Commonwealth of Kentucky

Environmental Oversight Report 2016
Paducah Gaseous Diffusion Plant

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This 2016 Environmental Oversight Report, finalized in April 2017, 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, 2016, to Dec. 31, 2016. 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**
Dense Non-Aqueous Phase Liquid	**DNAPL**
Department of Energy (US)	**DOE**
DOE Material Storage Area	**DMSA**
Engineering Evaluation/Cost Analysis	**EE/CA**
Environmental Indicators	**EI**
Environmental Management	**EM**
Environmental Protection Agency (US)	**EPA**
Environmental Restoration	**ER**
Feasibility Study	**FS**
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**
Maximum Concentration Level	**MCL**
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**
Regional Groundwater Aquifer	**RGA**
Remedial Design/Site Investigation	**RD/SI**
Remedial Design Work Plan	**RDWP**
Remedial Investigation/Feasibility Study	**RI/FS**
Resource Conservation and Recovery Act	**RCRA**
Sampling and Analysis Plan	**SAP**
Scrap Metal Removal Project	**SMRP**
Site Management Plan	**SMP**
Soils Operable Unit	**SOU**

Solid Waste Management Unit	**SWMU**
Solid Waste Management Unit Assessment Report	**SAR**
Surface Water Operable Unit	**SWOU**
Technetium-99	**Tc-99**
To Be Considered	**TBC**
Total Suspended Solids	**TSS**
Trichloroethene	**TCE**
University of Kentucky	**UK**
Upper Continental Recharge System	**UCRS**
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 enriched uranium 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 operations at the PGDP occurred inside a secured area of approximately 750 acres, surrounded and bounded by the West Kentucky Wildlife Management Area (WKWMA) on three sides. 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 for the time period covered (CY 2016) 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 and 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 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 D&D of

the remaining PGDP as well as upon potentially contaminated media that are presently unknown or currently 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 identified for the PGDP are:

Pre-GDP Shutdown

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

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 following completion of D&D of the PGDP and completion of clean-up of the media-specific 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 Kentucky. The Cabinet for Health and Family Services (CHFS) Radiation Health Branch (RHB), as radiation authority for the state, 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 is 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 the document's annual revision on Nov. 15.

Comments on the D1 2016 SMP were submitted by Kentucky on Dec. 15, 2015 and by EPA on Mar. 7, 2016. A clarification and comment resolution meeting was held on Mar. 30, 2016. The D2 2016 SMP was issued to the regulators on July 16, 2016. The submittal date for concurrence, non-concurrence or conditional concurrence was extended twice to Oct. 26, 2016. The 2016

SMP was never finalized. The FFA parties agreed to try to approve a 2017 SMP. The D1 2017 SMP was transmitted to the regulators on Nov. 15, 2016.

Site Management Plan Documents Reviewed In 2016

FY 2017 Annual Revision to Site Management Plan (2410&D1). Comments are due in 2017.

Agreement in Principle (AIP)

Under the AIP program, Kentucky conducts independent environmental monitoring activities and oversees DOE monitoring activities. Additionally, the program serves to disseminate information relevant to ongoing site cleanup activities to concerned citizens and the public in general. During 2016 the AIP wrote and distributed 3 issues of the *Oversight News,* its newsletter detailing activities at the PGDP. AIP also completed and distributed its 2015 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 2016

One of the primary goals of the Agreement in Principle (AIP) is to monitor 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 observes 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 split environmental (soil, surface water, air, and groundwater) samples with DOE and staff collect independent environmental samples. Over the years AIP staff have also worked with organizations such as the University of Kentucky in conducting research apart from DOE efforts.

As an element of some of these projects further environmental samples are collected. 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; and historically have split tissue samples collected from animals living near the PGDP to monitor the biota.

For 2016, 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, Radiation Health Branch (CHFS) 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

Residential Wells Sampled in 2016

During 2016, AIP staff collected samples from 11 different residential wells and 101 different monitoring wells. AIP staff sampled some wells more than once for a total of 105 sampling events during 2016. The 2016 AIP Groundwater Sampling Locations map (Figure 1) shows all wells sampled during the 2016 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.

The residential wells sampled by AIP staff were located outside of the two off-site contamination plumes. During this reporting period, AIP independently confirmed that, of the 11 residential wells

sampled in 2016, none are currently impacted by the plumes. For all residential wells sampled, the laboratory report and a discussion of the results were sent directly to the residents.

In 1988, when TCE and Tc-99 were discovered at off-site water wells, nearby residents using groundwater wells for domestic use were provided an alternative water supply. In response, DOE created an administrative boundary referred to as a water policy area that provides alternative water sources at no costs to residents located within the area who may be affected by contaminated groundwater. In exchange, residents must agree to refrain from using any existing wells to access the groundwater. This policy is used, in part, to protect the public from potential exposure to contaminants. Based upon the sampling results, both plumes are still within the water policy area.

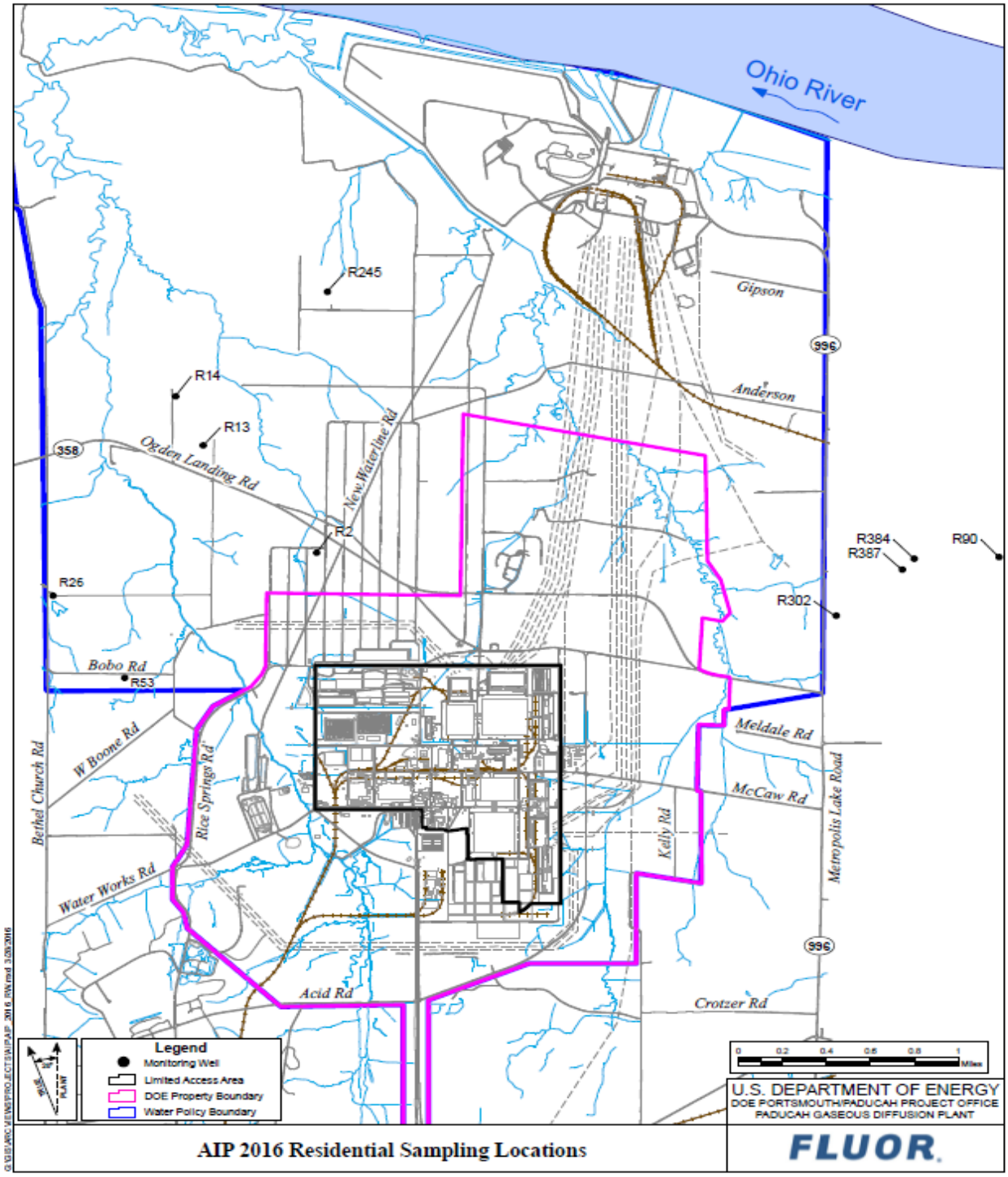


Figure 1. AIP 2016 Residential Wells Sampled

Monitoring Wells Sampled by Kentucky AIP

The objectives of the AIP sampling activities for monitoring wells were significantly different from the objectives of the residential well sampling. The 101 monitoring wells sampled involved 105 sampling events in 2016. Each of these sampling events was located either within the known plume footprint or in close proximity to the plumes. These sampling events were conducted to evaluate DOE's sampling procedures, to verify the quality of their laboratory analyses and to augment current DOE sampling. AIP evaluated plume contaminant concentrations and water quality parameters and compared 2016 results to previous years to determine if overall concentrations were increasing, decreasing or remaining stable. The concentrations detected by AIP and DOE for TCE and Tc-99 at various monitoring well locations are used to determine the extent of and monitor for any changes to the contaminant plumes originating from PGDP.

AIP staff split residential and monitoring well samples with DOE on 21 of the 105 sampling events conducted in 2016. 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 monitored DOE's sampling procedures to verify this work was performed in compliance with EPA and DOE Standard Operating Procedures for field measurements and sampling methods.

