Commonwealth of Kentucky

Environmental Oversight Report 2017
Paducah Gaseous Diffusion Plant

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This 2017 Environmental Oversight Report, finalized in April 2018, was prepared by the Kentucky Division of Waste Management to report activities under the U.S. Department of Energy Federal Facility Agreement (FFA) and Agreement in Principle (AIP) grants covering the period from Jan. 1, 2017, to Dec. 31, 2017. This report summarizes activities undertaken by the Commonwealth of Kentucky (Kentucky) to oversee environmental restoration activities at the Paducah Gaseous Diffusion Plant (PGDP). Copies of the report are available from the Hazardous Waste Branch, Division of Waste Management, 300 Sower Blvd., Frankfort, Kentucky 40601, phone 502-782-6317.

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ACRONYM and ABBREVIATION LIST

Agreement in Principle	**AIP**
Applicable or Relevant and Appropriate Requirements	**ARAR**
Area of Concern	**AOC**
Burial Ground Operable Unit	**BGOU**
Cabinet for Health and Family Services	**CHFS**
Citizens Advisory Board	**CAB**
Comprehensive Environmental Response, Compensation, and Liability Act	**CERCLA**
Decontamination and Decommissioning	**D&D**
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Department of Energy (US)	**DOE**
DOE Material Storage Area	**DMSA**
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Environmental Protection Agency (US)	**EPA**
Environmental Restoration	**ER**
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Federal Facilities Agreement	**FFA**

Gallons Per Minute	**gpm**
Groundwater Operable Unit	**GWOU**
In Situ Object Counting System	**ISOC**
Kentucky Department for Environmental Protection	**KDEP**
Kentucky Division of Waste Management	**KDWM**
Kentucky Ordnance Works	**KOW**
Kentucky Pollutant Discharge Elimination System	**KPDES**
Land Use Control Implementation Plan	**LUCIP**
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Memorandum of Agreement	**MOA**
Monitoring Well	**MW**
National Priorities List	**NPL**
Nevada Test Site	**NTS**
Non-Detect	**ND**
North-South Diversion Ditch	**NSDD**
Northeast Plume Containment System	**NEPCS**
Northwest Plume Groundwater System	**NWPGS**
Not Applicable	**NA**
Paducah Gaseous Diffusion Plant	**PGDP**

Paducah Remediation Services	**PRS**
Parts Per Billion	**ppb**
Parts Per Million	**ppm**
Polychlorinated Biphenyl	**PCB**
Principal Threat Waste	**PTW**
Proposed Remedial Action Plan	**PRAP**
Radiation Health Branch	**RHB**
Rapid Bioassessment Protocol	**RBP**
RCRA Facility Investigation	**RFI**
Record of Decision	**ROD**
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Remedial Design Work Plan	**RDWP**
Remedial Investigation/Feasibility Study	**RI/FS**
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Surface Water Operable Unit	**SWOU**
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Trichloroethene	**TCE**
University of Kentucky	**UK**
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United States Enrichment Corporation	**USEC**
United States Geological Survey	**USGS**
Uranium Hexafluoride	**UF_6**
Uranium Tetrafluoride	**UF_4**
Volatile Organic Compound	**VOC**
Waste Acceptance Criteria	**WAC**
West Kentucky Wildlife Management Area	**WKWMA**

Introduction

In July 2013, the Paducah Gaseous Diffusion Plant (PGDP) ended over 60 years of continuous uranium enrichment production. Today, the United States Department of Energy (DOE) oversees environmental cleanup activities at the site, including environmental management, waste management, depleted uranium hexafluoride conversion, deactivation, decontamination, and decommissioning. The PGDP is located on a 3,556-acre federal reservation in northwestern McCracken County, Kentucky. Most of the historical and ongoing operations at the PGDP occur within a footprint the size of approximately 750 acres. This area is surrounded and bounded by the West Kentucky Wildlife Management Area (WKWMA) to the north, east and west. Since construction, the PGDP has been owned by the DOE or its predecessor U.S. government agencies. The United States Enrichment Corp. (USEC) was responsible for the operation and maintenance of the PGDP production facilities from July 1993 to October 2014. Although DOE retains ultimate responsibility for environmental restoration and waste management, DOE has employed a series of support contractor teams to assist the implementation of various activities at the site. Fluor Federal Services was the deactivation contractor and the environmental remediation contractor from Jan. 1 through Oct. 19, 2017. Four Rivers Nuclear Partnership was the deactivation and environmental remediation contractor for the remainder of 2017, the time period covered (CY 2017) by this report.

A variety of environmental concerns have been identified at the site since 1988. Historical PGDP activities have adversely affected soil, sediment, surface water, and groundwater. Groundwater sampling and analyses have detected concentrations of primarily trichloroethylene (TCE) and Technetium-99 (Tc-99), a radioactive by-product of historic PGDP process operations. Soil and sediment sampling analyses have detected the presence of polychlorinated biphenyls (PCBs) and uranium. In addition, historic surface water studies have documented PCB concentrations in fish collected from both Bayou Creek (west of the site) and Little Bayou Creek (east of the site).

Site cleanup activities at the PGDP occur in a sequenced approach consisting of pre-shutdown and post-shutdown activities. The pre-shutdown scope is associated with accessible media-specific Operable Units (OUs). An OU is a grouping of areas or sources that share common attributes such as a contaminated media type (groundwater, surface water, soil) and associated

exposure pathways (ingestion, inhalation, dermal exposure). Post-shutdown activities will focus on deactivation and demolition of the remaining facilities associated with the PGDP, as well as on contaminated media. Post-shutdown activities will also focus on additional environmental investigations to determine if any impacts to the environment have occurred in areas within the 750 acres that have yet to be investigated or were previously inaccessible.

At the PGDP, media-specific OUs were established by developing a site conceptual risk model for each solid waste management unit (SWMU) and Area of Concern (AOC). This process included a qualitative evaluation of contaminant types and concentrations, release mechanisms, likely exposure pathways, estimated points of exposure, and potential receptors. Potential receptors included current and reasonably foreseeable future land assumptions in the evaluation.

The media-specific OUs (based on the 2015 SMP) identified for the PGDP are:

Pre-GDP Shutdown

- Surface Water OU
- Groundwater OU
- Burial Grounds OU
- Soils OU
- Decontamination and Decommissioning (D&D) OU (Inactive Facilities)

Post- GDP Shutdown

- GDP Lagoons and Ditches OU
- GDP Groundwater Sources OU
- Additional Burial Grounds Sources OU
- Soils and Slabs OU
- GDP D&D OU

A Final Comprehensive Site OU evaluation will occur at PGDP following completion of the remaining OUs.

Public Participation

Citizens Advisory Board (CAB)

The Paducah Citizens Advisory Board (CAB) is a stakeholders' board that provides advice and recommendations to DOE regarding environmental management programs at the PGDP. KDWM and Cabinet for Health and Family Services (CHFS) are non-voting (ex-officio) members who serve as advisors and inform the CAB on their respective agencies' policies and views. The CAB website is: http://www.pgdpcab.energy.gov/

Kentucky's Oversight Program

The Commonwealth of Kentucky is responsible for overseeing the environmental cleanup of the PGDP. Kentucky's Energy and Environment Cabinet (EEC) has designated the Hazardous Waste Branch (HWB) within the Division of Waste Management (DWM) to serve as the lead agency to coordinate this oversight and to implement both the Agreement in Principle (AIP) and the Federal Facility Agreement (FFA) programs for the Commonwealth of Kentucky. The Cabinet for Health and Family Services (CHFS) Radiation Health Branch (RHB), has radiation authority for the Commonwealth of Kentucky, also serves a critical role in implementing these two oversight programs. State agencies and other organizations assisting the HWB and RHB with oversight responsibilities include:

- Division of Waste Management (DWM)
- Division of Water (DOW)
- Division for Air Quality (DAQ)
- Kentucky Department of Fish and Wildlife Resources (KDFWR)
- University of Kentucky Research Consortium Energy and Environment (KRCEE)

For the purposes of this report, all references to activities conducted by the Paducah Gaseous Diffusion Plant Section of the Division of Waste Management (KDWM) will be referred to as

Kentucky. References to activities by other state government agencies that are not part of the ECC (and in some cases, not part of KDWM) will be specified as appropriate.

Coordination with Kentucky state government agencies, federal agencies and citizen's groups is another important function of the Paducah Section. Kentucky regularly cooperates and interacts with U.S. DOE, the U.S. Environmental Protection Agency (EPA), and the Paducah CAB. Kentucky is an active participant in the National Governor's Association Federal Facilities Task Force, State and Tribal Government Working Group, and the Environmental Council of the States.

Federal Facility Agreement / Site Management Plan

The Federal Facility Agreement (FFA) is a three-party agreement between DOE-Paducah, EPA Region 4 and the Kentucky Energy and Environment Cabinet. It was developed to ensure compliance with, and to avoid duplication between, the cleanup provisions of the Resource Conservation and Recovery Act (RCRA) and those of CERCLA. Moreover, the FFA outlines regulatory structure and guides interactions between the three parties. The FFA allows Kentucky and EPA to address contaminated areas at the PGDP that are not subject to permitting but nonetheless require remediation and provides a framework for project management, investigation and remediation.

The Site Management Plan (SMP) is an appendix to the FFA that serves to define and document operable units (OUs) requiring investigation and cleanup. The SMP,per the FFA, is intended to be revised annually and provides enforceable milestones for the investigation and cleanup of the site. Milestones are set for the current fiscal year (FY) and the following two years. Longer term out-year milestones are set for completion of the larger media-type OUs. The SMP also documents the three-party prioritization strategy for the complete remediation of the PGDP. The FFA parties meet to scope revisions for the document in the months leading up to DOE's annual transmittal deadline on November 15.

In early August 2017 the senior managers of DOE, EPA Region IV and Kentucky DEP signed a Memorandum of Agreement (MOA) to resequence all of the environmental remediation work at the Paducah site. DOE identified and initiated resequencing efforts in April/May 2016. While

several factors influenced DOE's conclusion, the main factor was that DOE regained control of the Gaseous Diffusion Plant facilities in 2014, making C-400 accessible to investigate and clean-up.

The C-400 building has long been suspected as the main source of the two four-mile long TCE groundwater contamination plumes, commonly identified as the Northeast and Northwest Plumes. The groundwater plumes are the largest known sources of contamination leaving the site and are therefore the main risk to human health and the environment from the site. Since 1989 DOE has provided free hook-ups to the municipal water supply for residences above or in close proximity to these groundwater plumes. In order to clean up contamination associated with the C-400 Complex, a comprehensive investigation of the area beneath and around the building must be performed. This investigation (action) will define all sources of contamination and how each contaminant is distributed vertically and laterally, beneath the overall vicinity of the C-400 Complex.

In order to accomplish a comprehensive investigation of the C-400 Complex, the senior managers agreed that the C-400 building would be demolished to slab by the first quarter of 2019. Once the building is down and the area is accessible to heavy drilling equipment, the remedial investigation (RI) field start date will follow in the first quarter of 2020. The Record of Decision to address all the sources of contamination at the C-400 Complex site is scheduled to be submitted during the 4th quarter of 2022. The ensuing field start date for the remedial action (RA) is planned to occur during the 1st quarter of 2024. It is foreseeable that multiple rounds of RIs and RAs will likely occur to make the best use of limited cleanup dollars.

The resequencing MOA was not signed until August 2017 and the senior managers agreed not to finalize a 2017 SMP, but to concentrate on the 2018 SMP. The 2018 Site Management Plan will memorialize the planning and enforceable dates associated with the C-400 Complex. The SMP will also integrate the balance of the pre- and post- GDP shutdown projects along with their schedules into one clean-up scope. All remaining environmental projects, except the area directly north of the C-720 "Machine Shop" Building - referred to as SWMU 211A, will be moved out into the future.

The 2018 SMP was scoped in a series of meetings in the fall of 2017. The D1 was submitted on Nov. 15, 2017. On Dec. 15, EPA and Kentucky requested a resubmittal of the SMP, because they deemed it incomplete. The document was resubmitted in Jan. 2018.

Site Management Plan Documents Reviewed In 2017

FY 2018 Annual Revision to Site Management Plan (2418&D1).

Agreement in Principle (AIP)

Under the AIP program, Kentucky conducts independent environmental monitoring activities and oversees DOE monitoring activities and procedures. Additionally, the program serves to disseminate information relevant to ongoing site cleanup activities to concerned citizens and the public in general. During 2017 the AIP wrote and distributed four issues of the *Oversight News,* its newsletter detailing activities at the PGDP. AIP also completed and distributed its 2016 Annual Report.

A fundamental goal of the AIP program is to allow Kentucky to conduct independent and impartial assessments of the potential environmental impacts of past, present and future DOE activities at the PGDP.

Kentucky AIP Program Elements for 2017

One of the primary goals of the Agreement in Principle (AIP) is to monitor and evaluate current site activities through sampling and observation, in order to identify possible threats to human health and the environment. The secondary goal is to independently verify data collected by DOE contractors to insure data quality. To achieve these goals, AIP staff routinely observe DOE facilities and operations to identify environmental issues or concerns. Any resulting significant conditions or practices are brought to DOE's attention for review.

