

Commonwealth of Kentucky

# Environmental Oversight Report 2018 Paducah Gaseous Diffusion Plant



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## **Environmental Oversight Report 2018 – Paducah Gaseous Diffusion Plant**

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This 2018 Environmental Oversight Report, finalized in November 2019, 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, 2018, to Dec. 31, 2018. 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.

**Acknowledgment:** This material is based upon work supported by the Department of Energy under Grant Numbers DE-EM-0002382 and DE-EM-0001946.

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**ACRONYMS**

Agreement in Principle	AIP
Below Ground Surface	bgs
Cabinet for Health and Family Services	CHFS
Citizens Advisory Board	CAB
Comprehensive Environmental Response, Compensation, and Liability Act	CERCLA
Comprehensive Site Operable Unit	CSOU
Decontamination and Decommissioning	D&D
Dense Non-Aqueous Phase Liquid	DNAPL
Department of Energy (US)	DOE
Depleted Uranium Hexafluoride	DUF <sub>6</sub>
Environmental Protection Agency (US)	EPA
Federal Facilities Agreement	FFA
Gallons Per Minute	gpm
Kentucky Department for Environmental Protection	KDEP
Kentucky Pollutant Discharge Elimination System	KPDES
Memorandum of Agreement	MOA
Monitoring Well	MW
Not Applicable	NA
Paducah Gaseous Diffusion Plant	PGDP

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Parts Per Billion	ppb
Polychlorinated Biphenyl	PCB
Radiation Health Branch	RHB
Requires Further Investigation	RFI
Record of Decision	ROD
Regional Groundwater Aquifer	RGA
Remedial Investigation/Feasibility Study	RI/FS
Resource Conservation and Recovery Act	RCRA
Site Management Plan	SMP
Solid Waste Management Unit	SWMU
Solid Waste Management Unit Assessment Report	SAR
Technetium-99	Tc-99
Total Suspended Solids	TSS
Trichloroethene	TCE
Upper Continental Recharge System	UCRS
United States Enrichment Corporation	USEC
Volatile Organic Compound	VOC
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 Corporation (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 with the implementation of various activities at the site. Four Rivers Nuclear Partnership was the deactivation and environmental remediation contractor during calendar year (CY) 2018.

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 trichloroethene (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 polychlorinated biphenyl (PCB) concentrations in fish collected from both Bayou Creek to the west of the site and Little Bayou Creek to the east of the site.

Site cleanup activities are prioritized and sequenced in the fiscal year (FY) 2018/2019 Site Management Plan (SMP). Activities will 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. Scoping activities and the Remedial Investigation/Feasibility Study (RI/FS) Work Plan (WP) for the C-400 building are scheduled to be completed in CY 2018.

At the PGDP, media-specific operable units (OU) were established by developing a site conceptual risk model for each solid waste management unit (SWMU) and Area of Concern. 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-use assumptions in the evaluation.

The OUs (based on the 2018-2019 SMP) identified for the PGDP are:

- C-400 Complex OU
- Groundwater OU
- Surface Water OU
- Soils OU
- Burial Grounds OU
- Decontamination and Decommissioning (D&D) OU (Inactive Facilities)
- Lagoons OU
- Depleted Uranium Hexafluoride (DUF<sub>6</sub>) Footprint Underlying Soils OU
- Comprehensive Site Operable Unit (CSOU)

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

## Public Engagement

### Citizens Advisory Board

The Paducah Citizens Advisory Board (CAB) is a stakeholders' board that provides advice and recommendations to DOE regarding environmental management programs at the PGDP. It is their responsibility to represent and communicate the views of their community as well as keep the public informed on key issues, upcoming decisions and board recommendations. Kentucky's Division of Waste Management (DWM) and Cabinet for Health and Family Services (CHFS) are non-voting (ex-officio) members that serve as advisors and inform the CAB on their respective agencies' policies and views. The CAB is a local board organized under the umbrella charter of

the Office of Environmental Management Site-Specific Advisory Board, whose activities are governed by the Federal Advisory Committee Act (FACA). The website for the Paducah CAB can be found at: <https://www.energy.gov/pppo/pgdp-cab/paducah-citizens-advisory-board>.

CAB meetings are held the third Thursday of every month and representatives from Kentucky were present at every meeting in 2018.

## **Oversight Newsletter**

During 2018, four newsletters titled *Oversight News* were released by the Kentucky Department for Environmental Protection (KDEP) Paducah Site Section. The newsletters are an effort to better inform the public and stakeholders about available resources and significant updates at the Paducah Site. Major features in the newsletters covered communication efforts by DOE and Kentucky’s Energy and Environment Cabinet (EEC), Radiation Health Branch (RHB) monitoring, updates on the northwest and northeast plumes, historical actions and future planning for the C-400 Complex, and an interesting feature about the National Retriever Trials held at the WKWMA surrounding the PGDP. Each newsletter also featured Paducah Site Section staff changes when applicable.

## **Kentucky’s Oversight Program**

The Commonwealth of Kentucky is responsible for overseeing the environmental cleanup of the PGDP. The 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 CHFS RHB has radiation authority for the Commonwealth of Kentucky, and 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 \(KRCEE\)](#)
- [Division of Environmental Program Support Lab](#)
- [Radiation Health Branch Radiation/Environmental Monitoring Section](#)
- [Program Planning and Administration Branch](#)

For the purposes of this report, all references to activities conducted by the Paducah Gaseous Diffusion Plant Section of the DWM will be referred to as Kentucky. References to activities by other state government agencies that are not part of the EEC (and in some cases, not part of DWM) will be specified as appropriate.

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

### **Federal Facility Agreement (FFA) / Site Management Plan (SMP)**

The FFA is a three-party agreement between DOE Portsmouth/Paducah Project Office (PPPO), EPA Region 4, and the KDEP. 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 investigation and remediation. The FFA also provides a framework for project management, investigation, dispute resolution, and remediation.

The SMP establishes the clean-up priorities and enforceable milestones for the current FY and the next two FYs. The SMP is scoped annually and becomes part of the FFA as an appendix. If the three parties to the FFA cannot agree on the current year's SMP, then the last approvable SMP remains in effect. The SMP also documents the three-party prioritization strategy for the complete remediation of the PGDP in a life-cycle baseline and life-cycle plan. The FFA parties

meet to scope revisions for the document in the months leading up to DOE's annual transmittal deadline on Nov. 15.

In early August 2017, the senior managers of DOE PPPO, EPA Region 4, and KDEP signed a Memorandum of Agreement (MOA) to reconfigure the sequence of 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 (dissolved phase) 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. In 1989 DOE established an administrative boundary called the Water Policy Box. Within this area, DOE provided free hookups to the municipal water supply. 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 will define all sources of contamination and how each contaminant is distributed vertically and laterally beneath the C-400 Complex.

In order to accomplish a comprehensive investigation of the C-400 Complex, the senior managers of the FFA 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 (ROD) to address all the sources of contamination at the C-400 Complex site is scheduled to be submitted during the fourth quarter of 2022. The ensuing field start-date for the remedial action (RA) is planned to occur during the first quarter of 2024. It is foreseeable that multiple rounds of RIs and RAs will likely occur for sequencing and to make the best use of limited cleanup dollars.

The C-400 MOA was not signed until August 2017 and at that time the senior managers agreed not to finalize a 2017 SMP, but instead to concentrate efforts toward a 2018 SMP. The draft 2018 SMP was scoped over several meetings with an independent technical facilitator to capture and guide discussions. The draft 2018 SMP was rewritten to incorporate the pre-GDP OUs with the post-GDP OUs. One of the new OUs was the C-400 Complex. The draft 2018 SMP was scoped

by all three parties without the benefit of a DOE-Headquarters approved Life Cycle Baseline (LCB). This resulted in an initial draft 2018 SMP that consisted of >90% of all out-year planning dates labelled as TBD (To Be Determined). Once DOE received permission from their own headquarters to reveal dates in their LCB, the PGDP project completion date slid from 2032 to 2065. All remaining environmental projects, except the C-400 Complex OU and the area directly north of the C-720 “Machine Shop” Building, referred to as SWMU 211A, will be moved decades into the future.

The D1 SMP resubmittal was transmitted on Jan. 16, 2018 after EPA and Kentucky determined the November 2017 SMP to be incomplete. Furthermore, DOE transmitted errata pages on Jan. 23, 2018. On Feb. 22, 2018 Kentucky issued comments and on April 16 DOE transmitted a D2 2018 SMP. The D2 version of the document did not contain any out-year enforceable milestones from the following OUs: groundwater, soil, burial grounds, and surface water. Kentucky invoked informal dispute with DOE on May 16, 2018 and DOE invoked informal dispute with EPA on June 15, 2018. Kentucky invoked formal dispute on July 30, 2018 and DOE invoked formal dispute with EPA on August 10, 2018. DOE requested that Kentucky issue a letter to align the formal dispute deadlines which occurred on August 27, 2018. Kentucky elevated the dispute it invoked to the Senior Executive Committee (SEC) level on Sept. 20, 2018 and DOE followed suit by invoking their dispute with the EPA on Sept. 24, 2018. As of the end of 2018, both disputes on the 2018 SMP were still ongoing.

### ***Site Management Plan Documents Reviewed In 2018***

*FY 2018 Annual Revision to Site Management Plan Resubmittal (2418&D1/R1).* Kentucky and EPA provided comments on Feb. 22 and March 2, 2018, respectively.

*FY 2018 Annual Revision to Site Management Plan (2418&D2).* Kentucky invoked informal dispute with DOE on May 16, 2018, formal dispute on August 27, 2018 and the dispute was elevated to the SEC on Sept. 20, 2018.

### **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 2018, the AIP wrote and distributed four issues of *Oversight News*, its newsletter detailing activities at the PGDP. The newsletter covered such topics as C-400 site investigation planning, and CHFS RHB monitoring of air and surface water. AIP also completed and distributed its 2017 Annual Report, which can be found at <https://eec.ky.gov/Environmental-Protection/Waste/hazardous-waste/Pages/paducah-gaseous-diffusion-plant.aspx>.

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 Sampling for 2018

One of the primary goals of the 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 has also worked with organizations such as the University of Kentucky in conducting scientific research apart from DOE cleanup and monitoring efforts. 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 2018, the primary AIP independent contract laboratory was TestAmerica Laboratories located in Earth City, Missouri. TestAmerica Laboratories is an accredited, independent laboratory that meets or exceeds the requirements set forth by governing EPA standards. The CHFS 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/or gross beta are exceeded, then CHFS will analyze the sample for isotopic radionuclides. AIP staff directly receives all analytical data from TestAmerica Laboratories and CHFS. The results are verified, interpreted and shared formally with the appropriate parties. DOE has developed a public website to share environmental data with the public. Analytical results collected by Kentucky AIP and DOE contractors can be searched, viewed spatially, and downloaded on [PEGASIS](#), the PPPO Environmental Geographic Analytical Spatial Information System.

### **AIP Groundwater Investigations**

#### **Groundwater Sampling**

During 2018, AIP staff collected samples from 44 different monitoring wells. The 2018 AIP monitoring wells and seep sampling locations map (Figure 1) shows all wells sampled during the 2018 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, AIP independent sampling conducted on monitoring wells and residential wells have yielded similar results to those obtained by DOE (Table 1). 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.

AIP staff also split six residential and 13 monitoring well samples with DOE in 2018. In most cases, AIP staff arranged to split groundwater 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 for field measurements and sampling methodology was being performed in compliance with EPA and DOE standard operating procedures. Of the 13 monitoring well samples split between Kentucky and DOE, most had similar TCE and Tc-99 concentrations (Table 1).