Of the 15 monitoring well samples split by Kentucky and DOE and analyzed for Tc-99, two had similar Tc-99 concentrations. On seven occasions, neither Kentucky nor DOE detected Tc-99. During the January 13, 2016 sampling event for MW-363, Kentucky's laboratory reported the higher reading while DOE's laboratory reported a non-detect reading. MW-363 is located at the C-746 U landfill. On July 13, 2016 split sampling occurred at MW-93 and MW-84 where Kentucky had the higher reading while DOE had the non-detect reading. The wells are located at the C-404 Landfill inside the fenced PGDP facility.

Well #	Date	AIP TCE ug/L	DOE TCE ug/L	AIP Tc-99 pCi/L	DOE Tc-99 pCi/L
MW369	1/12/16	0.65 J RL 1	1.08 DL 1	38.6 +/-1.55	52.7 +/-13.4
MW370	1/12/16	0.49 J RL 1	0.93 J DL 1	48.6 +/-1.60	32.1 +/- 12.7
MW391	1/12/16	5.7 RL 1	9.31 DL 1	U	U
MW392	1/12/16	11 RL 1	16.3 DL 1	U	U
MW393	1/12/16	ND	U	U	U
MW363	1/13/16	0.79 J RL 1	1.15 DL 1	16.3 +/-1.43	U
MW364	1/13/16	3.0 RL 1	5.21 DL 1	50.5 +/- 1.61	51 +/- 12
MW365	1/13/16	ND	U	U	U
MW542	6/22/16	83 RL 50	95.7DL 10	ND	NS
MW543	6/22/16	630 RL 50	702 DL 10	10.6 +/- 1.35	NS
MW544	6/22/16	200 RL 50	236 DL 5	ND	NS
MW545	6/22/16	18 J RL 50	20.2 DL 10	ND	NS
MW546	6/22/16	910 RL 50	963 DL 20	20.3 +/- 1.40	NS
MW547	6/22/16	2800 RL 250	3340 DL 50	ND	NS
MW84	7/13/16	1800 RL 100	1820 DL 20	9.92 +/- 1.33	U
MW87	7/13/16	1100 RL 50	1090 RL 20	U	U
MW90A	7/13/16	38 RL 1	35.3 DL 1	U	U
MW93	7/13/16	1800 RL 100	2020 DL 50	5.08 +/- 1.30	U
MW420	7/13/16	210 RL 10	169 DL 2	ND	U
MW85	7/13/16	11 RL 1	15.5 DL 1	68.1 +/- 1.63	71 +/- 12.5
MW88	7/13/16	10 RL 1	9.5 DL 1	23.8 +/- 1.14	24.4 +/- 10.9

Table 1. AIP/DOE DATA Comparison

RL = reporting limit, ND = Non detect at the reporting limit, NA = not applicable, U = not detected above laboratory reporting limit DL = Laboratory detection limit, NS = not sampled

MW100 was of special concern due to its close proximity to the eastern edge of the Water Policy Box and its locations 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, respectively. AIP staff will continue to closely evaluate this particular well over time

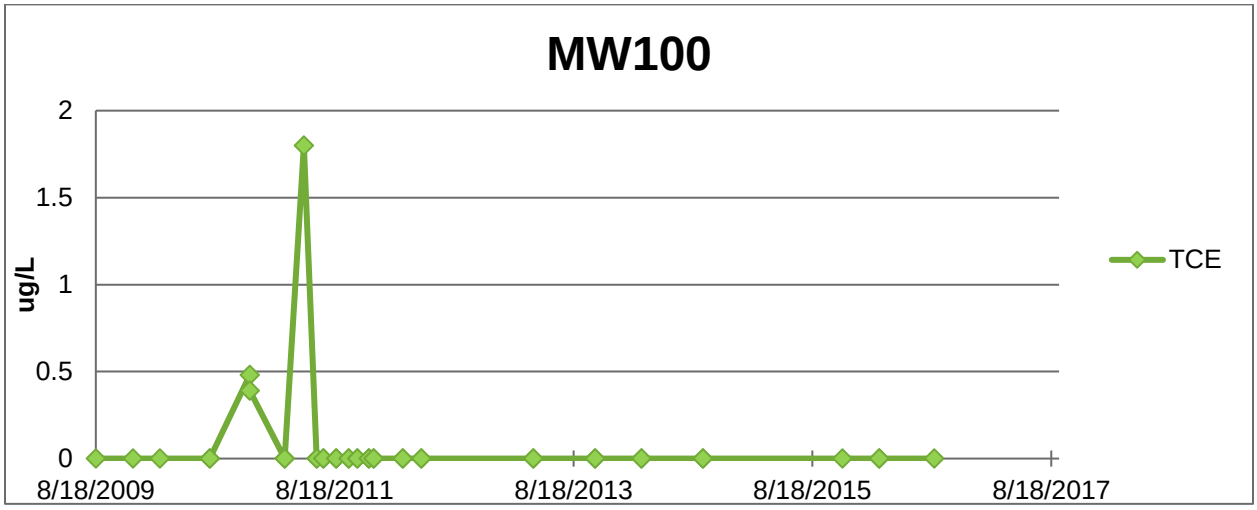


Figure 2. Monitoring Well 100 Sampling Results

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 of contaminant plumes at PGDP 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. Furthermore, AIP independent oversight helps to ensure that isoconcentration contours generated in maps produced by DOE can be verified and relied upon by regulators and the public.

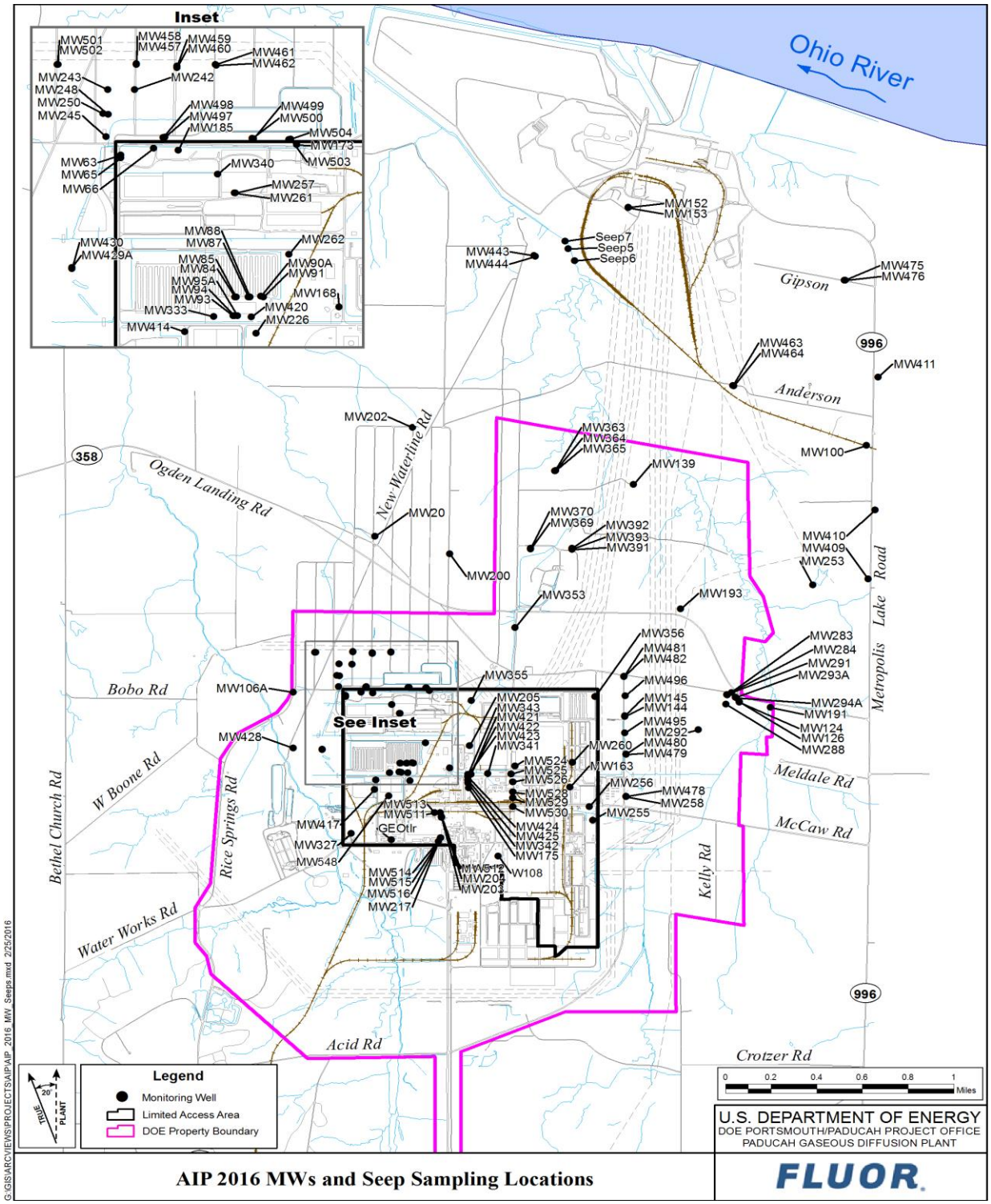


Figure 3. AIP 2016 Monitoring Well and Seep Sampling

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, 2 miles from the plant and 2 miles from the confluence of LBC and the Ohio River. AIP staff periodically check Little Bayou Creek for migrating and new seeps.

AIP split one seep water sample during 2016 from LBCSP5 for VOCs and Tc-99. The location can be seen on the 2016 AIP Monitoring Well and Seep Sampling Locations map (Figure 3). The sample had detectable levels of TCE: AIP sample; 1.7 ug/L RL 1.0 and DOE sample; 2.17 ug/L RL 1.0. Technetium 99 (Tc-99) and other site specific isotopes were not analyzed because Gross Alpha and Gross Beta did not exceed the following criteria: Gross Alpha ≥ 5 pCi/L and Gross Beta ≥ 9 pCi/ml.