AIP staff collect independent environmental samples (soil, surface water, air, and groundwater) and also split samples with DOE contractors. Over the years AIP staff have also worked with organizations such as the University of Kentucky in conducting scientific research apart from DOE cleanup and monitoring efforts. And some of the research involved collecting environmental samples. Samples collected by AIP, and by independent researchers working with AIP, are routinely sent to laboratories under contract to the AIP program or, in the case of independent researchers, selected by the researcher. AIP sampling includes the collection of groundwater samples (at the request of nearby property owners) from private residential wells as a means to inform the public of current groundwater conditions near the PGDP boundaries; AIP also splits environmental samples to independently validate DOE's sampling results. Historically AIP has split tissue samples collected from animals living near the PGDP to monitor any potential impact to the biota.

For 2017, the primary AIP independent contract laboratory was TestAmerica Laboratories (TAL) located in Earth City, Missouri. TAL is an accredited, independent laboratory that meets or exceeds the requirements set forth by governing EPA standards. The Cabinet for Health and Family Services (CHFS), Radiation Health Branch (RHB) analyzes groundwater samples as well as airborne and surface water samples collected using continuous monitoring equipment for gross alpha and gross beta concentrations, and gamma spectroscopy. If trigger levels for gross alpha and gross beta are exceeded, then CHFS will analyze the sample for isotopic radionuclides. AIP staff directly receives all analytical data from TAL and CHFS. The results are verified, interpreted and shared formally with the appropriate parties.

AIP Groundwater Investigations

Groundwater Sampling

During 2017, AIP staff collected samples from nine different residential wells and 116 different monitoring wells. The 2017 AIP Groundwater Sampling Locations map (Figure 1) shows all wells sampled during the 2017 reporting period. The vast majority of the wells sampled were less than two miles from PGDP plumes and/or less than two miles from the PGDP. In general, the

monitoring well and residential well sampling conducted by AIP staff, has produced results that are similar to those obtained by DOE. This is a line of evidence to support the validation of DOE data collection and analysis used to construct contaminant plume maps during the reporting period. AIP independent oversight of DOE's groundwater sampling program helps to ensure that results obtained by DOE are accurate, reproducible and verifiable.

The residential wells sampled by AIP staff were located around the two off-site contamination plumes. During this reporting period, AIP independently confirmed that, of the nine residential wells sampled in 2017, none are currently being impacted by the plumes. For all residential wells sampled, the laboratory report and discussion of the results were sent directly to the residents.

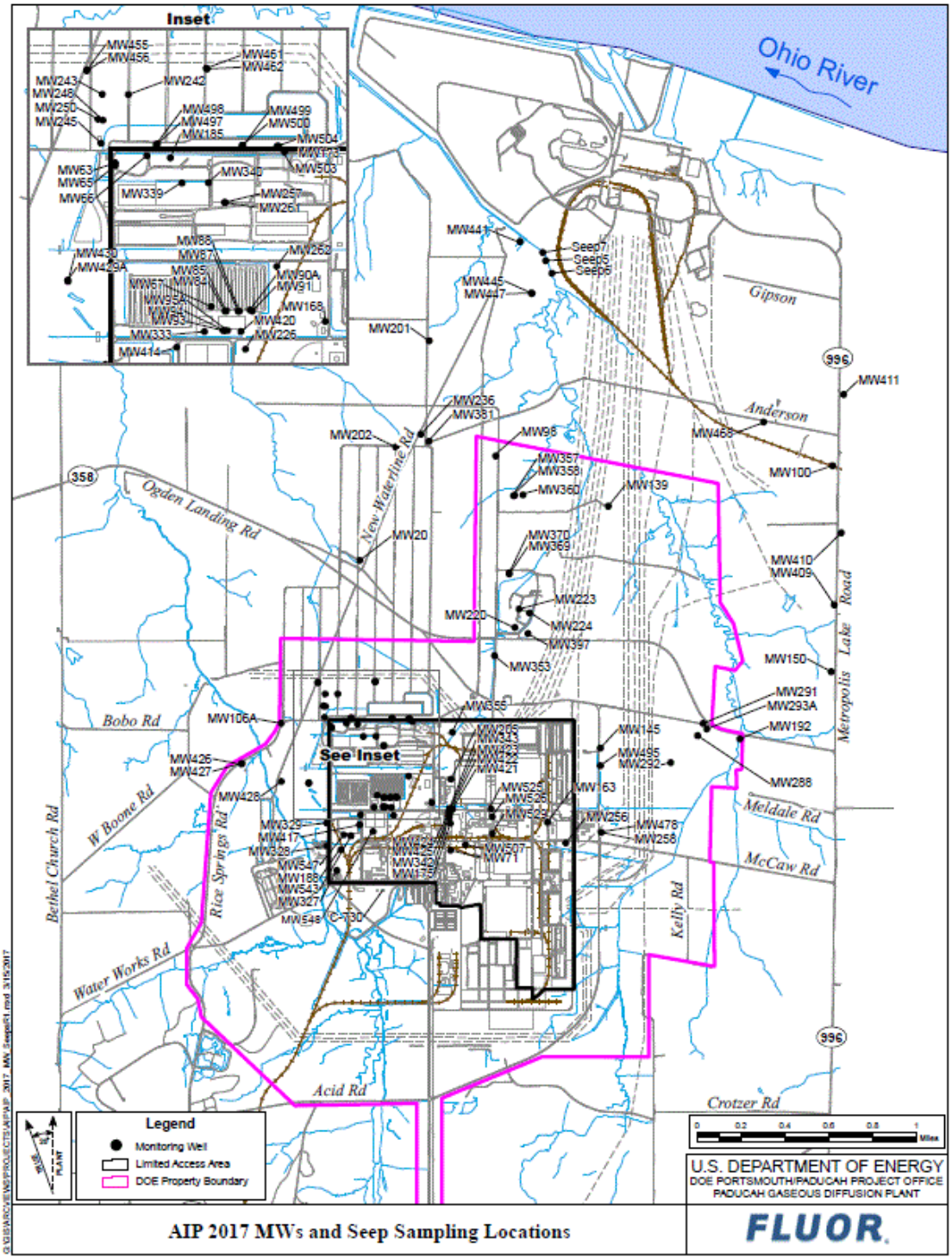


Figure 1. AIP 2017 Monitoring Wells Sampled

AIP staff split seven residential and 35 monitoring well samples with DOE in 2017. In most cases, AIP staff arranged to split samples with DOE during their scheduled sampling activities. These sampling events were conducted to evaluate and substantiate DOE's sampling procedures and to verify the quality of their laboratory analyses. Split sampling activities demonstrated a general similarity between those samples collected and analyzed by Kentucky and those collected and analyzed by DOE. During the split sampling events, Kentucky also monitored DOE's sampling procedures to verify work was being performed in compliance with EPA and DOE Standard Operating Procedures for field measurements and sampling methodology. Of the 35 monitoring well samples split by Kentucky and DOE, most had similar TCE and Tc-99 concentrations.

Well #	Date	AIP TCE ug/L	DOE TCE ug/L	AIP Tc-99 pCi/L	DOE Tc-99 pCi/L
MW525	1/10/17	500 RL 25	599 RL 10	75.3 +/- 1.64	88.4 +/- 12.8
MW526	1/10/17	200 RL 10	214 RL 5	127 +/- 1.87	134 +/- 15.1
MW529	1/10/17	82 RL 5.0	95.8 RL 1.0	168 +/- 2.04	165 +/- 16.2
MW220	1/11/17	ND	U	26.6 +/- 1.38	23.2 +/- 11.5
MW224	1/11/17	ND	U	ND	U
MW397	1/11/17	ND	U	10.2 +/- 1.28	8.85 +/- 11.2
MW369	1/18/17	4.0 RL 1.0	4.97 RL 1.0	14.0 +/- 1.31	27 +/- 12.1
MW370	1/18/17	1.5 RL 1.0	1.78 RL 1.0	78.2 +/- 1.65	82.8 +/- 15
MW357	1/18/17	5.2 RL 1.0	3.79 RL 1.0	38.3 +/- 1.45	43.5 +/- 10.6
MW358	1/17/17	3.7 RL 1.0	3.79 RL 1.0	43.3 +/- 1.47	47.3 +/- 10.5
MW360	1/17/17	ND	U	ND	U
MW106A	5/16/17	4.3 RL 1.0	3.63 RL 1.0	ND	U
MW496	5/17/17	130 RL 10	116 RL 2.0	22.3 +/- 1.37	22.4 +/- 12.3
MW191	5/16/17	ND	U	ND	U
MW288	5/17/17	160 RL 10	NS	32.8 +/- 1.43	41.3 +/- 11.2
MW292	5/17/17	180 RL 10	NS	30.9 +/- 1.42	45.9 +/- 12.7
MW441	5/16/17	1.9 RL 1.0	1.87 RL 1.0	ND	U
MW201	5/16/17	0.62 J RL 1.0	0.49 J RL 1.0	ND	U
MW202	5/16/17	ND	U	ND	U
MW98	5/16/17	ND	U	42.3 +/- 1.48	44.5 +/- 14.9
MW139	5/16/17	5.1 RL 1.0	4.47 RL 1	ND	U

Well #	Date	AIP TCE ug/L	17800 DOE TCE ug/L	AIP Tc-99 pCi/L	DOE Tc-99 pCi/L
MW 506	6/20/17	18000 RL 2000	17800 RL 250	58.9 +/- 1.47	52.5 +/- 23.3
MW507	6/20/17	4700 RL 500	4240 RL 100	61 +/- 1.48	55.6 +/- 23.9
MW543	6/20/17	180 RL 25	227 RL 4	ND	NA
MW547	6/20/17	1200 RL 200	1310 RL 20	ND	NA
MW108	6/28/17	1.6 RL 1.0	1.93 RL 1.0	18.5 +/- 1.24	24.8 +/- 17.6
MW84	7/12/17	2900 RL 200	2910 RL 50	14.70 +/- 1.34	U
MW87	7/12/17	1600 RL 100	1620 RL 50	ND	U
MW90A	7/12/17	45 RL 2.0	46.1 RL 1	ND	U
MW93	7/12/17	1300 RL 100	1400 RL 50	4.58 +/- 1.28	U
MW420	7/12/17	320 RL 25	264 RL 4	ND	U
MW85	7/12/17	7.3 RL 1.0	4.98 RL 1	62.00 +/- 1.59	67.3 +/- 13.9
MW88	7/12/17	1.8 RL 1.0	2.02 RL 1	20.10 +/- 1.37	20.4 +/- 12.1
MW91	7/12/17	76 RL 5.0	75.3 RL 2	2510 +/- 6.32	2620 +/- 54
MW94	7/12/17	2.6 RL 1.0	2.73 RL 1	500 +/- 3.03	604 +/- 25.9
R9	11/14/17	ND	U	ND	U
R20	11/14/17	ND	U	ND	U
R21	11/14/17	ND	U	ND	U
R83	11/14/17	ND	U	ND	U
R90	11/14/17	ND	U	ND	U
R114	11/14/17	ND	U	ND	U
R302	11/14/17	ND	U	ND	U

Table 1. AIP/DOE Data Comparison

RL = Reporting Limit, ND = Not Detected at the reporting limit, U = not detected above the laboratory reporting limit, J = result is less than the reporting limit but greater than or equal to the minimum detection level and the concentration is an approximate value.

MW100 was of special concern due to its close proximity to the eastern edge of the Water Policy Box and its location outside of the 5 ug/L TCE concentration line of the Northeast Plume. MW100 had detections of TCE two of the three times it was sampled in 2010 and 2011 (see Figure 2). The detections were below the laboratory reporting limit of 1.0 ug/L and the

EPA's maximum contaminant limit (MCL) of 5 ug/L. AIP staff will continue to closely evaluate this particular well over time.

