Department of Energy

Portsmouth/Paducah Project Office
1017 Majestic Drive, Suite 200
Lexington, Kentucky 40513
(859) 219-4000

December 29, 2022

Mr. Brian Begley
Federal Facility Agreement Manager
Division of Waste Management
Kentucky Department for Environmental Protection
300 Sower Boulevard, 2nd Floor
Frankfort, Kentucky 40601

PPPO-02-10022539-23C

Mr. Victor Weeks
Federal Facility Agreement Manager
U.S. Environmental Protection Agency, Region 4
61 Forsyth Street
Atlanta, Georgia 30303

Dear Mr. Begley and Mr. Weeks:

SIGNED EXPLANATION OF SIGNIFICANT DIFFERENCES TO THE RECORD OF DECISION FOR SOLID WASTE MANAGEMENT UNITS 1, 211-A, 211-B, AND PART OF 102 VOLATILE ORGANIC COMPOUND SOURCES FOR THE SOUTHWEST GROUNDWATER PLUME AT THE PADUCAH GASEOUS DIFFUSION PLANT, PADUCAH, KENTUCKY, DOE/LX/07-2480&D2

References:

1. Letter from B. Begley to T. Duncan, "RE: Concurrence with the Explanation of Significant Differences to the Record of Decision for Solid Waste Management Units 1, 211-A, 211-B and Part of 102 Volatile Organic Compound Sources for the Southwest Groundwater Plume (DOE/LX/07-2480&D2), Paducah Site, Paducah, McCracken County, Kentucky, KY8-890-008-982," dated December 5, 2022
2. E-mail from V. Weeks to B. Begley, "DOE-EPA signed ESD," dated December 2, 2022
3. Letter from T. Duncan to B. Begley and V. Weeks, "Transmittal of the Explanation of Significant Differences to the Record of Decision for Solid Waste Management Units 1, 211-A, 211-B, and Part of 102 Volatile Organic Compound Sources for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/LX/07-2480&D2," (PPPO-02-10022539-23B), dated November 28, 2022

Please find enclosed the signed *Explanation of Significant Differences to the Record of Decision for SWMUs 1, 211-A, 211-B, and Part of 102 Volatile Organic Compound Sources for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant Paducah, Kentucky*, DOE/LX/07-2480&D2 (ESD).

The enclosed and signed ESD documents the U.S. Environmental Protection Agency's approval of and the Kentucky Department for Environmental Protection's concurrence with the ESD.

If you have any questions or require additional information, please contact Richard Bonczek at (859) 219-4051.

Sincerely,

TRACEY DUNCAN

Digitally signed by TRACEY DUNCAN
Date: 2022.12.29 07:53:34 -06'00'

Tracey Duncan
Federal Facility Agreement Manager
Portsmouth/Paducah Project Office

Enclosure:
Signed ESD to the Record of Decision for Solid Waste Management Units 1, 211-A, 211-B, and Part of 102 Volatile Organic Compound Sources for the Southwest Groundwater Plume

Administrative Record File—SWP-PD

cc w/enclosure:
abigail.parish@pppo.gov, PPPO
april.ladd@pppo.gov, PPPO
april.webb@ky.gov, KDEP
arcorrespondence@pad.pppo.gov
bart.schaffer@ky.gov, KDEP
brian.begley@ky.gov, KDEP
bruce.ford@pad.pppo.gov, FRNP
bryan.clayton@pad.pppo.gov, FRNP
bwhatton@tva.gov, TVA
christopher.travis@ky.gov, KDEP
dcnorman0@tva.gov, TVA
eric@pgdpcab.org, CAB
frnpcorrespondence@pad.pppo.gov
hjlawrence@tva.gov, TVA
jennifer.woodard@pppo.gov, PPPO
joe.tarantino@pad.pppo.gov, FRNP
joel.bradburne@pppo.gov, PPPO
kentuckyes@fws.gov
kristan.avedikian@TechLawinc.com, EPA
leanne.garner@pad.pppo.gov, FRNP
leo.williamson@ky.gov, KDEP
mac.mcrae@TechLawinc.com, EPA
myrna.redfield@pad.pppo.gov, FRNP
nathan.garner@ky.gov, KYRHB
pad.rmc@pad.pppo.gov
rebecca.goodman@ky.gov, KEEC
richard.bonczek@pppo.gov, PPPO
sebenton@tva.gov, TVA
stephaniec.brock@ky.gov, KYRHB
tammi.hudson@ky.gov, KDEP
testher@tva.gov, TVA
thhenry@tva.gov, TVA
timothy.kreher@ky.gov, KDFWR
tracey.duncan@pppo.gov, PPPO
weeks.victor@epa.gov, EPA

DOE/LX/07-2480&D2
Primary Document

Explanation of Significant Differences to the Record of Decision for Solid Waste Management Units 1, 211-A, 211-B, and Part of 102 Volatile Organic Compound Sources for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

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DOE/LX/07-2480&D2
Primary Document

Explanation of Significant Differences to the Record of Decision for Solid Waste Management Units 1, 211-A, 211-B, and Part of 102 Volatile Organic Compound Sources for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

Date Issued—November 2022

U.S. DEPARTMENT OF ENERGY
Office of Environmental Management

Prepared by
FOUR RIVERS NUCLEAR PARTNERSHIP, LLC,
managing the
Deactivation and Remediation Project at the
Paducah Gaseous Diffusion Plant
under Contract DE-EM0004895

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PREFACE

The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) requires changes made to remedial actions that are proposed after the adoption of a signed Record of Decision (ROD) be documented using one of the following three processes: (1) ROD Amendment if the change "fundamentally alters" basic features of the remedy; (2) Explanation of Significant Differences (ESD) if the change to a component of the remedy does not fundamentally alter the overall cleanup approach; or (3) Memorandum to File if the proposed changes to the remedy are minor. The proposed changes to the Solid Waste Management Unit (SWMU) 211-A remedial action, an increase in the area and volume of treated soil and a resulting significant increase in the cost of the remedial action, do not "fundamentally alter" the basic features of the remedy as presented in the ROD, but are "significant" changes that require the development of an ESD. This *Explanation of Significant Differences to the Record of Decision for Solid Waste Management Units 1, 211-A, 211-B, and Part of 102 Volatile Organic Compound Sources for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-2480&D2, was prepared in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act, Section 117 (c); 40 *CFR* § 300.435(c)(2)(i) of the NCP; and *A Guide to Preparing Superfund Proposed Plans, Records of Decision, and other Remedy Selection Decision Documents*, EPA 540-R-98-031, July 1999. It provides the public with information to understand the significant differences between the remedial action, as implemented, and the approach proposed in the *Record of Decision for Solid Waste Management Units 1, 211-A, 211-B, and Part of 102 Volatile Organic Compound Sources for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0365&D2/R1 (DOE 2012).

