0390 | NAL | Yes | 0.1 | 0.0333 |

CAS = Chemical Abstracts Service
COPC = chemical of potential concern
MCL = maximum contaminant level
MDL = method detection limit
NAL = no action level for child resident scenario from the Risk Methods Document (DOE 2015d)
PCB = polychlorinated biphenyl
PQL = practical quantitation limit

[a] This QAPP references the MCLs (if available) to support project planning and identify whether lower reporting limits may be needed for some constituents. The worksheet also lists the NALs established by the Risk Methods Document (DOE 2015d) for the child resident scenario.
[b] Analytes marked with COPC are from Table 2.1 of the Risk Methods Document (DOE 2015d) and represent the list of chemicals, compounds, and radionuclides compiled from chemicals of potential concern retained as contaminants of concern in risk assessments performed at PGDP between 1990 and 2008.

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

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

| Radionuclides | CAS Number | Project Action Limit (pCi/L) | Project Action Limit Reference[a] | Site COPC?[b] | Laboratory-Specific MDAs (pCi//L) |
|---|---|---|---|---|---|
| Americium-241 | 14596-10-2 | 0.504 | NAL | Yes | 1 |
| Cesium-137 | 10045-97-3 | 1.71 | NAL | Yes | 10 |
| Neptunium-237 | 13994-20-2 | 0.763 | NAL | Yes | 1 |
| Plutonium-238 | 13981-16-3 | 0.398 | NAL | Yes | 1 |
| Plutonium-239/240 | 15117-48-3/14119-33-6 | 0.387 | NAL | Yes | 1 |
| Technetium-99 | 14133-76-7 | 4 mRem/year-dose (19.0 pCi/L) | MCL (NAL) | Yes | 50 |
| Thorium-230 | 14269-63-7 | 0.572 | NAL | Yes | 1 (4[c]) |
| Uranium-234 | 13966-29-5 | 0.739 | NAL | Yes | 1 (17[c]) |
| Uranium-235 | 15117-96-1 | 0.728 | NAL | Yes | 1 (18[c]) |
| Uranium-238 | 24678-82-8 | 0.601 | NAL | Yes | 1 (19[c]) |

CAS = Chemical Abstract Service
COPC = chemical of potential concern
MDA = minimum detectable activity
N/A = not applicable analyte not identified as a site COPC
NAL = no action level for child resident scenario from the Risk Methods Document (DOE 2015d)

[a] This QAPP references the MCLs (if available) to support project planning and identify whether lower reporting limits may be needed for some constituents. The worksheet also lists the NALs established by the Risk Methods Document (DOE 2015d) for the child resident scenario
[b] Analytes marked with COPC are from Table 2.1 of the Risk Methods Document (DOE 2015d) and represent the list of chemicals, compounds, and radionuclides compiled from chemicals of potential concern retained as contaminants of concern in risk assessments performed at PGDP between 1990 and 2008.
[c] The value in parentheses reflects MDAs requested under the Environmental Radiation Protection Program.

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

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

| PCBs | CAS Number | Project Action Limit (mg/kg) | Project Action Limit Reference[a] | Site COPC?[b] | Laboratory-Specific | |
|---|---|---|---|---|---|---|
| | | | | | PQLs (mg/kg) | MDLs (mg/kg) |
| Aroclor 1016 | 12674-11-2 | 0.190 | NAL | Yes | 0.0033 | 0.001099 |
| Aroclor 1221 | 11104-28-2 | 0.0659 | NAL | Yes | 0.0033 | 0.001099 |
| Aroclor 1232 | 11141-16-5 | 0.0659 | NAL | Yes | 0.0033 | 0.001099 |
| Aroclor 1242 | 53469-21-9 | 0.0782 | NAL | Yes | 0.0033 | 0.001099 |
| Aroclor 1248 | 12672-29-6 | 0.0782 | NAL | Yes | 0.0033 | 0.001099 |
| Aroclor 1254 | 11097-69-1 | 0.0543 | NAL | Yes | 0.0033 | 0.001099 |
| Aroclor 1260 | 11096-82-5 | 0.0782 | NAL | Yes | 0.0033 | 0.001099 |

CAS = Chemical Abstracts Service
COPC = chemical of potential concern
MDL = method detection limit
NAL = no action level for child resident scenario from the Risk Methods Document (DOE 2015d)
PCB = polychlorinated biphenyl
PQL = practical quantitation limit

Analytical laboratory results will be reported on a dry weight basis, as applicable, unless specified otherwise.
[a] This QAPP references the MCLs (if available) to support project planning and identify whether lower reporting limits may be needed for some constituents. The worksheet also lists the NALs established by the Risk Methods Document (DOE 2015d) for the child resident scenario.
[b] Analytes marked with COPC are from Table 2.1 of the Risk Methods Document (DOE 2015d) and represent the list of chemicals, compounds, and radionuclides compiled from chemicals of potential concern retained as contaminants of concern in risk assessments performed at PGDP between 1990 and 2008.