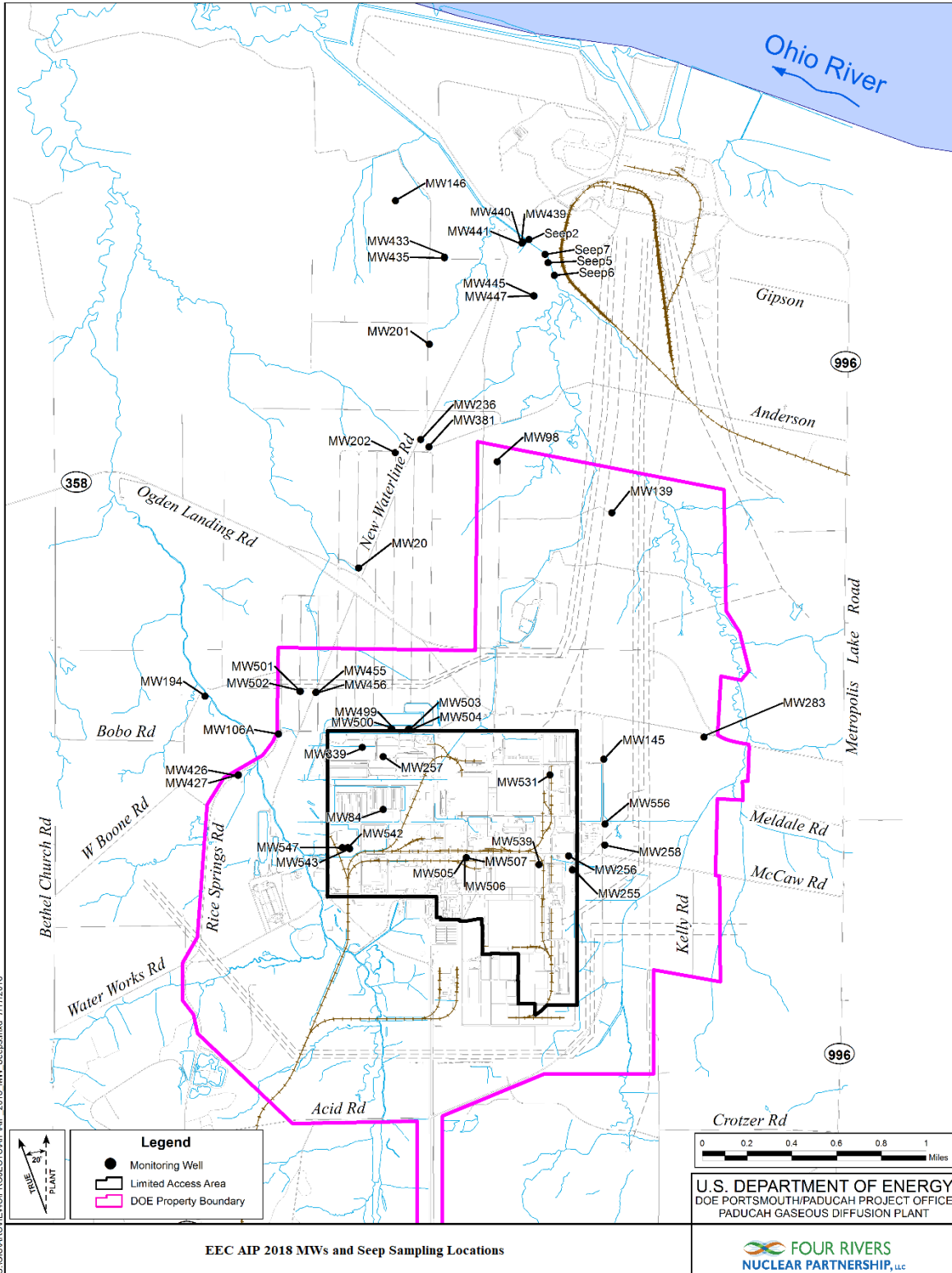


### **Seeps Sampled by Kentucky AIP**

Six unique 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 move by several feet over time and even disappear. 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 the LBC seep area for any migrating or new seeps.

AIP sampled LBC Seep #5 on August 7 and Nov. 27. The location of this seep can be seen on the 2018 AIP monitoring wells and seep sampling locations map in Figure 1. TCE concentrations here were 1.1 µg/L and 1 µg/L and Tc-99 concentrations were non-detect in the samples. Other seeps could not be identified during 2018 sampling events because the water level was elevated and the seeps were submerged or not flowing.

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EEC AIP 2018 MWs and Seep Sampling Locations

Figure 1.

**Environmental Oversight Report 2018 – Paducah Gaseous Diffusion Plant**

		AIP TCE µg/L		DOE TCE µg/L		AIP Tc-99 pCi/L		DOE Tc-99 pCi/L	
Well #	Sample Date	Value and/or Qualifier	DL	Value and/or Qualifier	DL	Value and/or Qualifier	MDA	Value and/or Qualifier	MDA
MW84	1/10/18	3,400	500	3,160 <sup>1</sup>	50	17.3 +/- 1.25	3.76	34.4 +/- 11.5 <sup>1</sup>	17.9
MW145	7/10/18	40	5	40.1	1	27.6 +/- 13.6	3.94	31.7 +/- 7.97	12.2
MW258	7/10/18	210	25	199	4	NA	NA	2.63 U +/- 7.4	12.6
MW283	7/10/18	18	1	13.9	1	NA	NA	4.58 U +/- 7.25	12.3
MW455	9/5/18	35.5	0.250	29.2	1	13.3 +/- 1.18	3.61	13.3 U +/- 10.2	17
MW456	9/5/18	23.5	0.250	22	1	13.3 +/- 1.18	3.61	24.5 +/- 10.3	16.6
MW505	5/15/18	7.9	1	10.2	1	54.9 +/- 1.48	3.85	59.7 +/- 13.5	19.9
MW506	5/15/18	15,000	1000	17,900	250	54.9 +/- 1.48	3.85	62.4 +/- 13.1	18.9
MW542	6/12/18	6.7 <sup>1</sup>	1	8.17	1	NA	NA	NS	NS
MW546	6/12/18	160	5	169	5	NA	NA	NS	NS
MW547	6/12/18	1,300	100	1,270	25	NA	NA	NS	NS
MW556	7/10/18	140	10	122	2	40.0 +/- 1.43	3.94	42.8 +/- 8.64	12.8
R2	11/13/18	4.7 <sup>1</sup>	1	6.28	1	NA	NA	NS	NS
R13	11/13/18	U	1	U	1	NA	NA	NS	NS
R14	11/13/18	U	1	U	1	NA	NA	NS	NS
R26	11/13/18	U	1	U	1	NA	NA	NS	NS
R53	11/13/18	0.67 J	1	0.55 J	1	NA	NA	NS	NS
R245	11/13/18	U	1	U	1	NA	NA	NS	NS

In Tc-99 samples, +/- represents the uncertainty in the measurement.  
 Kentucky samples were analyzed by TestAmerica of St. Louis and the Kentucky Radiation Health Branch.

<sup>1</sup>A field replicate was also analyzed. The higher of the two results is shown.

DL – Detection Limit

J – Estimated Quantitation

MDA – Minimum Detectable Activity

NA – Not applicable. Technetium-99 was not analyzed because the following criteria were not met:

Gross Alpha ≥ 5 pCi/L and Gross Beta ≥ 9 pCi/L

NS – Not sampled

U – TCE: Not detected; Tc-99: Value reported is <MDA and/or TPU.

**Table 1. Split Sampling Results between EEC AIP & DOE**

### MW66 Water Elevation and TCE Concentration

During 2018, AIP staff collected monthly water elevations at MW66 to study seasonal variations in the groundwater table. A 2012 DOE sponsored document (*Technical Evaluation of Temporal Groundwater Monitoring Variability in MW66 and Nearby Wells, Paducah Gaseous Diffusion Plant*) concluded that the spikes in TCE concentration at MW66 were likely due to variations in regional and local groundwater flow conditions. The conclusions of the 2012 DOE study recommended continued sampling of MW66.

As shown in Figure 2, water levels at MW66 rose several feet during the winter and spring months, generally February through June, with the highest elevation of 324.38 ft. above mean sea level (AMSL) recorded in June 2017. Water levels dropped throughout the summer and autumn months, sometimes into early winter, declining to the lowest elevation of 318.68 ft. AMSL in January 2018. TCE measurements done by DOE during this period ranged from 487 to

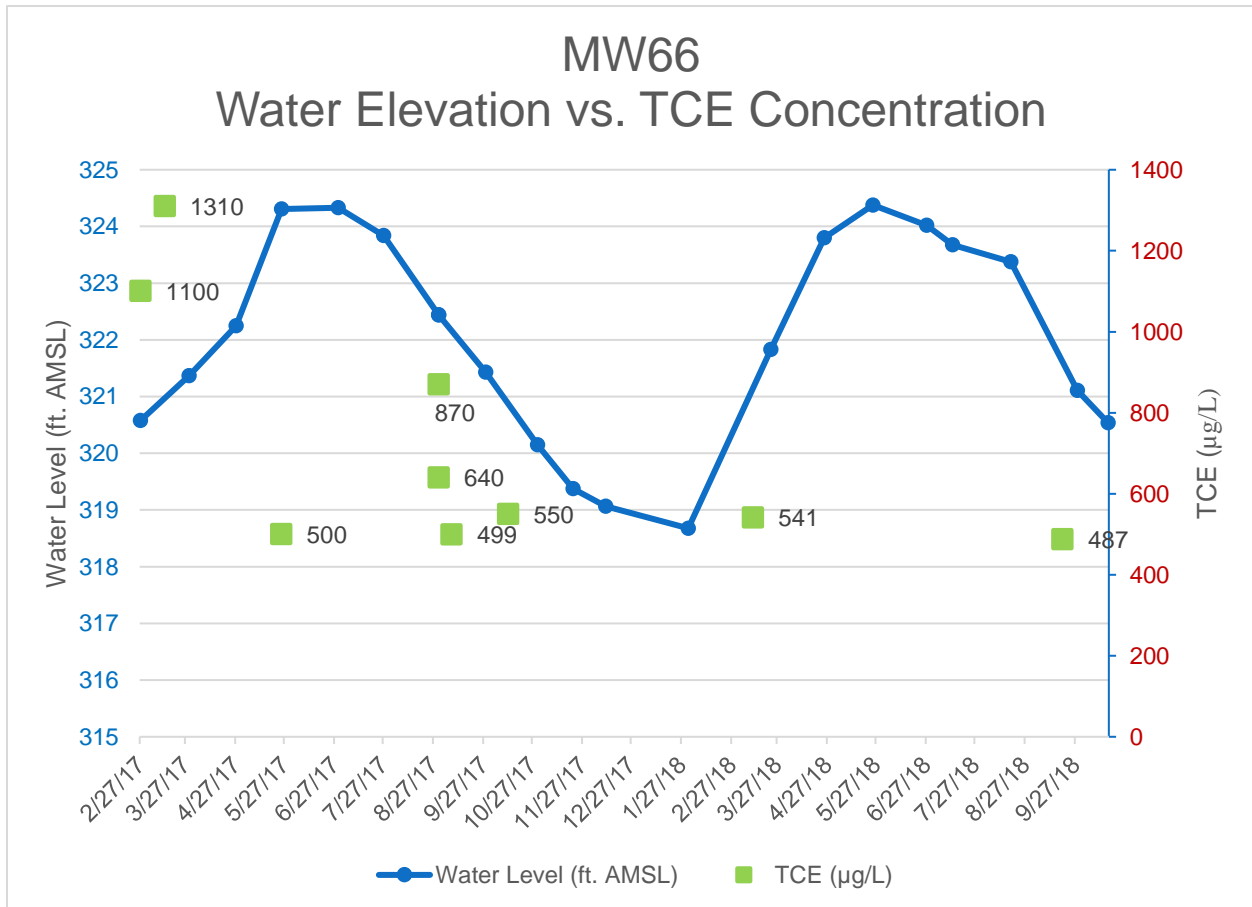


Figure 2.

1310 µg/L. An insufficient amount of TCE data was collected to make a determination concerning the correlation between the water levels and TCE concentrations within MW66.

Now that the trend for groundwater elevations has been identified, the information can be used to pinpoint which months additional TCE sampling will be added to the 2019 AIP Sampling Plan in order to further investigate potential correlation.

## **NW and NE Plume Extraction Well Area of Influence/Cone of Depression Assessments**

### ***Northwest Plume Extraction Wells***

Water levels in 25 monitoring wells located in the northwest portion of the plant were measured in August 2018 by AIP staff. Water level measurements indicate that the high concentration portion of the plume is captured laterally within the cone of depression of EW232 and EW233 (see Figure 3).