NW 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 2016. 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 2016. The new 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

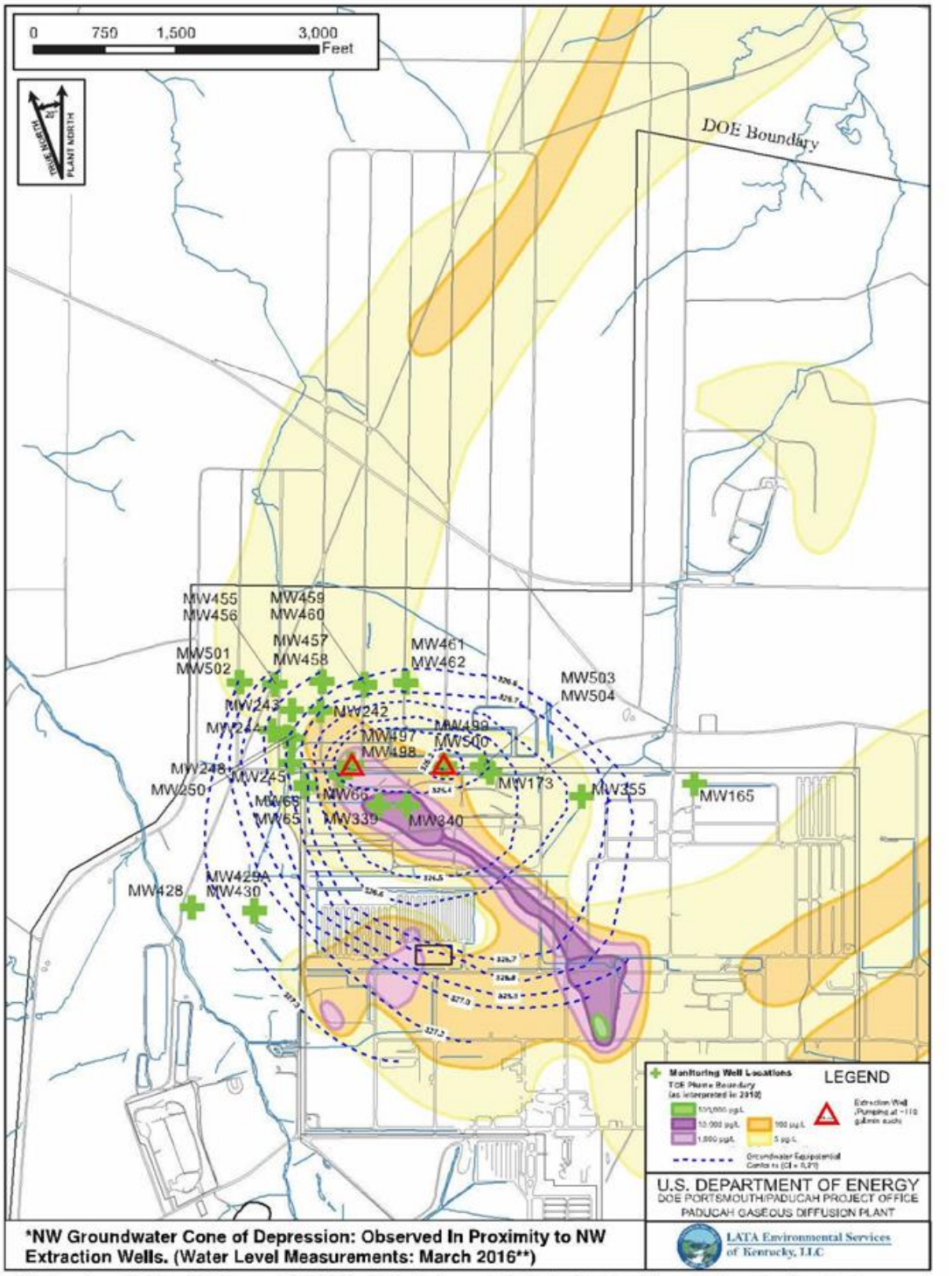
concentration portion of the plume. The new extraction wells are screened in the upper and middle portions of the RGA.

From 2009 through 2016, lower RGA wells MW 339 and MW 261, located upgradient of the extraction wells, have decreased in TCE concentrations by two and one orders of magnitude, respectively. MW 498, located immediately adjacent to EW 232 has also decreased TCE concentration by two orders of magnitude. During this time MW 456, on the western edge of the plume, downgradient of the extraction wells, decreased TCE concentrations by one order of magnitude. Furthermore, MW 458, MW 460 and MW 454 downgradient of the extraction wells in the centroid of the plume all increased TCE concentrations by an order of magnitude. During the same time period, middle RGA wells MW 243, MW 248 and MW 250, located on the western side of the plume showed concentrations of TCE decreased by one to two orders of magnitude. MW 242, located closer to the centroid of the plume has decreased slightly.

MW 66, a shallow RGA well located upgradient of the extraction wells decreased in TCE concentration by one order of magnitude. The downgradient proximal shallow RGA wells 497 and 499 first increased, but are now starting to decrease in concentration. Shallow RGA wells 503 and 461 increased, then decreased in concentration, and now are steady. Wells 453 and 197, located at the midpoint of the plume, concentrations remain unchanged.

Over the past five 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 2016, 34 monitoring wells located in the northeast plume were added to AIP's water level measurement program in anticipation of DOE's effort to relocate the northeast plume extraction wells in 2017. This information will also be helpful in detecting changes in groundwater gradients near the optimized extraction wells as well as those that may occur as the plant water system is changed.



*This figure is modified from DOE Document PAD-ENM-0055/R3 Environmental Monitoring Plan Fiscal Year 2014: Figure C.6 (Page C-29)
** March 2016 water level measurements also presented graphically on Figure 4 as blue line.

Figure 4. March 2016 NW GW Cone of Depression

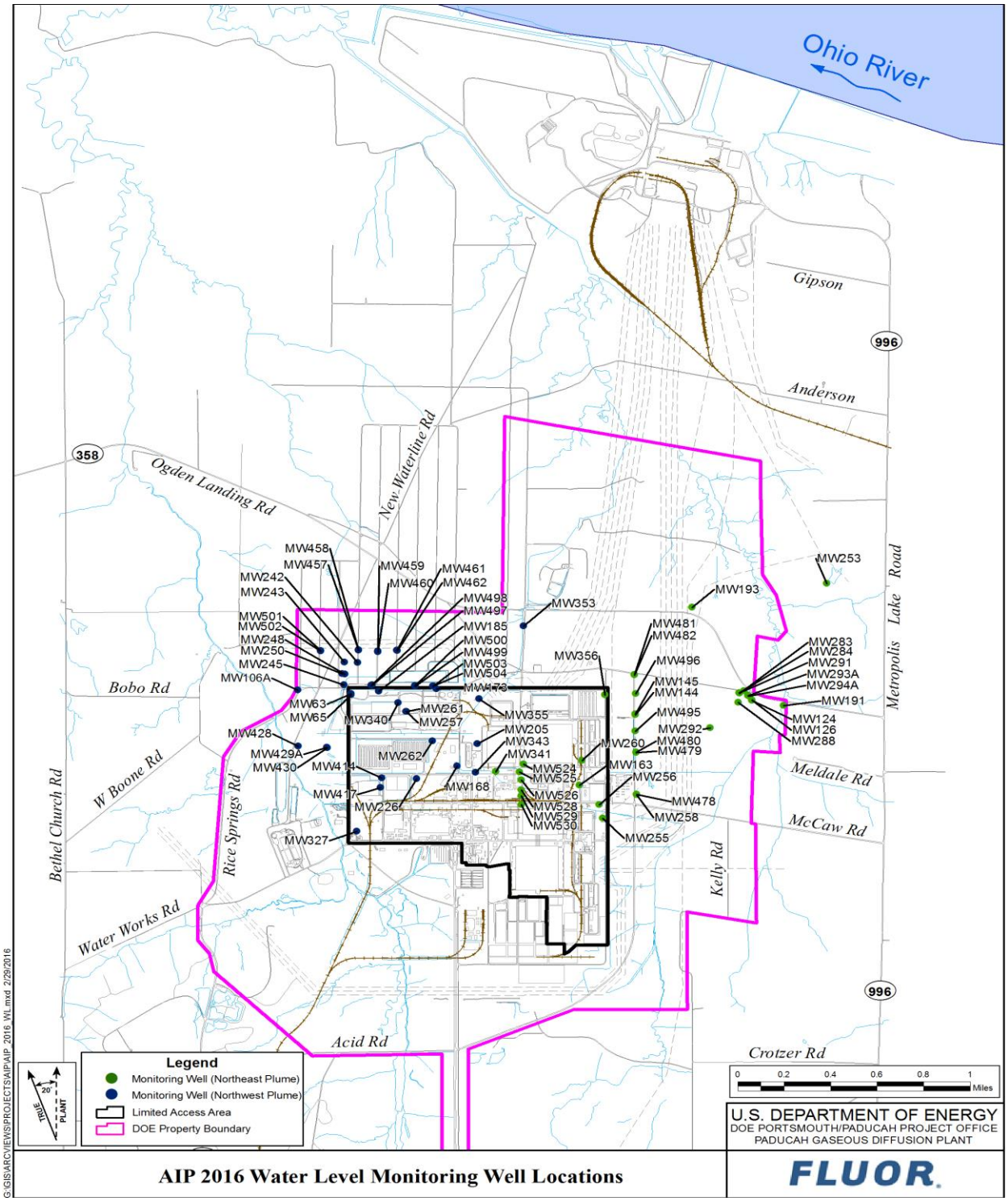


Figure 5. AIP 2016 Water Level Monitoring Wells

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. 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 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 declined over time or remained relatively constant. An increase in concentration was recently noted at MW421 P3 which 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. Further sampling of these MWs will be conducted in October 2017.