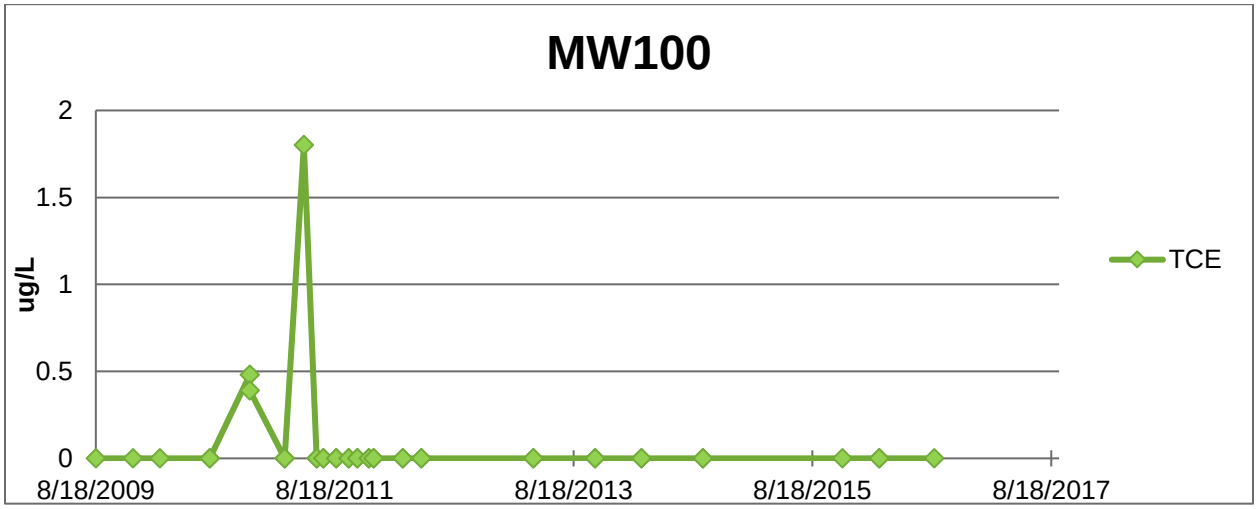


Figure 2. Monitoring Well 100 Sampling Results

Seeps Sampled by Kentucky AIP

Six seeps in Little Bayou Creek (LBC) were added to Kentucky's sampling program in 2002; a seventh seep was discovered and added in June 2007. These seeps are located where groundwater is upwelling in a channelized portion of LBC, along a Porter's Creek Clay exposure. The locations of the seeps can disappear or change by several feet after major storm events, when high flow causes changes in depositional features (sand bar shifting) and in the banks of the creek (sloughing). The base flow in LBC is comprised primarily of discharges from plant outfalls. These seeps are located downstream of the Paducah site, two miles from the plant and two miles from the confluence of LBC and the Ohio River. AIP staff periodically check Little Bayou Creek for any migrating or new seeps.

AIP sampled LBC seep #5 and locations upstream and downstream on Feb. 16. The location can be seen on the 2017 AIP Monitoring Well and Seep Sampling Locations map (Figure 1). TCE

was 3.3 ug/L in LCB seep #5 and 0.88J in Little Bayou Creek upstream of LBC seep #5 and 0.98J downstream. Tc-99 was 9.90 pCi/L upstream of LBC seep #5 and 9.67 pCi/L downstream. Tc-99 was not analyzed in the LBC seep #5 sample because the gross alpha and gross beta analyses were not above the screening criteria of Gross Alpha ≥ 5 pCi/L and Gross Beta ≥ 9 pCi/L.

AIP also sampled LBC seep #5 and the seeps immediately upstream and downstream of it on September 26 for TCE and Tc-99. TCE was 1.2 ug/L in the seep downstream of LBC seep #5 and 1.3 ug/L in LBC seep #5 and the seep upstream of it. Technetium 99 (Tc-99) was 7.73 pCi/L in the seep upstream of LBC seep #5. Tc-99 and other site specific isotopes were not analyzed in the other two samples because Gross Alpha and Gross Beta did not exceed the screening criteria.

MW-66 Water Level

During 2017, AIP staff collected monthly water elevations at MW-66 to study seasonal variations in the groundwater table and how they may relate to elevated TCE concentrations. A 2012 DOE sponsored document (*Technical Evaluation of Temporal Groundwater Monitoring Variability in MW-66 and Nearby Wells, Paducah Gaseous Diffusion Plant*) concluded that the spikes in TCE concentration at MW-66 were likely due to variations in regional and local groundwater flow conditions. The conclusions of the 2012 DOE study recommended continued sampling of MW-66. Due to the limited amount of data collected by KY AIP, conclusions were not readily discernable from the 2017 sampling events. Based on identified data needs, monthly water elevations will continue to be collected at MW-66 during 2018.

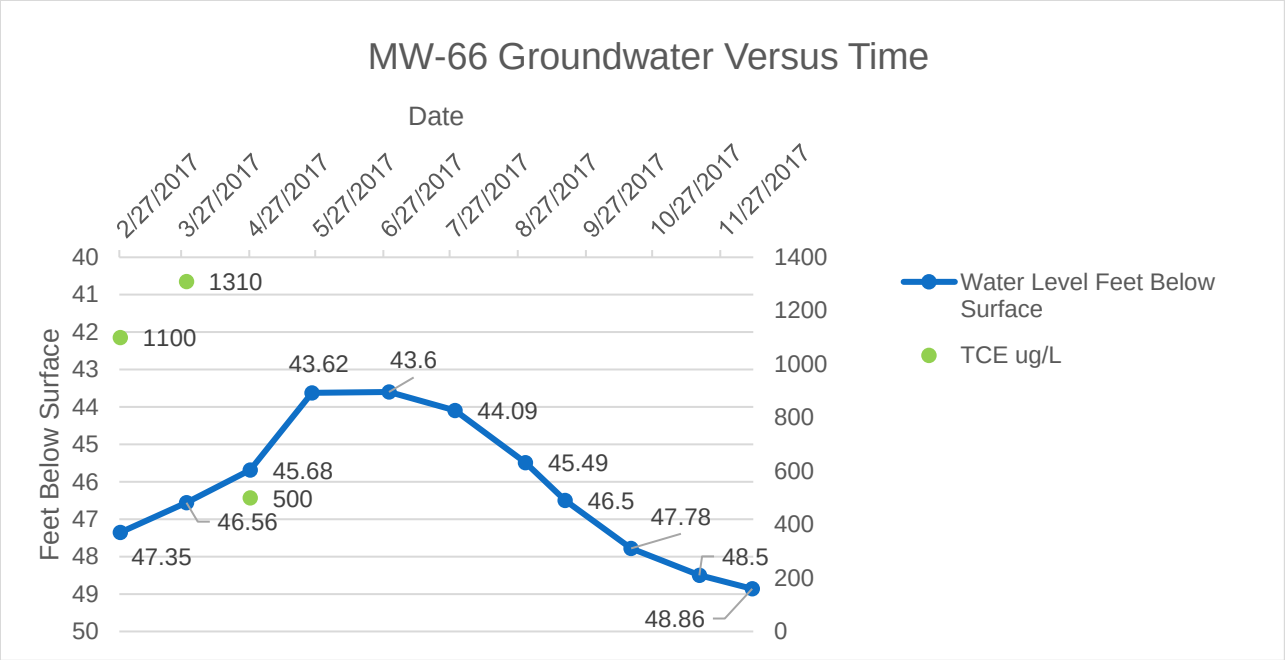


Figure 3. MW 66 Water Levels

Dual Purge Monitoring Well Chromium Sampling Event

During May and September of 2017, Kentucky AIP personnel conducted a limited study of five monitoring wells (MW-132, MW-150, MW-192, MW-328 and MW-329) to determine if purge methodology would have an impact on the analytical groundwater results. The two analytes for this study were total chromium and hexavalent chromium (chromium VI). The two purge methods being compared were; (1) micro-purge method ((consisting of 300 ml/minute) evacuating the water volume in the dedicated tubing, plus a minimal amount for water quality stabilization) and (2) one-well volume method (calculated from the diameter of the well and the thickness of the water column). The micro-purge is the method commonly referenced and used in standard operating procedures for collecting groundwater samples at the Paducah Site. On average, the volume of purge water generated by a micro-purge event is typically < 4 liters; whereas for this study, purge water generated by removing one well volume varied between 7 and 34 liters.

Samples were shipped to Test America Laboratories, Inc. of Earth City, Missouri, and analyzed for total chromium using EPA analytical method 6020A. Four of the five monitoring wells had

significantly lower analytical results for samples acquired during the second (one-well volume) purge event. The greatest change was noted in MW-132 during the September event with the micro-purge method result of 1,100 µg/L and a one-well volume purge method result of 180 µg/L. Hexavalent chromium sample results in monitoring wells MW-132 and MW-192 indicate a slight increase in the one-well volume purge method over micro-purge results. The results are summarized in the tables below.

May 2017 Chromium Sampling Event				
MW	**Total Chromium ug/L**	**Chromium VI ug/L**	**Purge Volume Liters**	**Date**
MW132	520	< MDL 2.6	3.7	5/23/2017
MW132A*	35	< MDL 2.6	33.7	5/23/2017
MW150	< MDL 4.0	< MDL 2.6	2.5	5/23/2017
MW150A*	< MDL 4.0	< MDL 2.6	29.6	5/23/2017
MW192	17	6.0 J	2.1	5/23/2017
MW192A*	23	3.7 J	7.3	5/23/2017
MW328	92	< MDL 2.6	2.9	5/23/2017
MW328A*	35	< MDL 2.6	17.1	5/23/2017
MW329	130	< MDL 2.6	3.1	5/23/2017
MW329A*	19	< MDL 2.6	16.1	5/23/2017

* - was purged one-well volume and sampled a second time
MDL: Method Detection Limit
J-qualifier: Result is approximated as being less than the reporting limit (RL) but greater than or equal to the method detection limit (MDL)

September 2017 Chromium Sampling Event				
MW	Total Chromium ug/L	Chromium VI ug/L	Purge Volume Liters	Date
MW132	1,100	2.6 J	3.7	9/20/2017
MW132A*	180	6.2 J	31	9/20/2017
MW150	5.9 J	< MDL 2.6	2.5	9/20/2017
MW150A*	< MDL 4.0	< MDL 2.6	29.6	9/20/2017
MW192	120	9.7 J	2.1	9/20/2017
MW192A*	140	16	7.3	9/20/2017
MW328	790	6.4 J	2.9	9/20/2017
MW328A*	350	4.0 J	17.1	9/20/2017
MW329	330	< MDL 2.6	3.1	9/20/2017
MW329A*	140	< MDL 2.6	16.1	9/20/2017

* - was purged one-well volume and sampled a second time
MDL: Method Detection Limit
J-qualifier: Result is approximated as being less than the reporting limit (RL) but greater than or equal to the method detection limit (MDL)

Table 2. Chromium Sampling Results

A review of these results raises the question of whether the current micro-purge methodology is acquiring data that is representative of concentrations in the formation. In a letter to DOE it was recommended that further studies be undertaken by DOE to arrive at a firm conclusion.

Dual Purge Monitoring Well VOC Sampling Event

During August of 2017, Kentucky AIP personnel conducted a limited study of four monitoring wells (MW-66, MW-173, MW-205, & MW-340) to determine if purge methodology would have an impact on the analytical groundwater results. The analytes for this study were volatile organic carbons (VOCs). Monitoring wells MW-66 and MW-340 were selected due to historical elevated results for VOCs, specifically TCE. Monitoring wells MW-173 and MW-205 were selected due to historically non-detect results for VOCs. The two purge methods being compared were; (1) micro-

purge method (consisting of ≥300 ml/minute) which evacuated the water volume in the dedicated tubing plus a minimal amount for water quality stabilization, and (2) three-well volume method (calculated from the diameter of the well and the thickness of the water column). The micro-purge method is commonly used and referenced in standard operating procedures for collecting groundwater samples at the Paducah Site. On average, the volume of purge water generated by a micro-purge event is typically less than four liters; whereas for this study, purge water generated by removing three well volumes was roughly between 24 and 87 liters.

Samples were shipped to Test America Laboratories, Inc. of Earth City, Missouri, and analyzed for total VOCs using EPA analytical method 8260. Results of the test indicate no significant change in micro-purge sampling and three-well purge volume purging. The greatest change was noted in MW-66 with the micro-purge method result of 870 µg/L and a three-well volume purge method result of 640 µg/L. The results are summarized in the table below:

August 2017 Volatile Organic Carbon Sampling Event			
Monitoring Well ID	**TCE ug/L**	**Purge Volume Liters**	**Date**
MW66	870	2.6	8/30/17
MW66A*	640	36.2	8/30/17
MW173	< MDL 0.25	2.6	8/30/17
MW173A*	< MDL 0.25	24.3	8/30/17
MW205	< MDL 0.25	3.2	8/25/17
MW205A*	< MDL 0.25	36.2	8/25/17
MW340	2900	4	8/29/17
MW340A*	3100	86.3	8/29/17

* - was purged three-well volume and sampled a second time
MDL: Method Detection Limit

Table 3 VOC Sampling Event

A review of these results indicate that varying the monitoring well purging method at the selected monitoring wells may cause slight variations in the sample results but overall it does not appear likely to cause a significant difference in VOC results. It should also be noted that the sample size of four monitoring wells is too small to draw any definitive conclusions, especially when two of the four monitoring wells chosen were below the method detection limit.

NW and NE Plume Pumping Well Area of Influence/Cone of Depression Assessments

Water levels in wells in the northwest portion of the plant were measured twice in 2017. March and September water level studies indicate that the high concentration portion of the plume is captured laterally within the cone of depression of EW 232 and EW 233.