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FIGURES

TABLE

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ACRONYMS

ARAR	applicable or relevant and appropriate requirement
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
DOE	U.S. Department of Energy
EISB	enhanced *in situ* bioremediation
EPA	U.S. Environmental Protection Agency
ESD	Explanation of Significant Differences
FC	final characterization
FFA	Federal Facility Agreement
FFS	focused feasibility study
FY	fiscal year
KDEP	Kentucky Department for Environmental Protection
LUC	land use control
MW	monitoring well
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
O	order
OU	operable unit
PGDP	Paducah Gaseous Diffusion Plant
PTW	principal threat waste
RAO	remedial action objective
RAWP	remedial action work plan
RCRA	Resource Conservation and Recovery Act
RDR	remedial design report
RDSI	remedial design support investigation
RGA	Regional Gravel Aquifer
ROD	Record of Decision
SMP	site management plan
SWMU	solid waste management unit
TBC	to be considered
UCRS	Upper Continental Recharge System
VOC	volatile organic compound

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EXECUTIVE SUMMARY

The U.S. Department of Energy (DOE) has prepared this Explanation of Significant Differences (ESD) to document significant differences between the remedial action selected in the Record of Decision (ROD) for Solid Waste Management Unit (SWMU) 211-A at the Paducah Gaseous Diffusion Plant (PGDP) and the revised remedial action described in this ESD that will be implemented. The differences are an increase in the area and volume of treated soil, and a resulting significant increase in cost for the action. SWMU 211-A is one of two areas associated with the Southwest Plume that is located near the C-720 Maintenance & Storage Building.

The ROD was signed by DOE and the U.S. Environmental Protection Agency in March 2012 (DOE 2012). The Kentucky Department for Environmental Protection concurred with the selected remedy. The selected remedy for SWMU 211-A includes the following:

- A final characterization (FC)/remedial design support investigation (RDSI) of the extent and magnitude of contamination present in the subsurface soils.

- A review of the data by the Federal Facility Agreement (FFA) parties and subsequent selection of either Alternative 8, *In Situ* Source Treatment Using Enhanced *In Situ* Bioremediation with Interim LUCs; or Alternative 2, Long-term Monitoring with Interim LUCs.

Review of the final characterization data by the FFA parties resulted in the final remedy selection of Alternative 8, *In Situ* Source Treatment Using Enhanced *In Situ* Bioremediation with Interim LUCs, for SWMU 211-A, and required an increase in the area and volume of soil to be treated at SWMU 211-A, which resulted in an increase in the number of injection and monitoring wells. While the basic features of the selected remedy with respect to scope and performance did not change, the increase in area and volume of soil to be treated resulted in a procured remedial action cost of approximately $10M compared to the estimated remedial action cost provided in the ROD of $3.7M. The expanded treatment area will ensure the remedy adequately covers the full nature and extent of the targeted level of contamination. This expanded treatment area does not change the overall cleanup approach; is necessary to ensure protection of human health and the environment; complies with the identified applicable or relevant and appropriate requirements (ARARs)/to be considered category; and achieves remedial action objectives identified in the ROD.

In August 2017, the FFA parties signed the *Memorandum of Agreement on the C-400 Complex under the Federal Facility Agreement for the Paducah Gaseous Diffusion Plant*, *Paducah, Kentucky* (DOE 2017a), which established that all projects, with the exception of C-400 and Southwest Plume SWMU 211-A, would be resequenced in the fiscal year (FY) 2018 site management plan (SMP) (DOE 2017b). Because of that agreement, this ESD will only focus on the planned remedial activity for SWMU 211-A. SWMU 211-B will not be included in this ESD, and the remedial action for SWMU 211-B will be reevaluated as part of the C-720 Complex as described in the FY 2022 SMP (DOE 2021b).

In a September 2021 Memorandum of Agreement (DOE 2021c), the FFA parties agreed to resolve the informal dispute for the SWMU 211-A Remedial Action Work Plan (DOE 2021a), and specifically that the effluent limits in 902 *KAR* 100:019 § 44 regulations and DOE Order (O) 5400.5 (replaced with DOE O 458.1, Radiation Protection of the Public and the Environment) identified in Table A.2, Action-Specific ARARs for the Oil Landfarm and the C-720 Northeast and Southeast Sites, of the ROD (DOE 2012) were not necessary for implementation of the remedial action for SWMU 211-A since these requirements are not being used to determine radionuclide effluent limits for discharge of wastewater generated by this remedial action. Wastewater containing trichloroethene (TCE) and other volatile organic compounds (VOCs) will

be treated at a wastewater treatment unit located at the PGDP and discharged through a Kentucky Pollutant Discharge Elimination System outfall unless transferred off the PGDP Facility for disposition in accordance with applicable requirements. The wastewater treatment system is designed to remove TCE and technetium-99 using air stripping and ion exchange technologies, respectively, (DOE 2021d) but will also treat other VOCs, some metals, and other radionuclides.

In April 2022, DOE prepared a memorandum that: (1) documented the FFA parties' historical discussions and agreements concerning the path forward for the use of two ARARs identified in the ROD (DOE 2012); (2) provided clarification for the Southwest Plume Sources Post-decision File of the Administrative Record use of the ARARs with respect to the Southwest Plume Sources Comprehensive Environmental Response, Compensation, and Liability Act remedial actions; and (3) documented the FFA parties' agreement that a modification to the 2012 ROD is not required. The memorandum can be found in the Southwest Plume Post-Decision File of the Administrative Record at https://eic.pad.pppo.gov/ (DOE 2022a).

1. INTRODUCTION AND PURPOSE

The U.S. Department of Energy (DOE) is conducting cleanup activities at the Paducah Gaseous Diffusion Plant (PGDP) under its environmental management program. Cleanup efforts are necessary to address contamination resulting from past waste-handling and disposal practices at the plant. The cleanup activities comply with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and Resource Conservation and Recovery Act (RCRA) in accordance with the Federal Facility Agreement (FFA) (EPA 1998).

The remedy selected for Solid Waste Management Unit (SWMU) 211-A at the C-720 Maintenance & Storage Building is documented in the *Record of Decision for Solid Waste Management Units 1, 211-A, 211-B, and Part of 102 Volatile Organic Compound Sources for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0365&D2/R1 (ROD) (DOE 2012). The ROD specified that the selected remedy for SWMU 211-A includes the following:

- A final characterization (FC)/remedial design support investigation (RDSI) of the extent and magnitude of contamination present in the subsurface soils.

- A review of the data by the FFA parties and subsequent selection of either Alternative 8, *In Situ* Source Treatment Using Enhanced *In Situ* Bioremediation with Interim LUCs; or Alternative 2, Long-term Monitoring with Interim LUCs (DOE 2012).

The final remedial action selected for SWMU 211-A is Alternative 8, *In Situ* Source Treatment Using Enhanced *In Situ* Bioremediation with Interim LUCs. The FFA parties made the final remedy selection following the completion of the final characterization as part of the RDSI in 2012–2013; completion of additional groundwater characterization in July 2015; identification of DOE's chosen remedy based on foregoing studies in December 2015 (DOE 2015); and issuance of an addendum to the final characterization report (DOE 2016). Remedial action selection was presented to the FFA parties on May 23, 2018; the presentation can be reviewed at https://eic.pad.pppo.gov/ (DOE 2018). A remedial design report (RDR) (DOE 2019) and a remedial action work plan (RAWP) (DOE 2021a) have been developed and approved by the FFA parties. Both the RDR and the RAWP will be used to implement the selected remedial action.

