Department of Energy

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MAY 17 2019

PPPO-02-5378119-19D

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

Ms. Julie Corkran
Federal Facility Agreement Manager
U.S. Environmental Protection Agency, Region 4
61 Forsyth Street
Atlanta, Georgia 30303

Dear Mr. Begley and Ms. Corkran:

TRANSMITTAL OF THE CY 2018 FIVE-YEAR REVIEW FOR REMEDIAL ACTIONS AT THE PADUCAH GASEOUS DIFFUSION PLANT, PADUCAH, KENTUCKY (DOE/LX/07-2426&D2)

References:

1. Letter from J. Corkran to T. Duncan, "RE: EPA Comments: Five-Year Review of Remedial Actions at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, (DOE/LX/07-2426&D1), transmittal dated July 25, 2018 (PPPO-02-4759760-18A)," dated December 26, 2018
2. Letter from A. Webb to T. Duncan, "RE: Submittal of Comments to the 2018 Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant (DOE/LX/07-2426&D1), Paducah Site, Paducah, McCracken County, Kentucky, #KY8-890-008-982," dated November 26, 2018

Please find enclosed the *CY 2018 Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/LX/07-2426&D2. This Five-Year Review encompasses activities associated with response actions from January 2013 through December 2017. Section XXX of the Federal Facility Agreement (FFA) for the Paducah Site includes requirements for synchronizing five-year reviews of remedial actions. The last five-year review at the Paducah Site was conducted in 2013 for the period January 2008 through December 2012.

This version includes comments received from the U.S. Environmental Protection Agency (EPA) and the Kentucky Department for Environmental Protection (KDEP) on December 26, 2018, and November 26, 2018, respectively, and comments from the FFA parties received during comment resolution meetings held February 20 and 26, 2019; March 4, 12, and 14, 2019; and April 3 and 17, 2019.

As discussed with the FFA parties on May 14, 2019, the following activities are not identified as recommendations in the 2018 Five-Year Review; however, the U.S. Department of Energy (DOE) is committed to implementing the following activities.

- As part of the C-400 Complex remedial investigation, additional geological data will be collected in the area of the C-400 Building, which is recognized as the primary source of trichloroethene contamination to groundwater at Paducah Gaseous Diffusion Plant, to reduce uncertainty in fault-control impacts on the location and migration of the primary dense nonaqueous-phase liquid source zone and migration of dissolved phase contamination. This information will be reported in the C-400 Complex remedial investigation/feasibility study report.

- As part of DOE's fiscal year 2019 Environmental Monitoring Plan for the Paducah Site, monitoring wells MW315 and MW330 will be sampled for certain per-and polyfluoroalkyl substances at the Fire Training Area (Solid Waste Management Unit 100). Results from this sampling should be reported in PEGASIS by March 31, 2020, reported in a letter from the DOE Site Lead to EPA and KDEP by April 30, 2020, and reported in the 2019 Annual Site Environmental Report (which will be available to the public and the regulatory agencies in the fall of 2020).

- The steps for conducting a review of the Water Policy program will be documented in a contractor procedure, which will be posted to https://pubdocs.pad.pppo.gov. DOE will post the contractor procedure and brief EPA and KDEP on the contents of the contractor's *Water Policy Annual Due Diligence Report* by December 30, 2019.

The FFA parties have 30 days to review and comment on the enclosed document. If you have any questions or require additional information, please contact Rich Bonczek at (859) 219-4051.

Sincerely,

Tracey Duncan
Federal Facility Agreement Manager
Portsmouth/Paducah Project Office

Enclosures:
1. CY 2018 Five-Year Review for Remedial Actions, DOE/LX/07-2426&D2—Clean
2. CY 2018 Five-Year Review for Remedial Actions, DOE/LX/07-2426&D2—Redline
3. Comment Response Summary—EPA
4. Comment Response Summary—KDEP
5. Other Changes Summary

General Reference Compendium

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DOE/LX/07-2426&D2
Secondary Document

CY 2018 Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

(Fourth Synchronized Five-Year Review)

DOE/LX/07-2426&D2
Secondary Document

CY 2018 Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

(Fourth Synchronized Five-Year Review)