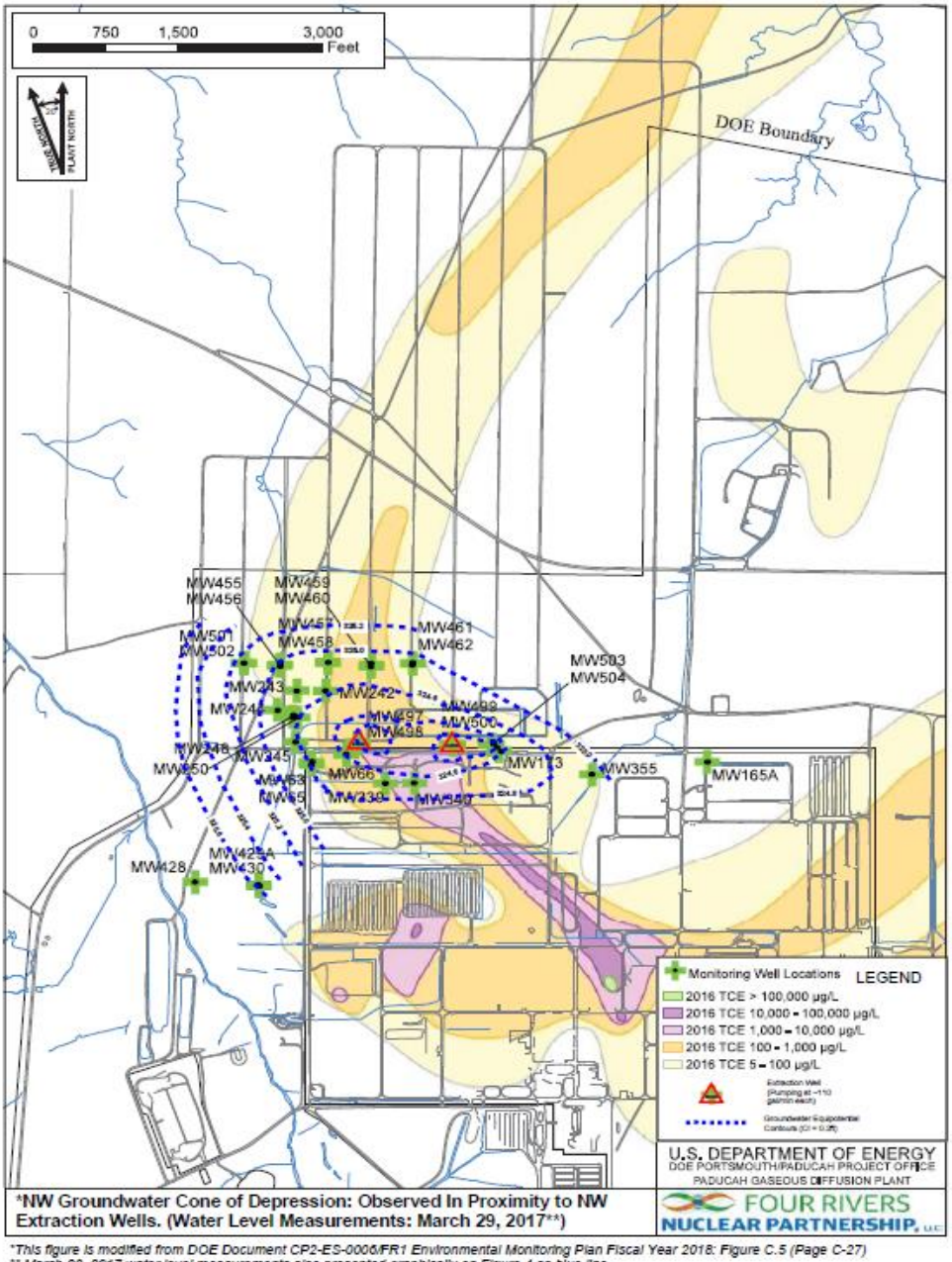
In order to assess whether the high concentration portion of the northwest plume is captured vertically, TCE levels in middle and deep RGA wells proximal to the pump and treat system were compared from 2009 through 2017. The optimized extraction wells EW 232 and EW 233 went online in August 2010. These wells are located further east of the original EW 230 and EW 231 locations. The new extraction wells were optimally placed to account for the eastward shifting of the high concentration portion of the plume. The new extraction wells are screened in the upper and middle portions of the RGA.

Generally, TCE concentrations in the northwest plume monitoring wells near the extraction wells have stabilized in the last 2 -3 years. Monitoring wells 456, 243, 248, and 250, located on the west side of the plume have decreased TCE concentrations into the single digits.

Over the past eight years, the concentration of TCE in deep RGA wells upgradient of the extraction wells has decreased rather dramatically. Over the same time period, TCE concentrations in proximal deep downgradient wells have increased. This appears to indicate that the new extraction wells are not entirely capturing the TCE contamination in the deep RGA, resulting in by-pass.

In 2017, 47 monitoring wells and piezometers located in proximity to the northeast plume were added to AIP's water level measurement program. The additional water level measurements were added in anticipation to DOE's effort to relocate the northeast plume extraction wells. Water

level measurements were collected in Nov. 2017, shortly after the new extraction wells started pumping. Water level measurements show discrete cones of depression that encompass the proximal ends of the high concentration lobes of the northeast plume.



*This figure is modified from DOE Document CP2-ES-0006/FR1 Environmental Monitoring Plan Fiscal Year 2018: Figure C.5 (Page C-27)
** March 29, 2017 water level measurements also presented graphically on Figure 4 as blue line.

Figure 4. March 2017 NW GW Cone of Depression

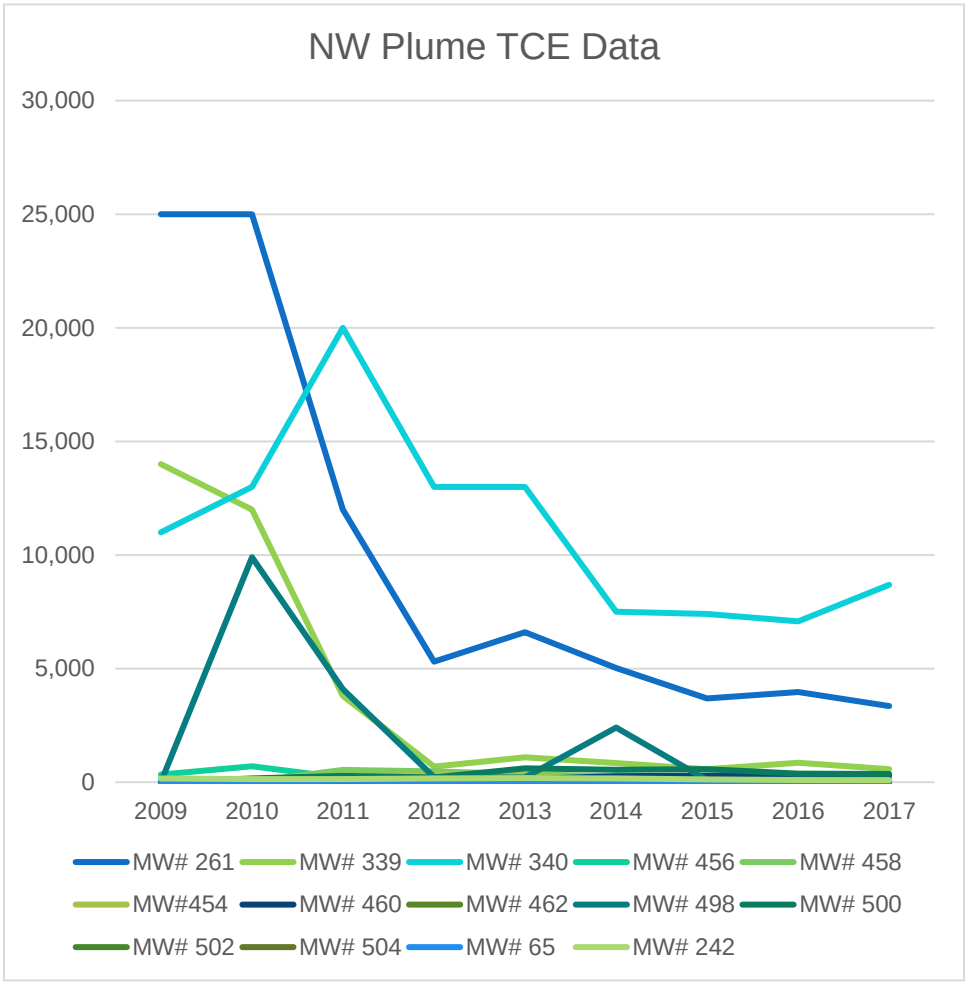


Figure 5. AIP 2017 NW Plume TCE Data

C-400 Monitoring Wells Sampled by Kentucky AIP

Since July of 2009 the AIP has monitored the effectiveness of various groundwater actions taken at C-400 by sampling all depths of the following downgradient MWs; MW421, MW422, MW423, MW424 and MW425. These MWs are located in the vicinity of the northwest corner of the C-400 building and are used to compare TCE concentrations over time. Each of the MWs contain three screened intervals corresponding to the shallow, middle, and deep RGA zones. The AIP has

collected samples from these down gradient wells since 2009 and tracked the associated chemical data in order to chart downgradient impacts of the remediation efforts (Figure 6).

Several remedial actions have occurred around the C-400 Building to extract TCE from the subsurface. In 2003 a Treatability Study was conducted utilizing Electrical Resistance Heating (ERH) which removed 1,900 gallons of TCE. Phase I ERH became operational on March 29, 2010 and ran for seven months along the southern portions of the C-400 building. TCE levels in all downgradient wells showed a decline after the Phase I operational period. During Phase IIa, January 1 through October 9, 2014, TCE levels also declined. Concentrations in the majority of downgradient C-400 monitoring wells continue to decline over time or remain relatively constant. An increase in concentration was noted at MW421 P3 in 2016, but levels decreased in 2017. MW421 P3 is screened at a depth of 83 to 85 ft bgs. DOE data from 2011, 2012 and 2013 was used to supplement AIP data in this analysis. Only the deep wells, designated by 'P3,' were sampled in 2012.

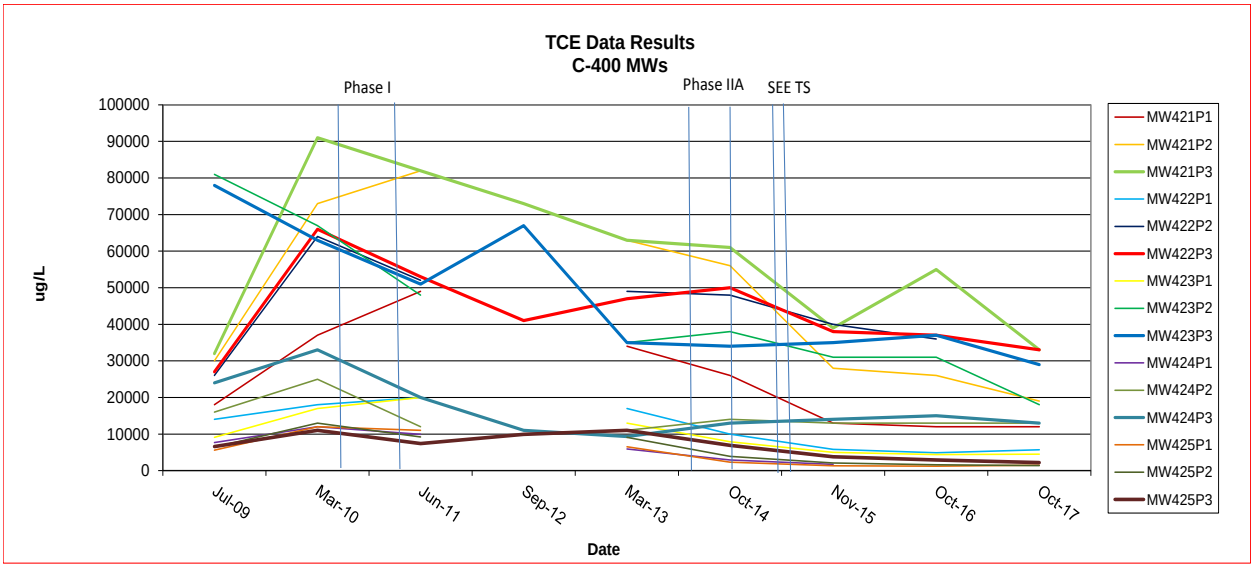


Figure 6. C-400 MW Data

Groundwater Model

Groundwater models are used to help evaluate hydrogeologic systems in an effort to better understand what could happen over time. A model is a simplified representation of the conditions

at the site and it incorporates many hydrologic processes. The Paducah Gaseous Diffusion Plant (PGDP) Sitewide Groundwater Flow Model was created to develop a tool that can be used to assist in determining additional data needs as well as evaluating potential remedies.

In a series of meetings, groundwater experts from DOE, EPA and Kentucky revised the Paducah Site specific groundwater model to determine additional data needs to support the evaluation of potential groundwater remedies. The first groundwater flow model at the Paducah Site was designed in 1990 and revised several times through 1997. A transport model was developed in 1997 and 1998. The next major revision to the model did not occur until 2008. That revision was developed to assist in determining additional data needs, evaluating potential remedies, and developing inputs to design selected remedies. The model was further refined in 2012 to evaluate how potential variability in anthropogenic recharge rates (e.g., leaking water from plant utility lines) can influence groundwater flow and extraction well capture zone performance. The 2016 model revision builds on the 2012 model update with revisions to technical parameters of the model.

The groundwater model simulates flow within the Regional Gravel Aquifer (RGA) and ignores flow in both the Upper Continental Recharge System (UCRS) and the McNairy Formations. The UCRS conveys natural and anthropogenic recharge vertically to the RGA. The underlying McNairy Formation is represented in the model as a no flow boundary. The model includes an upgradient zone which accounts for recharge to the model along Terrace Gravel deposits.