Review of the final characterization data by the FFA parties resulted in the final remedy selection of Alternative 8, *In Situ* Source Treatment Using Enhanced *In Situ* Bioremediation with Interim LUCs, for SWMU 211-A. The final remedy required an increase in the area and volume of soil to be treated at SWMU 211-A, which resulted in an increase in the number of injection and monitoring wells (MWs). While the basic features of the selected remedy with respect to scope and performance did not change, the increase in area and volume of soil to be treated resulted in a procured remedial action cost of approximately $10M, as compared to the estimated remedial action cost provided in the ROD of $3.7M. The expanded treatment area will ensure the remedy adequately covers the full nature and extent of the targeted contamination. This expanded treatment area does not change the overall cleanup approach, is necessary to ensure the protection of human health and the environment, complies with the identified applicable or relevant and appropriate requirements (ARARs)/to be considered (TBC) category, and achieves the remedial action objectives (RAOs) identified in the ROD.

In August 2017, the FFA parties signed the *Memorandum of Agreement on the C-400 Complex under the Federal Facility Agreement for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2017a) which established that all projects, with the exception of C-400 and Southwest Plume SWMU 211-A, would be resequenced in the fiscal year (FY) 2018 site management plan (SMP) (DOE 2017b). Because of that agreement, this Explanation of Significant Differences (ESD) will only focus on the planned remedial

activity for SWMU 211-A. SWMU 211-B will not be included in this ESD, and the remedial action for SWMU 211-B will be reevaluated as part of the C-720 Complex, as described in the FY 2022 SMP (DOE 2021b).

In a September 2021 Memorandum of Agreement (DOE 2021c), the FFA parties agreed to resolve the informal dispute for the SWMU 211-A RAWP and specifically that the effluent limits in 902 *KAR* 100:019 § 44 regulation and DOE Order (O) 5400.5 (replaced with DOE O 458.1, Radiation Protection of the Public and the Environment) identified in Table A.2, Action-Specific ARARs for the Oil Landfarm and the C-720 Northeast and Southeast Sites, of the ROD (DOE 2012) were not necessary for implementation of the remedial action for SWMU 211-A since these requirements are not being used to determine radionuclide effluent limits for discharge of wastewater generated by this remedial action. Wastewater containing trichloroethene (TCE) and other volatile organic compounds (VOCs) will be treated at a wastewater treatment unit located at the PGDP and discharged through a Kentucky Pollutant Discharge Elimination System outfall unless transferred off the PGDP Facility for disposition in accordance with applicable requirements. The wastewater treatment system is designed to remove TCE and technetium-99 using air stripping and ion exchange technologies, respectively, (DOE 2021d) but will also treat other VOCs, some metals, and other radionuclides.

In April 2022, DOE prepared a memorandum that (1) documented the FFA parties' historical discussions and agreements concerning the path forward for the use of two ARARs found in the ROD (DOE 2012); (2) provided clarification for the use of the ARARs, with respect to the Southwest Plume Sources CERCLA remedial actions; and (3) documented the FFA parties' agreement that a modification to the ROD is not required. The memorandum can be found in the Administrative Record under the Post-decision File for Southwest Plume Sources (SWMUs 1, 211-A, 211-B) at https://eic.pad.pppo.gov/ (DOE 2022a).

The interim land use controls (LUCs) for SWMU 211-A that were included in the signed ROD are in place and operating. The interim LUCs consist of the excavation/penetration permit program and warning signs. The interim LUCs for SWMU 211-A will remain in place pending selection of final remedies in subsequent operable units (OUs) for other contaminants of concern in environmental media at SWMU 211-A.

This ESD has been prepared in accordance with CERCLA Section 117(c) and 40 *CFR* § 300.435(c)(2)(i) of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). An ESD is required when a significant change is made to the remedy defined in the decision document (e.g., ROD). A significant change generally involves a change to a component of a remedy that does not fundamentally alter the overall cleanup approach. This ESD describes the nature of the significant changes, summarizes the information that led to making the changes, and affirms that the revised remedy complies with the NCP and the statutory requirements of CERCLA. As required by 40 *CFR* § 300.435(c)(2)(i)(B), a notice of availability and a brief description of the ESD is to be published in a major local newspaper of general circulation. The ESD is to be made public and placed in the Administrative Record File and information repository [40 *CFR* § 300.435(c)(2)(i)(A) and § 300.825(a)(2)].

1.1 SITE NAME AND LOCATION

PGDP is located in the northwestern corner of Kentucky in western McCracken County, about 10 miles west of Paducah, Kentucky, and 3.5 miles south of the Ohio River (Figure 1). Past operations and disposal of waste material resulted in the contamination of the groundwater migrating from PGDP. The Southwest Groundwater Plume is one of three groundwater plumes at the facility with the primary contaminant being trichloroethene (TCE). The Southwest Plume is a component of the Groundwater OU that is currently being addressed under the FFA. The C-720 Building Northeast Site—SWMU 211-A (Figure 2) is one VOC source within the Southwest Groundwater Plume.