In order to assess whether the high concentration portion of the northwest plume is captured vertically, TCE levels in middle and deep Regional Groundwater Aquifer (RGA) wells proximal to the pump and treat system were compared from 2009 through 2018 (Figure 4). The optimized extraction wells EW232 and EW233 went online in August 2010 and are located further east of the original EW230 and EW231 locations. EW232 and EW233 were optimally placed to account for the eastward shift of the high concentration portion of the plume. The optimized extraction wells are screened in the upper and middle portions of the RGA. In 2018, the extraction wells pumped 102,160,438 gallons of water.

Generally, TCE concentrations in the Northwest Plume monitoring wells near the extraction wells have stabilized in the last two to four years. On the west side of the plume, MW248, MW250, and MW456 have shown decreased TCE concentrations into the single digits. Over the same time period, TCE concentrations in proximal deep downgradient wells have increased. This appears to indicate that the extraction wells are not entirely capturing the TCE contamination in the deeper portions of the RGA, resulting in by-pass.

## August 2018 AIP Groundwater Level Map for NW Cone of Depression



Image adapted from 2016 National Agriculture Imagery Program

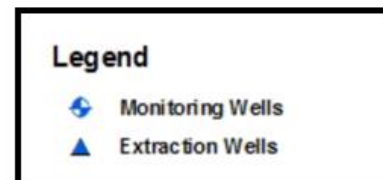
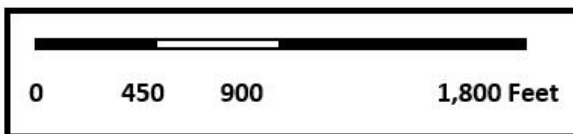


Figure 3. NW Groundwater Cone of Depression

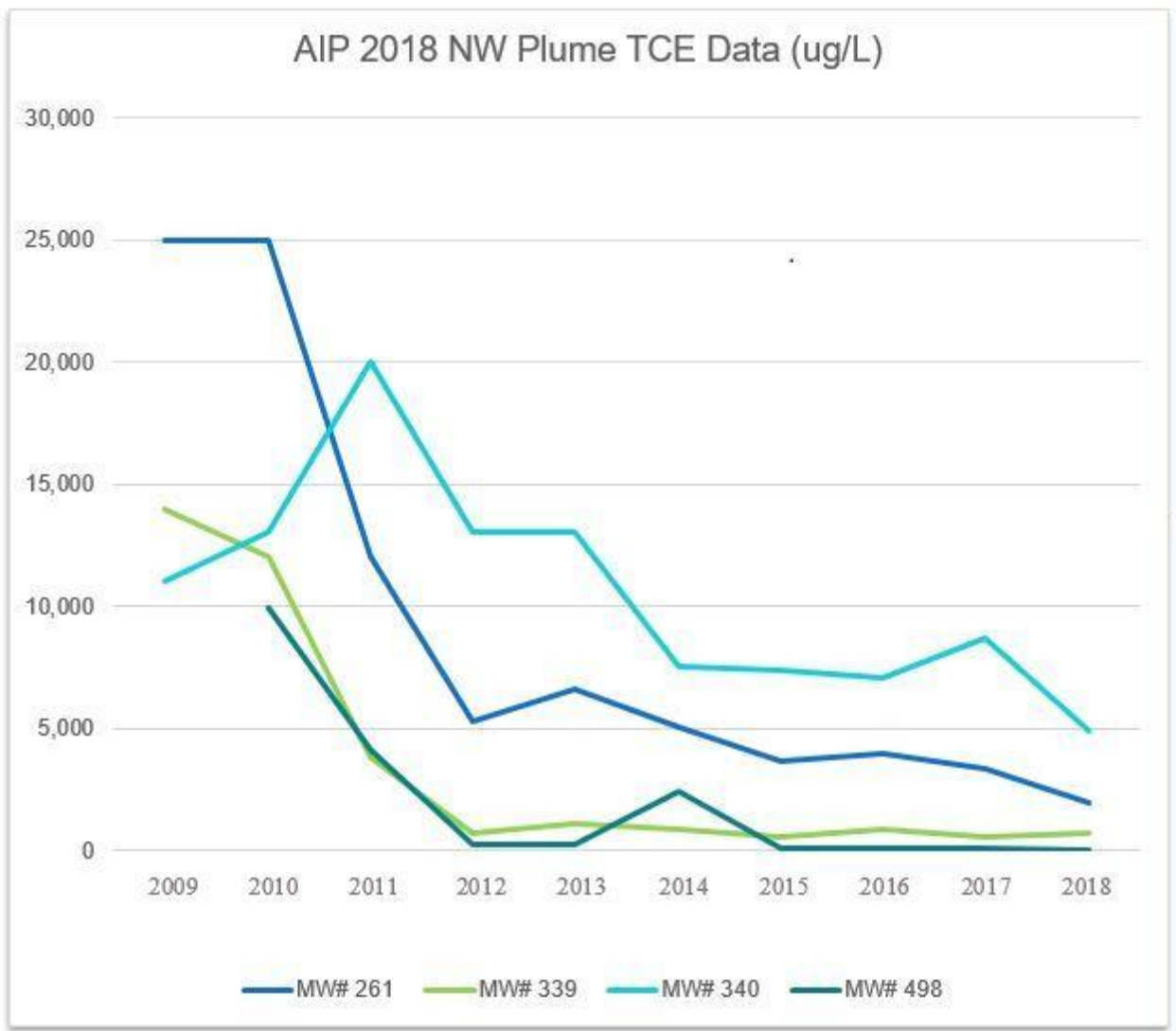


Figure 4. NW Plume TCE Data

**Northeast Plume Extraction Wells**

Water levels in 32 monitoring wells, located in the northeast portion of the plant were measured in November 2018 as part of AIP’s NE Plume Extraction Wells water level measurement program. During the 2018 reporting period, the extraction wells removed 101,347,005 gallons of water. Water elevation measurements indicate that a cone of depression has developed around EW234 and EW235 extraction wells at the proximal ends of the northeast plume (see Figure 5).

### August 2018 AIP Groundwater Level Map for NE Cone of Depression

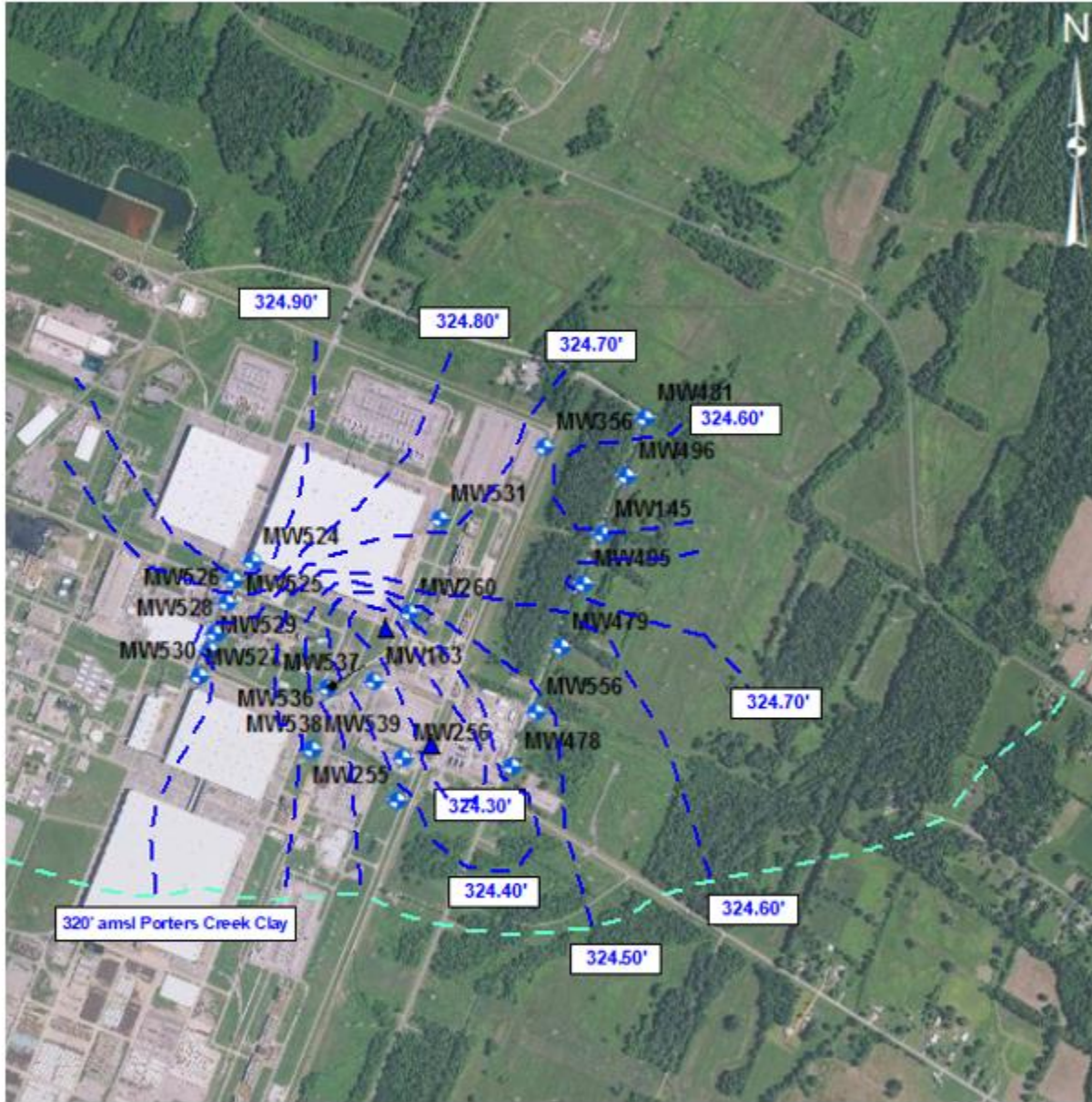


Image adapted from 2016 National Agriculture Imagery Program

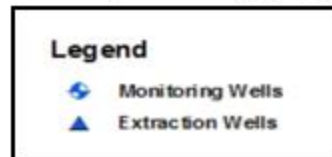
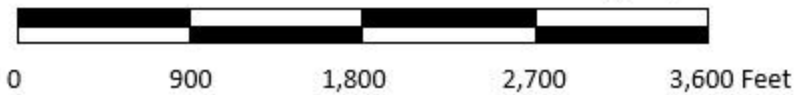


Figure 5. NE Groundwater Cone of Depression



EW234 and EW235 were installed as an optimization effort to the northeast system and went online in March 2017. The original wells EW331 and EW332 were placed in stand-by mode. The new extraction wells were installed to increase TCE mass removal, enhance control of the northeast plume migration at the eastern edge of the facility, and reduce further offsite migration.

Sampling results for several of the northeast plume transect monitoring wells, located ~800 ft east of the C-400 Building, revealed increasing TCE concentration trends in 2018. One such well with a significant increase was MW526. TCE increased in MW 526 from the established baseline concentration of 267 µg/L to 2,790 µg/L. Likewise, TCE levels in MW529 increased to 3,070 µg/L from its baseline concentration of 130 µg/L. Increases in these two wells appear to indicate that pumping rates in one or both extraction wells are likely too high. As a result, the extraction system pumping rates were reduced in the latter part of 2018 to halt TCE associated with the C-400 building from migrating east. Quarterly sampling of the transect wells by DOE field contractors will continue to monitor concentration trends into the future.

Generally, TCE concentrations in the monitoring wells downgradient of EW234 and EW235 (MW145, MW478, MW479, MW495, and MW556) have changed little since the extraction wells were turned on. Monitoring of downgradient wells will continue to be performed by DOE field contractors.

### **C-400 Monitoring Wells Sampled by Kentucky AIP**

Since July 2009, the AIP has monitored the effectiveness of various groundwater actions taken at C-400 by sampling all depths of the following downgradient multi-port monitoring wells: MW421, MW422, MW423, MW424 and MW425. These monitoring wells 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 monitoring wells contain three screened intervals corresponding to the upper (shallow), middle, and lower (deep) RGA zones. The AIP has collected samples from these downgradient wells since 2009 and tracked the associated chemical data in order to chart downgradient impact of the remediation efforts (Figure 6).