Prior to 2010 water elevations collected at the Paducah Site were collected over several weeks and in some cases over several months. Water level elevations fluctuate over time which introduced uncertainty into all level interpretations/maps prior to 2010. In 2010 DOE started collecting synoptic water level events on an annual basis. A synoptic water level event occurs over a relatively short time period (1-3 days). The revised groundwater model includes multiple sets of synoptic water level elevation events in order to better represent water elevations and test model predictions against actual conditions.

DOE submitted the ‘2016 Update of the Paducah Gaseous Diffusion Plant Sitewide Groundwater Flow Model’ document to the regulators in April 2017, even though it is not subject to regulatory

review and approval under the Federal Facilities Agreement (FFA). The 2016 update to the sitewide groundwater model was the result of a collaborative approach and process undertaken by all three parties to the FFA with an objective to represent and reflect groundwater flow conditions of the past, present, and future. The intent of the model update is to provide FFA decision makers with a tool that can predict how contamination will migrate over time. Both Kentucky and EPA reviewed and provided comments to be considered in the next groundwater model revision effort. The model will continue to be evaluated and updated periodically.

AIP Oversight Activities

During 2017 AIP staff observed portions of the PGDP reservation on a weekly basis. Locations within the security fence that were routinely observed included areas adjacent to the process buildings (C-310, C-331, C-333, C-335, C-337), the C-400 Maintenance Facility and groundwater treatment unit, the C-600 Steam plant and natural gas boilers, former scrap metal yards, cylinder yards, process and sanitary wastewater treatment facilities, the C-404 Landfill, and classified burial grounds. Those areas beyond the security fence that were observed weekly included wastewater lagoons, the Northeast and Northwest plume pump-and-treat units, the C-613 Sedimentation Basin, the closed K-Landfill, the water treatment plant and lagoons, and plant outfalls (001, 015, 008, 016, 006, 009, 017, 013, 012, 011, 010, 002). No significant issues requiring DOE's attention were noted during any oversight activity in 2017. The following is a short list of oversight activities that were completed in 2017:

- Approximately 6,875 nickel ingots are stored on-site near the C-746-A Warehouse. About 50 of the ingots contain trace amounts of asbestos. These nickel ingots were observed two times in 2017 to ensure that they are completely covered with the required tarps.

- The C-746-U Landfill was visited on a weekly basis during the year. The specific areas of the landfill that were observed included the landfill working face, the leachate collection building, the sedimentation basin, Outfalls 019 and 020, and the closed S & T Landfill. In addition, Outfall 020 was sampled 17 times this year for CHFS.

- A total of 1,438 monitoring well evaluations were completed. The components assessed included the well padlock, outer casing condition, protective bollards and the concrete pad and overall accessibility.

Sediment Basin Sampling

The C-613 Northwest Storm Water Control Facility (a.k.a. the C-613 Sediment Basin) was constructed as part of the first phase of the scrap metal removal project. The sediment basin began operation in March 2003, has a capacity of 4.5 million gallons and was designed to collect surface water runoff from the 27-acre former scrap yard area. The sediment basin collects storm water runoff and allows the associated sediment a period of time to settle, after which the storm water is discharged through the Kentucky Pollutant Discharge Elimination System (KPDES) Outfall 001 into Bayou Creek (see Figure 8). The Outfall 001 regulatory discharge limits are defined in the Division of Water (DOW) Permit as: Total Suspended Solids (TSS) will not exceed 30 mg/L averaged over a 30-day period, and shall not exceed a pH range of six to nine standard units.

Since sediment basin sampling began in 2003, the sampling regimen has been significantly modified twice. Frequent, non-periodic samples were collected from 2003 to 2007. These sample results identified specific contaminants of concern, provided baseline analyte concentrations and allowed for the determination of trends. After sufficient information was collected, a quarterly sampling regimen was established at the beginning of 2008. This quarterly regimen was performed from 2008 to 2011. Due to the stabilization of reported analyte concentrations as well as budgetary constraints, the sampling regimen was again modified at the beginning of 2012 when the frequency of sample collection was reduced from quarterly to semi-annually. The semi-annual sampling regimen continued through 2017 and includes one non-discharge sampling event per year to continue assessment of possible changes in contaminant concentrations that sediment basin releases may have on West Kentucky Wildlife Management Area (WKWMA) receptors.

The semi-annual sampling regimen for 2017 is as follows:

First Semi-Annual Sampling Event:

Locations: Sediment Basin Inlet, KPDES Outfall 001 and Iron Bridge

Purpose: The first semi-annual event collects samples from the basin inlet (Sediment Basin), outlet (Outfall 001) and at a point (Iron Bridge) where WKWMA recreators can be exposed to Bayou Creek water. Samples are always collected during a sediment basin discharge event.

Second Semi-Annual Sampling Event:

Part 1) Locations: Sediment Basin Inlet, KPDES Outfall 001 and Iron Bridge

Purpose: The second semi-annual event collects samples from the basin inlet (Sediment Basin), outlet (Outfall 001) and at a point (Iron Bridge) where WKWMA recreators can be exposed to Bayou Creek water. Samples are always collected during a sediment basin discharge event.

Part 2) Locations: KPDES Outfall 001 and Iron Bridge (Annual)

Purpose: This annual sample is collected to determine analyte concentrations when there is not an active discharge from the Sediment Basin. This is referred to as a non-discharge event sample. This sample is collected during the second semi-annual event as it has historically been a period of both steady rainfall and stream flow. This sampling event was designed to be representative of the stream conditions for the vast majority of the year. This condition is also considered to be the most likely condition in which an average WKWMA recreator would encounter and potentially be exposed to the water and/or sediments in Bayou Creek.

Each sample is analyzed for the following analytes: Total Suspended Solids (TSS), Metals, including Uranium and Mercury, Gross Alpha and Beta activity, Isotopic Uranium (U-234, U-235 and U-238)

Results: TSS and pH

During the 2017 reporting period, neither the total suspended solids (TSS) concentrations nor the pH limits exceeded DOW KPDES Outfall 001 permit requirements. Flocculent, a material used to enhance particulate precipitation causing suspended solids to settle out of the water column, was not reported as being used during 2017. Since completion of the scrap metal removal project, the facility continues to cultivate and maintain a well-developed vegetative grass cover. It has been observed that there is a greater absorption of rainfall into the soil due to the vegetative cover and an overall increase in soil stability. This effect continues to result in lower sediment basin

turbidity measurements and TSS sample results. Based on a comparison of these sample results and the Outfall 001 discharge requirements, AIP concludes that the sediment basin continues to perform its primary design function, which is to comply with KPDES discharge limits.

Results: Uranium Metal, Uranium radionuclides and alpha and beta

The following is a summary of the 2017 analytical results for the C-613 Sediment Basin. For comparison, EPA and KDEP criteria for radionuclides that apply to domestic water supply use are used to develop the KPDES permit limitations on PGDP. The value for Uranium is 30 ug/L. Gross alpha, including Ra-226, but excluding uranium and radon, is 15 pCi/L. Gross beta is 50 pCi/L. Isotopes of uranium are not regulated.

2017 First Semi-Annual Sampling Event:

Results from the Discharge Event Samples Collected on June 14, 2017:

Analyte	**Basin Inlet**	MDL / MDC	Total Uncertainty (2σ +/-)	**Basin Outlet (Outfall 001)**	MDL / MDC	Total Uncertainty (2σ +/-)	**Iron Bridge**	MDL / MDC	Total Uncertainty (2σ +/-)
Uranium Metal (µg/L)	140.0	0.4	N/A	88.0	0.4	N/A	47.0	0.4	N/A
Gross Alpha (pCi/L)	56.0	1.07	7.28	30.1	0.84	4.24	18.1	1.12	2.92
Gross Beta (pCi/L)	55.4	1.79	6.19	39.8	1.73	4.66	21.3	1.51	2.80
U-234 (pCi/L)	25.9	0.11	2.69	17.7	0.11	1.99	8.83	0.07	1.17
U-235 (pCi/L)	1.99	0.09	0.52	1.5	0.09	0.44	0.50	0.09	0.24
U-238 (pCi/L)	44.6	0.11	4.29	30.4	0.11	3.08	15.5	0.11	1.78

2017 Second Semi-Annual Sampling Event:

Part 1: Results from the Non-Discharge Event Samples Collected on November 22, 2017:

The non-discharge sample was collected when the Sediment Basin was not being actively discharged. Samples were collected at KPDES Outfall 001 (Outlet) and at the "Iron Bridge" sample point, which is considered to be representative of potential contaminant exposure to an average WKWMA recreator.

Analyte	Basin Outlt (Outfall 001)	MDL / MDC	Total Uncertainty (2σ +/-)	Iron Bridge	MDL / MDC	Total Uncertainty (2σ +/-)
Uranium Metal (µg/L)	2.7	0.4	N/A	1.7	0.4	N/A
Gross Alpha (pCi/L)	0.69	0.86	0.58	0.42	0.81	0.50
Gross Beta (pCi/L)	1.64	0.91	0.68	3.06	0.81	0.79
U-234 (pCi/L)	0.36	0.06	0.18	0.49	0.16	0.21
U-235 (pCi/L)	0.01	0.14	0.01	0.00	0.08	0.01
U-238 (pCi/L)	0.87	0.06	0.28	0.64	0.09	0.24

Part 2: Results from the Discharge Event Samples Collected on November 28, 2017:

Analyte	Basin Inlet	MDL / MDC	Total Uncertainty (2σ +/-)	Basin Outlet (Outfall 001)	MDL / MDC	Total Uncertainty (2σ +/-)	Iron Bridge	MDL / MDC	Total Uncertainty (2σ +/-)
Uranium Metal (µg/L)	190.0	0.40	N/A	140.0	0.4	N/A	52.0	0.4	N/A
Gross Alpha (pCi/L)	25.3	0.88	3.77	18.8	0.83	2.92	7.12	0.74	1.49
Gross Beta (pCi/L)	86.8	1.89	9.32	61.3	1.63	6.75	22.0	1.20	2.82
U-234 (pCi/L)	34.8	0.21	3.57	24.6	0.14	2.62	9.39	0.10	1.22
U-235 (pCi/L)	2.0	0.17	0.58	1.54	0.10	0.47	0.68	0.13	0.28
U-238 (pCi/L)	61.4	0.21	5.83	45.5	0.14	4.41	17.2	0.12	1.91

Sediment Basin sampling has been performed regularly since the Sediment Basin became operational. The following data was compiled from 2003 to 2017 showing average uranium concentrations (averaged from all results available for a given year) as well as the annual discharge through the Sediment Basin (in gallons). The average yearly rainfall in the Paducah, Kentucky area is 49.1 inches (based on 2018 U.S. Climate Data version 2.3). Average Uranium metal (total) concentrations, Sediment Basin discharge volume, annual rainfall and percentage of annual rainfall for each year from 2003 through 2017 are as follows:

2003: Inlet: 346.0 µg/L Outlet: 156.0 µg/L

Annual Discharge: Data Not Collected Rainfall: 47.84 inches (97% of Average)

2004: Inlet: 371.0 µg/L Outlet: 206.0 µg/L

Annual Discharge: Partial Year Only Rainfall: 40.66 inches (82% of Average)

2005: Inlet: 458.0 µg/L Outlet: 193.0 µg/L

Annual Discharge: 57,800,000 Gallons Rainfall: 37.45 inches (76% of Average)

2006: Inlet: 454.0 µg/L Outlet: 244.0 µg/L

Annual Discharge: 101,100,000 Gallons Rainfall: 67.11 inches (136% of Average)

2007: Inlet: 276.0 µg/L Outlet: 36.0 µg/L

Annual Discharge: 34,000,000 Gallons Rainfall: 43.33 inches (88% of Average)

2008: Inlet: 338.0 µg/L Outlet: 110.0 µg/L

Annual Discharge: 51,000,000 Gallons Rainfall: 53.69 inches (109% of Average)

2009: Inlet: 439.0 µg/L Outlet: 46.0 µg/L

Annual Discharge: 45,000,000 Gallons Rainfall: 55.60 inches (113% of Average)

2010: Inlet: 176.7 µg/L Outlet: 93.3 µg/L

Annual Discharge: 32,550,000 Gallons Rainfall: 36.67 inches (74% of Average)

2011: Inlet: 188.0 µg/L Outlet: 75.7 µg/L

Annual Discharge: 51,012,000 Gallons Rainfall: 74.85 inches (152% of Average)

2012: Inlet: 196.0 µg/L Outlet: 31.3 µg/L

Annual Discharge: 2,820,000 Gallons Rainfall: 30.06 inches (61% of Average)

2013: Inlet: 78.5 µg/L Outlet: 57.5 µg/L

Annual Discharge: 24,439,000 gallons Rainfall: 60.3 inches (122% of Average)

2014: Inlet: 93.0 µg/L Outlet: 100.0 µg/L

Annual Discharge: 30,663,000 gallons Rainfall: 46.84 inches (95% of Average)

2015: Inlet: 167.0 µg/L Outlet: 71.3 µg/L

Annual Discharge: 42,399,000 gallons Rainfall: 51.77 inches (105% of Average)

2016: Inlet: 218.0 µg/L Outlet: 111.0 µg/L

Annual Discharge: 37,760,800 gallons Rainfall: 49.24 inches (100% of Average)

2017: Inlet: 165.0 µg/L Outlet: 114.0 µg/L

Annual Discharge: 31,345,800 gallons Rainfall: 46.33 inches (94% of Average)

Observations:

The data reports that the concentration of uranium metal has historically decreased by roughly two-thirds between the basin inlet and Outfall 001. The average reduction in the concentrations of uranium for 2017 was approximately one-third. The decrease in radionuclide activity has historically reported reductions of two-thirds to three-fourths between the inlet and Outfall 001. The average reduction in radionuclide readings for 2017 was approximately one-third, which is less than historical reductions. From 2003 to 2008, the average inlet concentration, when active scrap metal removal was being performed, was 374.0 µg/L. From 2009 to 2013, concentrations of metals and radionuclides at Outfall 001 generally trended downwards. Since 2014, uranium concentrations ceased trending downwards and have remained relatively stable, with the 2014 to 2017 analytical results averaging 99.0 µg/L.