Date Issued—May 2019

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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CONTENTS

TABLES

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FIGURES

ACRONYMS

AM	Action Memorandum
ARAR	applicable or relevant and appropriate requirement
BGOU	Burial Grounds Operable Unit
CAB	Citizens Advisory Board
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
COC	contaminant of concern
CSOU	Comprehensive Site Operable Unit
CY	calendar year
D&D	decontamination and decommissioning
D&R	deactivation and remediation
DCS	derived concentration standard
DNAPL	dense nonaqueous-phase liquid
DOE	U.S. Department of Energy
EE/CA	engineering evaluation/cost analysis
EI	environmental indicator
ELCR	excess lifetime cancer risk
EM	environmental management
EMP	Environmental Monitoring Plan
EPA	U.S. Environmental Protection Agency
EQ	equalization
ERH	electrical resistance heating
ESD	explanation of significant differences
EU	exposure unit
EW	extraction well
FAQ	frequently asked question
FFA	Federal Facility Agreement
FRNP	Four Rivers Nuclear Partnership, LLC
FS	feasibility study
FY	fiscal year
GDP	gaseous diffusion plant
GWOU	Groundwater Operable Unit
HI	hazard index
ICM	interim corrective measure
ICRP	International Commission on Radiological Protection
IRA	interim remedial action
ITR	independent technical review
KAR	*Kentucky Administrative Regulations*
KDEP	Kentucky Department for Environmental Protection
KDWM	Kentucky Division of Waste Management
KPDES	Kentucky Pollutant Discharge Elimination System
KRS	*Kentucky Revised Statutes*
LUC	land use control
LUCAP	land use control assurance plan
LUCIP	land use control implementation plan
MCL	maximum contaminant level
MIP	membrane interface probe
MOA	memorandum of agreement

MW	monitoring well
N/A	not applicable
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
ND	nondetect
NEPCS	Northeast Plume Containment System
NFA	no further action
NPL	National Priorities List
NSDD	North-South Diversion Ditch
NTCRA	non-time-critical removal action
NWPGS	Northwest Plume Groundwater System
O&M	operation and maintenance
OSWER	Office of Solid Waste and Emergency Response
OU	operable unit
PAH	polyaromatic hydrocarbon
PGDP	Paducah Gaseous Diffusion Plant
PHEA	Public Health and Ecological Assessment
POE	point of exposure
RA	remedial action
RACR	remedial action completion report
RAIS	Risk Assessment Information System
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
RI	remedial investigation
ROD	record of decision
SARA	Superfund Amendments and Reauthorization Act
SI	site investigation
SMP	Site Management Plan
SVGTS	soil vapor and groundwater treatment system
SWMU	solid waste management unit
SWOU	Surface Water Operable Unit
TBC	to be considered
TBD	to be determined
TVA	Tennessee Valley Authority
UCRS	Upper Continental Recharge System
USCA	*United States Code Annotated*
USEC	United States Enrichment Corporation
VOC	volatile organic compound
WAC	waste acceptance criteria
WAG	waste area group
WKWMA	West Kentucky Wildlife Management Area
ZVI	zero-valent iron

EXECUTIVE SUMMARY

The cleanup strategy under the Site Management Plan (SMP) and required by the *Federal Facility Agreement for the Paducah Gaseous Diffusion Plant* (FFA) (EPA 1998), establishes operable units (OUs) to be accomplished to achieve delisting of the Paducah Site from the National Priorities List and the decommissioning of the Paducah Gaseous Diffusion Plant (PGDP). These include the C-400 Complex OU, the Groundwater OU (GWOU), the Surface Water OU (SWOU), the Soils OU, the Soils and Slabs OU, the Burial Grounds OU (BGOU), the Decontamination and Decommissioning (D&D) OU, the Lagoons OU, the Depleted Uranium Hexafluoride (DUF_6) Footprint Underlying Soils OU, and the Comprehensive Site OU (CSOU). Each OU leading up to the CSOU is scoped to remediate areas and media associated with the DOE Paducah Site.[1] A final CSOU evaluation will occur following completion of the D&D OU of (PGDP), completion of the DUF_6 Footprint Underlying Soils OU, and completion of cleanup of each of the specific OUs. The specific scopes and further discussions for each OU and associated follow-up actions are addressed in the fiscal year (FY) 2018 and 2019 SMP (DOE 2019a).