In 2018 AIP also split samples with DOE contractors from monitoring wells cluster MW505, MW506, and MW507, which are located south and hydraulically upgradient of the C-400 building. Each of the three monitoring wells has a unique screened interval corresponding to the shallow, middle, and deep RGA zones. This monitoring well cluster provides a good comparison to several

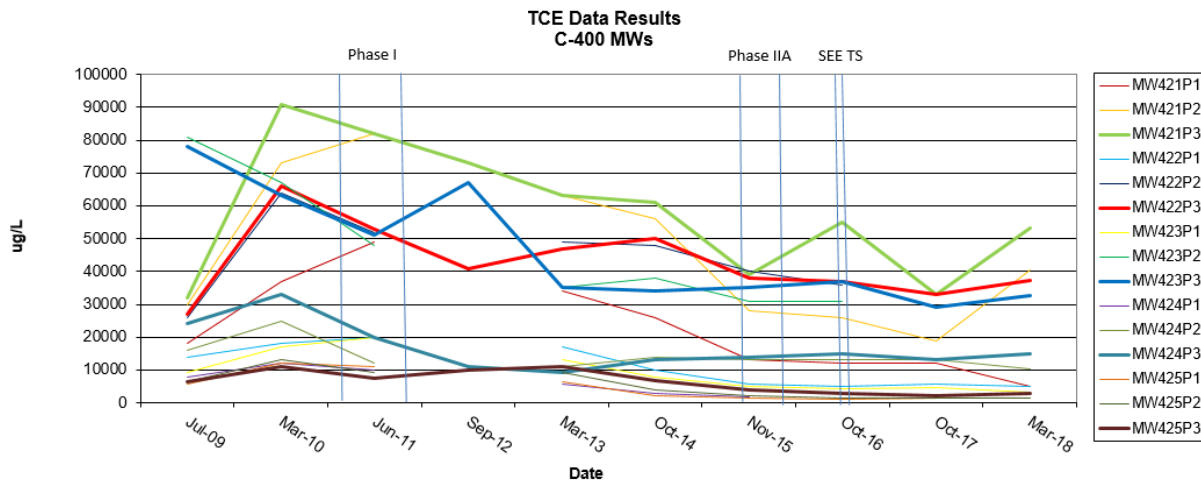


Figure 6. C-400 Monitoring Well TCE Data

downgradient multi-port monitoring wells. It will also be useful to continue sampling efforts of both up- and down-gradient monitoring well clusters in order to monitor contaminant mobilization that will occur during field activities associated with the C-400 Complex OU RI.

Several remedial actions have historically occurred around the C-400 Building to extract TCE from the subsurface. In 2003 a treatability study was conducted utilizing six-phase heating, a form of electrical resistance heating (ERH) which removed 1,900 gallons (22,000 lbs) of TCE. Phase I ERH became operational on March 29, 2010 and ran for seven months, removing 535 gallons (6,525 lbs) of TCE 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, TCE totaling 1,137 gallons (13,871 lbs) was removed during ERH operation (Jan. 1 through Oct. 9, 2014). TCE levels also generally declined downgradient during the months and years following Phase IIA. In 2016 a treatability study utilizing steam enhanced extraction was conducted upgradient from the Phase IIb area and no extraction component was utilized.

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 feet below ground surface (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. Concentrations in the upgradient of C-400 monitoring well cluster are increasing. The increase in TCE concentrations

to the middle and lower RGA monitoring wells is suspected to be inadvertent mobilization of TCE from the Phase IIb area during the Steam Enhanced Extraction Treatability Study in 2016.

### **PGDP Sitewide Groundwater Flow Model**

Groundwater models are used to help evaluate hydrogeologic systems in an effort to simulate and predict aquifer conditions and travel times. A groundwater model is a simplified mathematical representation of the subsurface hydrogeologic flow conditions at a site. The Paducah Gaseous Diffusion Plant (PGDP) Sitewide Groundwater Flow Model was created to develop a tool that can assist in evaluating potential remedies. The Groundwater Model Working Group is comprised of technical experts that work collaboratively to develop, discuss, evaluate, modify, and make recommendations in support of potential groundwater related projects.

In a series of meetings, DOE, EPA, Kentucky, and their associated contractors work together to revise the PGDP groundwater model in an effort to determine if additional data needs are necessary to support the evaluation of potential groundwater remedies. The first groundwater flow model at the PGDP 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, calculating cleanup criteria, 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. Revisions to the 2016 model included revisions to the southern model boundary, refinement of anthropogenic recharge rates within the industrial area, upgradient Terrace Gravel recharge refinement, optimization of calibration periods by utilizing more complete synoptic water level datasets, refinement of lithologic/stratigraphic/hydrostratigraphic thickness intervals, and changing drain cells to river boundary cells in the lower reaches of Bayou and Little Bayou Creeks.

The PGDP groundwater model simulates flow within the Regional Gravel Aquifer (RGA) and essentially ignores flow in both the Upper Continental Recharge System (UCRS) and the McNairy Formations which are above and below the RGA, respectively. The UCRS conveys natural and anthropogenic recharge vertically to the RGA and an evaluation was conducted to identify UCRS lithologic areas with less than 2-ft of clay above the RGA, which also was near suspected areas

of elevated anthropogenic recharge. The underlying McNairy Formation is represented in the model as a no-flow boundary. The model includes an upgradient zone which accounts for recharge (upgradient input) to the model along Terrace Gravel deposits.

Prior to 2010 water elevations collected at PGDP were collected during sampling events which typically occurred over several months. Water level elevations fluctuated over time which introduced uncertainty into all water level potentiometric surface interpretations/maps prior to 2010. In August 2010 DOE initiated synoptic water level events on an annual basis. A synoptic water level event occurs over a relatively short time period (one-three days) when atmospheric conditions are expected to remain consistent. Subsequent revisions to the groundwater model includes multiple sets of synoptic water level elevation events as a way to test model predictions against actual recorded 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 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 in the RGA over time. Both Kentucky and EPA reviewed and provided comments and recommendations to be considered in the next groundwater model revision effort. The model will continue to be evaluated and updated periodically, as warranted. The Groundwater Modeling Group met on a quarterly basis during 2018.

Efforts to collect additional water level data (based on recommendations) to refine the groundwater model proceeded in 2018. For the first time, fifteen monitoring wells belonging to and located on Tennessee Valley Authority (TVA) property were collected by Kentucky AIP field staff as part of the sitewide synoptic water elevation monitoring event. The water level elevations (Table 2) were collected on August 21, 2018 by DWM AIP to enhance the DOE synoptic water level event that occurred during the same week. Synoptic water level data collected during the 2018 time period will be used to refine future iterations of the groundwater model.

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<b>Well</b>	<b>OREISName</b>	<b>Measuring point</b>	<b>Measured GW elevation</b>	<b>GW Elevation</b>	<b>Date measured</b>
SHF-D10	TVA-D10	354.66	44.45	310.21	8/21/2018
SHF-D11B	TVA-D11B	321.77	17.97	303.8	8/21/2018
SHF-D17	TVA-D17	366.8	49.56	317.24	8/21/2018
SHF-D27	TVA-D27	354.52	38.69	315.83	8/21/2018
SHF-D30B	TVA-D30B	324.5	24.58	299.92	8/21/2018
SHF-D74B	TVA-D74B	332.39	24.10	308.29	8/21/2018
SHF-D75B	TVA-D75B	354.05	43.01	311.04	8/21/2018
SHF-D8A	TVA-D8A	332.03	14.84	317.19	8/21/2018
SHF-D8R	NA	352.93	35.24	317.69	8/21/2018
TVAGW-1D	TVAGW-1D	370.12	50.91	319.21	8/21/2018
TVAGW-2D	TVAGW-2D	370.06	45.97	324.09	8/21/2018
TVAGW-3D	TVAGW-3D	363.77	45.00	318.77	8/21/2018
TVAGW-4D	TVAGW-4D	365.77	46.99	318.78	8/21/2018
TVAGW-5D	TVAGW-5D	368.55	49.70	318.85	8/21/2018
TVAGW-6D	TVAGW-6D	368.8	49.54	319.26	8/21/2018
Barometer Start		7.54 mm/Hq			8/21/2018
Barometer End		7.53 mm/Hq			8/21/2018
River elevation from TVA measuring point				296.24	8/21/2018

**Table 2. AIP Synoptic Water Level Event**

The Groundwater Modeling Working Group discussed methods for measuring surface water elevations in Metropolis Lake in 2018, and, in addition, DWM AIP learned that TVA maintains and monitors an Ohio River gauging station which will be of interest to the groundwater modeling project team.

### **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 specifically designed to collect surface water runoff from the 61-acre northwest watershed, which includes the 27-acre former scrap yard area. The sediment basin collects storm water runoff and allows

suspended sediment time to settle, after which the stormwater is periodically discharged through the Kentucky Pollutant Discharge Elimination System (KPDES) Outfall 001 into Bayou Creek. 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.

The C-613 Sediment Basin sampling regimen began in October of 2002. Samples from Outfall 001 were collected during discharge events prior to completion of the basin. The C-613 Sediment Basin 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 2018, includes one non-discharge sampling event per year to continue assessment of possible changes in contaminant concentrations that sediment basin releases may have on WKWMA receptors. Since the basin began operation in 2003, there has not been an attempt to remove any of the accumulated sediments.

### **2018 Semi-Annual Sampling Regimen**

#### ***First Semi-Annual Sampling Event - June 27, 2018:***

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

Purpose: The first semi-annual event collects samples from the sediment basin inlet (Sediment Basin), outlet (Outfall 001) and at a point (Iron Bridge) where WKWMA recreators can be exposed to Bayou Creek water (Figure 7). Samples are collected during a sediment basin discharge event.

### KY AIP Sediment Basin Sampling Locations



Figure 7. AIP Surface Water Sampling Locations

***Second Semi-Annual Sampling Event:***

Part 1: Sediment Basin Inlet, KPDES Outfall 001 and Iron Bridge Sampling Points – January 9, 2019

Purpose: The second semi-annual event collects samples from the sediment 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 collected during a sediment basin discharge event.

Part 2: KPDES Outfall 001 and Iron Bridge Sample Points (Annual) – December 29, 2018

Purpose: This annual sample is collected to determine analyte concentrations when there is not an active discharge from the sediment basin. This sample is referred to as a non-discharge event. 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 an average WKWMA recreator's possible contaminant exposure during normal stream flow.

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)

**2018 Semi-Annual Sampling Results**

***Results: TSS and pH***

During the 2018 reporting period, neither the TSS concentrations nor the pH limits exceeded DOW KPDES Outfall 001 permit requirements. Flocculent, a material used to enhance particulate precipitation, was not used during 2018. The DOE's service contractor maintains a well-developed grass cover over the (former) scrap yards area. Observations reveal that greater soil absorption of rainfall occurs due to the presence of the vegetative cover and subsequent increased soil stability. This effect continues to result in low sediment basin turbidity measurements and TSS sample results. Based on a comparison of these sample results and the Outfall 001 discharge requirements, Kentucky concludes that the sediment basin continues to perform its primary design function, which is to comply with DOW KPDES requirements.



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**Results: Uranium Metal, Uranium Radionuclides, Gross Alpha and Gross Beta**

*2018 First Semi-Annual Sampling Event:*

Results from the Discharge Event Samples Collected on June 27, 2018:

<b>Analyte</b>	<b>Basin Inlet</b>	MDL / MDC	Total Uncertainty (2σ +/-)	<b>Basin Outlet (Outfall 001)</b>	MDL / MDC	Total Uncertainty (2σ +/-)	<b>Iron Bridge</b>	MDL / MDC	Total Uncertainty (2σ +/-)
<b>Uranium Metal (µg/L)</b>	<b>100.0</b>	0.4	N/A	<b>64.0</b>	0.4	N/A	<b>17.0</b>	N/A	0.4
<b>Gross Alpha (pCi/L)</b>	<b>33.1</b>	1.72	2.02	<b>19.8</b>	1.72	1.66	<b>5.0</b>	1.72	1.06
<b>Gross Beta (pCi/L)</b>	<b>79.3</b>	3.21	2.39	<b>45.95</b>	3.21	1.94	<b>22.3</b>	3.21	1.53
<b>U-234 (pCi/L)</b>	<b>15.5</b>	0.25	1.83	<b>10.4</b>	0.29	1.39	<b>2.5</b>	0.19	0.51
<b>U-235 (pCi/L)</b>	<b>1.3</b>	0.21	0.41	<b>0.68</b>	0.18	0.29	<b>0.1</b>	0.15	0.11
<b>U-238 (pCi/L)</b>	<b>27.0</b>	0.14	2.88	<b>19.4</b>	0.22	2.23	<b>4.35</b>	0.15	0.71

**Table 3. 2018 First Semi-Annual Sampling Event**

*2018 Second Semi-Annual Sampling Event:*

Part 1: Results from the Non-Discharge Event Samples Collected on January 9, 2019:

The non-discharge sample was collected at a time 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 recreator as this sample point borders the WKWMA.