The average outlet concentration for 2017 was 114.0 µg/L, which was slightly higher than 2016 (111.0 µg/L). The concentration of uranium during the second semi-annual sampling event at the Iron Bridge (52.0 µg/L) was the third-highest ever recorded (the fourth quarter of 2008 had the highest at 125.0 µg/L). The highest reported average inlet concentration was 458.0 µg/L in 2005 and the lowest was 31.3 µg/L in 2012. The highest reported average outlet (Outfall 001) concentration was 244.0 µg/L in 2006, which was at the end of the scrap metal removal project

and before the growth of a vegetative cover. The lowest concentration, 31.3 µg/L, occurred in 2012, the driest period out of the fifteen years of data collection.

Conclusions:

The concentration of uranium reported during the November 22, 2017 non-discharge sampling event was 1.7 µg/L. This was thirty times less than the concentration (52.0 µg/L) reported in the sample collected at the same location six days later during the November 28, 2017 discharge sampling event. This analytical data shows that uranium metal continues to be released during discharge events, which warrants continued oversight and management of on-site storm water.

Based on data analysis and field observations, Kentucky concludes that former Scrap Yard storm water runoff, as well as runoff from D&D and remedial activities, contributes to the off-site migration of metals and radionuclides. The Sediment Basin continues to serve its function by reducing the off-site migration of concentrations of metals, turbidity and radionuclides. Therefore, Kentucky believes that the C-613 Sediment Basin is performing its prime function and should continue operation.

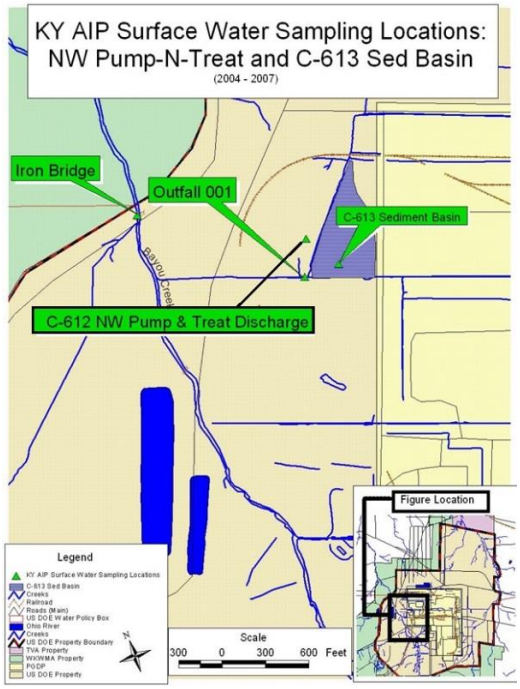


Figure 7. AIP Surface Water Sampling Locations: NW Pump and Treat and C-613 Sed Basin

Radiation Health Branch AIP Sampling

The Radiation Health Branch (RHB) has a robust environmental monitoring program, funded by the AIP grant, designed to ensure that there is no danger to public health from PGDP's radionuclide releases to groundwater, surface water, or air. In 2016, RHB collected 1,644 samples and performed 1,140 analyses on those samples. In addition, RHB conducted 419 analyses on 138 samples collected by EEC AIP.

Groundwater

RHB monitors residential groundwater quality (specifically for radionuclides) by collecting quarterly samples at 10 wells surrounding the site (Figure 8). Gross alpha/beta analysis is performed on all the samples, at a minimum. Additional isotope specific analyses may be performed based on the results of the gross measurement.

The majority of the locations sampled are private drinking water wells that are potentially impacted by the TCE/Tc-99 plume travelling away from the site. These wells are no longer used for drinking water. RHB routinely evaluates the results from this activity, along with results from other activities at the site, to determine the need for additional monitoring locations or if any changes in current locations need to occur.

In 2017, there were no abnormal measurements from RHB groundwater monitoring efforts.

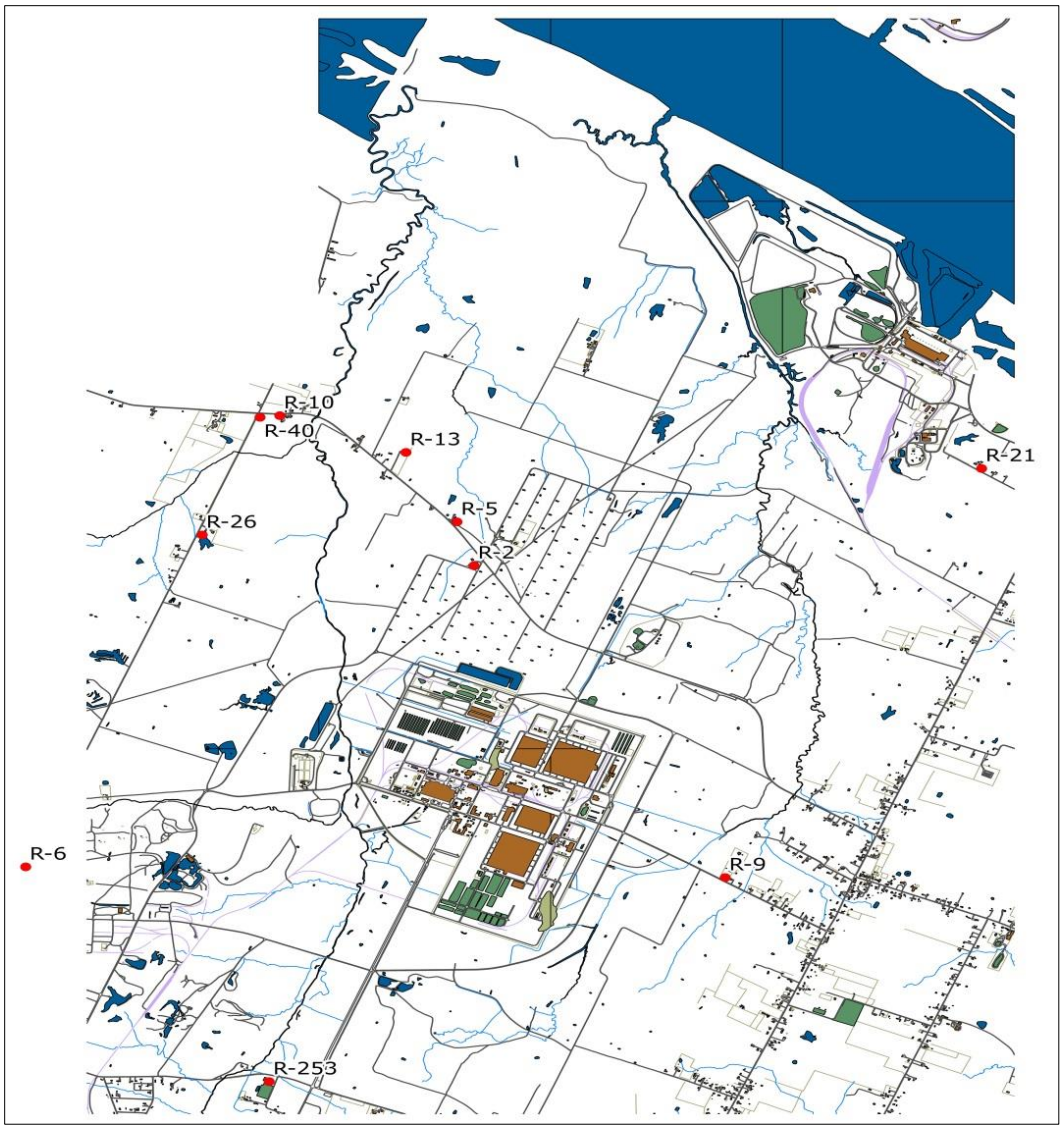


Figure 8. RHB Groundwater Monitoring Locations

Surface Water

RHB monitors surface water by taking quarterly samples at 28 locations surrounding the site (Figure 9) and through continuous sampling (e.g. ISCO) at an additional four locations (Figure 10). Gross alpha/beta analysis and isotope specific analyses are performed on the samples, with the ISCO samples being collected and composited over 21-day periods, all year long.

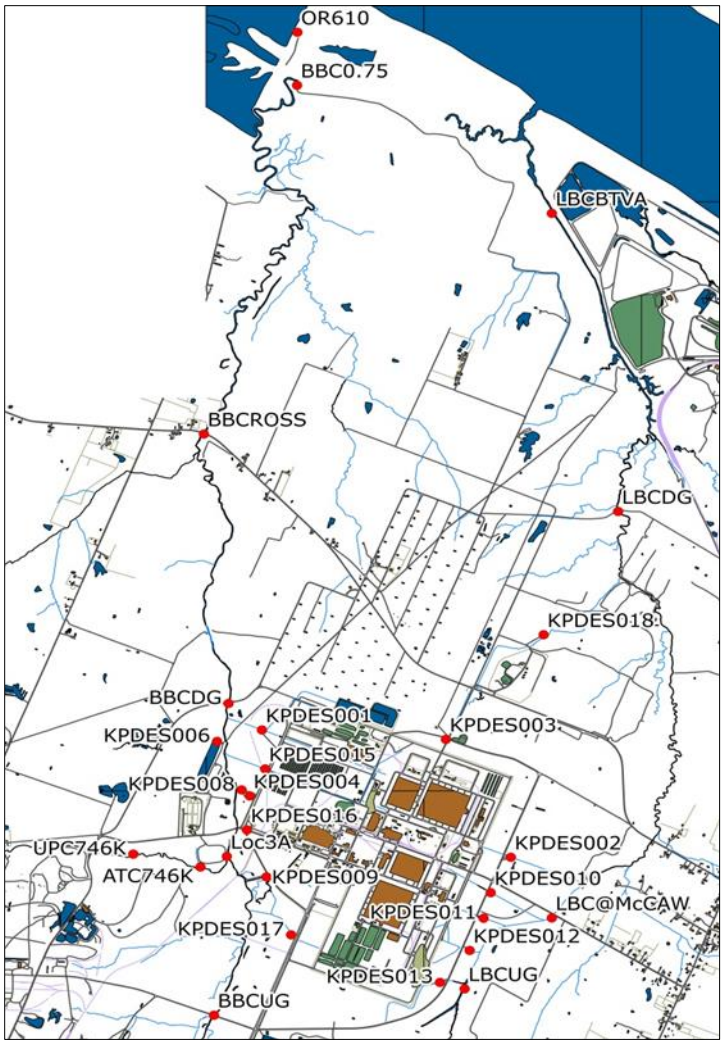


Figure 9. RHB Quarterly Surface Water Sampling Locations

The locations for surface water monitoring were selected based on outfalls from the site, locations of known runoff from contaminated areas, and historical sampling locations (see Figures 9 and 10). The background monitoring locations are located upstream in Bayou Creek (ISCO B and BBCUG), upstream in Little Bayou Creek (LBCUG), upstream of the C-746-K Landfill (UPC746K), and approximately five miles to the southeast on Massac Creek (a known unimpacted local waterway, not shown on the map).

In 2013, elevated levels of uranium were found leaving the C-746-U solid waste landfill from surface water at KPDES outfall 020. This contamination was determined to be sourced from

recently removed paneling and debris associated with the C-340 demolition that had high levels of surface contamination by a mobile uranium compound (likely uranyl fluoride (UO2F2). As a result, RHB began to periodically monitor points along the discharge path from C-746-U, beginning in August 2013. Monitoring was conducted to ensure that effluent release limits were not being exceeded. These levels have naturally decreased with time and have been well below the effluent release limits. During the 4th quarter 2015, DOE implemented treatment, including particulate filters, activated carbon, apatite media and ion exchange media on C-746-U discharges. This effort significantly lowered the levels of uranium being released to Outfall 020. Future results are expected to be comparable to background levels and monitoring will continue.