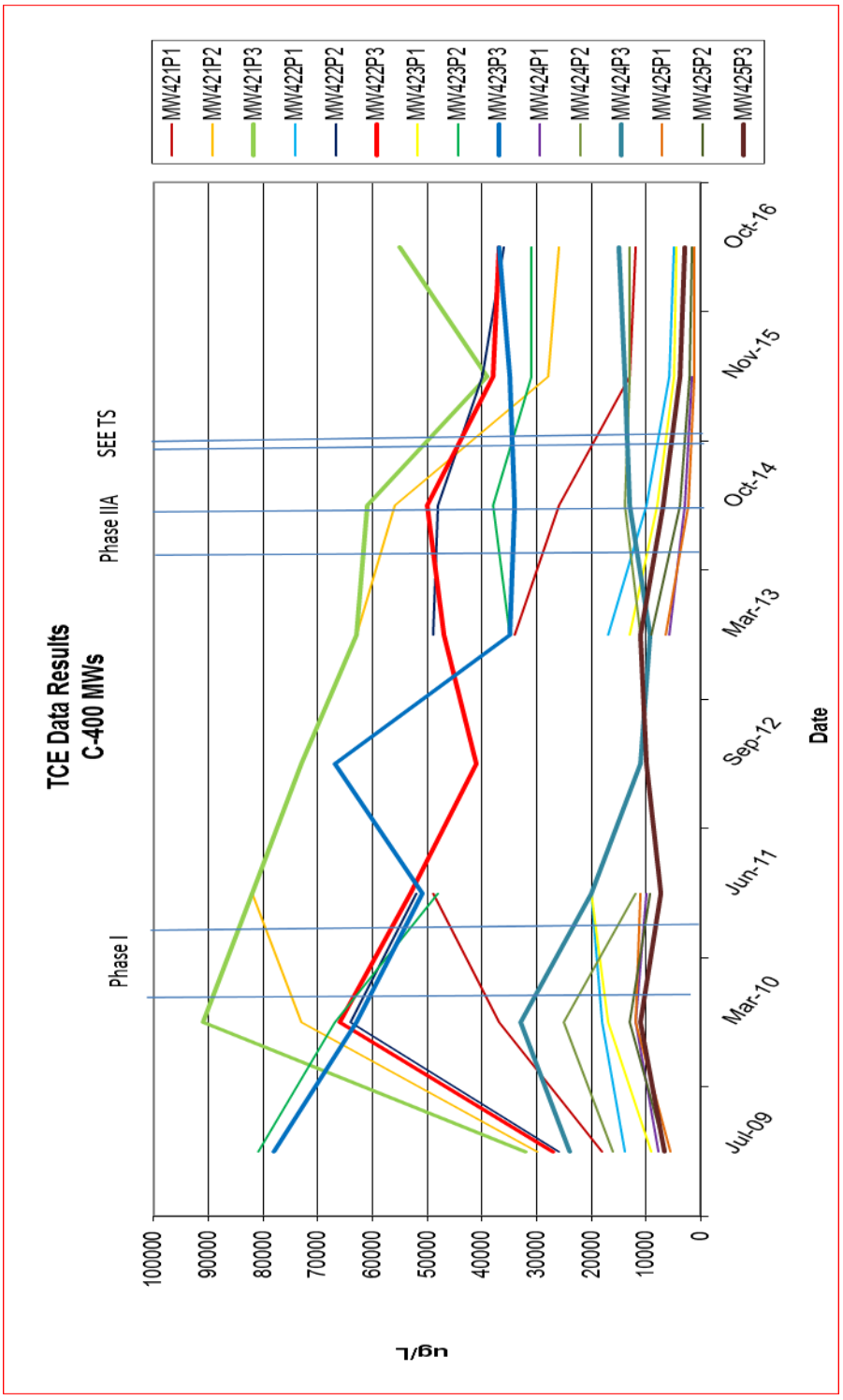


Figure 6. C-400 MW Data

WKWMA Pond Sampling

In April 2016, composite samples were taken in three ponds located within the Western Kentucky Wildlife Management Area (WKWMA). The purpose of this sampling effort was to determine if metals or radionuclides are present in the ponds at levels of concern for dogs being trained to retrieve using the ponds. Dog breeds associated with retrieving, are trained to fetch ducks, using primarily these three WKWMA ponds. A dog owner raised a concern to WKWMA officials about a possible link between perceived elevated levels of cancer in dogs being trained at the WKWMA ponds. Three sediment samples were collected from the following ponds: Retriever Pond, Rock Levee Pond and Metzger's Pond. (See Figure 7 for locations. Rock Levee pond is not named on the map, but it is east of Turkey Pond in the northern part of the WMA.) These locations were chosen based on their reported frequent usage and the fact that all three ponds contain visible concrete rubble dams. Concrete rubble was historically utilized at the WKWMA for various erosion control features and the source is generally understood to be the Paducah Gaseous Diffusion Plant (personal communications with Tim Kreher, WKWMA Manager). Each pond is also susceptible to airborne deposition from two nearby coal-fired power plants.

A composite sediment sample was obtained at each of the ponds, from locations near the concrete rubble. Samples were divided and shipped to separate laboratories. TestAmerica Laboratories, Inc. of Earth City, Missouri, analyzed the samples for total metals. The Cabinet for Health and Family Services (CHFS) of Frankfort, Kentucky, analyzed the samples for radionuclides using alpha and gamma spectroscopy. The analytical results were compared to background soil/sediment values (Methods for Conducting Risk Assessments and Risk Evaluations, DOE 2016, Table A.4). All results were consistent with established background levels with the exception of two selenium values that were slightly higher than background. Both values for selenium (1.2 mg/L and 1.8mg/L) were slightly greater than the 0.8 mg/Kg background level, but less than the 3.3 – 3.6 mg/Kg reporting limit of the test.

Known anthropogenic sources of selenium include burning coal. Selenium is also sold as a health supplement. All other sediment results reported by the two laboratories were either non-detect or consistent with background soil/sediment levels for the surrounding area.

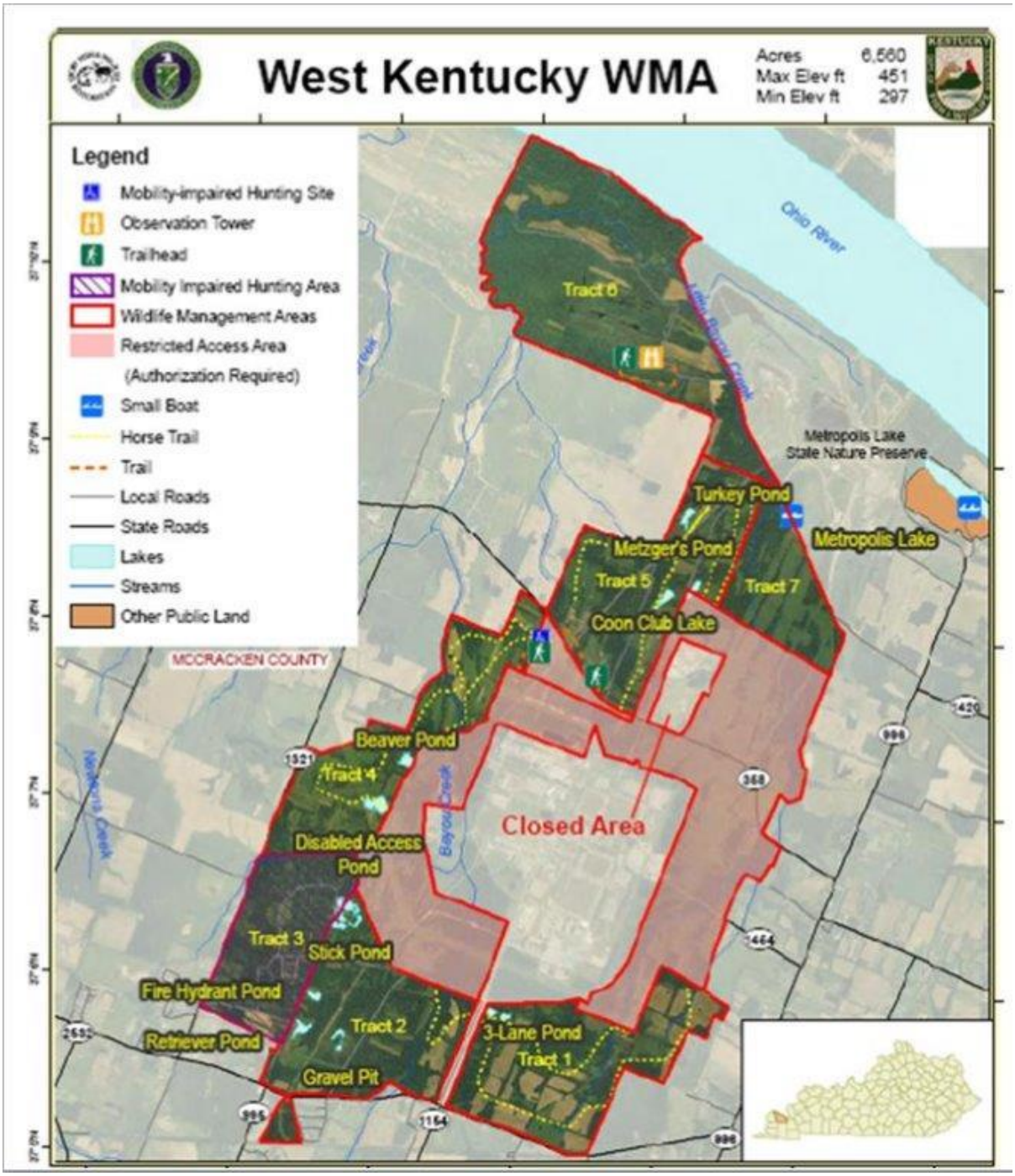


Figure 7. WKWMA Map

AIP Oversight Activities

During 2016 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. The following is a short list of oversight activities that were completed in 2016:

- 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 2016 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 1438 monitoring well evaluations were completed. The components assessed included the well padlock, outer casing condition, protective bollards and the concrete pad.

Participation in DOE Paducah Site Emergency Management Exercise

On October 19th the on-site AIP staff member, as part of the KY Environmental Response Team, participated in the DOE Paducah Site full-scale emergency management exercise. A response scenario exercise was conducted at the DUF6 facility, which had simulated a release of hydrofluoric acid (HF) during transfer operations. Prior to the arrival of the AIP staff member, the

release had been stopped and was contained in a building. Air monitoring was taking place along Dyke Road.