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Analyte	Basin Outlet (Outfall 001)	MDL / MDC	Total Uncertainty (2σ +/-)	Iron Bridge	MDL / MDC	Total Uncertainty (2σ +/-)
Uranium Metal (µg/L)	7.5	0.4	N/A	4.1	0.4	N/A
Gross Alpha (pCi/L)	1.7	0.85	0.61	1.9	0.85	0.60
Gross Beta (pCi/L)	9.1	2.70	1.16	8.0	2.70	1.12
U-234 (pCi/L)	Not Analyzed	---	---	Not Analyzed	---	---
U-235 (pCi/L)	52.8	42.2	20.1	6.6	37.4	15.60
U-238 (pCi/L)	Not Analyzed	---	---	Not Analyzed	---	---

**Table 4. 2018 Second Semi-Annual Non-Discharge Sampling Event**

Part 2: Results from the Discharge Event Samples Collected on December 18, 2018:

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)	210.0	0.40	N/A	37.0	0.4	N/A	13.0	0.4	N/A
Gross Alpha (pCi/L)	62.1	0.96	2.48	6.3	0.96	0.90	3.2	0.96	0.69
Gross Beta (pCi/L)	130.9	2.67	2.87	14.9	2.67	1.26	8.7	2.67	1.10
U-234 (pCi/L)	16.2	0.20	2.28	3.6	0.24	0.80	Not Analyzed	---	---
U-235 (pCi/L)	0.9	0.30	0.42	0.3	0.25	0.25	11.2	37.5	15.70
U-238 (pCi/L)	28.4	0.36	3.63	10.2	0.36	1.60	Not Analyzed	---	---

**Table 5. 2018 Second Semi-Annual Discharge Sampling Event**

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Sediment basin sampling has been performed regularly since the sediment basin became operational in March of 2003. Discharge times, volumes and water quality parameters have been collected and compiled since November of 2004. The following data was compiled from 2003 to 2018 concerning average uranium concentrations (averaged from all results available for a given year) and the annual discharge through the sediment basin (in gallons). Rainfall data was collected from the National Oceanic and Atmospheric Administration. The average yearly rainfall in the Paducah, Kentucky area is 49.1 inches. Average inlet and outlet uranium metal (total) concentrations, sediment basin discharge volume, annual rainfall and percentage of annual rainfall for each year from 2003 through 2018 are as follows:

2003:	Inlet: 346.0 µg/L	Outlet: 156.0 µg/L
	Annual Discharge: Not Collected	Rainfall: 47.84 inches (97% of Average)
2004:	Inlet: 371.0 µg/L	Outlet: 206.0 µg/L
	Annual Discharge: Nov & Dec 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)

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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)
2018: Inlet: 155.0 µg/L	Outlet: 50.5 µg/L
Annual Discharge: 45,670,800 gallons	Rainfall: 60.64 inches (124% of Average)

### Observations

The data reports that the concentration of uranium metal has historically decreased by roughly one-half to three-fourths between the C-613 Sediment Basin inlet and Outfall 001 discharge point. The average reduction in the concentrations of uranium for 2018 was approximately two-thirds. The average reduction in radionuclide measurements for 2018 was approximately one-third, which was less than historical reductions of one-half to two-thirds. This may be due to the higher-than-average rainfall during 2018. From 2003 to 2008, when active scrap metal removal was being performed, the average inlet concentration was 374.0 µg/L. From 2009 to 2018, after the scrap metal had been removed, concentrations of uranium metal at Outfall 001 has varied from a low of 31.3 µg/L in 2012 to a high of 114.0 µg/L in 2017.

### ***C-613 Sediment Basin Inlet***

The average inlet concentration in 2018 for uranium was 155.0 µg/L, which was slightly less than the 2017 average of 165.0 µg/L. The ten-year average inlet concentration from 2009 to 2018 was 187.6 µg/L. The highest historically reported average inlet concentration of 458.0 µg/L was reported in 2015 and the lowest to date, in 2012, was 31.3 µg/L.

### ***C-613 Sediment Basin Outlet (KPDES Outfall 001)***

The average outlet concentration in 2018 was 50.5 µg/L, which was the second-lowest recorded. The highest reported average outlet 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, which, to date, has received the least rainfall since data collection began in November of 2004.

### ***Iron Bridge***

The average concentration of uranium metal at the Iron Bridge sampling point in 2018 during discharge sampling events was 15.0 µg/L. The concentration of uranium reported at the Iron Bridge non-discharge sampling event performed on Jan. 9, 2019 was 4.1 µg/L. This sample was collected in 2019 as the Division's field personnel was unable to schedule sufficient time during December. The Iron Bridge sampling point was first integrated into the sample regimen in 2007, and the average concentration of uranium metal in non-discharge events from 2007 to 2018 is 3.1 µg/L.

### **Conclusions**

The average 2018 discharge event alpha inlet measurement was 47.6 pCi/L and the average outlet measurement was 13.1 pCi/L. The average 2018 beta inlet measurement was 105.0 pCi/L and the outlet measurement was 30.4 pCi/L. These alpha and beta activity measurements showed an approximate decrease of 3.5 times between the C-613 Sediment Basin inlet and the Outfall 001 KPDES discharge point. The concentration of uranium metal also decreased from an inlet average of 155.0 µg/L to an outlet average of 50.0 µg/L, a three-fold reduction. Analytical results from the Iron Bridge sampling point reported nearly four times as much uranium metal during discharge events (15.0 µg/L) as opposed to the non-discharge event (4.1 µg/L).

Analysis of the data reports 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 yards' storm water runoff, building demolition and RI activities contribute to the off-site migration of metals and radionuclides. Interpretation of this data has determined that the sediment basin continues to serve its function by reducing the off-site migration of concentrations of metals, suspended solids and radionuclides. Therefore, Kentucky believes that the C-613 Sediment Basin is performing its prime function and should continue operation.

## **Radiation Health Branch AIP Sampling**

The RHB has a robust environmental monitoring program, funded by the AIP, designed to ensure that there is no danger to public health from PGDP's radionuclide releases to groundwater, surface water, or air. In 2018, RHB collected 1,608 samples and performed 1,119 analyses on those samples, plus 170 analyses on additional 65 samples collected by EEC.

### **Groundwater**

RHB monitors groundwater by routinely collecting quarterly samples at 10 residential wells surrounding the site (Figure 8). Each sample is analyzed for gross alpha/beta counting and gamma spectroscopy. If gross alpha equals or exceeds 5 pCi/L and/or gross beta equals or exceeds 9 pCi/L, then technetium-99 is also analyzed.

The majority of the locations are private drinking water wells that are potentially impacted by the TCE and Tc-99 plumes travelling away from the site. These wells are no longer used for drinking water. RHB continually evaluates the results from this activity, along with results from third party activities and activities at the site, to determine the need for additional monitoring locations or modification of current locations.

In 2018, there were no abnormal measurements from RHB groundwater monitoring efforts.

### **Surface Water**

RHB AIP monitors surface water by taking quarterly samples at 28 locations surrounding the site (Figure 9) and through continuous sampling at an additional 4 locations (Figure 10). (The sampling locations are labeled "ISCO" due to the brand name of the samplers that are used.) 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.

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. The background 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 5 miles to the southeast on Massac Creek (a known unimpacted local waterway, not shown on map).