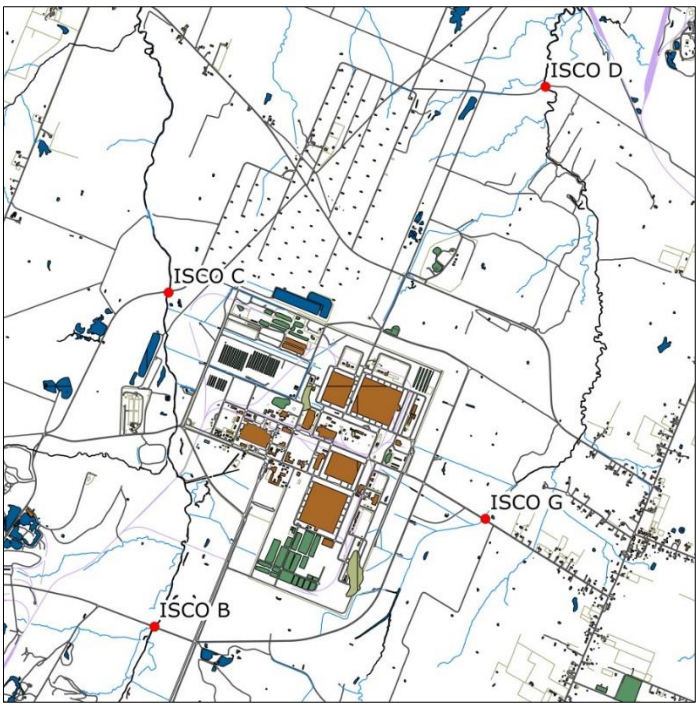


Figure 10. RHB ISCO Sampling Locations

In 2017, there were no abnormal measurements from samples collected at RHB surface water monitoring locations.

Air

RHB monitors particulates in air by taking continuous samples at 10 locations surrounding the site (Figure 11) collected throughout the year at 21-day intervals. A gross alpha/beta analysis is performed on each filter, and the filters are composited quarterly for isotope specific analyses.

The locations for air monitoring were selected based on prevailing wind direction and expected release points/types from the plant. The background air monitor is approximately three miles southeast of the plant at the Barkley Regional Airport (not shown on map) and is > 90 degrees offset from prevailing winds. RHB routinely evaluates the results from this activity, along with results from other activities at the site, to determine the need for additional monitoring locations or if any changes in current locations need to occur.

In January of 2012, due to reductions in the federal budget, the frequency of filter collection was reduced from weekly to once every 21 days. The potential consequences of this reduction are an increased probability of overloading the filters in drier months due to increased dust and greater sampled volume, and a 200 percent increase in potential response time following a release. Both have yet to be an issue.

In 2017, there were no observed abnormal measurements from RHB air monitoring efforts.

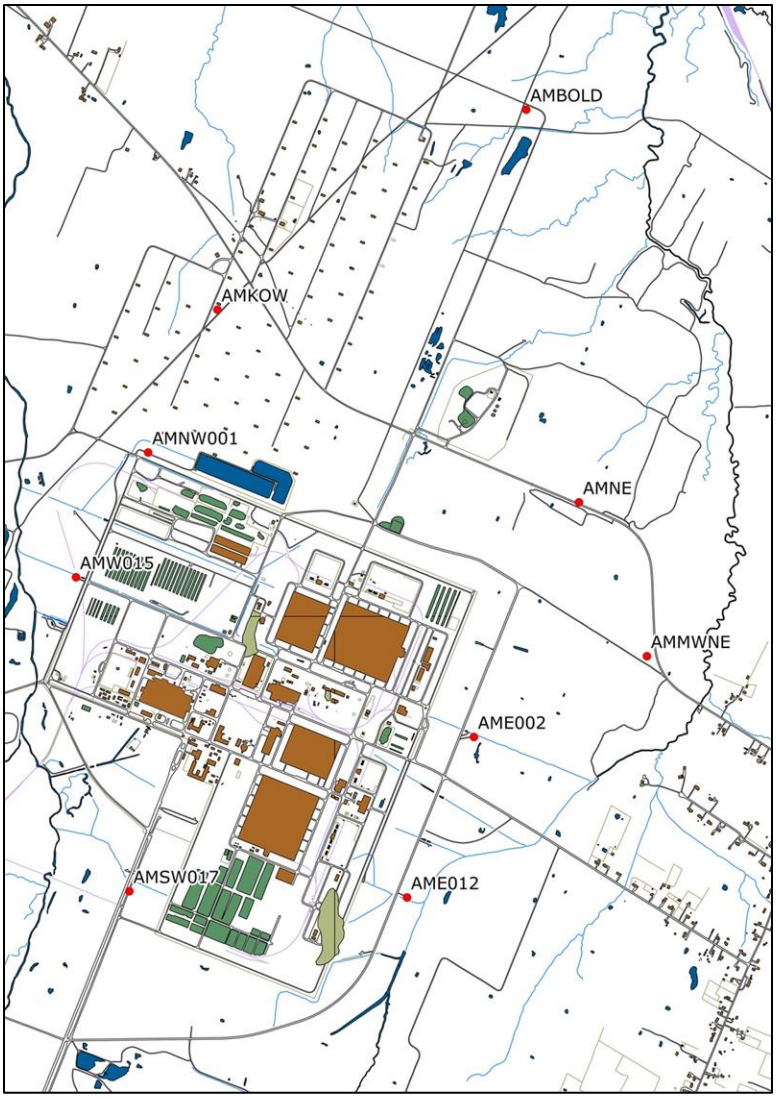


Figure 11. RHB Air Monitoring Locations

Kentucky FFA Program Elements for 2017

Surface Water Operable Unit

The SWOU is comprised of thirty-one (31) Solid Waste Management Units (SWMUs), including on-site and off-site ditches and the creeks themselves, which have likely contributed contamination to the creeks that receive surface water runoff from the PGDP. The three parties

plan to address the offsite portion of the SWOU after the completion of D&D, so that the possibility of recontamination is low.

Surface Water OU Documents reviewed in 2017:

No SWOU documents were reviewed in 2017.

Groundwater Operable Unit

Northeast Plume Containment System (Pump-and-Treat)

The Northeast plume containment system is operated to contain and treat the higher concentration portions of the Northeast Plume. Two groundwater extraction wells, pumping at a combined average rate of 170 gpm, send water to two air strippers, which treat the water to less than the effluent concentration goal of 30 ppb trichloroethene. Once it is treated, the water is discharged to a CERCLA outfall that flows to Little Bayou Creek.

In 2017 the Northeast Plume system pumped 89,107,743 gallons of water from extraction wells 331, 332, 234, and 235 which resulted in the removal of 8.3 gallons of TCE. Since Northeast Plume pumping operations began on Feb. 28, 1997, approximately 318 gallons of TCE have been removed from 1,743,066,892 gallons of extracted groundwater. An operational chart of the Northeast Plume breaks down the operational efficiency and gallons of water treated during each month in 2017 (Table 2).

The Northeast plume optimization project continued in 2017 with the installation of the two closer extraction wells, the remaining monitoring well network and supporting infrastructure. The system started up on Oct. 10. The seven sentinel wells, located approximately 400 feet east of C-400, were monitored quarterly for TCE and Tc-99. These wells provide baseline concentrations and an early warning in the event that Tc-99 is pulled east (away) from the C-400 area by the two new extraction wells. They act as an early warning system that will allow the FFA parties time to develop a solution before Tc-99 or TCE could migrate eastward from the C-400 building towards the two new extraction wells.

Month	% Operational	Gallons	Month	% Operational	Gallons
January	99.5	8,144,457	July	73.3	6,286,700
February	100	7,791,500	August	56.7	4,493,800
March	98.8	8,484,925	September	5	517,100
April	100	8,327,825	October	68.7	8,067,471
May	100	8,313,950	November	99.1	9,231,105
June	88.9	7,124,100	December	100	12,324,810

Table 4. Northeast Plume Containment System Data

Northeast Plume Optimization Documents Reviewed In 2017:

Operation and Maintenance Plan for the Northeast Plume Containment system Interim Remedial Action, *DOE/OR/07-1535&D3/R5.* Kentucky and EPA provided comments on July 20 and July 24, 2017, respectively.

Operation and Maintenance Plan for the Northeast Plume Containment system Interim Remedial Action, *DOE/OR/07-1535&D3/R6.* Kentucky and EPA approved on Sept. 15, 2017

Northwest Plume Groundwater System

The northwest plume groundwater system consists of two extraction wells and the C-612 water treatment facility, which are both located at the plant's northwest corner. The pump-and-treat system was optimized in 2010. The optimized system is performing as designed. A major refurbishing and upgrade of the system was completed in 2015 and early 2016. In 2017 the northwest plume system pumped 102,008,378 gallons of water from the two extraction wells which resulted in the removal of 140.5 gallons of TCE. Since northwest plume pumping operations began on Aug. 28, 1995, approximately 3,564 gallons of TCE have been removed

from 1,743,066,892 gallons of extracted groundwater. An operational chart of the northwest plume breaks down the operational efficiency and gallons of water treated during each month in 2017 (Table 3).

Month	% Operational	Gallons	Month	% Operational	Gallons
January	100	8,753,836	July	100	8,883,503
February	98.5	7,783,600	August	99.9	8,824,630
March	99.9	8,755,973	September	99.1	8,446,740
April	99.9	8,475,873	October	99.9	8,775,450
May	100	8,840,975	November	100	8,445,170
June	99.6	8,552,388	December	89.1	7,490,242

Table 5. Northwest Plume Groundwater System Data

Northwest Plume Groundwater System Documents Reviewed In 2017:

No documents were submitted for review in 2017.

Southwest Plume Sources

SWMU 1 C-747-C Oil Landfarm

A deep soil mixing remedial action using a large (8-ft) diameter auger, followed by steam with vapor extraction/treatment and zero-valent iron injection was completed in 2015 at the SWMU 1 oil landfarm. The purpose of the project was to remove organic solvents (primarily TCE) from 258 soil columns to a depth of approximately 60 feet bgs. The remedial action recovered 24 +/- 12 gallons of VOCs during operation. Passive treatment using zero valent iron (ZVI) is on-going. Semi-annual sampling of SWMU 1 monitoring wells was performed to monitor the continuing effects of the ZVI. Monitoring wells MW 161, MW 543, MW 546 and MW 547 show decreasing

levels of TCE. MW 542 and MW 545 show little change in TCE levels. MW544 showed increasing levels of TCE that have since declined somewhat.

SWMU 211-A & 211-B (C-720 sites)

An investigation of RGA groundwater conducted in 2015 found TCE concentrations at 211-A in the upper RGA, indicating an upgradient UCRS source that possibly originates under the C-720 building or from 211-B. The investigation concluded that for SWMU 211-A the conceptual site model (CSM) is valid. DOE recommended implementing bioremediation and long term monitoring at 211-A. For 211-B the CSM was found to be invalid because of analytical results indicating the presence of DNAPL in the upper RGA. The Southwest Plumes Sources ROD only addresses VOCs in UCRS soils and shallow groundwater. The active remediation (enhanced bioremediation) proposed in the current ROD, would not be effective against DNAPL in the RGA. EPA and Kentucky have requested tri-party discussions to determine the paths forward for these SWMUs.

Southwest Plume Sources Documents Reviewed in 2017:

Remedial Action Completion Report for In Situ Source Treatment by Deep Soil Mixing of the Southwest Groundwater Plume Volatile Organic Source at the C-747-C Oil Landfarm (SWMU 1) (*DOE/LX/07-2405&D2)* EPA and Kentucky concurred on Feb. 14 and Feb.15, 2017, respectively.

Groundwater Remedial Action – C-400 Building

The C-400 Building was constructed early in the PGDP's history and one of its primary missions was to serve as a parts cleaning facility. Soil and groundwater near the building are contaminated with trichloroethene (TCE), a solvent that for years was used to remove oil and grease from metal parts. The physical properties of this contaminant (e.g., it is denser than water) cause it to migrate downward and dissolve slowly over time, making it difficult to remove or treat once it enters the subsurface.

Since 2003, electrical resistance heating (ERH) has been used to remediate subsurface TCE contamination at C-400 to a depth of approximately 60 feet. ERH relies upon electrical current

and vapor extraction wells to heat and then remove volatile contaminants such as TCE from the subsurface. ERH removed approximately 3000 gallons of TCE from the subsurface near C-400.

A treatability study of steam enhanced extraction (SEE) was developed to determine if steam will advance through the RGA enough to effectively and economically remove TCE within the lower RGA. The results of the study support steam injection as a technically implementable technology to achieve in-situ TCE contamination source removal.

Phase IIb

In an Aug. 8, 2017 Memorandum of Agreement, the FFA senior managers agreed to reprioritize the work at PGDP for the C-400 complex, including integrating the C-400 Phase IIb Interim Action into the final remediation of the C-400 complex. The senior managers also agreed to a path forward concerning the submittal of the D1 Proposed Plan for the Phase IIb Interim Action. This was documented in the Sept. 28, 2017 official transmittal of the Memorandum of Agreement for Resolution of Formal Dispute Regarding the Non-concurrence by EPA and KDEP on the DOE Milestone Modification Request for Submittal of the Revised Proposed Plan for VOC contamination at C-400.

C-400 IRA Documents Reviewed In 2017:

No C-400 IRA documents were reviewed in 2017.