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

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

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

CAS = Chemical Abstracts Service
COPC = chemical of potential concern
NAL = no action level for child resident scenario from the Risk Methods Document (DOE 2015d)
MDA = minimum detectable activity

Analytical laboratory results will be reported on a dry weight basis, as applicable, unless specified otherwise.
[a] This QAPP references the MCLs (if available) to support project planning and identify whether lower reporting limits may be needed for some constituents. The worksheet also lists the NALs established by the Risk Methods Document (DOE 2015d) for the child resident scenario.
[b] Analytes marked with COPC are from Table 2.1 of the Risk Methods Document (DOE 2015d) and represent the list of chemicals, compounds, and radionuclides compiled from chemicals of potential concern retained as contaminants of concern in risk assessments performed at PGDP between 1990 and 2008.

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

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

| KPDES Parameters with Permit Limits | CAS Number | Project Action Limit | KPDES Outfall | Site COPC?[b] | Laboratory-Specific | |
|---|---|---|---|---|---|---|
| | | | | | PQLs | MDLs[e] |
| 1,1,1-Trichloroethane | 71-55-6 | 0.2 mg/L | Outfall 020 | No | 1 µg/L | 0.3 µg/L |
| Trichloroethene | 79-01-6 | 0.0308 mg/L | Outfall 020 | Yes | 1 µg/L | 0.3 µg/L |
| Total Suspended Solids | N/A | 30 mg/L | Outfall 001, Outfall 016, 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 |
| Total Phosphorus | 7723-14-0 | 1 mg/L | Outfall 001, Outfall 002, Outfall 008, Outfall 009, Outfall 010, Outfall 011, Outfall 012 | No | 0.05mg/L | 0.02 mg/L |
| Arsenic | 7440-38-2 | 150 µg/L | Outfall 020 | Yes | 5 µg/L | 1.7 µg/L |
| Nickel | 7440-02-0 | 94 µg/L | Outfall 020 | Yes | 2 µg/L | 0.5 µg/L |
| Zinc | 7440-66-6 | 216 µg/L | Outfall 017, Outfall 020 | Yes | 10 µg/L | 3.5 µg/L |
| Nitrates | N/A | 500 mg/L | Outfall 020 | No | 0.1 mg/L | 0.033 mg/L |
| Chlorides | 16887-00-6 | 600 mg/L | Outfall 020 | No | 0.2 mg/L | 0.067 mg/L |
| Aroclor 1016 | 12674-11-2 | PQL | 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 | 0.033 µg/L |
| Aroclor 1221 | 11104-28-2 | PQL | 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 | 0.033 µg/L |

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

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

| KPDES Parameters with Permit Limits | CAS Number | Project Action Limit | KPDES Outfall | Site COPC?[b] | Laboratory-Specific PQLs | Laboratory-Specific PQLs |
|---|---|---|---|---|---|---|
| Aroclor 1232 | 11141-16-5 | PQL | 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 | 0.033 µg/L |
| Aroclor 1242 | 53469-21-9 | PQL | Outfall 001, Outfall 002, Outfall 008, Outfall 009, Outfall 010, Outfall 011, Outfall 012, Outfall 013, Outfall 015, Outfall 017, Outfall 019, Outfall 020 | Yes | 0.01 µg/L | 0.033 µg/L |
| Aroclor 1248 | 12672-29-6 | PQL | 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 | 0.033 µg/L |
| Aroclor 1254 | 11097-69-1 | PQL | 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 | 0.033 µg/L |
| Aroclor 1260 | 11096-82-5 | PQL | 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 | 0.033 µg/L |
| Aroclor 1268 | 11100-14-4 | PQL | 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 | No | 0.1 µg/L | 0.033 µg/L |

[b] Analytes marked with COPC (chemical of potential concern) are from Table 2.1 of the Risk Methods Document (DOE 2015d) and represent the list of chemicals, compounds, and radionuclides compiled from COPCs retained as contaminants of concern in risk assessments performed at PGDP between 1990 and 2008.

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

| Sampling Location/ID Number | Matrix | Depth (units) | Analytical Group | Concentration Level[a] | Number of Samples (Identify Field Duplicates) | Sampling SOP Reference[b] | Rationale for Sampling Location |
|---|---|---|---|---|---|---|---|
| Sitewide (see Appendix C of the EMP for specific locations) | Sediment | Surface (Creek Bed Samples) | See Appendix C of the EMP | Varies by location and analyte | See Appendix C of the EMP (Minimum of 5%) | CP4-ES-2302, *Collection of Sediment Samples Associated with Surface Water* | See Appendix C of the EMP |
| | Surface Water | Surface Water in Creeks and Effluent Discharge | See Appendix C of the EMP | Varies by location and analyte | See Appendix C of the EMP (Minimum of 5%) | CP4-ES-2203, *Surface Water Sampling* | |
| | Groundwater | UCRS, URGA, LRGA | See Appendix C of the EMP | Varies by location and analyte | See Appendix C of the EMP (Minimum of 5%) | CP4-ES-2101, *Groundwater* | |