In conjunction with the incident at the DUF6 facility, there was a large fire at the C-741 Mobile Equipment Building and C-740B Oil Storage Building on the west side of the Plant. Mobile equipment and straw in C-741 were ablaze (simulated) and the fire was spreading to C-740B, where compressed gas cylinders were being threatened. Prior to the arrival of the AIP staff member, the fire had been extinguished and absorbent booms had been deployed.

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 was continued through 2016 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 2016 is as follows:

First Semi-Annual Sampling Event:

Sediment Basin Inlet, KPDES Outfall 001 and Iron Bridge Locations

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

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) KPDES Outfall 001 and Iron Bridge Locations (Annual)

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)

Results: TSS and pH

During the 2016 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 2016. Since completion of the (former) scrap metal removal project, the facility continues to cultivate and maintain a well-developed grass cover. It has been observed that there is a greater absorption of rainfall into the soil due to the vegetative cover and increased 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 DOW KPDES requirements.

Results: Uranium Metal, Uranium radionuclides and alpha and beta

The following is a presentation of the 2016 analytical results for the C-613 Sediment Basin:

2016 First Semi-Annual Sampling Event:

Results from the Discharge Event Samples Collected on February 26, 2016:

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)	340.0	0.23	N/A	170.0	0.23	N/A	48.0	0.23	N/A
Gross Alpha (pCi/L)	129.0	2.86	16.6	59.2	2.48	8.29	17.3	3.22	3.87
Gross Beta (pCi/L)	136.0	2.87	14.5	70.5	1.89	7.74	20.9	1.33	2.72
Uranium -234 (pCi/L)	61.6	0.2	5.70	25.8	0.11	2.49	8.82	0.07	0.97
Uranium -235 (pCi/L)	3.68	0.19	0.73	1.80	0.05	0.34	0.58	0.09	0.19

Uranium -238 (pCi/L)	103.0	9.2	9.20	44.30	0.09	4.05	14.10	0.06	1.42

2016 Second Semi-Annual Sampling Event:

Part 1 Results from the Non-Discharge Event Samples Collected on November 16, 2016:

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 the possible contaminant exposure to an average WKWMA recreator.

Analyte	**Basin Outlet (Outfall 001)**	MDL / MDC	Total Uncertainty (2σ +/-)	**Iron Bridge**	MDL / MDC	Total Uncertainty (2σ +/-)
Uranium Metal (µg/L)	1.0	0.40	N/A	0.92 J	0.40	N/A
Gross Alpha (pCi/L)	1.10	0.96	0.69	0.05 U	1.07	0.57
Gross Beta (pCi/L)	3.08	1.05	0.88	6.65	0.95	1.21
Uranium-234 (pCi/L)	0.34	0.14	0.17	0.25	0.17	0.15
Uranium-235 (pCi/L)	0.04 U	0.13	0.07	0.03 U	0.16	0.03
Uranium-238 (pCi/L)	0.55	0.06	0.21	0.29	0.18	0.16

Part 2 Results from the Discharge Event Samples Collected on December 13, 2016:

Analyte	**Basin Inlet**	MDL / MDC	Total Uncertainty (2σ +/-)	**Basin Outlet (Outfall 001)**	MDL / MDC	Total Uncertainty (2σ +/-)	**Iron Bridge**	MDL / MDC	Total Uncertainty
Uranium Metal (µg/L)	96.0	0.4	N/A	52.0	0.4	N/A	34.0	0.4	N/A
Gross Alpha (pCi/L)	24.9	1.31	3.78	14.6	0.99	2.41	10.3	1.05	1.96

Gross Beta (pCi/L)	57.9	0.85	6.10	39.9	0.81	3.80	25.2	0.71	2.83
Uranium-234 (pCi/L)	20.1	0.96	2.33	11.0	0.20	1.52	7.58	0.18	1.20
Uranium-235 (pCi/L)	1.75	0.18	0.55	0.70	0.25	0.25	0.42	0.13	0.27
Uranium-238 (pCi/L)	35.8	0.15	3.69	18.7	0.18	2.22	12.5	0.15	1.67

Sediment Basin sampling has been performed regularly since the Sediment Basin became operational. The following data was compiled from 2003 to 2016 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. Average Uranium metal (total) concentrations, Sediment Basin discharge volume, annual rainfall and percentage of annual rainfall for each year from 2003 through 2016 are as follows:

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

Annual Discharge: Not Applicable 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)

Observations:

The data reports that the concentration of uranium metal has historically decreased by roughly two-thirds between the inlet and Outfall 001. The average reduction in the concentrations of uranium for 2016 was approximately half. 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 2016 was approximately half, which is less than historical reductions. Although average inlet concentrations have varied during the fourteen-year reporting period, concentrations of metals and radionuclides at Outfall 001 from 2009 to 2014 generally trended downwards. 2016 reported an average outlet concentration of 111.0 µg/L, which was roughly fifty percent higher than 2015. The concentration of uranium during the first semi-annual

sampling event at the Iron Bridge (48.0 µg/L) was the fourth-highest ever recorded, the highest being (125.0 µg/L) in the fourth quarter of 2008.

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 of the fourteen years of data collected. The average outlet concentration of 111.0 µg/L for 2016 was the fourth-highest and was also slightly greater than the fourteen-year running average of 109.3 µg/L.

Conclusions:

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 investigation activities, continues to contribute to the off-site migration of metals and low-level radionuclides. Data show that operation of the Sediment Basin has a pronounced effect on reducing concentrations of metals, turbidity and radionuclide activity that leave the site. Therefore, Kentucky believes that the C-613 Sediment Basin is performing its prime function and should continue operation.

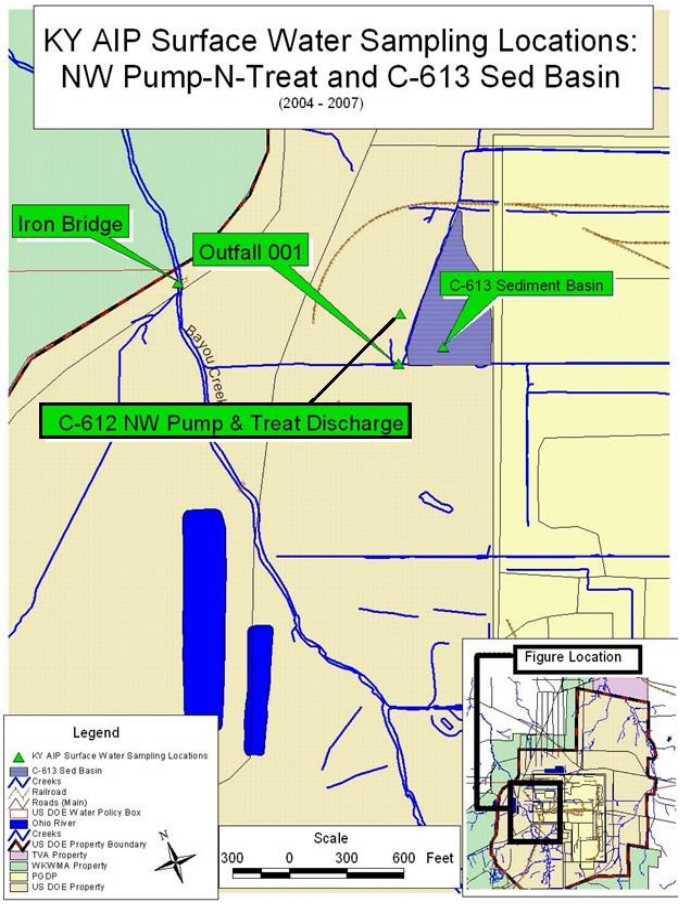


Figure 8. AIP Surface Water Sampling Locations: NW Pump and Treat and C-613 Sed Basin

Radiation Health Branch AIP Sampling

The Radiation Health Branch (RHB) has a robust environmental monitoring program, funded by the AIP, 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 1,594 samples and performed 1015 analyses on those samples. In addition, RHB conducted 389 analyses on 146 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 9). 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 2016, there were no abnormal measurements from RHB groundwater monitoring efforts.