Burial Grounds Operable Unit

The historic generation of various types of waste materials at the PGDP led to on-site subsurface disposal in areas referred to as Burial Grounds. The Burial Grounds Operable Unit is comprised of 10 such areas that are designated by their respective SWMU numbers: SWMU 2, the C-749 Uranium Burial Ground; SWMU 3, the C-404 Low-Level Radioactive Waste Burial Grounds; SWMU 4, the C-747 Contaminated Burial Yard and C-748-B Burial Area; SWMU 5, the C-746-F Burial Yard; SWMU 6, the C747-B Burial Grounds; SWMU 7, the C-747-A Burial Grounds and Burn Area; SWMU 9, the C-746-S Landfill; SWMU 10, the C-746-T Landfill; SWMU 30, the C-747-A Burial Grounds and Burn Area and SWMU 145, the P Landfill.

SWMUs 5 and 6 are grouped together in a separate FS. SWMUs 2, 3, 7 and 30 are grouped together in an FS. SWMU 4 is following a separate path as it undergoes further sampling and investigation. SWMUs 9, 10 and 145 are deferred until 2026 under the current (FY2015) SMP.

SWMUs 5 and 6

On January 25, 2016, the formal dispute on the *Proposed Plan for SWMUs 5 and 6* was resolved. The D1R1 Proposed Plan for SWMUs 5 and 6 was approved in February and March, 2016 and the public notice for the Proposed Plan was issued in March. The Record of Decision was included in the revised prioritization of site activities and was not issued in 2017.

SWMUs 2, 3, 7 and 30

The Dispute Resolution Committee (DRC) formal dispute on the *D2 Feasibility Study for SWMUs 2, 3, 7 and 30 of the Burial Grounds OU* was resolved with the signing of a Memorandum of Agreement (MOA) on May 16. The document was revised and reissued on July 14. Kentucky and EPA approved the document on Aug. 4 and Aug. 9, 2017, respectively.

SWMU 4

SWMU 4 was investigated using a phased approach to sample collection, with each subsequent phase informed by the preceding one. Test pit excavation and related sampling and analysis began in January and were completed in March 2016. This was followed by data collection efforts for engineering and design which is the final phase of field work at SWMU 4. The *Addendum to the Remedial Investigation Report for BGOU SWMU 4, D2/R1/A1/R2* was revised and submitted to Kentucky and EPA on April 12, 2017. Kentucky and EPA approved the document on April 26, 2017.

The Feasibility Study for SWMU 4 was issued on April 21. Kentucky provided comments on Aug. 18. EPA issued preliminary comments on Aug. 21 and supplemental comments on Nov. 1, 2017.

BGOU Documents Reviewed in 2017:

A Feasibility Study for SWMUs 2, 3, 7, and 30 of the BGOU (*DOE/LX/07-1274&D2R1)* Kentucky and EPA was approved on Aug. 4 and Aug. 9, 2017, respectively.

Addendum to the Remedial Investigation Report for the Burial Grounds Operable Unit Solid Waste Management Unit 4 at the PGDP, *(DOE/LX/07-0030&D2/R1/A1R2).* Kentucky and EPA approved on April 26, 2017.

Feasibility Study for SWMU 4 of the BGOU (*DOE/LX/07-2408&D1).* Kentucky commented on Aug. 18 and EPA commented on Aug.21 and Nov.1, 2017.

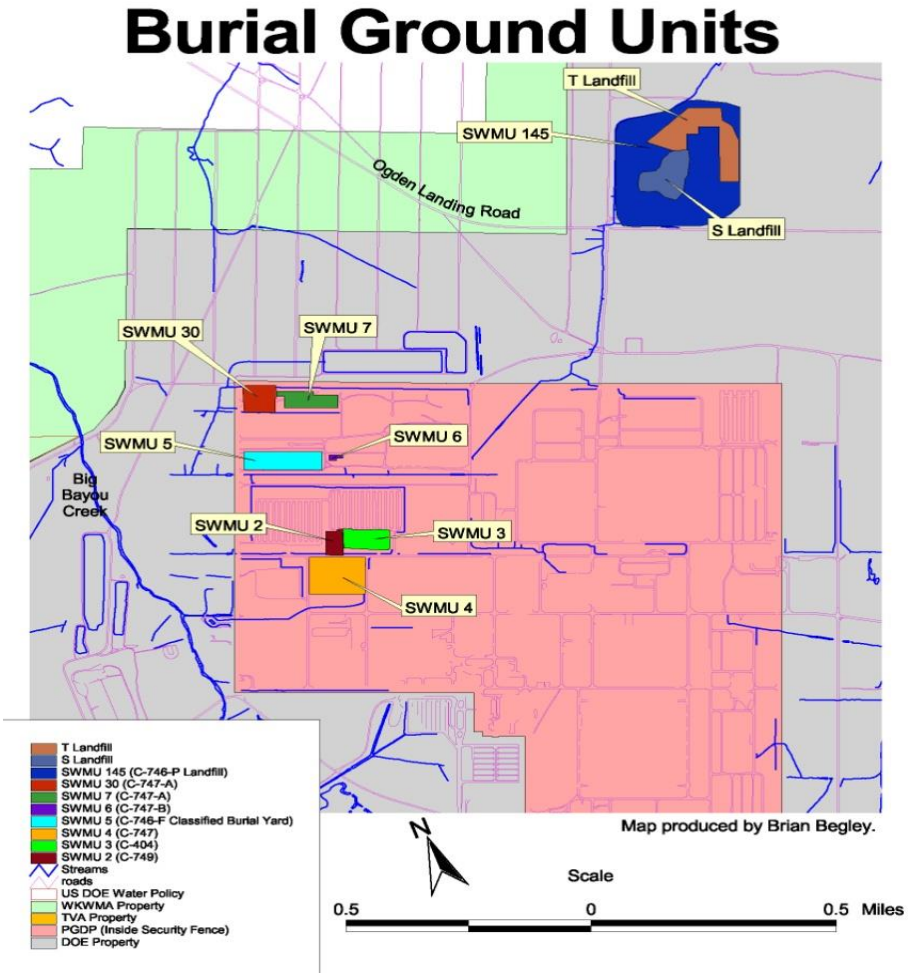


Figure 12. Burial Ground SWMUs

Soils Operable Unit

SWMU 27

SWMU 27, an underground storage tank located beside the C-720 building, was opened and the contents were removed, to the extent practicable, September 13 through 21, 2016. DOE issued the D1 Removal Action Report on Feb.8, 2017. Kentucky and EPA provided comments on May 4 and 9, 2017, respectively. DOE revised the document and issues a D2 version on June 23. EPA and Kentucky concurred with the D2 Removal Action Report on July 6, 2017.

SWMU 229

DOE completed additional RI characterization activities in 2015 at SWMU 229, a former outside DMSA in the northwest corner of the plant. Kentucky concurred with the D2 Addendum to Soils OU RI2 on Sept. 9 and EPA conditionally concurred on Nov. 17, 2016. After meetings and discussions to address EPA's conditions, DOE provided a revised Addendum on Dec. 19, 2016. Kentucky and EPA concurred with the revised document on Jan. 18 and 31, 2017, respectively.

SWMU 1

SWMU 1, the former oil land farm in the southwest corner of the plant was the subject of a deep soil mixing groundwater remedial action in 2015. In 2016, the top four feet of soil removed to prep the site for mixing operations was placed back into the treatment area. This material was sampled in accordance with the Addendum to the Work Plan for the Soils OU RI/FS, Remedial Investigation 2, Sampling and Analysis Plan. The RI Addendum for SWMU 1 was submitted to the regulators on Jan. 18, 2017. Kentucky and EPA submitted comments in May 2017. The revised RI for SWMU 1 Soils was issued on Aug. 15. Kentucky conditionally concurred on Sept. 6 and EPA conditionally concurred on Oct. 16. DOE revised the document and EPA and Kentucky concurred on Oct. 26 and 23, respectively.

Soils Operable Unit Documents Reviewed in 2017:

Removal Action Report for SWMU 27 (*DOE/LX/07-2411&D1*) Kentucky and EPA commented on May 4 and 9, 2017

Removal Action Report for SWMU 27 (*DOE/LX/07-2411&D2*) Kentucky and EPA concurred on July 6, 2017

Addendum to the Soils OU Remedial Investigation 2 Report for SWMU 229, (*DOE/LX/07-2306&D2/A1/R2)* Kentucky and EPA concurred on Jan.18 and 31, 2017, respectively.

Addendum to the Soils OU Remedial Investigation Report for SWMU 1 (*DOE/LX/07-0358&D2/R1/A2)* Kentucky and EPA commented on May 9 and 17, respectively.

Addendum to the Soils OU Remedial Investigation Report for SWMU 1 (*DOE/LX/07-0358&D2/R1/A2R1)* Kentucky and EPA conditionally concurred on Sept. 6 and Oct. 16, respectively.

Addendum to the Soils OU Remedial Investigation Report for SWMU 1 (*DOE/LX/07-0358&D2/R1/A2R2)* Kentucky and EPA concurred on Oct. 23 and Oct. 26, respectively.

Decontamination and Decommissioning Operable Unit

The Pre-GDP Decontamination and Decommissioning (D&D) Operable Unit has addressed 32 inactive facilities at the Paducah site, some of which have been out of service for decades. The C-410/420 Complex was the last of the inactive facilities to be addressed under this Operable Unit. The scope of the pre-GDP shutdown D&D OU has been completed.

C-410/420 Complex Infrastructure D&D

The Removal Action Report for the C-410 Complex Infrastructure D&D Project was issued by DOE on April 11, 2016. Kentucky and EPA approved the document on June 3 and June 9, respectively. DOE also issued the D&D OU completion notification letter on April 11, stating that the scope of the pre-GDP shutdown D&D OU scope was complete. Errata pages for the Removal Action Report for the C-410 D&D Project were submitted on Jan. 10, 2017. Kentucky acknowledged receipt of the pages on Jan. 18. A final copy of the Removal Action Report for C410 was issued on March 22, 2017. EPA acknowledged incorporation of errata pages into the final document on March 28, 2017.

D&D Documents Reviewed in 2017:

Errata Pages for Removal Action Report for the C-410 Complex Infrastructure Decontamination and Decommissioning Project at the PGDP, *(DOE/LX/07-2182&D1)* Kentucky acknowledged on Jan. 18 and EPA acknowledged on Mar. 28, 2017.

Waste Management

Waste Disposition Alternatives (WDA) Project

During the next several decades large quantities of waste will be generated at the Paducah site. Much of this waste will be in the form of concrete, structural steel and decommissioned equipment that will require disposal following decontamination and decommissioning of large process buildings. Lesser volumes of waste will be created as contaminated soils and burial grounds are remediated. As much as 4.6 million cubic yards of waste are projected to be generated at the Paducah site during the remaining course of site cleanup. The question as to where all of this waste will eventually be disposed is the subject of a CERCLA waste disposal alternatives feasibility study.

The WDA Feasibility Study evaluates two general disposal options, on-site disposal versus off-site disposal. Since it is somewhat uncertain how much waste will actually require disposal, both the on-site and off-site alternatives are further broken down into subcategories based upon certain assumptions. The base case subcategory assumes that some of the waste generated will go to an existing on-site solid waste landfill. The high volume subcategory assumes that this landfill will not be available for use and that all waste will require disposal in a new on-site cell or disposition in an off-site landfill. An on-site repository would allow for safe disposal of non-hazardous, hazardous, TSCA, low-level radioactive and low-level radioactive mixed wastes on-site, thereby avoiding more costly off-site disposal options. However, the option to ship all or a portion of the waste off-site to a DOE owned or commercial waste facility still exists.

In May 2014, DOE initiated an informal dispute in response to certain conditions imposed by Kentucky and EPA that would need to be met prior to approval of the feasibility study. Informal

dispute resolution efforts in CY 2015 did not yield a resolution, and the dispute has been elevated to formal status, where resolution efforts continued through CY 2016 and 2017.

Waste Disposition Alternatives Documents Reviewed in 2017:

No WDA documents were reviewed in 2017.

Solid Waste Management Units (SWMUs)

During the reporting period from January 1 to December 31, 2017, Kentucky received one Revised Solid Waste Management Unit Report (SAR). No Further Action (NFA) was not granted to any SWMUs and no SARs are currently under review. There are currently no SWMUs listed in either Appendix A-4(a) (DOE Material Storage Areas for which the permittee has submitted SARs and are Under Review by the Cabinet) or in Appendix A-4(b) (SWMUs under Review by the Cabinet) in the Paducah Site Permit.

REVISED AND NEWLY-DISCOVERED SWMU ASSESSMENT REPORTS SUBMITTED TO KENTUCKY BETWEEN JANUARY 1 AND DECEMBER 31, 2017

SWMU Number	Description	OU Location	Sub-project	Status	SAR Report Date	Date(s) SAR Amended	Date of NFA or RFI
51	C-400-D Lime Precipitation Tank	C-400	N/A	NFA	8/24/1987	4/5/2017	8/8/1994

SOLID WASTE MANAGEMENT UNITS THAT KENTUCKY GRANTED NO FURTHER ACTION STATUS BETWEEN JANUARY 1 AND DECEMBER 31, 2017

SWMU Number	Description	(Former) OU Location	(Former) Sub-project	Status	SAR Report Date	Date(s) SAR Amended	Date of NFA
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

SWMU DOCUMENTS REVIEWED IN 2017

In 2017, one SAR Revision was submitted and no newly-discovered SWMUs were reported. At the end of the reporting period, no SARs were under review.