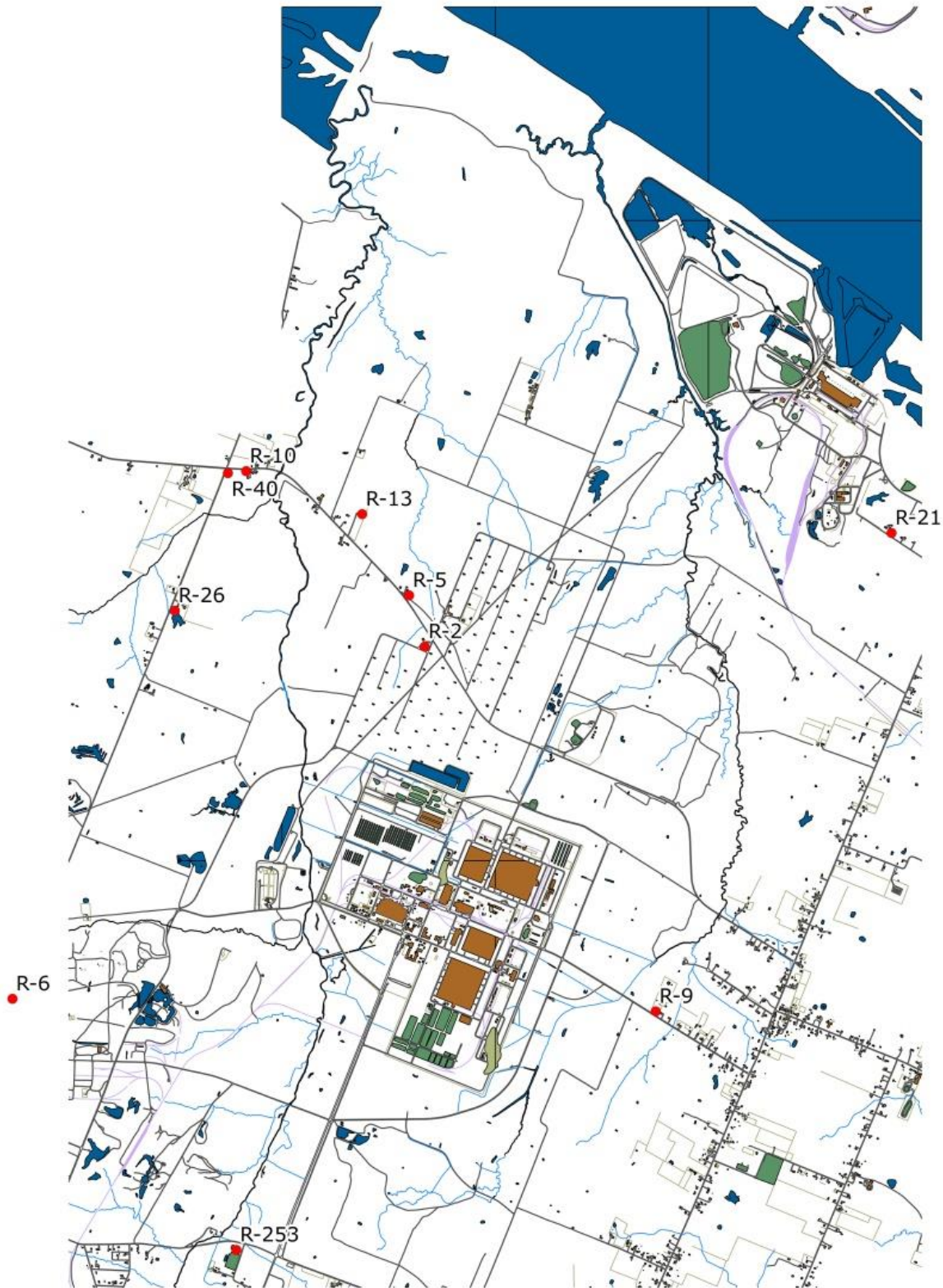


Figure 8. RHB AIP Groundwater Monitoring Locations

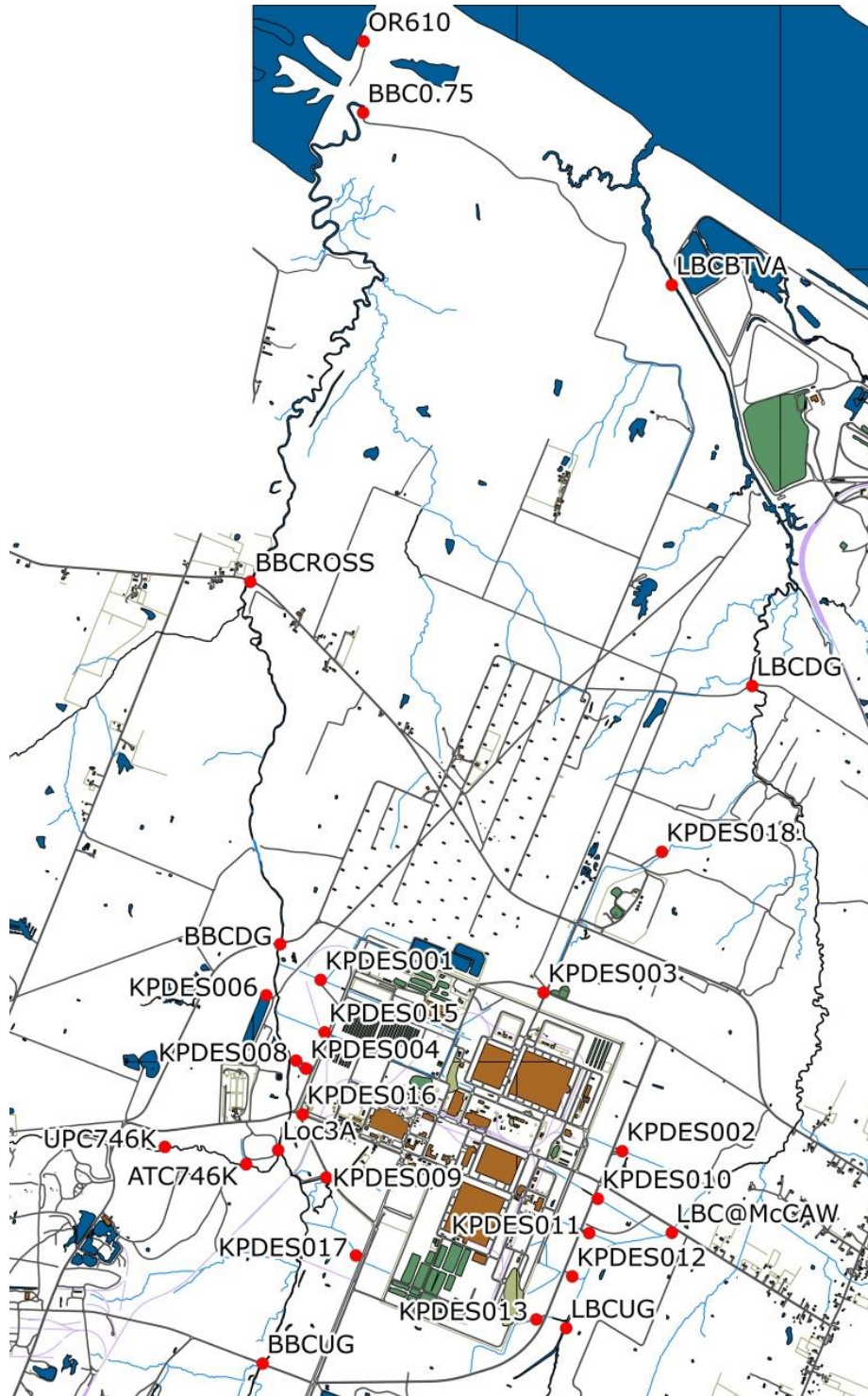


Figure 9. RHB AIP Quarterly Surface Water Sampling Locations



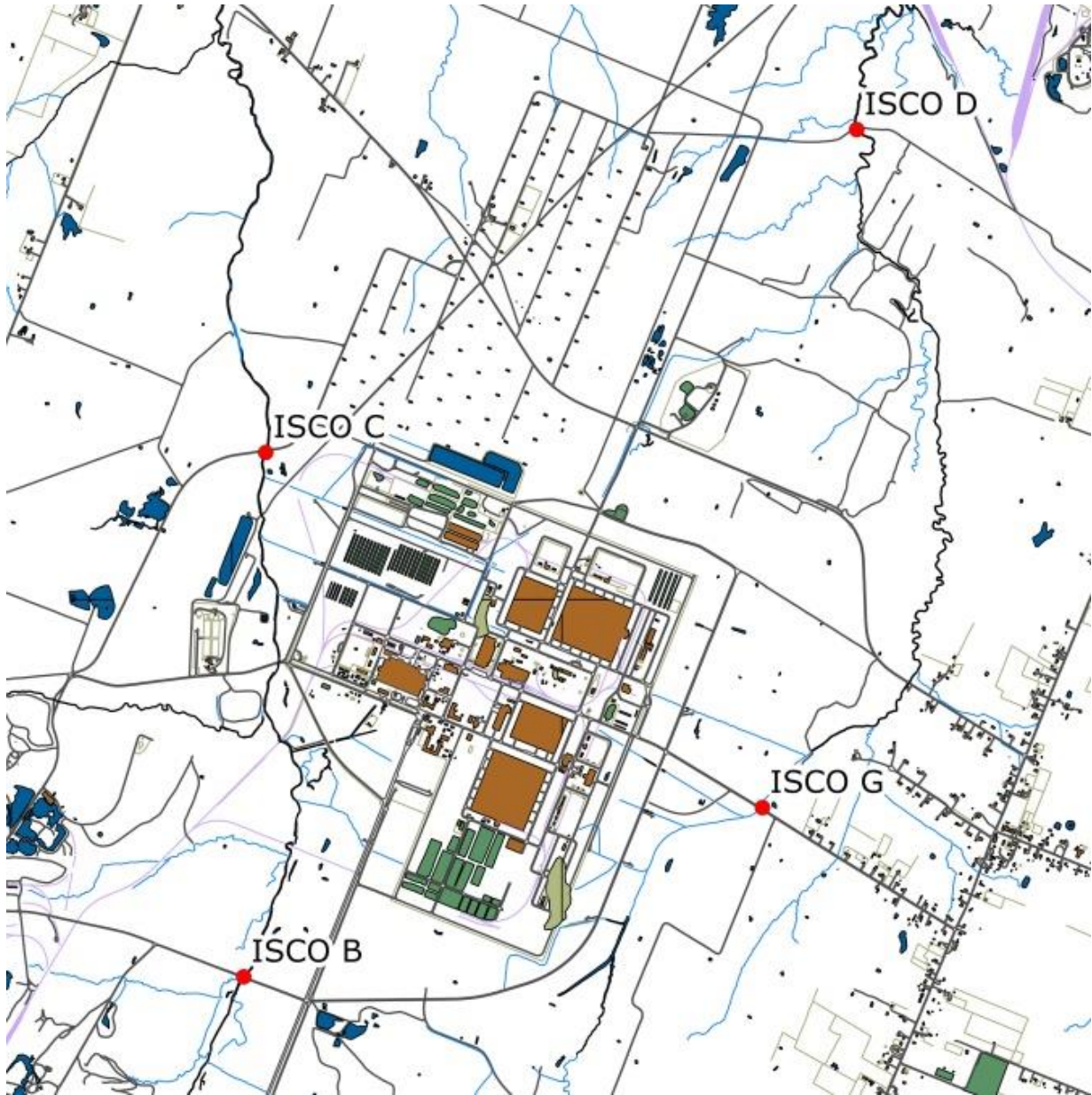


Figure 10. RHB AIP ISCO Sampling Locations

In 2013, elevated levels of uranium were found leaving the C-746-U solid waste landfill in surface water. This contamination was determined to be sourced from recently removed C-340 paneling that had high levels of surface contamination by a mobile uranium compound (likely  $UO_2F_2$ , uranyl fluoride). In response, RHB AIP began monitoring points in the discharge path from C-746-U, beginning in August 2013, in order to ensure that effluent release limits were not exceeded. These

levels have naturally decreased with time and have been well below the effluent release limits. During the fourth quarter of 2015, DOE implemented treatment on C-746-U discharges, significantly lowering the levels of contamination. Future results are expected to be comparable to background at current landfill inventory, but monitoring will continue.

In 2018, there were no abnormal measurements from samples collected at RHB AIP surface water monitoring locations.

### **Air**

RHB AIP monitors air by taking continuous samples at 10 locations surrounding the site (Figure 11), collected at 21-day periods. 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 winds at the plant and expected release points/types from the plant. The background location 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 continually evaluates the results from this activity, along with results from third party activities and other activities at the site, to determine the need for additional monitoring locations or modification of current locations.

In 2018, there were no observed abnormal measurements from RHB AIP air monitoring efforts.

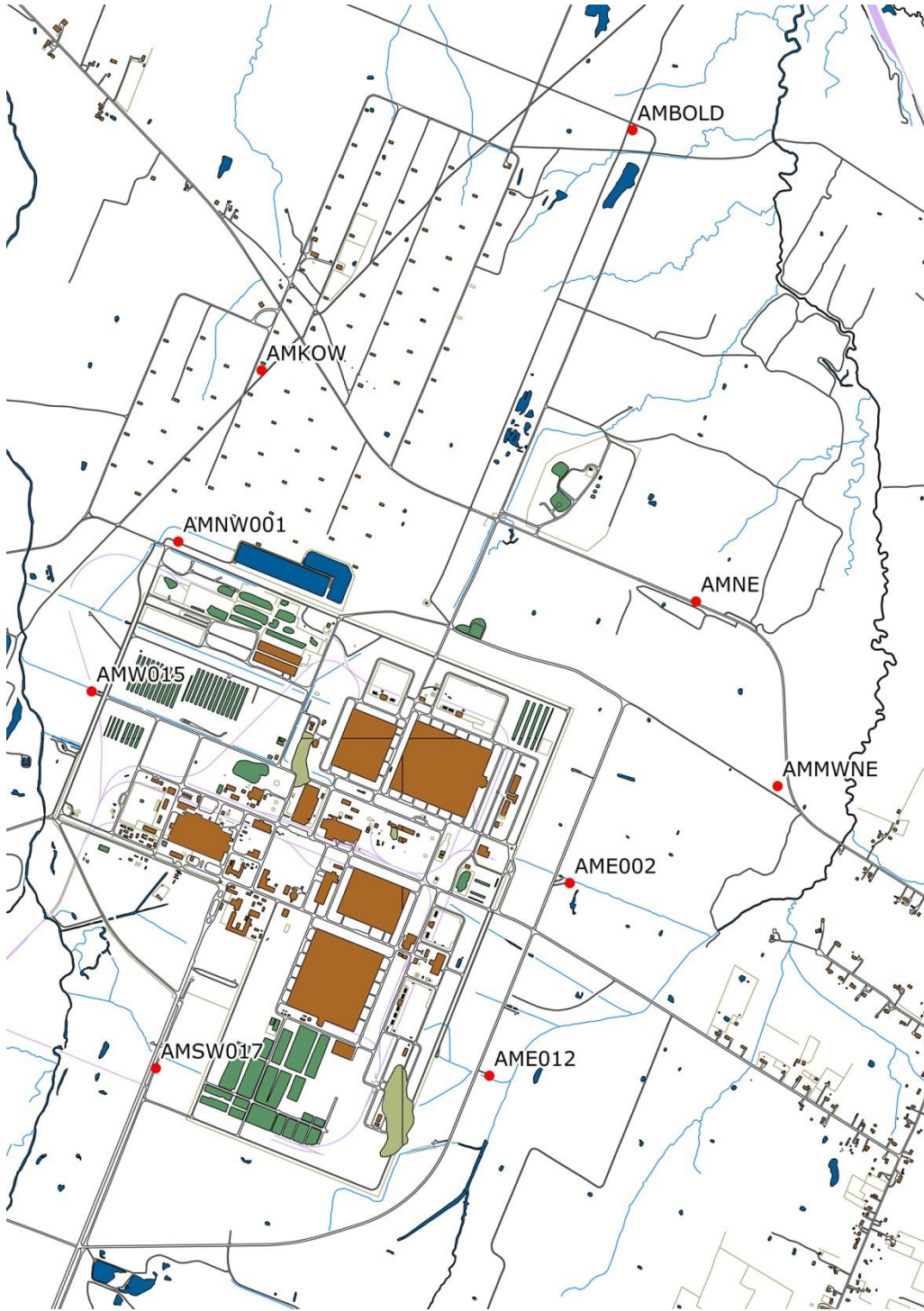


Figure 11. RHB AIP Air Monitoring Locations

## **Additional Oversight Activities**

During 2018 DWM AIP staff routinely observed portions of the PGDP reservation on a weekly basis. Locations within the Limited Area 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 burial grounds. Those areas outside of the Limited Area that were observed weekly included wastewater lagoons, the Northeast and Northwest Plume Pump-and-Treat Units, the C-613 Sedimentation Basin, the K-Landfill, the water treatment plant and sedimentation ponds, and plant outfalls (001, 002, 006, 008, 009, 010, 011, 012, 013, 015, 016, 017). No significant issues requiring DOE's attention were noted during any oversight activity in 2017. The following is an abbreviated list of oversight activities that were completed in 2018:

- 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 2018 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.
- A total of 1,619 monitoring well evaluations were completed. The components assessed during an evaluation include the well padlock, outer casing condition, protective bollards, the concrete pad and overall accessibility.