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

N/A = not applicable
SOP = standard operating procedure

## QAPP Worksheet #19.
## Analytical SOP Requirements Table

| Matrix | Analytical Group | Concentration Level | Analytical and Preparation Method/SOP Reference* | Sample Volume | Containers (number, size, and type) | Preservation Requirements (chemical, temperature, light protected) | Maximum Holding Time (preparation/ analysis) |
|---|---|---|---|---|---|---|---|
| Water | VOC | See Worksheet #18 | See Worksheet #23 | 120 mL | 3 x 40 mL Glass VOA Vial | HCl; pH < 2, cool to < 4°C, no headspace | 14 days for preserved |
| Water | Metals | See Worksheet #18 | See Worksheet #23 | 1 liter | 1 liter Plastic | $HNO_3$ pH < 2, Cool to < 4°C | 6 months (28 days for Hg) |
| Water | Anions | See Worksheet #18 | See Worksheet #23 | 125 mL | 125 mL Plastic | Cool to < 4°C | 28 days (2 days for nitrate) |
| Water | PCBs | See Worksheet #18 | See Worksheet #23 | 1 liter | 1 liter Amber Glass | Cool to < 4°C | N/A[b] |
| Water | RADs | See Worksheet #18 | See Worksheet #23 | 3 liters | 3 x 1 liter Plastic | $HNO_3$ pH < 2, Cool to < 4°C[a] | 6 months |
| Sediment | PCBs | See Worksheet #18 | See Worksheet #23 | 30 g | 125 mL wide-mouth Amber Glass | Cool to < 4°C | N/A[b] |
| Sediment | RADs | See Worksheet #18 | See Worksheet #23 | 250 g | 500 mL wide-mouth plastic straight side | Cool to < 4°C | 6 months |

NOTE: Sample volume and container requirements will be specified by the laboratory. This table includes standard requirements for routine analytical groups.
*See Analytical SOP References table (Worksheet #23).
[a] Check with specific laboratory conducting analyses to ensure that acidification will not interfere with laboratory procedures.
[b] A 45-day holding time is an expectation of the laboratory; however, since SW846 does not indicate a holding time for PCBs, any data that exceeds the 45 days will be identified, but not qualified.

HCl = hydrochloric acid
Hg = mercury
$HNO_3$ = nitric acid
PCB = polychlorinated biphenyl
RAD = radionuclide
VOC = volatile organic compound

## QAPP Worksheet #30.
## Analytical Services Table

| Matrix | Analytical Group | Concentration Level | Sample Locations/ID Numbers | Analytical SOP* | Data Package Turnaround Time | Laboratory/Organization (Name and Address, Contact Person and Telephone Number)** | Backup Laboratory/Organization (Name and Address, Contact Person and Telephone Number) |
|---|---|---|---|---|---|---|---|
| Sediment | PCBs | See Worksheet #18 | See Appendix C of the EMP | See Worksheet #23 | 28-day | GEL Laboratories, LLC<br>2040 Savage Road<br>Charleston, SC 29407<br>PM: Valerie Davis<br>(843) 769-7391 | MO00054<br>TestAmerica Laboratories, Inc.<br>13715 Rider Trail North<br>Earth City, MO 63045<br>PM: Jayna Awalt<br>(314) 298-8566 |
| Sediment | Radionuclides | See Worksheet #18 | | See Worksheet #23 | 28-day | | |
| Water | PCBs | See Worksheet #18 | | See Worksheet #23 | 28-day | | |
| Water | Metals | See Worksheet #18 | | See Worksheet #23 | 28-day | | |
| Water | Radionuclides | See Worksheet #18 | | See Worksheet #23 | 28-day | | |
| Water | VOCs | See Worksheet #18 | | See Worksheet #23 | 28-day | | |
| Water | SVOCs | See Worksheet #18 | | See Worksheet #23 | 28-day | | |
| Water | Anions and Miscellaneous | See Worksheet #18 | | See Worksheet #23 | 28-day | | |

*Analytical method SOPs for radiochemistry parameters are laboratory specific.
**These are current laboratories and are subject to change.

ID = identification
PCB = polychlorinated biphenyl
TBD = to be determined
VOC = volatile organic compound
SVOC = semivolatile organic compound