The U.S. Environmental Protection Agency (EPA) defines the four following types of Five-Year Reviews: (1) statutory review, (2) policy review, (3) discretionary review, and (4) five-year review addendum (for deferred protectiveness). This document is a combination of statutory and discretionary reviews.

This fourth synchronized Five-Year Review encompasses the remedial actions (RAs) that DOE has taken under the respective OUs, plus the Water Policy removal action, Surface Water Interim Corrective Measures (ICMs), and Surface Water On-site Sediment Removal.[2] The FFA for the Paducah Site includes requirements for synchronizing Five-Year Reviews of RAs (Section XXX). The triggering action for this review is the five-year anniversary of the third synchronized Five-Year Review conducted at the Paducah Site in 2013 for activities associated with response actions from 2008 through 2012 [*Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-1289&D2 (DOE 2014a)[3]]. This fourth synchronized Five-Year Review encompasses activities associated with response actions from 2013 through 2017. A form summarizing the Paducah Site, issues from the review, recommendations, and protectiveness statements is presented following Table ES.1. This form is the updated 2011 version of the form from Appendix F of EPA guidance document *Comprehensive Five-Year Reviews Guidance* (EPA 2001).

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[1] References in this report to the Paducah Site generally mean the property, programs, and facilities at or near Paducah Gaseous Diffusion Plant for which DOE has ultimate responsibility. The Paducah Site is located in a generally rural area of McCracken County, Kentucky, 10 miles west of Paducah, Kentucky, and 3.5 miles south of the Ohio River. The gaseous diffusion plant (GDP) is on a 3,556-acre DOE site comprised of the following: 628 acres within a fenced security area, approximately 809 acres located outside the security fence, 133 acres in acquired easements, and the remaining 1,986 acres licensed to the Commonwealth of Kentucky as part of the West Kentucky Wildlife Management Area.

[2] As shown in Table 2.1, four individual OUs had five-year reviews conducted prior to the 2003 synchronized five-year review.

[3] A D2/R1/A2/R2 version of the Five-Year Review for 2013 was issued in October 2017. Associated documents to support related vapor intrusion studies include *Sampling and Analysis Plan to Support the Additional Action for the CERCLA Five-Year Review at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-2200&D1 (DOE 2015a); *Water Policy Area Vapor Intrusion Screening Study Report for the Five-Year Review of Remedial Actions, Paducah, Kentucky*, DOE/LX/07-1289&D2/R1/A1/R1 (DOE 2016a); and *C-400 Vapor Intrusion Study Work Plan to Support the Additional Actions for the CERCLA Five-Year Review at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-2403&D2/R1 (DOE 2017a).

Table ES.1. Five-Year Review Summary Form

SITE IDENTIFICATION		
Site Name: Paducah Gaseous Diffusion Plant		
EPA ID: KY8-890-008-982		
Region: 4	State: KY	City/County: Paducah/McCracken
SITE STATUS		
NPL Status: Final		
Multiple OUs? Yes	Has the site achieved construction completion? No	
REVIEW STATUS		
Lead agency: Other Federal Agency If "Other Federal Agency" was selected above, enter Agency name: U.S. Department of Energy		
Author name (Federal or State Project Manager): Rich Bonczek		
Author affiliation: U.S. Department of Energy		
Review period: 01/01/2013–12/31/2017		
Date of site inspection: 12/04/2017–12/20/2017		
Type of review: Statutory and Discretionary		
Review number: Fourth Synchronized		
Triggering action date: 12/30/2013		
Due date (*five years after triggering action date*): 12/30/2018		

Issues/Recommendations
OU(s) without Issues/Recommendations Identified in the Five-Year Review:
SWOU and BGOU
Issues and Recommendations Identified in the Five-Year Review:

OU(s): Groundwater, Northwest Plume	**Issue Category:** Remedy Performance			
	Issue: The Northwest Plume [Solid Waste Management Unit (SWMU) 201] interim remedial action (IRA), designed to initiate hydraulic control of the high trichloroethene (TCE) concentration of the Northwest Plume, saw increases in TCE levels in a downgradient monitoring well. Increasing TCE levels in downgradient MW460 may be an indication of capture of downgradient groundwater impacted by site contaminants in response to drawdown of the aquifer or increasing TCE levels may indicate limited plume bypass of the optimization extraction well (EW) wellfield.			
	Recommendation: EW pump placement and pumping rates should be evaluated to optimize capture of the Northwest Plume.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No*	No*	Federal Facility	EPA/State	12/30/2022 (End of Next Five-Year Review Period)

*Although the issue does not affect the current or future protectiveness, the issue and recommended actions are an optimization to the current remedy established and are included as recommended by guidance.

Protectiveness Statement(s)

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
GWOU, Northwest Plume	Short-term Protective	N/A

Protectiveness Statement:

The remedy for the Northwest Plume (SWMU 201) is protective of human health and the environment in the short-term. Exposure pathways that could result in unacceptable risk are being controlled; however, additional actions, as part of the Dissolved-Phase Plumes OU [see Appendix 3 of the FY 2018 and FY 2019 SMP for a discussion of the scope of the Dissolved-Phase Plumes OU (DOE 2019a)], need to be evaluated for long-term protection. A recommendation was made for an evaluation of EW pump placement and pumping rates to optimize capture of the Northwest Plume in response to increasing TCE levels in downgradient MW460.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
GWOU, Northeast Plume	Short-term Protective	N/A

Protectiveness Statement:

The remedy for the Northeast Plume (SWMU 202) is protective of human health and the environment in the short-term. The Northeast Plume groundwater extraction system is being optimized to increase TCE mass removal, to enhance control of plume migration at the eastern edge of the PGDP industrial area. Exposure pathways that could result in unacceptable risk are being controlled; however, additional actions, as part of the Dissolved-Phase Plumes OU [see Appendix 3 of the FY 2018 and FY 2019 SMP for a discussion of the scope of the Dissolved-Phase Plumes OU (DOE 2019a)], need to be evaluated for long-term protection.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
GWOU, Cylinder Drop Test Area	Short-term Protective	N/A

Protectiveness Statement:

The remedy for the Cylinder Drop Test Area (SWMU 91) is protective of human health and the environment in the short-term. Exposure pathways that could result in unacceptable risk are being controlled through DOE access controls. This project is not a final action and was not designed to return the areas to unrestricted use and unlimited exposure. A final TCE cleanup level providing long-term protection of groundwater has not yet been established. In order to establish long-term protectiveness, per the FFA, "…any necessary RA shall be selected and implemented…." as part of the CSOU.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
GWOU, Water Policy	Short-term Protective	N/A

Protectiveness Statement:

The remedy for the Water Policy currently protects human health and the environment by institutional controls, including administrative controls, in the short-term. Exposure pathways that could result in unacceptable risk are being controlled; however, additional actions, as part of the Dissolved-Phase Plumes OU, need to be evaluated for long-term protection.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
GWOU, C-400 Electrical Resistance Heating	Short-term Protective	N/A

Protectiveness Statement:

The IRA for the VOC contamination at C-400 Building is protective of human health and the environment in the short-term. In the interim, land use controls (LUCs) for this action include property record notices and deed restrictions, administrative controls, and access controls. This action, in combination with other Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) response actions and existing controls (alternate water supply, monitoring, etc.), has adequately addressed known exposure pathways that could result in unacceptable risks originating from C-400. In order to establish long-term protectiveness, additional RAs will be evaluated and selected, as necessary, under the C-400 Complex OU Record of Decision (ROD).