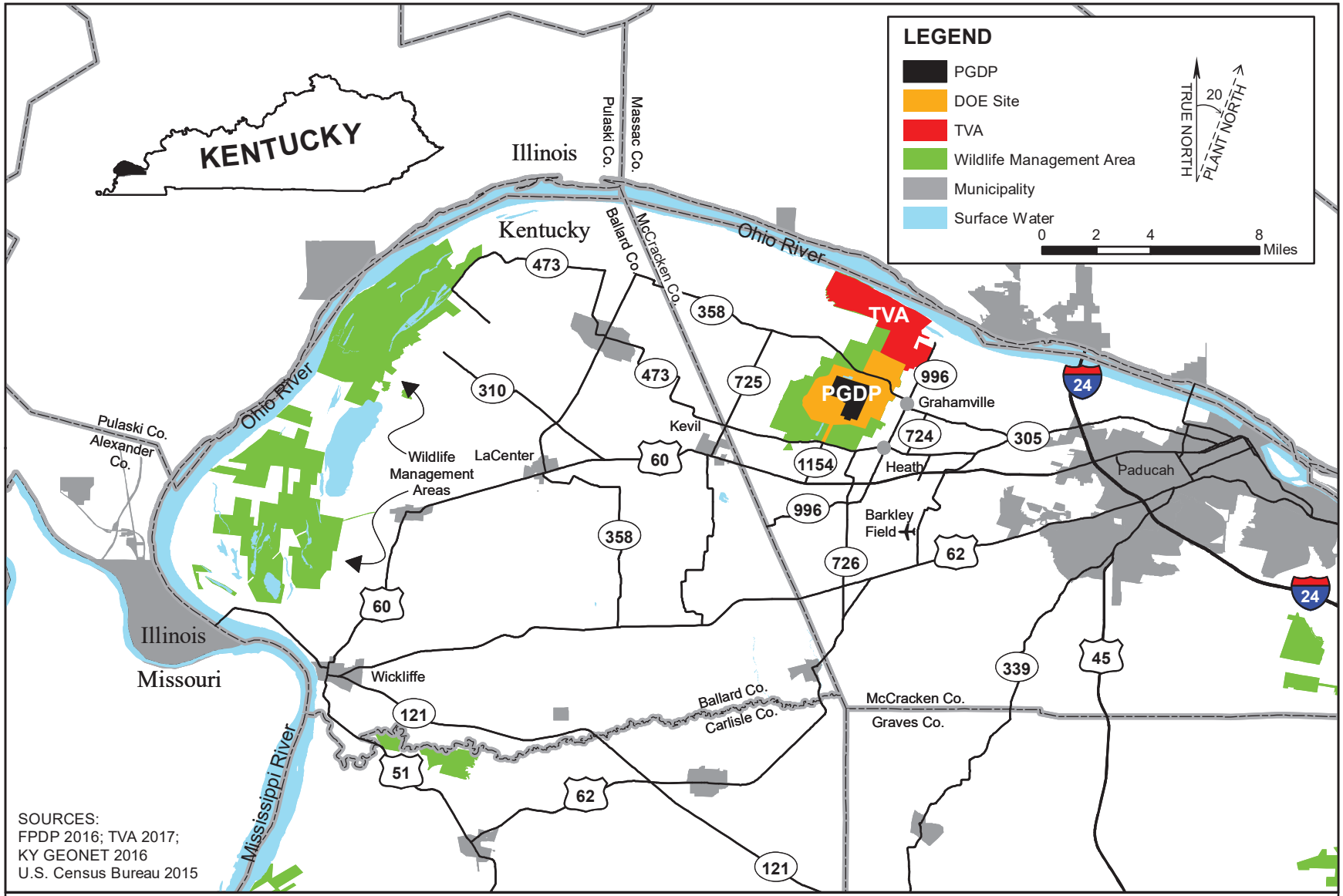

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Figure 1. PGDP Site Location

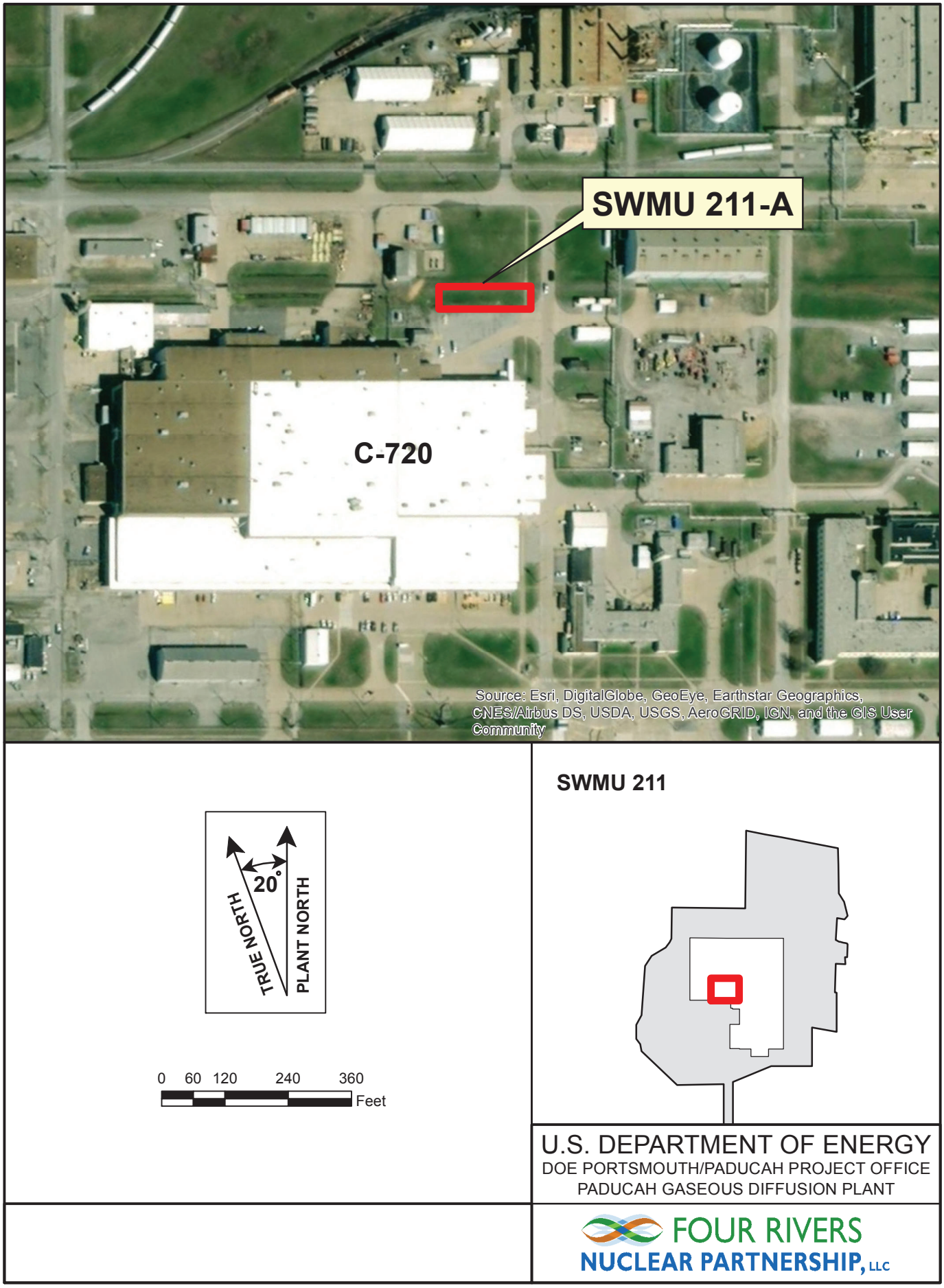

Figure 2. SWMU 211-A Location

Source: DOE 2021a

1.2 REGULATORY BACKGROUND

PGDP was placed on the National Priorities List in 1994. Pursuant to Section 120 of CERCLA, the PGDP FFA (EPA 1998) was negotiated and implemented to coordinate the CERCLA remedial action and RCRA corrective action process into a set of comprehensive requirements for site remediation. Since 1998, DOE, the U.S. Environmental Protection Agency (EPA), and the Kentucky Department for Environmental Protection (KDEP) have operated under the FFA, with DOE acting as the lead agency and EPA and KDEP acting as support agencies that provide oversight.

The ROD was signed in March 2012 and specified that the remedy to be implemented for SWMU 211-A Upper Continental Recharge System (UCRS) soils would be either Alternative 8, *In Situ* Source Treatment Using Enhanced *In Situ* Bioremediation with Interim LUCs; or Alternative 2, Long-term Monitoring with Interim LUCs, based on the findings of the FC/RDSI. Final selection was made by the FFA parties following performance of the final characterization that was part of the RDSI in 2012–2013; performance of additional groundwater characterization in July 2015; letter notification that identified the DOE chosen remedy based on foregoing studies in December 2015 (DOE 2015); and issuance of an addendum to the final characterization report (DOE 2016). Remedial action selection was presented to the FFA parties on May 23, 2018; the presentation can be reviewed at https://eic.pad.pppo.gov/ (DOE 2018). An RDR (DOE 2019) and a RAWP (DOE 2021a) have been developed and approved by the FFA parties. Both the RDR and the RAWP will be used to implement the selected RA. Public notice of the selected remedy by the FFA parties was published in *The Paducah Sun* on February 12–13, 2022. The public notice can be found at https://eic.pad.pppo.gov/ (DOE 2022b).