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

| Matrix | Analytical Group | Concentration Level | Analytical and Preparation SOP Reference | No. of Sampling Locations | No. of Field Duplicate Pairs | Inorganic No. of MS | No. of Field Blanks | No. of Equip. Blanks | Total No. of Samples to Lab |
|---|---|---|---|---|---|---|---|---|---|
| Sediment | PCBs | Low | See Worksheet #12 | See Appendix C of the EMP | 5% | 5% | 5% | 5% | See Appendix C of EMP |
| Sediment | Radionuclides | Low | See Worksheet #12 | See Appendix C of the EMP | 5% | 5% | 5% | 5% | See Appendix C of EMP |
| Water (Groundwater and Surface Water) | VOCs | Low | See Worksheet #12 | See Appendix C of the EMP | 5% | 5% | 5% | 5% | See Appendix C of EMP |
| Water (Groundwater and Surface Water) | Metals | Low | See Worksheet #12 | See Appendix C of the EMP | 5% | 5% | 5% | 5% | See Appendix C of EMP |
| Water (Groundwater and Surface Water) | PCBs | Low | See Worksheet #12 | See Appendix C of the EMP | 5% | 5% | 5% | 5% | See Appendix C of EMP |
| Water (Groundwater and Surface Water) | Radionuclides | Low | See Worksheet #12 | See Appendix C of the EMP | 5% | 5% | 5% | 5% | See Appendix C of EMP |

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

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

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

| Reference Number | Title and Number[a] | Originating Organization[b] | Equipment Type | Modified for Project Work? (Y/N) | Comments |
|---|---|---|---|---|---|
| 2 | CP4-ES-0043, *Temperature Control for Sample Storage* | Contractor | Sampling | N | N/A |
| 3 | CP2-ES-0025, *Paducah Environmental Monitoring Waste Management Plan* | Contractor | N/A | N | N/A |
| 4 | CP2-ES-0026, *Wet Chemistry and Miscellaneous Analyses Data Verification and Validation* | Contractor | N/A | N | N/A |
| 5 | CP2-ES-0811, *Pesticide and PCB Data Verification and Validation* | Contractor | N/A | N | N/A |
| 6 | CP4-ES-1001, *Transmitting Data to the Paducah Oak Ridge Environmental Information System (OREIS)* | Contractor | N/A | N | N/A |
| 7 | CP2-ES-0063, *Environmental Monitoring Data Management Plan* | Contractor | N/A | N | N/A |
| 8 | CP4-ES-2100, *Groundwater Level Measurement* | Contractor | Sampling | N | N/A |
| 9 | CP4-ES-2101, *Groundwater Sampling* | Contractor | Sampling | N | N/A |
| 10 | CP4-ES-2203, *Surface Water Sampling* | Contractor | Sampling | N | N/A |
| 12 | CP4-ES-2302, *Collection of Sediment Samples Associated with Surface Water* | Contractor | Sampling | N | N/A |
| 13 | CP4-ES-0074, *Monitoring Well Inspection and Maintenance* | Contractor | Sampling | N | N/A |
| 14 | CP4-ES-2700, *Logbooks and Data Forms* | Contractor | N/A | N | N/A |
| 15 | CP4-ES-2702, *Decontamination of Sampling Equipment and Devices* | Contractor | Sampling | N | N/A |
| 16 | CP4-ES-2704, *Trip, Equipment, and Field Blank Preparation* | Contractor | N/A | N | N/A |
| 17 | CP4-ES-2708, *Chain-of-Custody Forms, Field Sample Logs, Sample Labels, and Custody Seals* | Contractor | N/A | N | N/A |

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

| Reference Number | Title and Number[a] | Originating Organization[b] | Equipment Type | Modified for Project Work? (Y/N) | Comments |
|---|---|---|---|---|---|
| 18 | CP3-ES-5003, *Quality Assured Data* | Contractor | N/A | N | N/A |
| 19 | CP3-ES-5004, *Sample Tracking, Lab Coordination, and Sample Handling Guidance* | Contractor | N/A | N | N/A |
| 20 | CP4-ES-5007, *Data Management Coordination* | Contractor | N/A | N | N/A |
| 21 | CP2-ES-5102, *Radiochemical Data Verification and Validation* | Contractor | N/A | N | N/A |
| 22 | CP4-ES-5103, *Polychlorinated Dibenzodioxins-Polychlorinated Dibenzofurans Verification and Validation* | Contractor | N/A | N | N/A |
| 23 | CP2-ES-5105, *Volatile and Semivolatile Data Verification and Validation* | Contractor | N/A | N | N/A |
| 24 | CP2-ES-5107, *Inorganic Data Validation and Verification* | Contractor | N/A | N | N/A |
| 25 | CP2-ES-0026, *Wet Chemistry and Miscellaneous Analyses Data Verification and Validation* | Contractor | N/A | N | N/A |
| 26 | CP3-ES-1003, *Developing, Implementing, and Maintaining Data Management Implementation Plans* | Contractor | N/A | N | N/A |
| 27 | CP4-ES-1002, *Submitting, Reviewing, and Dispositioning Changes to the Environmental Databases OREIS and PEMS* | Contractor | N/A | N | N/A |

[a] SOPs are posted to the FPDP S Drive.
[b] The work will be conducted by FPDP staff or a subcontractor. In either case, SOPs listed will be followed.
N/A = not applicable