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
GWOU, Southwest Plume, Oil Landfarm	Short-term Protective	N/A

Protectiveness Statement:

The RA for VOC sources at Southwest Plume Oil Landfarm (SWMU 1) is expected to be protective of human health and the environment upon completion. A period of time is required before attainment of all remedial action objectives (RAOs). Interim LUCs consisting of placement of warning signs and DOE's excavation/penetration permit program are in place to prevent exposure to site contaminants. This action, in combination with other CERCLA response actions and existing controls (alternate water supply, monitoring, etc.), will address adequately known exposure pathways that could result in unacceptable risks originating from the Southwest Plume.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
GWOU, Southwest Plume, C-720 Building NE and SE Spill Sites	Will Be Protective	N/A

Protectiveness Statement:

The RA for VOC sources at Southwest Plume C-720 Building NE and SE Spill Sites (SWMUs 211-A and 211-B) is expected to be protective of human health and the environment upon completion. Interim LUCs consisting of placement of warning signs and DOE's excavation/penetration permit program are in place to prevent exposure to site contaminants. This action, in combination with other CERCLA response actions and existing controls (alternate water supply, monitoring, etc.), will address adequately known exposure pathways that could result in unacceptable risks originating from the Southwest Plume (SWMU 210).

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Surface Water OU, North-South Diversion Ditch Source Control	Protective	N/A

Protectiveness Statement:

The remedy for the North-South Diversion Ditch (NSDD) Source Control is protective of human health and the environment. Exposure pathways that could result in unacceptable risk are being controlled. This project is not a final action and was not designed to return the areas to unrestricted use.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Surface Water OU, North-South Diversion Ditch Sections 1 and 2	Short-term Protective	N/A

Protectiveness Statement:

The remedy for the NSDD Sections 1 and 2 (SWMU 59) is protective of human health and the environment in the short-term. Exposure pathways that could result in unacceptable risk currently are being controlled. This project is not a comprehensive final action for the NSDD Sections 1 and 2. In order to establish long-term protectiveness, additional action will be evaluated and selected, as necessary, under the SWOU.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Surface Water OU, C-746-K Sanitary Landfill	Protective	N/A

Protectiveness Statement:

The remedy for the C-746-K Sanitary Landfill (SWMU 8) is protective of human health and the environment. Exposure pathways that could result in unacceptable risk are being controlled. This project is not a final action and was not designed to return the areas to unrestricted use.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Surface Water OU, Fire Training Area	Short-term Protective	N/A

Protectiveness Statement:

The remedy for the Fire Training Area (SWMU 100) is protective of human health and the environment in the short-term. Exposure pathways that could result in unacceptable risk are being controlled. This project is not a final action and was not designed to return the areas to unrestricted use and unlimited exposure. In order to establish long-term protectiveness, per the FFA, "…any necessary RA shall be selected and implemented…." as part of the CSOU.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Surface Water Interim Corrective Measures	Short-term Protective	N/A

Protectiveness Statement:

The remedy for the surface water ICMs currently protects human health and the environment by institutional controls; however, additional actions under the SWOU need to be evaluated for long-term protectiveness.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Surface Water OU, On-site Sediment Removal	Short-term Protective	N/A

Protectiveness Statement:

The remedy for the Surface Water On-site Sediment Removal is protective of human health and the environment in the short-term due to excavation of contaminated sediment/soil and placement of clean soil to meet the cleanup goal. In order to establish long-term protectiveness, additional RAs will be evaluated and selected, as necessary, under the SWOU.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Burial Grounds OU, C-749 Uranium Burial Ground	Short-term Protective	N/A

Protectiveness Statement:

The remedy for the C-749 Uranium Burial Ground (SWMU 2) is protective of human health and the environment in the short-term. Exposure pathways that could result in unacceptable risk are being controlled through DOE access controls. This earlier remedy is not a final RA and was not designed to fully address the risks to human health and the environment from the buried wastes nor return the areas to unrestricted use and/or unlimited exposure. The selected remedy for the C-749 Uranium Burial Ground was an interim action, and a final CERCLA action will be evaluated under the BGOU to ensure long-term protectiveness.

Sitewide Protectiveness Statement (if applicable)

For sites that have achieved construction completion, enter a sitewide protectiveness determination and statement.

Protectiveness Determination:	*Addendum Due Date (if applicable):*
N/A	N/A

Protectiveness Statement:

N/A

The assessments of this fourth synchronized Five-Year Review find that DOE has implemented and operated the remedies in accordance with the requirements of the RODs or Action Memorandums (AMs). Table ES.2 is a list of the continuing or completed response actions by decision document, site or project name, and OU contained in this fourth synchronized Five-Year Review.