1.3 CIRCUMSTANCES CREATING THE NEED FOR AN EXPLANATION OF SIGNIFICANT DIFFERENCES

Because the ROD required a FC/RDSI to determine the extent and magnitude of contamination present in the subsurface soils, the ROD did not specify a treatment area for SWMU 211-A. For costing purposes, it was assumed in the ROD that SWMU 211-A would have six estimated injection well locations and a MW network of four wells (DOE 2012). Based on the results of the FC/RDSI and additional groundwater characterization, the treatment area is approximately 13,200 ft^2. Approximately 33 injection well locations and 27 MWs (9 MWs outside the treatment area and 18 in the treatment area) are required for the remedial action (DOE 2021a). The engineering design changes resulted in a procured remedial action cost of approximately $10M, as compared to the original estimated remedial action cost provided in the ROD of $3.7M.

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2. SITE HISTORY, CONTAMINATION, AND SELECTED REMEDY

This section provides a brief summary of the site contamination and history, along with a presentation of the selected remedy as originally described in the ROD.

2.1 SITE HISTORY AND CONTAMINATION ASSOCIATED WITH SWMU 211-A

SWMU 211-A is one of two areas associated with the Southwest Plume located near the C-720 Maintenance & Storage Building. The C-720 building consists of several repair and machine shops, an instrument shop, equipment and material storage areas, and other support operations for the PGDP. The building is located in the southwest portion of the plant. The source of the contaminants to SWMU 211-A is not known; however, it is suspected that SWMU 211-A originated from spills that included leaks of solvents that were released during the routine cleaning and rinsing of equipment that was performed in C-720. The TCE contamination is from spent solvent releases or from the disposal of unused TCE and is considered a RCRA-listed hazardous waste (F001, F002, or U228); therefore, per EPA's Contained-In Policy, any contaminated soil or groundwater that is removed from the ground is considered to contain these RCRA-listed wastes unless determined by EPA and KDEP to no longer contain them.

2.2 REMEDIAL ACTION REMEDY APPROVED IN THE ROD; FINAL REMEDY SELECTED

The RAOs for the Southwest Plume are as follows:

(1) Treat and/or remove the principal threat waste (PTW) consistent with the NCP.

(2a) Prevent exposure to VOC contamination in the source areas that will cause an unacceptable risk to excavation workers (< 10 ft).

(2b) Prevent exposure to non-VOC contamination and residual VOC contamination through interim LUCs within the Southwest Plume source areas (i.e., SWMU 1, SWMU 211-A, and SWMU 211-B) pending remedy selection as part of the Soils OU and Groundwater OU.

(3) Reduce VOC migration from contaminated subsurface soils in the treatment areas at the Oil Landfarm (SWMU 1) and the C-720 Northeast and Southeast sites so that contaminants migrating from the treatment areas do not result in the exceedance of maximum contaminant levels in the underlying Regional Gravel Aquifer (RGA) groundwater.

The selected remedy for SWMU 211-A includes the following:

- An FC/RDSI of the extent and magnitude of contamination present in the subsurface soils.
- A review of the data by the FFA parties and subsequent selection by the FFA parties of either Alternative 8, *In Situ* Source Treatment Using Enhanced *In Situ* Bioremediation with Interim LUCs; or Alternative 2, Long-term Monitoring with Interim LUCs (DOE 2012).
- Enhanced *In Situ* Bioremediation (EISB) System—A bioamendment composed of microbes, nutrients, and/or reductants, as necessary, will be injected into the subsurface under pressure. Periodically, additional bioamendment will be added to the system. The bioamendment will enhance subsurface biological activity, which will result in the destruction of the TCE contaminant by the microbes. Testing

and monitoring will include the measurement of bioamendment concentrations and soil and groundwater parameters during the *in situ* operation.

- Groundwater monitoring—Groundwater sampling and testing will be performed prior to, during, and following the remediation to determine how groundwater contaminant levels are changing and if the treatment is having an impact on the RGA groundwater concentration.

- Secondary waste management—The remedial action will generate waste materials that will require disposition including contaminated water, drill cuttings, soils, bioamendment, and general construction debris. These materials will require management and disposal in accordance with ARARs.

- Site restoration—Following completion of the remedial actions (i.e., active treatment), injection wells will be abandoned and treatment systems will be removed. The areas will be returned to original contours and seeded. Groundwater MWs will remain in place until applicable RAOs are attained.

- Interim LUCs—Interim LUCs will consist of the excavation/penetration permit program and placement of warning signs to provide notice and warning of environmental contamination and are necessary for any residual or remaining VOC and non-VOC contamination that is not treated by the remedial action contained in both Alternatives 8 and 2 and whose concentrations prevent unrestricted use/unlimited exposure in the Southwest Groundwater Plume source areas. The interim LUCs will remain in place pending final remedy selection as part of a subsequent OU that addresses the relevant media.

Following the FC/RDSI and the performance of additional groundwater characterization, the final remedy selected by the FFA parties for SWMU 211-A was Alternative 8, *In Situ* Source Treatment Using Enhanced *In Situ* Bioremediation with Interim LUCs. Public notice of the selected remedy by the FFA parties was published in *The Paducah Sun*, February 12–13, 2022. The public notice can be found at https://eic.pad.pppo.gov/ (DOE 2022b).

3. BASIS FOR THE EXPLANATION OF SIGNIFICANT DIFFERENCES

This section presents information that formed the basis for the selection of the final remedial action of *in situ* source treatment using EISB with interim LUCs and the engineering design changes that resulted in an increase to remedial action costs, as compared to the ROD cost estimate.

3.1 INFORMATION SUPPORTING THE FINAL REMEDY SELECTION

3.1.1 Record of Decision

In situ source treatment using EISB with interim LUCs was not evaluated for the source zone at SWMU 211-A in the revised focused feasibility study (FFS) based on low technical implementability when compared to other alternatives (DOE 2011). Subsequent to the final evaluation in the revised FFS, however, DOE determined that EISB would be applicable to SWMU 211-A using pressure injection methods, as opposed to gravity injection and infiltration, which was evaluated in the revised FFS for SWMU 1. This determination was based on the larger grain-size soils that make up the UCRS soils at the C-720 area (DOE 2012).

For Alternative 8 of the ROD, which included application of EISB at SWMU 211-A, the ROD anticipated that the number of injection points required for the SWMU 211-A treatment area would be determined in the design phase, but for costing purposes in the ROD, it was assumed that the SWMU 211-A treatment area would have six injection points. The MW network was expected to include four wells (DOE 2012).

The ROD also assumed that a bioamendment mixture (i.e., microbes, nutrients, reductants) would be introduced into the subsurface via vertical injection wells. The specific bioamendment mixture would be determined through the use of sample results from the RDSI (DOE 2012).

The ROD cost estimate for Alternative 8, *In Situ* Source Treatment Using Enhanced *In Situ* Bioremediation with Interim LUCs, for SWMU 211-A was $3.7M, and was based on the best available information in regard to the anticipated implementation costs of the remedial alternative. Per the ROD, an RDSI would be performed to better determine the extent and distribution of VOCs, which included dense nonaqueous-phase liquid TCE, and the UCRS soil and groundwater parameters specific to the EISB technology. As a result, changes to the cost elements were anticipated to occur because of new information and data collected during the engineering design of the remedial alternative (DOE 2012).

3.1.2 Addendum to the Final Characterization Report

The 2015 phase of the SWMU 211-A investigation sampled groundwater from the RGA in 5-ft intervals from a depth of 65 ft to the base of the RGA. The sampling results and subsequent analysis determined that TCE contamination in soil in the UCRS in the SWMU 211-A treatment area contributed more than 400 parts per billion (ppb) but less than 11,000 ppb TCE to the RGA, consistent with the conceptual site model in the ROD. The SWMU 211-A decision rules utilized for the additional groundwater investigation directed implementation of enhanced bioremediation and long-term monitoring (i.e., ROD Alternative 8).