## **Fill Soil Incident**

Following an inadvertent transaction and transport of multiple loads of potentially contaminated fill soil in 2018 by a DOE contractor to a local resident, which was then placed at the resident's property on Hobbs Road, RHB AIP and EEC AIP reviewed a survey plan, at the request of DOE, for the soil with the expressed intention of removal and replacement of clean soil. RHB AIP observed the survey, reviewed the results, and concluded that it did not pose a threat due to external radiation exposure and could be safely removed. DOE changed their mind about the removal that had been agreed to, so RHB and EEC reviewed a sampling plan sufficient to

ensure that public health was protected, were the soil left in place. EEC AIP, with RHB AIP assistance, collected split soil samples with DOE. RHB analyzed these soil samples for plant related radionuclides and found the fill soil to be similar to background.

### **Mineral Oil Spill**

On Jan. 10, 2018 AIP and DWM officials responded to a mineral oil release at PGDP. The mineral oil originated from a reactor located in the C-533-2 Switchyard which had been out of service since January 2017. This particular switchyard contained 500,000 gallons of mineral oil within the reactors. Approximately 15,000 gallons of mineral oil leaked from multiple flanges due to extreme cold weather. The mineral oil flowed from the switchyard through Outfall 012 and into Little Bayou Creek. The ditches and portions of Little Bayou Creek impacted by the release were already designated as a solid waste management unit. Spill response involved tightening reactor flanges and placing absorbent pads and booms in drainage ditches leading to Outfall 012. More booms were placed downstream of Outfall 012 as a precaution; however, those booms were gradually removed throughout the year by DOE contractors. Outfall 012 has been monitored for oil sheens throughout 2018. The last visible mineral oil sheen at the outfall was reported on May 31, 2018 and the sheen was captured by a boom prior to reaching Little Bayou Creek. KY AIP has continued to monitor the area weekly and after every rain event, and has notified DOE a few times during 2018 whenever booms were not functioning as intended. In each case these notifications were preceded by heavy rainfall events and DOE contractors repaired or replaced the boom.

## **Kentucky FFA Program Elements for 2018**

### **Surface Water Operable Unit**

Kentucky, along with DOE and EPA, agreed that preventing off-site migration of contamination is the highest non-time critical site-wide priority at the Paducah Site. The Surface Water OU is comprised of 31 SWMUs which have likely contributed significant contamination to the creeks and outfalls that receive surface water runoff from the PGDP. This potential to affect off-site waterways is one of the main reasons for the historic prioritization of investigative and removal actions.

During uranium enrichment operations (pre-2014), the Paducah Site used approximately 17 million gallons of Ohio River water daily. After active enrichment operations ceased on July 25, 2013, the PGDP began using significantly less water. After use, water is discharged via unlined ditches through outfalls which flow into Little Bayou and Bayou Creeks. These two creeks converge and ultimately discharge into the Ohio River. The Kentucky Division of Water regulates these discharges from the outfalls under a Kentucky Pollutant Discharge Elimination System (KPDES) permit. Waters discharged through these outfalls include storm water runoff, wastewater from groundwater treatment systems, process wastewater, cooling wastewater, sediment basin discharge water and sanitary wastewater.

***Surface Water OU Documents reviewed in 2018***

No Surface Water OU documents were received or reviewed in 2018.

**C-400 Complex Operable Unit**

The C-400 Complex OU has been re-prioritized over all other media-specific operable units at the Paducah Site and is memorialized in the August 2017 C-400 Complex OU Memorandum of Agreement. The C-400 Building's primary use was to serve as a parts cleaning facility where solvents (TCE and TCA) were used to remove oil and grease from metal parts. The C-400 Complex OU (C-400 Building and surrounding city-block area bounded by adjacent streets) contains 22 SWMUs and all contaminated environmental media. The C-400 Building is believed to be the primary source of off-site trichloroethene (TCE) groundwater contamination at the Paducah Site. Seven of the 22 SWMUs (11, 40, 47, 98, 203, 480, and 533) still require further CERCLA evaluation under the FFA.

The nature and extent of contamination at the C-400 Complex OU is to be fully characterized in order to achieve a final remedial action for the unit. The investigation will include, but not be limited to, principal threat waste (e.g., TCE dense non-aqueous phase liquid [DNAPL] and high concentration TCE contamination). The ensuing final remedial action will include soils, groundwater sources, and building slabs. The C-400 Complex OU is to be sequenced where the building demolition will be completed as a Non Time Critical Removal Action and completed prior to conducting the RI.

The objectives for the combined RI/FS WP will be to characterize the full nature and extent of the source zone by using existing data and identifying locations to collect additional data. All of the data will be evaluated to ensure that contaminant pathways for the OU are defined adequately to support a remedy decision. Surface and subsurface transport mechanisms will be identified to support RI/FS WP development. Additional data requirements for conducting a screening and risk evaluation will be identified and acquired. Finally, historical and newly collected data will be evaluated to develop a final remedy action(s) that will reduce overall risk to human health and the environment and meet the remedial action objectives (RAOs).

An independent technical facilitator oversaw scoping of the C400 RI/FS WP between Kentucky, EPA, and DOE, which officially began in 2018. The primary purposes of the scoping meetings were to support an exchange of information and expectations, as well as identify and resolve concerns and issues related to the RI/FS WP development. Several multi-day meetings were held by the tri-parties in 2018 to meet the scoping objectives and document a path forward for the C-400 investigation. Scoping meetings were focused around the RI/FS WP document outline. Progress was made in defining sample locations, clarifying concepts and identifying data needs. DOE transmitted the D1 RI/FS WP on August 16, 2018 and Kentucky issued comments on Sept. 17. Documents pertaining to the Non Time Critical Removal Action of the C-400 building demolition were elevated to formal dispute by DOE in mid- to late-2018.

### **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 TCE, a solvent that for years was used in large quantities 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.

In 2003, electrical resistance heating (ERH) was used to remediate subsurface TCE contamination at C-400 to a depth of approximately 60 feet. ERH relies upon electrical current to heat the subsurface and vapor extraction wells to remove volatile contaminants, such as TCE, from the subsurface. Multiple ERH actions have removed approximately 3600 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 radially 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 August 8, 2017 Memorandum of Agreement, the FFA Senior Executive Committee 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 Operable Unit. 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 Operable Unit Documents Reviewed in 2018***

*Removal Notification for Demolition of the C-400 Cleaning Building (DOE/LX/2420&D1).* Kentucky submitted concurrence on Feb. 2, 2018. EPA comments submitted on March 11, 2018.

*Removal Notification for Demolition of the C-400 Cleaning Building (DOE/LX/2420&D2).* Kentucky submitted concurrence on April 16, 2018. EPA submitted comments on April 6, 2018 and conditional approval on May 7, 2018. (DOE invoked formal dispute on June 4, 2018)

*Remedial Action Completion Report for the Interim Remedial Action for the Groundwater Operable Unit for the Volatile Organic Compound Contamination at the C-400 Cleaning Building (DOE/LX/2417&D1).* Kentucky and EPA submitted comments on April 27 and May 7, 2018.

*Scoping Document for the C-400 Complex Remedial Investigation/Feasibility Study (DOE/LX/2424&D1).* Kentucky and EPA submitted comments on May 16 and June 15, 2018.

*Remedial Action Completion Report for the Interim Remedial Action for the Groundwater Operable Unit for the Volatile Organic Compound Contamination at the C-400 Cleaning Building (DOE/LX/07-2417&D2).* Kentucky and EPA concurrence on July 18, and July 30 2018, respectively.



*Engineering Evaluation/Cost Analysis for Demolition of the C-400 Cleaning Building in the C-400 Complex Operable Unit (DOE/LX/2425&D1).* Kentucky commented on July 2, 2018 and submitted additional comments on July 26, 2018.

*Action Memorandum for the C-400 Cleaning Building Non-Time Critical Removal Action (DOE/LX/2427&D1).* Kentucky and EPA submitted comments on August 20, 2018.

*Removal Action Work Plan for Demolition of the C-400 Cleaning Building in the C-400 Complex Operable Unit (DOE/LX/2432&D1).* Kentucky and EPA submitted comments on Sept. 17 and Oct. 15, 2018, respectively.

*Engineering Evaluation/Cost Analysis for Demolition of the C-400 Cleaning Building in the C-400 Complex Operable Unit (DOE/LX/2425&D2).* Kentucky submitted concurrence and EPA submitted a conditional concurrence on Sept. 21, 2018. (DOE invoked formal dispute on Sept. 21, 2018)

*Paducah Gaseous Diffusion Plant C-400 Cleaning Building Basement Slab and Subsurface Structures Sampling and Analysis Plan (DOE/LX/2430&D1).* Kentucky and EPA commented on Nov. 21 and Dec. 15, 2018, respectively.

## **Groundwater Operable Unit**

### **Northeast Plume Containment System (Pump-and-Treat)**

The Northeast Plume Containment System is operated to capture and treat the higher concentration portions of the Northeast Plume. The system consists of extraction wells EW234 and EW235 and their respective water treatment units C-765 and C-765A. The treatment units each contain an air stripper, which treats the water to less than the effluent concentration goal of 30 ppb TCE. Once treated, the water from each unit is piped to a reservoir and discharged to CERCLA Outfall 001, which flows to Little Bayou Creek.

In 2018, the Northeast Plume extraction wells EW234 and EW235 pumped 101,347,005 gallons of water, which resulted in the removal of 11.4 gallons of TCE. Since Northeast Plume pumping operations began on Feb. 28, 1997, approximately 329.3 gallons of TCE have been removed from 1,844,413,897 gallons of extracted groundwater. An operational chart of the Northeast

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Plume Containment System breaks down the operational efficiency and gallons of water treated during each month in 2018 (Table 6).

Month	% Operational		Gallons	Month	% Operational		Gallons
	C765	C765A			C765	C765A	
January	99.8	99.8	12,231,084	July	99.1	97.8	7,673,636
February	65.2	74.9	7,838,985	August	72.9	98.8	6,544,304
March	57.1	48.1	6,286,541	September	98.6	99.3	7,478,839
April	99.7	97.5	11,147,626	October	100	99.6	7,791,592
May	99.0	97.6	10,640,110	November	99.6	100	7,546,169
June	97.8	98.5	9,367,306	December	100	67.7	6,800,813

**Table 6. 2018 Northeast Plume Containment System Operation Data**

During 2018 the Northeast Plume Interim Remedial Action Optimization Project continued with adjusting extraction well pumping rates and quarterly monitoring of seven (C-400) transect wells. Each sentinel well is spaced ~200 feet apart and located approximately 800 feet east of the C-400 building. Transect wells are monitored quarterly for volatile organic compounds (VOC) and Tc-99 and results are compared to background (pre-pumping) concentrations in order to provide an early warning in the event that TCE or Tc-99 is pulled east (away) from the C-400 area by the two optimized extraction wells. If concentration trends significantly increase over time, the FFA parties will meet to develop a solution before TCE or Tc-99 can spread by migrating eastward from the C-400 building toward the two new extraction wells.

The FFA senior parties signed an MOA in 2015 which outlined actions that would be taken to prevent the extraction wells from causing or contributing to the undesirable expansion of TCE and Tc-99 from C-400 within the NE Plume. The quarterly 2018 sampling results for TCE concentrations continued to increase in some transect wells. Quarterly sampling of the transect wells will continue to monitor if optimization efforts are mobilizing contaminants away from the C-400 area.