Table ES.2. Decision Document and Site/Project Name Included in Fourth Synchronized Five-Year Review

Decision Document	Site or Project	Operable Unit
Record of Decision for Interim Remedial Action of the Northwest Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/OR/06-1143&D4, and *Explanation of Significant Differences to the Record of Decision for Interim Remedial Action of the Northwest Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0343&D2	Northwest Plume (SWMU 201)	GWOU
Record of Decision for Interim Remedial Action at the Northeast Plume, Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/OR/06-1356&D2	Northeast Plume (SWMU 202)	GWOU
Record of Decision for Remedial Action at Solid Waste Management Unit 91 of Waste Area Group 27 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/OR/06-1527&D2	Cylinder Drop Test Area (SWMU 91) or Lasagna™	GWOU
Action Memorandum for the Water Policy at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/OR/06-1201&D2	Water Policy	GWOU
Record of Decision for Interim Remedial Action for the Groundwater Operable Unit for the Volatile Organic Compound Contamination at the C-400 Cleaning Building at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/OR/07-2150&D2/R2	C-400 Electrical Resistance Heating	GWOU
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	Southwest Plume	GWOU
Record of Decision for Interim Action Source Control at the North-South Diversion Ditch, Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/OR/06-1213&D3	North-South Diversion Ditch Source Control	SWOU
Record of Decision for Interim Remedial Action at the North-South Diversion Ditch at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/OR/07-1948&D2	North-South Diversion Ditch Sections 1 and 2 (SWMU 59)	SWOU
Record of Decision for Waste Area Groups 1 and 7 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/OR/06-1470&D3	C-746-K Sanitary Landfill (SWMU 8)	SWOU
Record of Decision for Waste Area Groups 1 and 7 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/OR/06-1470&D3	Fire Training Area (SWMU 100)	SWOU
Interim Measure Report for Institutional Control of Off-Site Contamination in Surface Water, DOE/OR/07-1206&D1	Surface Water Interim Corrective Measures	SWOU
Action Memorandum for Contaminated Sediment Associated with the Surface Water Operable Unit (On-Site) at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/LX/07-0119&D2/R1	Surface Water On-site Sediment Removal	SWOU
Record of Decision for Interim Remedial Action at Solid Waste Management Units 2 and 3 of Waste Area Group 22 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/OR/06-1351&D1	C-749 Uranium Burial Ground (SWMU 2)	BGOU

The response actions are functioning as intended by the decision documents. Each of these projects had specific remedies cited in each applicable decision document (e.g., ROD or AM). This fourth synchronized Five-Year Review concludes, for completed response actions, that additional actions are not required to meet the remedial goals or RAOs of the decision documents. For those response actions that are not completed, future actions are appropriate as identified in the issues and recommendations.

1. INTRODUCTION

The purpose of this fourth synchronized Five-Year Review is to determine whether the remedies at the U.S. Department of Energy (DOE) Paducah Site[4] remain protective of human health and the environment and evaluate the implementation and performance of the selected remedies. The methods, findings, conclusions, and recommendations of reviews of 13 projects are documented in this report.

DOE has conducted this fourth synchronized Five-Year Review pursuant to the Federal Facility Agreement (FFA) (EPA 1998) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) [42 *USCA* § 9621(c)]; the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) [40 *CFR* § 300.400(f)(4)(ii)]; and the U.S. Environmental Protection Agency (EPA) Office of Solid Waste and Emergency Response (OSWER) Directive 9355.7-03B-P (EPA 540-R-01-007) (EPA 2001). Additionally, this document meets guidance set forth in the "Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Five-Year Review Guide," Office of Environmental Management, DOE, March 2002 [DOE 2002a (unnumbered)]; Assessing Protectiveness at Sites for Vapor Intrusion Supplement to the "Comprehensive Five-Year Review Guidance," OSWER 9200.2-84; Recommended Evaluation of Institutional Controls: Supplement to the Comprehensive Five-Year Review Guidance Five-Year Reviews, OSWER 9355.7-18; Frequently Asked Questions (FAQs) and Answers, Clarifying the Use of Protectiveness Determinations for Comprehensive Environmental Response, Compensation, and Liability Act Five-Year Reviews, OSWER 9355.7-21; and Memorandum issued September 13, 2012, OSWER 9200.2.111. Per guidance, community involvement activities during the Five-Year Review should include notifying the community that the Five-Year Review will be conducted. DOE published a public notice in the local newspaper on December 17, 2017, announcing that the Five-Year Review had been initiated and requesting that any suggestions, issues, questions, or concerns regarding this review be provided from December 18 through December 31, 2017. No comments were received.