3.1.3 Southwest Plume SWMU 211-A Presentation to FFA Parties

Remedial action selection was presented to the FFA parties on May 23, 2018, and included implementation of Alternative 8 from the ROD, *In Situ* Source Treatment Using Enhanced *In Situ* Bioremediation with Interim LUCs, for a treatment area of approximately 13,200 ft^2 (DOE 2018).

3.1.4 Remedial Design Report for SWMU 211-A

An RDR has been developed to support the specific implementation of Alternative 8, *In Situ* Source Treatment Using Enhanced *In Situ* Bioremediation with Interim LUCs, at SWMU 211-A (DOE 2019). EISB will be performed on the SWMU 211-A treatment area (see Figure 3). The recommended implementation of EISB increased the treatment area size and resulted in an increase of the following:

- Injection wells—33 locations (85 wells) from 6 locations (18 wells) in the ROD;
- MW network—9 wells external to the treatment area from 4 wells in the ROD; and
- Performance MW network—18 wells internal to the treatment area from 0 wells in the ROD.

The SWMU 211-A monitoring well layout is shown on Figure 4. The procured remedial action cost to support the increase is approximately $10M, as compared to the ROD's estimated cost of $3.7M. While the cost increase is a significant change, it does not alter or fundamentally change the remedy selected in the ROD.

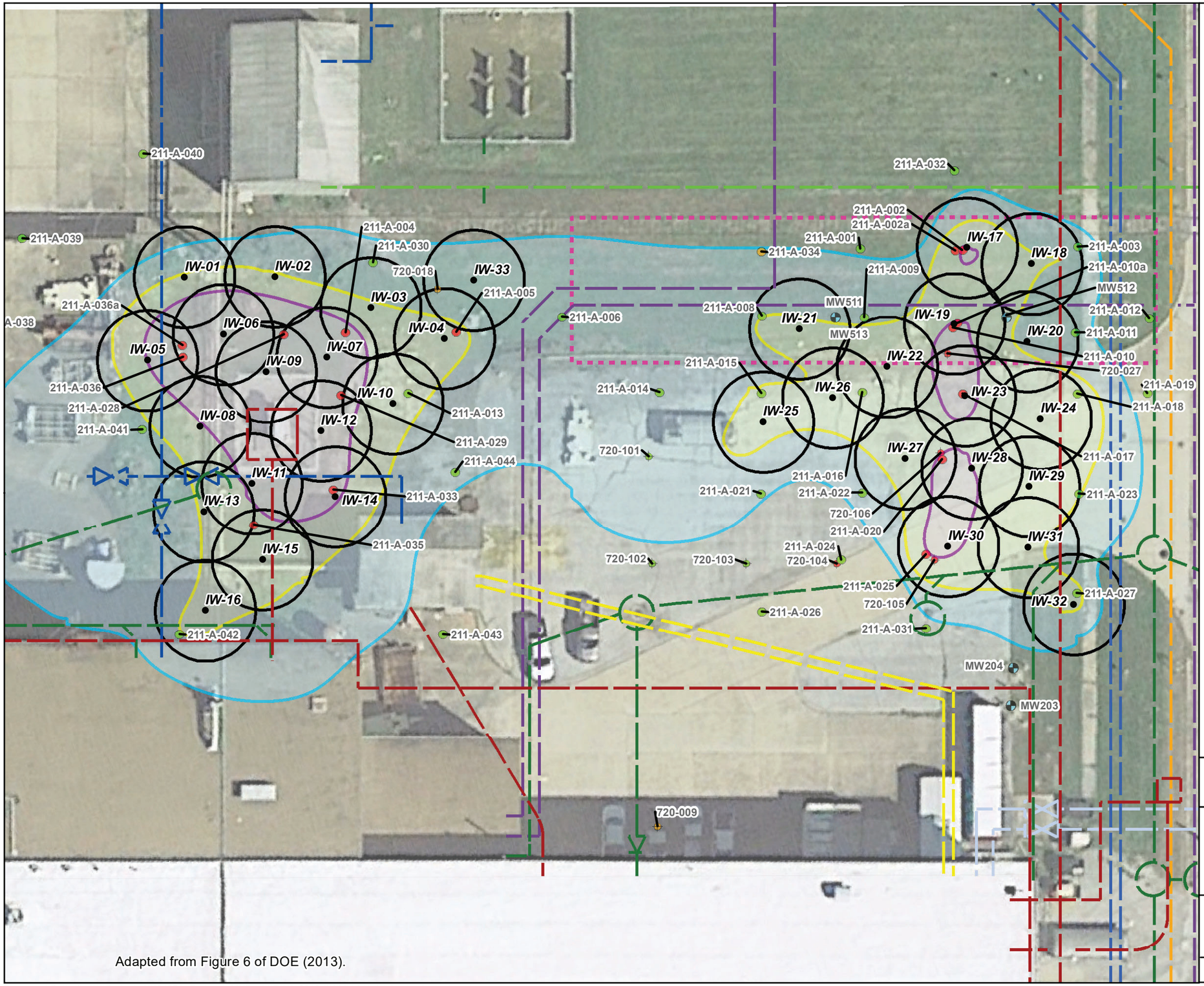
3.2 REMEDIAL ACTION WORK PLAN FOR SWMU 211-A

The RAWP for SWMU 211-A Enhanced *In Situ* Bioremediation documents the design and construction associated with the remedial action (DOE 2021a). Detailed information is included in regard to the planned injection layout, treatment areas and depths, injection techniques, bioaugmentation of each injection well, real-time process monitoring, and post-injection monitoring.

3.3 ADMINISTRATIVE RECORD INFORMATION SUPPORTING THE NEEDED CHANGE

Information contained in the Administrative Record that supports the final remedy is discussed in Section 3.1. As required by 40 *CFR* § 300.825(a)(2), this ESD will be made available to the public through the Administrative Record for the Southwest Plume Sources. Contact information for the Administrative Record is as follows:

DOE Environmental Information Center
Emerging Technology Center, Room 221
5100 Alben Barkley Drive
Paducah, KY 42001
(270) 554-3004
https://eic.pad.pppo.gov
Hours of Operation: Monday through Friday,
8:00 a.m.–12:00 p.m.



Adapted from Figure 6 of DOE (2013).