***Northeast Plume Optimization Documents Reviewed In 2018:***

*Postconstruction Report for the Northeast Plume Optimization at the Paducah Gaseous Diffusion Plant, DOE/LX/07-2419&D1. Kentucky and EPA comments transmitted on April 2, 2018 and March 21, 2018, respectively.*

*Remedial Action Work Plan for Optimization of the Northeast Plume Interim Remedial Action Transect Well Baseline Determination DOE/LX/07-1280&D2/R3.* Kentucky and EPA approved on March 22, 2018 and March 30, 2018, respectively.

*Postconstruction Report for the Northeast Plume Optimization at the Paducah Gaseous Diffusion Plant, DOE/LX/07-2419&D2.* Kentucky and EPA comments on May 22, 2018 and June 1, 2018, respectively.

*Postconstruction Report for the Northeast Plume Optimization at the Paducah Gaseous Diffusion Plant, DOE/LX/07-2419&D2/R1.* Kentucky and EPA approved on July 2, 2018 and June 28, 2108, respectively.

*Remedial Action Work Plan for Optimization of the Northeast Plume Interim Remedial Action Transect Well Baseline Determination DOE/LX/07-1280&D2/R3/A1.* Kentucky and EPA approved on August 8, 2018.

**Northwest Plume Containment System (Pump-and-Treat)**

The Northwest Plume Groundwater System is located at the plant’s northwest corner and consists of two extraction wells and the C-612 water treatment facility. The pump-and-treat system was optimized in 2010. A major refurbishing and upgrade of the C-612 water treatment system was completed in early 2016. In 2018 the northwest plume system pumped 102,160,438 gallons of water from the two extraction wells which resulted in the removal of 120 gallons of TCE. Since northwest plume pumping operations began on Aug. 28, 1995, approximately 3,684 gallons of TCE have been removed from 2,325,194,561 gallons of extracted groundwater. An operational chart (Table 7) of the northwest plume breaks down the operational efficiency and gallons of water treated during each month in 2018.

<b>Month</b>	<b>% Operational</b>	<b>Gallons</b>	<b>Month</b>	<b>% Operational</b>	<b>Gallons</b>
January	100	8,097,778	July	98.8	8,777,754
February	99.7	7,665,910	August	99.7	8,843,274
March	99.5	8,741,842	September	98.8	8,336,350
April	98.8	8,399,768	October	100	8,817,786
May	99.2	8,856,140	November	99.3	8,441,890
June	97.8	8,414,736	December	99.7	8,767,210

**Table 7. 2018 Northwest Plume Groundwater System Operation Data**

**Northwest Plume Groundwater System Documents Reviewed In 2018:**

No Northwest Plume groundwater system documents were received or reviewed in 2018.

**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 MW543 and MW544 are located upgradient of the mixing area and have a downward trend in TCE concentrations for the 2018 monitoring period. MW545 and MW547 are located downgradient of the mixing area and both had decreasing trends of TCE in 2018. MW161 and MW542 both had a slight increase in TCE concentrations. Concentrations in MW546 increased for the 2018 reporting year (Table 8).

<b>Well #</b>	<b>Sample Date</b>	<b>TCE µg/L</b>	<b>DL</b>	<b>Conc. Trend</b> ↑↓
MW 161	6/12/2018	739	10	↑
	12/17/18	785	10	
MW 542	6/12/2018	8.17	1	↑
	12/17/18	14	1	
MW 543	6/12/2018	160	5	↓
	12/17/18	25.9	5	
MW544	6/12/2018	446	10	↓
	12/17/18	415	10	
MW545	6/12/2018	54	1	↓
	12/17/18	1.39	1	
MW546	6/12/2018	169	5	↑
	12/17/18	431	5	
MW 547	6/12/2018	1270	25	↓
	12/17/18	716	25	

**Table 8. SWMU 1 C-747-C Oil Landfarm TCE Concentrations**

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

An investigation of RGA groundwater conducted in 2015 found TCE concentrations at SWMU 211-A in the upper RGA, indicating an upgradient UCRS source that possibly originates under the C-720 building or from SWMU 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 DNAPL is likely nearby. The Southwest Plumes Sources ROD only addresses VOCs in UCRS soils and corresponding shallow groundwater. The active remediation (enhanced bioremediation) proposed in the current ROD would not be effective against higher VOC concentrations associated with DNAPL-like concentrations known to exist in the upper RGA. EPA and Kentucky have requested tri-party discussions to determine the path forward for SWMU 211-B.

***Southwest Plume Sources Documents Reviewed in 2018:***

No Southwest Plume sources documents were received or reviewed in 2018.

**Burial Grounds Operable Unit**

The historic generation of various types of waste materials at the PGDP led to on-site multiple subsurface disposal areas referred to as burial grounds (Figure 12). The Burial Grounds OU is comprised of 12 such areas that are designated by their respective SWMU numbers: the C-749 Uranium Burial Ground (SWMU 2); the C-404 Low-Level Radioactive Waste Burial Grounds (SWMU 3); the C-747 Contaminated Burial Yard and C-748-B Burial Area (SWMU 4); the C-746-F Burial Yard (SWMU 5); the C-747-B Burial Grounds (SWMU 6); the C-747-A Burial Grounds and Burn Area (SWMU 7); the C-746-S Landfill (SWMU 9); the C-746-T Landfill (SWMU 10); the C-747-A Burial Grounds and Burn Area (SWMU 30); the Residential/Inert Landfill Borrow Area (P-Landfill) (SWMU 145); the C-746-B Pad (SWMU 472) and the Scrap Material West of C-746-A (SWMU 520).

## Burial Ground Units

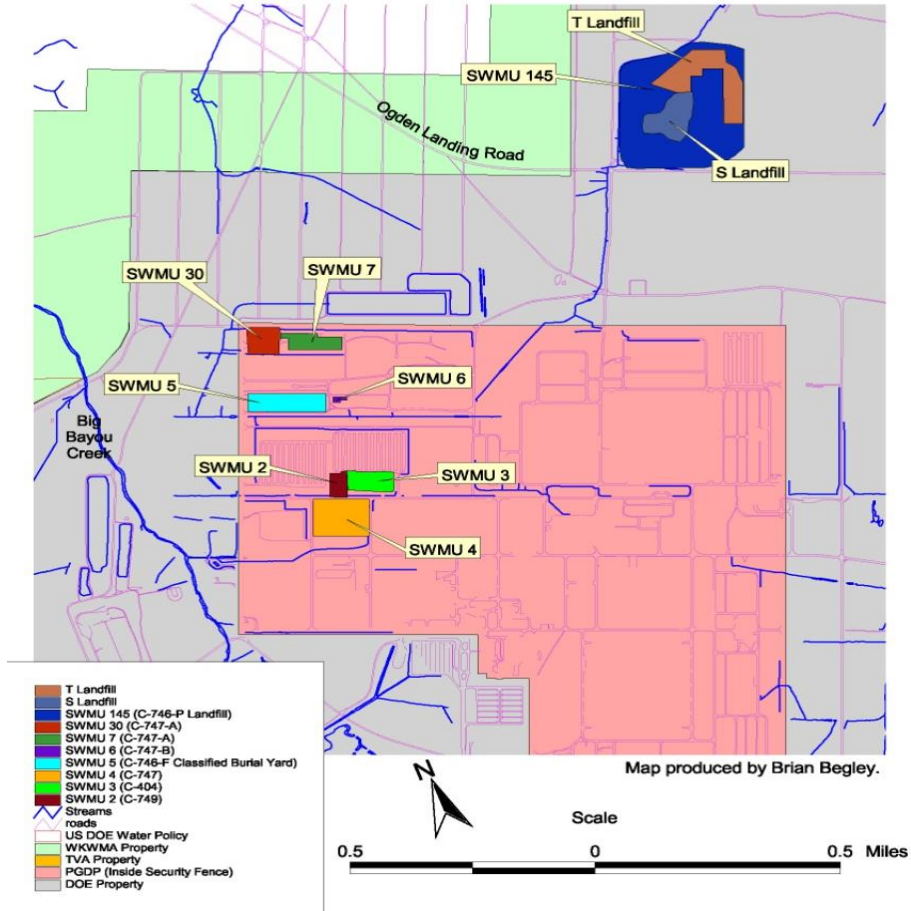


Figure 12. Burial Ground SWMUs

### SWMUs 5 and 6

On July 22, 2016, the DOE requested a milestone modification for submittal of a *Proposed Plan for SWMUs 5 and 6*. Eight modification requests were received and approved, extending the submittal date until August 30, 2017. No further extension requests were received after the August 30, 2017 date. The FFA parties agreed that the next SMP will establish a new planning date for a Proposed Plan and ROD for SWMUs 5 and 6.

### ***Burial Grounds Operable Unit Documents Reviewed in 2018:***

No Burial Grounds OU documents were received or reviewed in 2018.

## **Soils Operable Unit**

There are currently 72 SWMUs in the Soils OU. A major objective of the Soils OU investigations is to determine the nature and extent of contamination in the soils to a depth of 10 feet below grade surface.

### ***Soils Operable Unit Documents Reviewed in 2018:***

No Soils OU documents were received or reviewed in 2018.

## **Decontamination and Decommissioning Operable Unit**

The pre-GDP D&D OU has addressed 17 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 OU. 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, 2017. 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. A second set of errata pages for this same report were submitted on Dec. 20, 2018.

### ***D&D Documents Reviewed in 2018:***

*Second Errata Pages for the Removal Action Report for the C-410 Complex Infrastructure Decontamination and Decommissioning Project at the PGDP, (DOE/LX/07-2182&D1) were under review in 2018.*

## **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 excavated. 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 the existing on-site C-746U 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 engineered disposal of non-hazardous, hazardous, Toxic Substances Control Act (TSCA), low-level radioactive and low-level radioactive mixed wastes on-site, thereby avoiding potentially 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.

### **Formal WDA Dispute History**

The DOE initiated Formal Dispute #1 on Feb. 19, 2016 over conditions imposed by Kentucky and EPA concerning the establishment of radiological effluent limits from the WDA project. The DOE initiated Formal Dispute #2 on May 13, 2016 concerning finalization, approval and placement of the document into the Administrative Record.

Formal Dispute #1 was resolved in an MOA which was signed by the three parties on Feb. 8, 2017. Formal Dispute #2 was resolved in an MOA which was signed by the three parties on Feb. 27, 2018. The DOE subsequently submitted a D2/R1 version of the RI/FS report on May 7, 2018.



**Waste Disposition Alternatives Documents Reviewed in 2018:**

*Remedial Investigation / Feasibility Study Report for CERCLA Waste Disposal Alternatives Evaluation (DOE/LX/07-0244&D2/R1).* EPA commented on June 6, 2018 and Kentucky conditionally concurred on June 7, 2018.

*Remedial Investigation / Feasibility Study Report for CERCLA Waste Disposal Alternatives Evaluation (DOE/LX/07-0244&D2/R2).* Kentucky concurred on July 6 and EPA concurred on July 10, 2018.

**Solid Waste Management Units (SWMUs)**

During the reporting period from Jan. 1 to Dec. 31, 2018, Kentucky received one revised Solid Waste Management Unit Assessment Report (SAR). No SWMUs were granted No Further Action (NFA) or assigned Requires Further Investigation (RFI). Currently, the Paducah Site permit lists no SWMUs in Appendix A-4(a) as “DOE Material Storage Areas for which the permittee has submitted SARs and are Under Review by the Cabinet,” or in Appendix A-4(b) as “SWMUs Under Review by the Cabinet.”

<b>SWMU Number</b>	<b>Description</b>	<b>OU Location</b>	<b>Sub-project</b>	<b>Status</b>	<b>SAR Report Date</b>	<b>Date(s) SAR Amended</b>	<b>Date of NFA or RFI</b>
478	C-410/420 Feed Plant	Soils & Slabs OU	N/A	Requires RFI	7/18/2001	12/20/2018	8/15/2001

**Table 9. Revised & Newly-Discovered SWMU Assessment Reports Submitted to Kentucky in 2018**

**SWMU DOCUMENTS REVIEWED IN 2018**

In 2018, one SAR revision was submitted and no newly-discovered SWMUs were reported. At the end of the reporting period, no SARs were under review.