CERCLA requires that reviews be conducted no less often than once every five years. The FFA, Section XXX, requires a Five-Year Review for final remedial actions (RAs) for any operable unit (OU), "including selected alternatives entailing institutional controls with remedial action, result in Hazardous Substances, pollutants or contaminants, or Hazardous Wastes and Hazardous Constituents remaining at the Site above levels that allow for unlimited use and unrestricted exposure in accordance with Section 300.430(f)(4)(ii) of the NCP." EPA Guidance (OSWER 9355.7-21) defines the following four types of Five-Year Reviews: (1) statutory reviews; (2) policy reviews; (3) discretionary reviews; and (4) five-year review addendum (for deferred protectiveness).

Statutory Reviews are conducted pursuant to CERCLA § 121(c) and 40 *CFR* § 300.430(f)(4)(ii) of the NCP and are conducted when the following conditions exist:

- Upon completion of the RA, hazardous substances, pollutants, or contaminants will remain at the site above levels that allow for unlimited use and unrestricted exposure; and

[4] References in this report to the Paducah Site generally mean the property, programs, and facilities at or near Paducah Gaseous Diffusion Plant (PGDP) for which DOE has ultimate responsibility. The Paducah Site is located in a generally rural area of McCracken County, Kentucky, 10 miles west of Paducah, Kentucky, and 3.5 miles south of the Ohio River. The gaseous diffusion plant (GDP) is on a 3,556-acre DOE site comprised of the following: 628 acres within a fenced security area, approximately 809 acres located outside the security fence, 133 acres in acquired easements, and the remaining 1,986 acres licensed to the Commonwealth of Kentucky as part of the West Kentucky Wildlife Management Area (WKWMA).

- The record of decision (ROD) for the site was signed on or after October 17, 1986, [the effective date of Superfund Amendments and Reauthorization Act (SARA)] and the RA was selected under CERCLA § 121.

Policy reviews generally are conducted for the following types of actions:

- A pre- or post-SARA RA that, upon completion, will not leave hazardous substances, pollutants, or contaminants on-site above levels that allow for unlimited use and unrestricted exposure, but requires five years or more to complete;

- A pre-SARA RA that leaves hazardous substances, pollutants, or contaminants on site above levels that allow for unlimited use and unrestricted exposure; or

- A removal-only site on the National Priorities List (NPL) where a removal action leaves hazardous substances, pollutants, or contaminants on-site above levels that allow for unlimited use and unrestricted exposure and where no RA has or will take place.

Discretionary reviews are not required by statute or policy. These types of five-year reviews may be done at the discretion of the region or federal agency to help ensure the protectiveness of selected remedies. A five-year review addendum generally is completed for remedies where the protectiveness determination was deferred in a prior five-year review report in order to collect further information.

All the projects listed in Table 1.1 are undergoing a Statutory Five-Year Review with the exception of the following: Water Policy, Surface Water Interim Corrective Measures (ICMs), and Surface Water On-site Sediment Removal. Five-year reviews are being conducted for the Water Policy, Surface Water ICM, and Surface Water On-site Sediment Removal as discretionary reviews. For the Water Policy and C-400 Electrical Resistance Heating (ERH), addendum reviews have been conducted based on findings from the previous five-year review. The Water Policy addendum was approved in November 2017. The C-400 ERH addendum was submitted in May 2018 to EPA and the Kentucky Department for Environmental Protection (KDEP).