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

| Field Equipment* | Calibration Activity | Maintenance Activity | Testing Activity | Inspection Activity | Frequency | Acceptance Criteria | Corrective Action | Responsible Person | SOP Reference |
|---|---|---|---|---|---|---|---|---|---|
| Water Quality Meter (permit application of the landfills specify Hydrolab) | Calibration check at the beginning of the day | Performed monthly and as needed | Measure solutions with known values (National Institute for Standards and Technology traceable buffers and conductivity calibration solutions) | Upon receipt, successful operation | Daily before each use | Per manufacturer's specifications | Recalibrate or service as necessary | Field Team Leader | Manufacturer's specifications |
| Turbidity Meter (Nephthelometer) | Accuracy check at the beginning of each day's use | As needed | Measure solutions with known turbidity standards | Upon receipt, successful operation | Check daily before each use | N/A (instrument zeroed) | Service by manufacturer or replace | Field Team Leader | Manufacturer's specifications |
| Ferrous Iron Colorimeter | Accuracy check at the beginning of each day's use | Return to manufacturer as needed | Measure with standard solution | Upon receipt, successful operation | Check daily before each use | Within range of manufacturer's standard | Service by manufacturer or replace | Field Team Leader | Manufacturer's specifications |
| Colorimeter (for total residual chlorine) | Accuracy check at the beginning of each day's use | As needed | Measure with standard solution | Upon receipt, successful operation | Check daily before each use | Within range of manufacturer's standard | Service by manufacturer or replace | Field Team Leader | Manufacturer's specifications |
| Titrator (for total residual chlorine) | Accuracy check at the beginning of each day | As needed | Measure with standard solution | Upon receipt, successful operation | Check daily before each use | With range of manufacturer's standard | Service by manufacturer or replace | Field Team Leader | Manufacturer's specifications |
| Electron Water Level Meter | Accuracy check annually against a steel tape | Replace as needed | Annual verification | Upon receipt, successful operation | Check daily before each use | Pass/Fail | Service by manufacturer or replace | Field Team Leader | Manufacturer's specifications |
| Hach flow meter | Calibrate to readings on flume | Quarterly or as needed | Measure against flume | Upon receipt, successful operation | Weekly as needed | Pass/Fail | Service by manufacturer or replace | Field Team Leader | Manufacturer's specifications |

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

| Reference Number* | Title, Revision Date, and/or Number | Definitive or Screening Data | Analytical Group | Instrument | Organization Performing Analysis | Modified for Project Work? (Y/N) |
|---|---|---|---|---|---|---|
| SW-846-8260/ EPA-624 | | | VOA (Unless noted below) | Per SOP | GEL Laboratories, Charleston, SC | N |
| SW-846-8011 | | | VOA (1,2-Dibromo-3-chloropropane) | Per SOP | GEL Laboratories, Charleston, SC | N |
| SW-846-8270 | | | SVOC | Per SOP | Southwest Research Institute, San Antonio, TX | N |
| SW-846-9056/ EPA-300 | | | Anions | Per SOP | GEL Laboratories, Charleston, SC | N |
| N/A | RSK175 | | VOA (Ethene, Ethane, Methane) | Per SOP | GEL Laboratories, Charleston, SC | N |
| EPA-410.4 | | | Miscellaneous (Chemical Oxygen Demand) | Per SOP | GEL Laboratories, Charleston, SC | N |
| EPA-350.1 | | | Miscellaneous (Ammonia as Nitrogen) | Per SOP | GEL Laboratories, Charleston, SC | N |
| SW-846-9010/9012B | | | Miscellaneous (Cyanide) | Per SOP | GEL Laboratories, Charleston, SC | N |
| SW-846-9040 | | | Miscellaneous (pH—when not as field measurement) | Per SOP | GEL Laboratories, Charleston, SC | N |
| SM 5210 B | | | Miscellaneous (Carbonaceous Biological Oxygen Demand) | Per SOP | GEL Laboratories, Charleston, SC | N |
| EPA-180.1 | | | Miscellaneous (Turbidity—when not as field measurement) | Per SOP | GEL Laboratories, Charleston, SC | N |
| EPA-130.2/ SM 2340 B | | | Miscellaneous (Hardness) | Per SOP | GEL Laboratories, Charleston, SC | N |