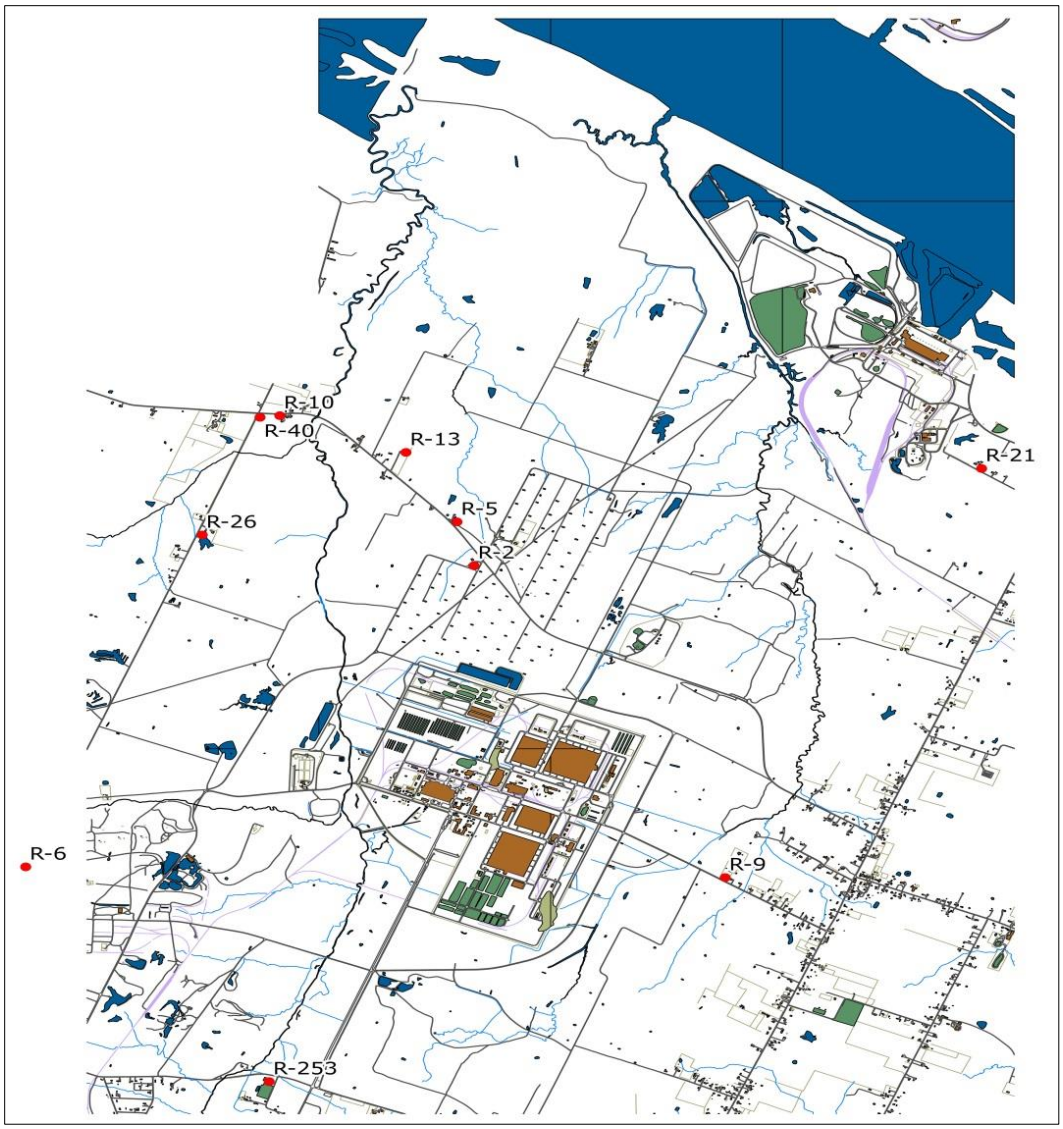


Figure 9. RHB Groundwater Monitoring Locations

Surface Water

RHB monitors surface water by taking quarterly samples at 28 locations surrounding the site (Figure 10) and through continuous sampling (e.g. ISCO) at an additional 8 locations (Figure 11). 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.

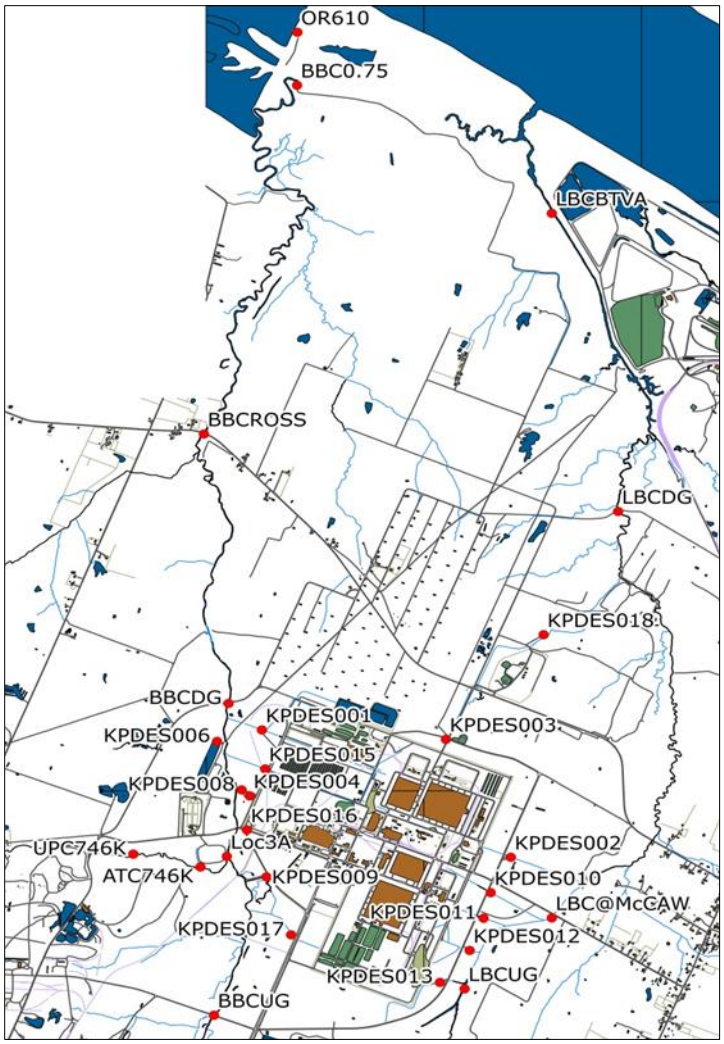


Figure 10. RHB Quarterly Surface Water Sampling Locations

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 10 and 11). 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 at KPDES outfall 020, leaving the C-746-U solid waste landfill, in surface water. This contamination was determined to be sourced from recently

removed paneling from the C-340 demolition that had high levels of surface contamination by a mobile uranium compound (likely uranyl fluoride (UO2F2) In response, RHB began monitoring 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, significantly lowering the levels of contamination. Future results are expected to be comparable to background at current landfill inventory, but monitoring will continue.

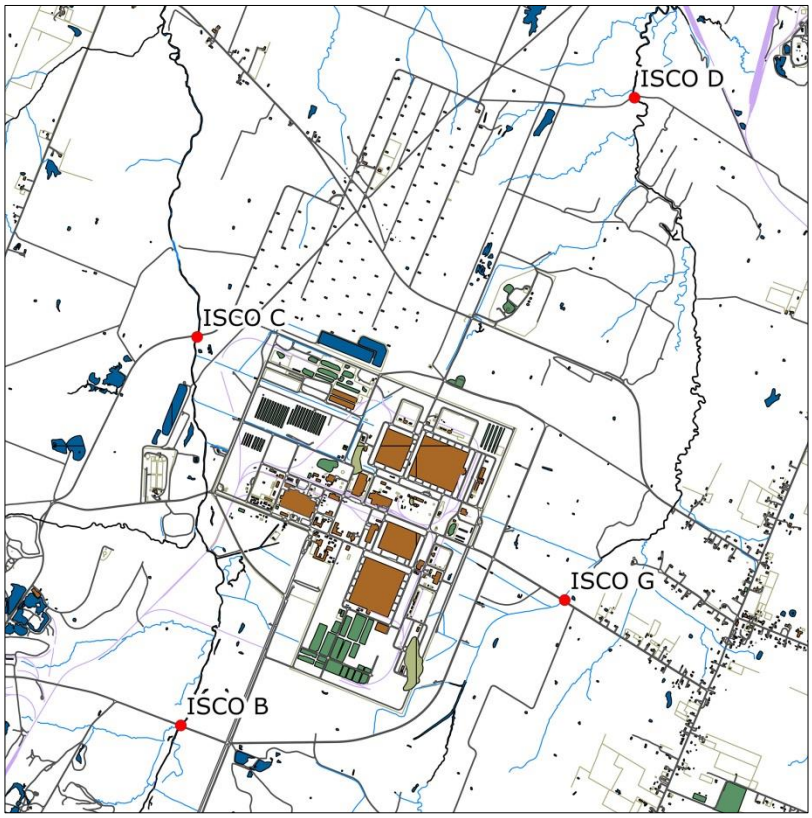


Figure 11. RHB ISCO Sampling Locations

In 2016, 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 12) 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 2016, there were no observed abnormal measurements from RHB air monitoring efforts.

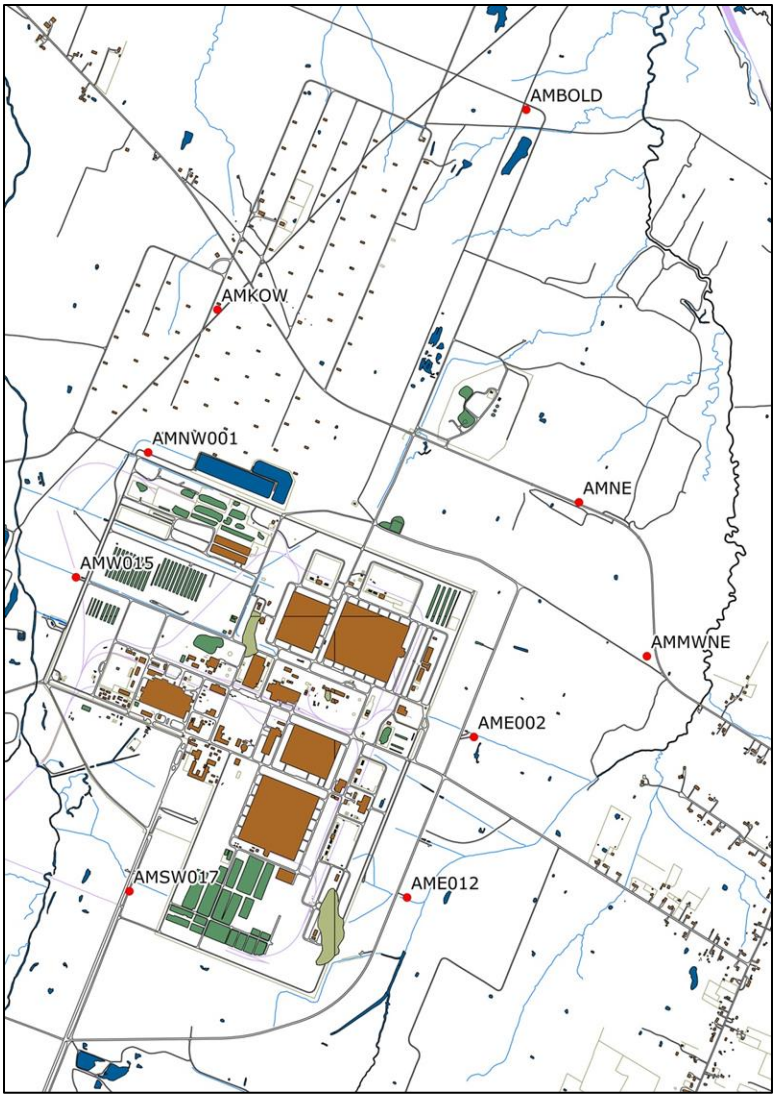


Figure 12. RHB Air Monitoring Locations

Kentucky FFA Program Elements for 2016

Surface Water Operable Unit

The SWOU is comprised of thirty-one (31) Solid Waste Management Units (SWMUs) which have likely contributed contamination to the creeks that receive surface water runoff from the PGDP.