Legend

- Injection Point
- 15' Injection Point Radius
- Soil Boring Location with Average Soil Concentration Exceeding One or Both Remediation Goals (DOE 2013)
- Soil Boring Location with Average Soil Concentration Less than Both Remediation Goals (DOE 2013)
- Archive Core Soil Boring Location - Not Sampled (DOE 2013)
- Historic Soil Boring Location with Average Soil Concentration Exceeding TCE Remediation Goal (DOE 2013)
- Historic Soil Boring Location with Average Soil Concentration Less than TCE Remediation Goal (DOE 2013)
- Historic Archive Core Soil Boring Location - Not Sampled (DOE 2013)
- Existing Monitoring Well Location
- Area defined by 90% Confidence Level TCE Concentrations greater than 1,000 µg/kg
- Area defined by Nominal (50%) Confidence Level TCE Concentrations greater than 75 µg/kg
- Area defined by 90% Confidence Level TCE Concentrations greater than 75 µg/kg
- SWMU 211-A
- Gas (5'-7' BG)
- Electric (5'-8' BG)
- Storm Drain (6'-10' BG)
- Plant Water (5'-14' BG)
- Chilled Water (2'-5' BG)
- Sanitary Sewer (5'-7' BG)
- Sanitary Water (2'-5' BG)
- Cathodic Protection (3'-5' BG)
- Recirculating Cooling Water (Waste/Heat)

20° True North — Plant North

Notes:
1. TCE isopleths are based upon individual soil sample results over all depths of sampling.
2. Section 7 of the Final Characterization Report includes explanation of the modeling conducted to establish the TCE contours based upon confidence levels.
3. Source of 2018 Aerial: Google Earth.
4. Existing monitoring wells MW511, MW512, and MW513 will be abandoned prior to performing injections.

30 15 0 30 Feet

SWMU 211-A Planned Injection Layout

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

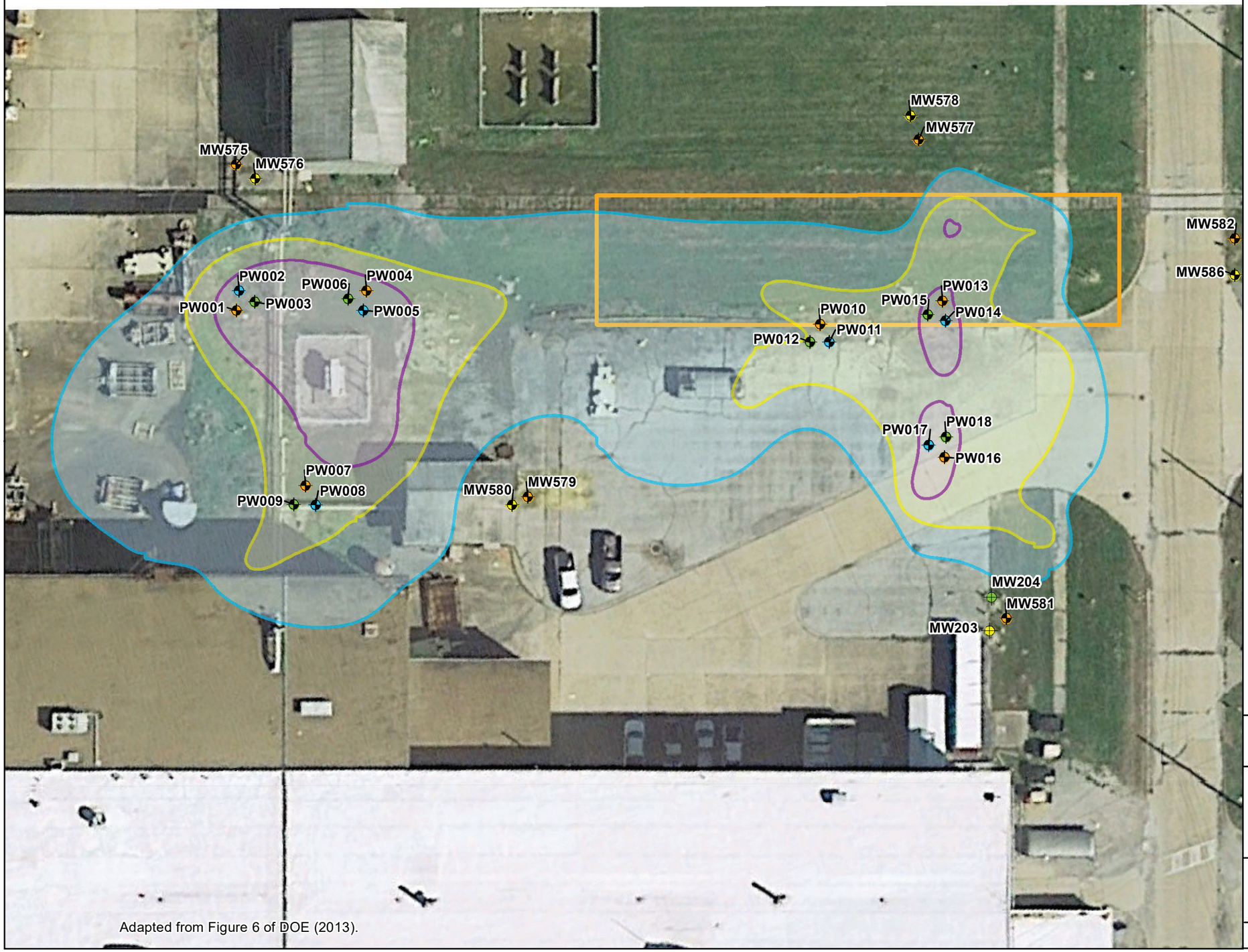
FOUR RIVERS NUCLEAR PARTNERSHIP, LLC

October 2019

Document Path: Q:\GISProjects\KX6467A_Paducah\MXDs\ACTON_2018\SWMU 211-A Injection Layout.mxd

Source: DOE 2021a

Figure 3. SWMU 211-A Planned Injection Layout



20° True North
Plant North

Legend

Existing Monitoring Well Locations That Will Remain

- Well screened within the middle UCRS
- Well screened within the middle RGA

Proposed Monitoring Well Locations

- Well screened within the middle UCRS
- Well screened within the lower UCRS
- Well screened within the upper RGA
- Well screened within the middle RGA
- Area defined by 90% Confidence Level TCE Concentrations greater than 1,000 µg/kg
- Area defined by Nominal (50%) Confidence Level TCE Concentrations greater than 75 µg/kg
- Area defined by 90% Confidence Level TCE Concentrations greater than 75 µg/kg
- SWMU 211-A

Notes:
1. Section 7 of the Final Characterization Report includes explanation of the modeling conducted to establish the TCE contours based upon confidence levels.
2. Source of 2018 Aerial: Google Earth.

30 15 0 30 Feet

SWMU 211-A Monitoring Well Layout

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

FOUR RIVERS NUCLEAR PARTNERSHIP, LLC

September 2019

Document Path: Q:\GISProjects\KX6467A_Paducah\MXDs\ACTON_2018\SWMU 211-A all MW.mxd

Figure 4. SWMU 211-A Monitoring Well Layout

Source: DOE 2019

4. DESCRIPTION OF SIGNIFICANT DIFFERENCES

This section describes the key differences between the remedy in the ROD and the modifications documented in this ESD, which highlight scope, cost, performance, and any changes to expected outcomes when the modifications are implemented.

4.1 SIGNIFICANT DIFFERENCES BETWEEN THE REMEDY AND ESD MODIFICATIONS

Table 1 summarizes the main components of the selected remedy and identifies how the remedy modification impacts these components.