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

| Reference Number* | Title, Revision Date, and/or Number | Definitive or Screening Data | Analytical Group | Instrument | Organization Performing Analysis | Modified for Project Work? (Y/N) |
|---|---|---|---|---|---|---|
| SW-846-9060 | | | Miscellaneous (Total Organic Carbon) | Per SOP | GEL Laboratories, Charleston, SC | N |
| EPA-300.0 | | | Miscellaneous (Iodide) | Per SOP | GEL Laboratories, Charleston, SC | N |
| EPA-160.1 | | | Miscellaneous (Total Dissolved Solids) | Per SOP | GEL Laboratories, Charleston, SC | N |
| EPA-160.2/ SM 2540 D | | | Miscellaneous (Total Suspended Solids) | Per SOP | GEL Laboratories, Charleston, SC | N |
| SM 2540 B | | | Miscellaneous (Total Solids) | Per SOP | GEL Laboratories, Charleston, SC | N |
| EPA-365.4 | | | Miscellaneous (Total Phosphorous) | Per SOP | GEL Laboratories, Charleston, SC | N |
| SW-846-9020 | | | Miscellaneous (Total Organic Halides) | Per SOP | GEL Laboratories, Charleston, SC | N |
| EPA-200.7 | | | Miscellaneous (Silica) | Per SOP | GEL Laboratories, Charleston, SC | N |
| SM 4500-S (2-) D | | | Miscellaneous (Sulfide) | Per SOP | GEL Laboratories, Charleston, SC | N |
| SM 4500-SO3 (2-) B | | | Miscellaneous (Sulfite) | Per SOP | GEL Laboratories, Charleston, SC | N |
| SM 9223 | | | Miscellaneous (Total Coliform) | Per SOP | GEL Laboratories, Charleston, SC | N |
| EPA-310.1 | | | Miscellaneous (Alkalinity) | Per SOP | GEL Laboratories, Charleston, SC | N |
| EPA-1664 A | | | Miscellaneous (Oil and Grease) | Per SOP | GEL Laboratories, Charleston, SC | N |
| SW-846-6020/EPA-200.8/245.2 | | | Metals (Unless noted below) | Per SOP | GEL Laboratories, Charleston, SC | N |

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

| Reference Number* | Title, Revision Date, and/or Number | Definitive or Screening Data | Analytical Group | Instrument | Organization Performing Analysis | Modified for Project Work? (Y/N) |
|---|---|---|---|---|---|---|
| SW-846-7470 | | | Metals (Mercury) | Per SOP | GEL Laboratories, Charleston, SC | N |
| SW-846-8082/ SW-846-8081 (Heptachlor) | | | PCBs and Heptachlor | Per SOP | GEL Laboratories, Charleston, SC | N |
| SW-846-9310/ EPA-900.0 | | | Radionuclides (Gross Alpha and Gross Beta) | Per SOP | GEL Laboratories, Charleston, SC | N |
| EPA-906.0 | | | Radionuclides (Tritium) | Per SOP | GEL Laboratories, Charleston, SC | N |
| Gamma Spec | | | Radionuclides (Cesium-137) | Per SOP | GEL Laboratories, Charleston, SC | N |
| Gas Flow Proportional | | | Radionuclides (Strontium-90) | Per SOP | GEL Laboratories, Charleston, SC | N |
| Liquid Scintillation | | | Radionuclides (Technetium-99) | Per SOP | GEL Laboratories, Charleston, SC | N |
| Alpha Spec | | | Radionuclides (Americium-241, Thorium-230, Uranium-234, Uranium-235, Uranium-238, Neptunium-237, Plutonium-238, Plutonium-239/240) | Per SOP | GEL Laboratories, Charleston, SC | N |

*Information will be based on laboratory used.

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

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

The laboratory is responsible for maintaining instrument calibration information per their QA Plan including control charts established for all instrumentation. This information is audited annually by DOECAP. Laboratory(s) contracted will be DOECAP audited.

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

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

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

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

## QAPP Worksheet #26.
## Sample Handling System

| | |
|---|---|
| **SAMPLE COLLECTION, PACKAGING, AND SHIPMENT** | |
| **Sample Collection (Personnel/Organization):** | Sampling Teams/DOE Prime Contractor and Subcontractors |
| **Sample Packaging (Personnel/Organization):** | Sampling Teams/DOE Prime Contractor and Subcontractors |
| **Coordination of Shipment (Personnel/Organization):** | Lab Coordinator/DOE Prime Contractor |
| **Type of Shipment/Carrier:** | Direct Delivery or Overnight/Federal Express or UPS |
| **SAMPLE RECEIPT AND ANALYSIS** | |
| **Sample Receipt (Personnel/Organization):** | Sample Management/Contracted Laboratory |
| **Sample Custody and Storage (Personnel/Organization):** | Sample Management/Contracted Laboratory |
| **Sample Preparation (Personnel/Organization):** | Analysts/Contracted Laboratory |
| **Sample Determinative Analysis (Personnel/Organization):** | Analysts/Contracted Laboratory |
| **SAMPLE ARCHIVING** | |
| **Field Sample Storage (No. of days from sample collection):** | The fixed-base laboratory will archive samples for 4 months or less depending on project-specific requirements. |
| **Sample Extract/Digestate Storage (No. of days from extraction/digestion):** | 120 Days |
| **Biological Sample Storage (No. of days from sample collection):** | Not applicable. |
| **SAMPLE DISPOSAL** | |
| **Personnel/Organization:** | Waste Disposition/Sample Management Office/DOE Prime Contractor and Subcontractors |
| **Number of Days from Analysis:** | 6 months |

**QAPP Worksheet #27.**
**Sample Custody Requirements***

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

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

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

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

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

**Sample Identification Procedures:**

Sample identification requirements will be specified in the Environmental Monitoring Data Management Implementation Plan.