The three parties plan to sequence the offsite portion of the SWOU to after the completion of D&D, so that the possibility of recontamination is low.

Surface Water OU Documents reviewed in 2016:

No SWOU documents were reviewed in 2016.

Groundwater Operable Unit

Northeast Plume Containment System (Pump-and-Treat)

The Northeast plume containment system is operated to contain the higher concentration portions of the Northeast Plume. Two groundwater extraction wells, pumping at a combined average rate of 170 gpm, send water to an air stripper, which treats the water to less than the MCL of 5 ppb trichloroethene. Once it is treated, the water is discharged to a CERCLA outfall that flows to Little Bayou Creek. The extraction wells are located approximately 3000 feet northeast of the PGDP facility, near the crossing of Little Bayou Creek and Ogden Landing Road.

In 2016 the Northeast Plume system pumped 102,028,443 gallons of water from the two extraction wells which resulted in the removal of 8.3 gallons of TCE. Since Northeast Plume pumping operations began on Feb. 28, 1997, approximately 309.7 gallons of TCE have been removed from 1,636,119,920 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 2016 (Table 2).

In 2013 the FFA parties began a project to optimize the Northeast plume containment system. A Remedial Action Work Plan, an Operation and Maintenance Plan and an Explanation of Significant Difference (to the 1995 Record of Decision for Interim Remedial Action) were submitted and commented on. An effluent treatment standard (goal) for Tc-99 became a point of contention and DOE invoked informal dispute in November 2013. The dispute was eventually resolved in 2015. To satisfy the terms of the dispute resolution, DOE installed in July, August and September, a line of seven sentinel wells approximately 400 feet east of C-400 to be routinely monitored for TCE and Tc-99. These wells will provide baseline concentrations and an early warning in the event that Tc-99 is pulled east (away) from the C-400 area once the two new

extraction wells are operational. An early warning system will allow the FFA parties time to develop a solution to that problem before the Tc-99 would make it to the new extraction wells. The first set of samples were taken Oct. 4.

Month	% Operational	Gallons	Month	% Operational	Gallons
January	100	9,659,300	July	99.2	8,427,900
February	100	9,043,500	August	92.7	7,924,500
March	100	9,540,000	September	100	8,001,125
April	100	8,921,967	October	98.7	7,574,775
May	83.1	7,495,732	November	99.9	8,781,800
June	98.3	7,944,901	December	100	8,712,943

Table 2. Northeast Plume Containment System Data

Northeast Plume Optimization Documents Reviewed In 2016:

Record of Decision for Interim Remedial Action at the Northeast Plume – Explanation of Significant Differences *DOE/LX/07*-1291&D2/R2 (FFA approval on 01-13-16)

Public notice of availability of the Record of Decision for Interim Remedial Action at the Northeast Plume – Explanation of Significant Differences *DOE/LX/07*-1291&D2/R2

Remedial Action Work Plan for Optimization of the Northeast Plume Interim Remedial Action *DOE/LX/07-1280&D2/R2* Kentucky concurrence on 3-8-16.

Addendum to the Remedial Action Work Plan for Optimization of the Northeast Plume Interim Remedial Action, Appendix D, Quality Assurance Project Plan, *DOE/LX/07-1280&D2/R2/A1* Kentucky provided comments on 3-9-16.

Addendum to the Remedial Action Work Plan for Optimization of the Northeast Plume Interim Remedial Action, Appendix D, Quality Assurance Project Plan, *DOE/LX/07-1280&D2/R3* Kentucky concurred on 5-20-16.

Figure 13. Northeast Plume Transect Well Drilling Operation (MW524)

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. The system was shut down in Dec. 2015 and Jan. 2016 for piping upgrades. This was the culmination of a major refurbishing and upgrade of the system. In 2016 the northwest plume system pumped 92,438,865 gallons of water from the two extraction wells which resulted in the removal of 134.9 gallons of TCE. Since northwest plume pumping operations began on Aug. 28, 1995, approximately 3,423.3 gallons of TCE have been removed from 2,099,823,862 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 2016 (Table 3).

Month	% Operational	Gallons	Month	% Operational	Gallons
January	0	0	July	97.2	8,566,208
February	91.7	7,480,739	August	100	8,825,153
March	98.1	8,634,510	September	100	8,532,185
April	100	8,281,157	October	100	8,818,615
May	96.5	8,365,973	November	100	8,515,550
June	98.9	7,772,960	December	99.5	8,690,814

Table 3. Northwest Plume Groundwater System Data

Northwest Plume Groundwater System Documents Reviewed In 2016:

No documents were submitted for review in 2016.

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 is on-going. Six monitoring wells and eleven soil borings were installed in spring 2016. After the ground had cooled sufficiently, post treatment sampling to verify the VOC concentrations remaining in the soil was performed.

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.

Southwest Plume Sources Documents Reviewed in 2016:

Addendum to the Final Characterization Report for SWMUs 211A and 211B Volatile Organic Compound Sources for the Southwest Groundwater Plume (*DOE/LX/07-1288&D2/A1)* Kentucky commented on 03-05-16.

Addendum to Final Characterization Report for SWMUs 211-Aand 211-B Volatile Organic Compound Sources for the Southwest Groundwater Plume (*DOE/LX/07-128&D2/A1/R1)* Kentucky approved on 5-23-16.

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&D1)* Kentucky provided comments on 11-30-16.

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.

Electrical Resistance Heating (ERH) was selected in an August 2005 ROD as the technology best suited to remediate subsurface TCE contamination at C-400. ERH relies upon electrical current and vapor extraction wells to heat and then remove volatile contaminants such as TCE from the subsurface. ERH was first demonstrated at PGDP during a treatability study in 2003 where approximately 1,900 gal of TCE was removed in the vicinity of a historic pipeline leak associated with C-400. During Phase I of the C-400 remediation project, ERH proved to be well suited to remediating contaminated soils near the surface; however, the technology was found to be less effective within the deeper portions (60 to 100 ft. bgs) of the contaminated Regional Gravel Aquifer (RGA). When it became clear that another approach was needed to address TCE present in the deeper portions of the RGA a decision was made to divide Phase II of the C-400 remedial action into two parts. In 2014 ERH operations conducted during Phase IIa effectively treated near-surface contaminated soils by removing over 1,100 gal of TCE.

DOE chose to undertake a treatability study of steam enhanced extraction (SEE) in a small uncontaminated area located adjacent and up-gradient to the C-400 Phase IIb treatment area. The treatability study was developed by a collaborative approach in order to determine if steam will advance through the RGA enough to effectively and economically remove TCE within the lower RGA.

Phase IIb

The D2 Treatability Study Report for the Steam Injection (Phase IIb) was submitted on May 10, 2016. The study was designed “to observe the movement and distribution of steam using varying injection depths, rates, and pressures and provide data to refine the estimates of permeability, anisotropy/heterogeneity, local extraction (well spacing, locations, steam injection rates, and timing), to assess the technical implementability, and cost-effectiveness of steam injection.”

Steam-enhanced extraction (SEE) is a combination of steam injection and multiphase extraction technology used to remediate the subsurface by removing volatile and semi-volatiles sources of contamination. Steam injected into a target source area volatilizes and mobilizes contaminants which are then collected and removed by a dual-phase extraction system. Once the contaminants are at the surface they are captured.

The injection and monitoring points were constructed near the southeast corner of the C-400 Building. The system consisted of 10, 6-inch diameter drilled monitoring points laid out in an increasing radial distance from the injection point. The injection points consisted of two nested steam injection wells to allow for injection at the lower and upper screened intervals simultaneously.

Field data obtained during the study was compared to model calibration results which indicated a moderate to high permeability, high anisotropy, and lateral heterogeneity. The RGA within the area of study consisted of an upper zone and lower zone with hydraulic conductivity of approximately 100 ft/day and 300 ft/day respectively. Isolated zones and lenses of lower conductivity materials are present throughout the study area.

Characterization data collected during the Phase IIb treatability study was inserted into multiple 2-D and 3-D computer models to evaluate variations in SEE design components necessary to optimize and predict full-scale SEE implementation. The results of the study support steam injection as a technically implementable technology to achieve in-situ TCE contamination source removal. Based on field data and modeling results a conceptual design for full-scale implementation was developed by DOE.

C-400 IRA Documents Reviewed In 2016:

D1 Revised Proposed Plan for the Volatile Organic Compound Contamination at the C-400 Cleaning Building Informal Dispute FFA Milestone Modification Request, *(DOE-2407&D1)* dated November 30.

D1 Revised Proposed Plan for the Volatile Organic Compound Contamination at the C-400 Cleaning Building Informal Dispute FFA Milestone Modification Request, *(DOE-2407&D1)* dated November 9.

D1 Revised Proposed Plan for the Volatile Organic Compound Contamination at the C-400 Cleaning Building DOE Invocation of Informal Dispute, *(DOE-2407&D1)* dated October 11.

D1 Revised Proposed Plan for the Volatile Organic Compound Contamination at the C-400 Cleaning Building FFA Milestone Modification Request, *(DOE-2407&D1)* dated September 6.

D2 Treatability Study Report for the C-400 Interim Remedial Action Phase IIB Steam Injection Treatability Study, *(DOE/LX/07-2202&D2)* dated May 10, Kentucky approved May 27.