Table 1. Summary of Modifications to the Remedy in the ROD

Remedy in the ROD	Revised Remedy
EISB will be performed at SWMU 211-A. The total area expected to be treated is estimated at approximately 1,300 ft^2.	EISB will be performed in a treatment area of approximately 13,200 ft^2.
Because the ROD required an FC/RDSI to determine the extent and magnitude of contamination present in the subsurface soils, the ROD did not specify a treatment depth for SWMU 211-A.	Primary treatment depths include 25 ft bgs to 65 ft bgs, with some limited areas above the 25 ft depth.
Jet injection technology—not discussed in the ROD estimate.	Because of the fine-grained nature of the UCRS soils, prior to initiating the bioremediation component, each of the injection well locations will be fractured with direct-push technology jet injection, which utilizes a water jetting technique.
Six injection well locations, with three wells each (18 wells).	An estimated 33 injection well locations (85 wells), plus 325 jet fracturing operations will be utilized.
Because the ROD required an FC/RDSI to determine the extent and magnitude of contamination present in the subsurface soils, the ROD did not identify injection rates.	The emulsified vegetable oil injected into each injection well will be pumped using low pressure estimated at 15 to 40 pounds per square inch (psi) (not to exceed 60 psi), and in a volume of up to 2% by volume of pore space.
Geochemical concerns—not discussed in the ROD cost estimate.	Water conditioned to remove dissolved oxygen to assist in the creation of the subsurface-reducing environment will be utilized to emulsify the vegetable oil for injection.
Real-time process monitoring—not discussed in the ROD cost estimate.	Real-time process monitoring will occur during the injection processes.
MW network—four wells.	Post-injection monitoring will be performed utilizing a network of nine MWs located external to the treatment area and 18 performance MWs located internal to the treatment area. The wells will be screened in the UCRS and in the RGA.

As documented in the ROD, EISB is expected to remove approximately 95% of the contaminant mass in the UCRS, with the remaining mass estimated to attenuate and attain groundwater protection remediation goals within approximately 39 years (DOE 2012). As documented in the addendum to the FC report, the total TCE volume present in the UCRS is estimated to be up to 2.2 gal (DOE 2016).

The basic features of the selected remedy with respect to scope and performance did not change; however, the increased soil treatment area and volume resulted in a procured remedial action cost of approximately $10M, as compared to the estimated remedial action cost provided in the ROD of $3.7M. The expanded treatment area will ensure the remedy adequately addresses the full nature and extent of the targeted level of contamination. This expanded treatment area does not change the overall cleanup approach, is necessary to ensure the protection of human health and the environment, complies with the identified ARARs/TBC category, and will achieve the RAOs identified in the ROD. Under EPA guidance, the engineering design and cost changes would be considered a "significant" change that should be documented in an ESD. The guidance states that while the ESD is being prepared and made available to the public, the lead agency may proceed with the predesign, design, construction, or operation activities associated with the remedy (EPA 1999).

4.2 EXPECTED OUTCOMES OF THE ESD

The expected outcome of implementing modifications to the remedy identified in the ROD (Table 1) is the same outcome contained in the ROD, with the exception that the action was implemented over a larger area than originally planned. Based on the final characterization required by the ROD, the area treated is approximately 10 times larger than previously expected. The overall impacts to the treated area from the remedy are included in Section 2.11.4, Expected Outcomes of the Selected Remedy of the ROD. The remedy will biologically treat the high concentration TCE soils and TCE dense nonaqueous-phase liquid, which are present at the SWMU 211-A site and which constitute PTW. The implementation of the modifications in Table 1 is not expected to increase or decrease the contaminant removal proportional amount or the overall treatment period in the attainment of the RAOs and cleanup levels, as discussed in Section 2.11.4 of the ROD.

5. SUPPORT AGENCY COMMENTS AND CONCURRENCE

KDEP and EPA have evaluated the information contained in the Administrative Record for this remedial action. EPA approves and KDEP concurs that the information supports the need for the modifications to the remedy as documented in this ESD, and both agencies concur with changes to the selected remedy in this ESD.

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6. STATUTORY DETERMINATIONS

The selected remedial action was determined in the ROD to satisfy the relevant mandates of CERCLA Section 121 and the NCP, including the threshold statutory requirements that the remedial action protect human health and the environment and attain ARARs. The remedy, as revised by the changes described in this ESD, remains protective of human health and the environment and will comply with the identified ARARs; however, as noted earlier in the ESD and per the agreement of the FFA parties in a September 2021 Memorandum of Agreement (DOE 2021c), 902 *KAR* 100:019 § 44(7)(a), Table II, Effluent Limits, (identified as an action-specific ARAR) and DOE O 5400.5 (replaced by DOE O 458.1 and identified as TBC) in Table A.2 of the ROD (DOE 2012) are not necessary for implementation of the remedial action for SWMU 211-A because these requirements are not being used to determine radionuclide effluent limits for discharge of wastewater generated by this remedial action. The remedy is cost-effective considering the scope of the treatment areas and the overall effectiveness in achieving RAOs, and it utilizes treatment to the maximum extent practicable that will permanently reduce the toxicity and volume of VOC sources to groundwater that are considered PTW.

6.1 FIVE-YEAR REVIEW

The remedial action, until the TCE remaining after treatment attenuates within approximately 39 years to the remediation goal for TCE of 0.075 mg/kg, will result in hazardous substances, pollutants, or contaminants preventing unlimited use and unrestricted exposure. Because the selected remedial action will result in hazardous substances remaining on-site in excess of levels that allow for unlimited use and unlimited exposure, a statutory review of the remedial action under CERCLA Section 121(c) will be conducted every five years until the levels of contaminants of concern allow for unlimited use and unrestricted exposures of the SWMU 211-A treatment area. The five-year reviews will be conducted to ensure that the remedy is or will be protective of human health and the environment. If the results of a five-year review reveals that protection of human health and the environment is insufficient, the FFA parties will evaluate whether implementation of additional or modified remedial actions is necessary to achieve the RAOs identified in the ROD. The statutory reviews will be conducted in accordance with CERCLA 121(c), 40 *CFR* § 300.430(f)(5)(iii)(C) of the NCP, and EPA guidance. These reviews, although required by CERCLA, are not considered components of the selected remedy.

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7. PUBLIC PARTICIPATION REQUIREMENTS

As required by 40 *CFR* § 300.435(c)(2)(i), a Notice of Availability and brief description of this ESD will be published in the local newspaper that announces the availability of the ESD for review through the Administrative Record and information repository, as required by the NCP [40 *CFR* § 300.435(c)(2)(i)(A) and 300.825(a)(2)]. The Administrative Record File that contains the ROD and other associated documentation is available for review at the following location:

DOE Environmental Information Center
Emerging Technology Center, Room 221
5100 Alben Barkley Drive
Paducah, KY 42001
(270) 554-3004
https://eic.pad.pppo.gov
Hours of Operation: Monday through Friday,
8:00 a.m.–12:00 p.m.

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8. APPROVALS

Explanation of Significant Differences to the Record of Decision for Solid Waste Management Units 1, 211-A, 211-B, and Part of 102 Volatile Organic Compound Sources for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

DOE/LX/07-2480&D2

November 2022

APPROVAL

Joel Bradburne, Manager
Portsmouth/Paducah Project Office
U.S. Department of Energy

11/28/2022
Date

RANDALL CHAFFINS
Digitally signed by RANDALL CHAFFINS
Date: 2022.12.02 13:38:33 -05'00'

Carol Monell, Director
Superfund Division
U.S. Environmental Protection Agency, Region 4

Date

CONCURRENCE

Tammi Hudson
Digitally signed by Tammi Hudson
Date: 2022.12.05 09:24:56 -05'00'

Tammi Hudson, Director
Division of Waste Management
Kentucky Department for Environmental Protection

Date

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9. REFERENCES

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