**Chain-of-custody Procedures:**

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

*It is understood that SOPs are contractor specific.

## QAPP Worksheet #28.
## QC Samples Table

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

| QC Sample | Frequency/Number* | Method/SOP QC Acceptance Limits | Corrective Action | Person(s) Responsible for Corrective Action | Data Quality Indicator (DQI) | Measurement Performance Criteria |
|---|---|---|---|---|---|---|
| Field blank | Minimum 5% | ≤ CRQL** | Verify results; reanalyze | Laboratory should alert project | Contamination—Accuracy/bias | See procedure CP3-ES-5003, *Quality Assured Data* |
| Trip blank | 1 per cooler containing VOC samples | ≤ CRQL | Verify results; reanalyze | | Contamination—Accuracy/bias | See procedure CP3-ES-5003, *Quality Assured Data* |
| Equipment blank | Minimum 5% | ≤ CRQL | Verify results; reanalyze | | Contamination—Accuracy/bias | See procedure CP3-ES-5003, *Quality Assured Data* |
| Spiked field samples (MS and/or MSD) | 1 per analytical batch | See data validation procedures CP2-ES-0026, -0811, -5102, -5105, -5107 | Check calculations and instrument; reanalyze affected samples | Laboratory should alert project | Accuracy/Precision | See procedure CP3-ES-5003, *Quality Assured Data* |
| Laboratory spiked blanks (LCS) | 1 per analytical batch | See data validation procedures 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* |

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

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

| QC Sample | Frequency/Number* | Method/SOP QC Acceptance Limits | Corrective Action | Person(s) Responsible for Corrective Action | Data Quality Indicator (DQI) | Measurement Performance Criteria |
|---|---|---|---|---|---|---|
| Method blank | 1 per analytical batch | See data validation procedures CP2-ES-0026, -0811, -5102, -5105, -5107 | Check calculations and instrument; reanalyze affected samples | Laboratory should alert project | Accuracy | See procedure CP3-ES-5003, *Quality Assured Data* |
| Surrogate standards | All samples, blanks, and QC samples | See data validation procedures 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* |
| Internal standards | All samples and standards | See data validation procedures 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* |

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

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

| QC Sample | Frequency/Number* | Method/SOP QC Acceptance Limits | Corrective Action | Person(s) Responsible for Corrective Action | Data Quality Indicator (DQI) | Measurement Performance Criteria |
|---|---|---|---|---|---|---|
| Field duplicate | Minimum 5% | None | Data reviewer will place qualifiers on samples affected | Project | Homogeneity/ Precision | RPD ≤ 50% sediment, RPD < 25% aqueous |
| Laboratory duplicate | Per laboratory procedure | See data validation procedures CP2-ES-0026, -0811, -5102, -5105, -5107 | Verify results re-prepare and reanalyze | Laboratory analyst | Precision | See procedure CP3-ES-5003, *Quality Assured Data* |
| Tracers/Carriers | Each sample tested by a radiochemical separation method | See data validation procedure CP2-ES-5102 | Check calculations and instrument; reanalyze affected samples | Laboratory analyst | Accuracy | See procedure CP3-ES-5003, *Quality Assured Data* |

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

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

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

| Sample Collection Documents and Records | On-site Analysis Documents and Records | Off-site Analysis Documents and Records | Data Assessment Documents and Records* | Other |
|---|---|---|---|---|
| Data logbooks (electronic or paper) and associated completed sampling forms; sample chains-of-custody | Laboratory data packages, OREIS database, and associated data packages | OREIS database and associated data packages | CP3-ES-5003, Att. G, Data Assessment Review Checklist and Comment Form | CP3-OP-0009-F01, Observation Checklist Form (quarterly assessment on permit driven sampling event is stipulated in the EMP) |

*It is understood that SOPs are contractor specific.

OREIS = Oak Ridge Environmental Information System

**QAPP Worksheet #31.**
**Planned Project Assessments Table**

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

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

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

**QAPP Worksheet #32.**
**Assessment Findings and Corrective Action Responses***

All provisions shall be taken in the field and laboratory to ensure that any problems that may develop shall be dealt with as quickly as possible to ensure the continuity of the project/sampling events. Field modifications to procedures in the QAPP must be approved before the modifications are implemented and then documented. The process controlling procedure modification is CP3-OP-0002, *Development, Approval, and Change Control for FPDP Performance Documents*. Field modifications are documented through the work control process per CP3-SM-1003. Corrective action in the field may be necessary when the sampling design is changed. For example, a change in the field may include increasing the number or type of samples or analyses, changing sampling locations, and/or modifying sampling protocol. When this occurs, the project team shall identify any suspected technical or QA deficiencies and note them in the field logbook. Listed in Worksheet #32 is how project teams will address assessment findings.