D1 Treatability Study Report for the C-400 Interim Remedial Action Phase IIB Steam Injection Treatability Study DOE Extension Request, *(DOE-2202&D1)* dated 4/28/2016, Kentucky commented on May 10.

D1 Treatability Study Report for the C-400 Interim Remedial Action Phase IIB Steam Injection Treatability Study, *(DOE-2202&D1)* dated May 6.

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 was approved on Feb.29, 2016 by Kentucky and March 8, 2016 by EPA. The public notice for the Proposed Plan was issued on March 18, 2016. The PGDP CAB requested a 30-day extension on the public comment period. The deadline for submittal of the D1 Record of Decision is 2017.

SWMUs 2, 3, 7 and 30

The *D2 Feasibility Study for SWMUs 2, 3, 7 and 30 of the Burial Grounds OU* remained in formal dispute at the Dispute Resolution Committee (DRC) level throughout 2016.

SWMU 4

SWMU 4 is being investigated using a phased approach to sample collection, with each subsequent phase being 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* was submitted to Kentucky and EPA on August 2, 2016. Kentucky provided comments on Oct 31, 2016.

BGOU Documents Reviewed in 2016:

Proposed Plan for the Burial Grounds Operable Unit Source Areas at the PGDP, Solid Waste Management Units 5 and 6, *(DOE/LX/07-1275&D2/R1).* Kentucky approved on March 8, 2016.

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/A1).* Kentucky provided comments on Oct. 31, 2016.

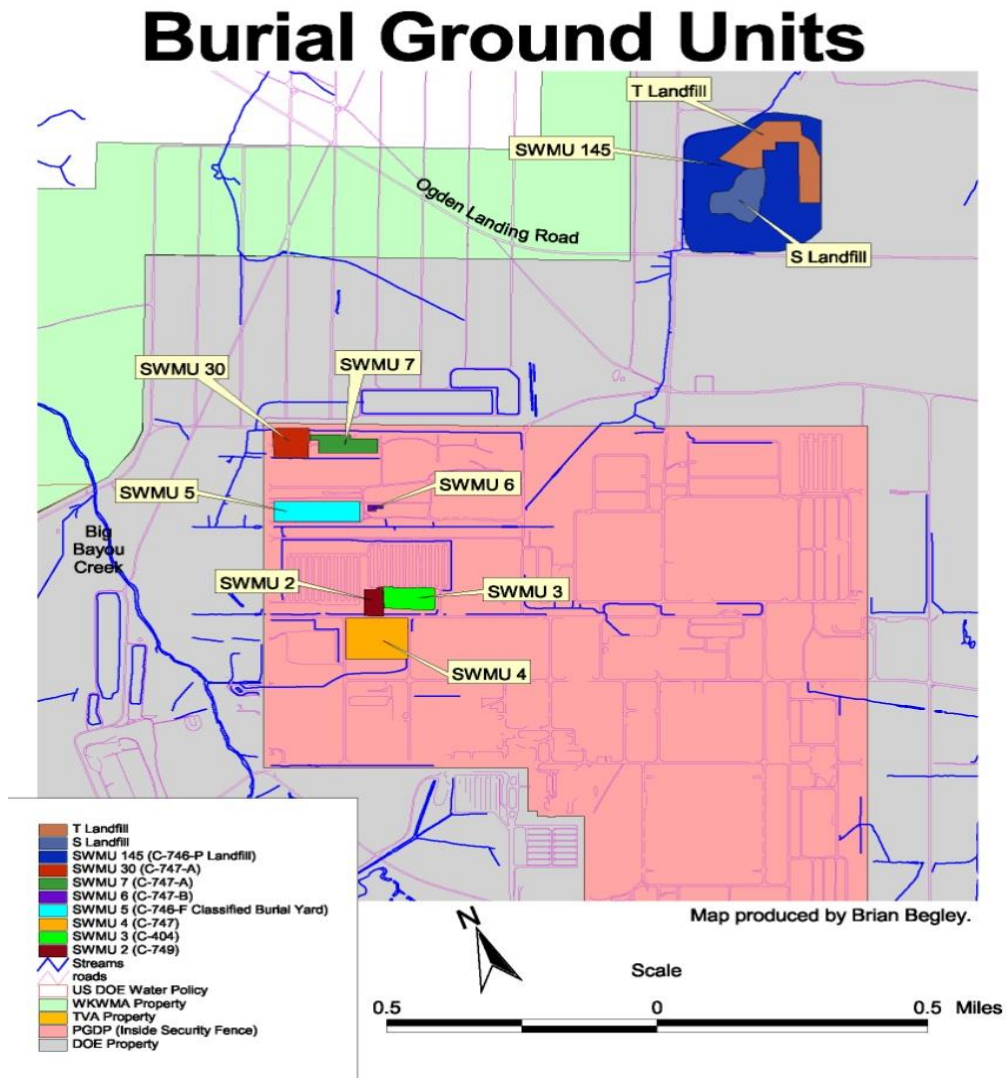


Figure 14. Burial Ground SWMUs

Soils Operable Unit

The *Soils Operable Unit Remedial Investigation 2 Report* D2 was issued on March 28, 2016. Kentucky and EPA concurred on the D2 April 26 and May 18, respectively.

SWMU 27

SWMU 27, an underground storage tank located beside the C-720 building, was opened and sampled according to the *Addendum to the Work Plan for the Soils OU RI/FS Remedial*

Investigation 2 Sampling and Analysis Plan in 2015. *The Addendum to the Soils Operable Unit Remedial Investigation Report for SWMU 27 D2/R1/A1* was approved by Kentucky and EPA on March 14 and March 18, respectively. A path forward to address removal of the contents of SWMU 27 via a time critical removal action was defined and approved on Feb.12. A D1 removal notification was issued to the regulators on June 21. EPA and Kentucky commented on July 20, and July 22. The removal notification was revised and reissued as a D2 on Sept. 8. Kentucky and EPA concurred on Sept. 9. The contents of the tank were removed, to the extent practicable, September 13 through 21. DOE advertised a public notification of the availability of the public record for SWMU 27 Time Critical Removal Action in the Oct. 16, 2016 Paducah Sun. After the 30 day public comment period closed, DOE notified EPA and Kentucky that no comments had been received.

SWMU 229

After completing RI activities in 2015 at SWMU 229, a former outside DMSA in the northwest corner of the plant, DOE issued an Addendum to the Soils OU RI2 for SWMU 229 on March 18, 2016. EPA and Kentucky provided comments on June 14 and June 15, respectively. The D2 Addendum was issued on August 12. Kentucky concurred on Sept. 9 and EPA conditionally concurred on Nov. 17. After meetings and discussions to address EPA's conditions, DOE provided a revised Addendum on Dec. 19.

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 4 feet of soil that been removed from the treatment area and from the access route to the treatment area was replaced. These areas were 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 is expected in early 2017.

Soils Operable Unit Documents Reviewed in 2016:

Soils Operable Unit Remedial Investigation 2 Report, *(DOE/LX/07-2306&D2)* Kentucky concurred on April 26.

Addendum to the Soils OU Remedial Investigation Report for SWMU 27, *(DOE/LX/07-0358&D2/R1/A1)* Kentucky concurred on March 14.

Removal Notification for Solid Waste Management Unit 27 (*DOE/LX/07-2406&D1)* Kentucky commented on July 20.

Removal Notification for Solid Waste Management Unit 27 (*DOE/LX/07-2406&D2)* Kentucky concurred on Sept. 9.

Addendum to the Soils Operable Unit Remedial Investigation 2 Report for Solid Waste Management Unit 229, (*DEO/LX/07-2306&d2/A1)* Kentucky provided comments on June 15.

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 is the last of the inactive facilities to be addressed under this Operable Unit.

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.

D&D Documents Reviewed in 2016:

Removal Action Report for the C-410 Complex Infrastructure Decontamination and Decommissioning Project at the PGDP, *(DOE/LX/07-2182&D1)* Kentucky approved on June 9.

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 DOE generated CERCLA waste disposal alternatives feasibility study, currently under review and dispute by Kentucky and U.S. EPA.

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.

Waste Disposition Alternatives Documents Reviewed in 2016:

No WDA documents were reviewed in 2016.

Solid Waste Management Units (SWMUs)

During the reporting period from January 1 to December 31, 2016, Kentucky received no Revised Solid Waste Management Unit Reports (SARs) and granted No Further Action (NFA) status to four SWMUs. 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 PGDP Permit.

REVISED AND NEWLY-DISCOVERED SWMU ASSESSMENT REPORTS SUBMITTED TO KENTUCKY BETWEEN JANUARY 1 AND DECEMBER 31, 2016

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

SOLID WASTE MANAGEMENT UNITS THAT KENTUCKY GRANTED NO FURTHER ACTION STATUS BETWEEN JANUARY 1 AND DECEMBER 31, 2016

SWMU Number	Description	(Former) OU Location	(Former) Sub-project	Status	SAR Report Date	Date(s) SAR Amended	Date of NFA
494	Ash Receiver Area in C-410/420	D&D	C-410 Inactive Facilities	NFA	12/10/2001	N/A	6/3/2016
495	C-410-I Ash Receiver Shed	D&D	C-410 Inactive Facilities	NFA	12/26/2001	N/A	6/3/2016
496	C-410 Fluorine / Hydrogen Filters (Northeast Mezzanine)	D&D	C-410 Inactive Facilities	NFA	12/11/2001	N/A	6/3/2016
497	C-410/420 F2 Cell Neutralization Room Vats	D&D	C-410 Inactive Facilities	NFA	12/11/2001	N/A	6/3/2016

Note: NFA was granted via approval (KDWM on 6/3/16 and EPA on 6/9/16) of the *Removal Action Report for the C-410 Complex Infrastructure D & D Project* (2182&D1).

SWMU DOCUMENTS REVIEWED IN 2016

In 2016, no SAR Revisions were submitted and no newly-discovered SWMUs were reported. At the end of the reporting period, no SARs were under review.