| Assessment Type | Nature of Deficiencies Documentation | Individual(s) Notified of Findings (Name, Title, Organization) | Time frame of Notification | Nature of Corrective Action Response Documentation | Individual(s) Receiving Corrective Action Response (Name, Title, Org.) | Time Frame for Response |
|---|---|---|---|---|---|---|
| Management, Independent, and Surveillances | Form CP3-QA-1003-F02, Management/Self-Assessment Report, Form CP3-QA-1003-F03, Management/Self-Assessment Checklist, and Form CP3-QA-3001-F02, Issue Identification Form | Project management, issue owner, contractor | Upon issuance of Forms CP3-QA-1003-F02, Management/Self-Assessment Report and CP3-QA-1003-F03, Management/Self-Assessment Checklist, form CP3-QA-3001-F02, Issue Identification Form, will be completed and attached to the assessment report | CP3-QA-3001, Issue Identification Form, documents the issue response and/or corrective actions | Action owner as designated by issue owner, contractor | Fifteen days for initial issue response, corrective action schedule determined by issue owner, per CP3-QA-3001 |

*It is understood that SOPs are contractor specific.

**QAPP Worksheet #33.**
**QA Management Reports Table**

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

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

TBD = to be determined
QA = quality assurance

## QAPP Worksheet #34.
## Verification (Step I) Process Table

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

| Verification Input | Description[a] | Internal/ External | Responsible for Verification (Name, Organization) |
|---|---|---|---|
| Field Logbooks/Data Forms | Field logbooks are verified per DOE Prime Contractor procedure, CP4-ES-2700, *Logbooks and Data Forms*, and CP3-ES-5003, *Quality Assured Data*. | Internal | Project Management or designee, Contractor |
| Chains-of-Custody | Chains-of-custody are controlled by DOE Prime Contractor procedure, CP3-ES-5004, *Sample Tracking, Lab Coordination and Sample Handling Guidance*. Chains-of-custody will be included in data assessment packages for review as part of data verification and data assessment. | Internal | Sample Management Office Personnel, and Project Management, Contractor |
| Field and Laboratory Data | Field and analytical data are verified and assessed per DOE Prime Contractor procedure, CP3-ES-5003, *Quality Assured Data*. Data assessment packages will be created per this procedure. The data assessment packages will include field and analytical data, chains-of-custody, data verification and assessment queries, and other project-specific information needed for personnel to review the package adequately. Data assessment packages will be reviewed to document any issues pertaining to the data and to indicate if data met the data quality objectives of the project. | Internal | Sample Management Office Personnel, and Project Management, Contractor |
| Sampling Procedures | Evaluate whether sampling procedures were followed with respect to equipment and proper sampling support using audit and sampling reports, field change requests and field logbooks. | Internal | Sample Management Office Personnel, Project Management, and QA Personnel,[b] Contractor |
| Laboratory Data | All laboratory data will be verified by the laboratory performing the analysis for completeness and technical accuracy prior to submittal to FPDP. Subsequently, FPDP will evaluate the data packages for completeness and compliance. | External/ Internal | Laboratory Manager, FPDP Sample Management Office Personnel |
| Electronic Data Deliverables (EDDs) | Determine whether required fields and format were provided. | Internal | Sample Management Office Personnel |
| QAPP | All planning documents will be available to reviewers to allow reconciliation with planned activities and objectives. | Internal | All data users |

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

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

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

[a] It is understood that SOPs are contractor specific.

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

| Step IIa/IIb | Matrix | Analytical Group | Concentration Level | Validation Criteria | Data Validator (title and organizational affiliation) |
|---|---|---|---|---|---|
| Step IIa/IIb | Sediments | All | All | National Functional Guidelines; Worksheets #12, #15, and #28; and CP2-ES-0026, CP2-ES-0811, CP2-ES-5102, CP2-ES-5105, CP4-ES-5103, and CP2-ES-5107 | Data Validator[a] |
| Step IIa/IIb | Water | All | All | | Data Validator[a] |

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

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

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

**Summarize the usability assessment process and all procedures, including interim steps and any statistics, equations, and computer algorithms that will be used:** Field and analytical data are verified and assessed per procedure CP3-ES-5003, *Quality Assured Data*. Data assessment packages will be created per this procedure. Data assessment packages will include field and analytical data, chains-of-custody, data verification and assessment queries, and other project-specific information needed for personnel to review the package adequately. Data assessment packages will be reviewed to document any issues pertaining to the data and to indicate if data quality objectives of the project were met. For data selected for validation, the following procedures are used: CP2-ES-0026, CP2-ES-0811, CP2-ES-5102, CP4-ES-5103, CP2-ES-5105, and CP2-ES-5107.

**Describe the evaluative procedures used to assess overall measurement error associated with the project:** PARCCS parameters (precision, accuracy, representativeness, comparability, completeness, and sensitivity) will be evaluated per procedure CP3-ES-5003, *Quality Assured Data*. This information will be included in the data assessment packages for review by project personnel. Data assessment also will include documentation of QC exceedances, trends, and/or bias in the data set. Data assessment will document any statistics used.

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

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

*It is understood that SOPs are contractor specific.