The Water Policy is a removal action that originally was implemented and currently is being maintained to eliminate and/or reduce potential exposure from contaminated groundwater at the Paducah Site. Various RA projects at Paducah Site rely on the Water Policy to demonstrate protectiveness for the groundwater exposure pathway. The Surface Water ICM was conducted as a Resource Conservation and Recovery Act (RCRA) ICM intended to identify the areas of contamination through the posting of warning signs and to help restrict casual public access to the creeks. Proper monitoring and maintenance of these controls are necessary to demonstrate ongoing protectiveness for the surface water exposure pathway until such time that a final RA is implemented as part of the Surface Water Operable Unit (SWOU). The Surface Water On-site Sediment Removal Project was conducted as a removal action to remove on-site areas of elevated sediment contamination. The removal action reduced contaminant levels to within the acceptable CERCLA risk range based on the current and reasonably anticipated future land use (industrial, recreational), but did not achieve cleanup levels that would allow for unlimited use and unrestricted exposure.

This review encompasses the response actions listed in Table 1.1 by decision document, site/project name, and OU.

Table 1.1. Decision Document and Site/Project Name Included in Fourth Synchronized Five-Year Review

Decision Document	Site/Project Name Used in This Report	Operable Unit	Project Name Used in Previous Five-Year Reviews
Record of Decision for Interim Remedial Action of the Northwest Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/OR/06-1143&D4 and *Explanation of Significant Differences to the Record of Decision for Interim Remedial Action of the Northwest Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0343&D2	Northwest Plume (SWMU 201)	Groundwater Operable Unit (GWOU)	Northwest Plume (SWMU 201)
Record of Decision for Interim Remedial Action at the Northeast Plume, Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/OR/06-1356&D2	Northeast Plume (SWMU 202)	GWOU	Northeast Plume (SWMU 202)
Record of Decision for Remedial Action at Solid Waste Management Unit 91 of Waste Area Group 27 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/OR/06-1527&D2	Cylinder Drop Test Area (SWMU 91) or Lasagna™	GWOU	Cylinder Drop Test Area (SWMU 91) or Lasagna™
Action Memorandum for the Water Policy at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/OR/06-1201&D2	Water Policy	GWOU	Water Policy
Record of Decision for Interim Remedial Action for the Groundwater Operable Unit for the Volatile Organic Compound Contamination at the C-400 Cleaning Building at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/OR/07-2150&D2/R2	C-400 ERH	GWOU	C-400 ERH
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	Southwest Plume	GWOU	Southwest Plume
Record of Decision for Interim Action Source Control at the North-South Diversion Ditch, Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/OR/06-1213&D3	North-South Diversion Ditch (NSDD) Source Control	SWOU	North-South Ditch (NSDD) Source Control
Record of Decision for Interim Remedial Action at the North-South Diversion Ditch at the Paducah Gaseous Diffusion Plan, Paducah, Kentucky, DOE/OR/07-1948&D2	NSDD Sections 1 and 2 (SWMU 59)	SWOU	NSDD Sections 1 and 2 (SWMU 59)
Record of Decision for Waste Area Groups 1 and 7 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/OR/06-1470&D3	C-746-K Sanitary Landfill (SWMU 8)	SWOU	C-746-K Landfill (SWMU 8)
Record of Decision for Waste Area Groups 1 and 7 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/OR/06-1470&D3	Fire Training Area (SWMU 100)	SWOU	Fire Training Area (SWMU 100)

Table 1.1. Decision Document and Site/Project Name Included in Fourth Synchronized Five-Year Review (Continued)

Decision Document	Site/Project Name Used in This Report	Operable Unit	Project Name Used in Previous Five-Year Reviews
Interim Measure Report for Institutional Control of Off-Site Contamination in Surface Water, DOE/OR/07-1206&D1	Surface Water ICMs	SWOU	Surface Water ICMs
Action Memorandum for Contaminated Sediment Associated with the Surface Water Operable Unit (On-Site) at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/LX/07-0119&D2/R1	Surface Water On-Site Sediment Removal	SWOU	Surface Water On-Site Sediment Removal
Record of Decision for Interim Remedial Action at Solid Waste Management Units 2 and 3 of Waste Area Group 22 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/OR/06-1351&D1	C-749 Uranium Burial Ground (SWMU 2)	Burial Grounds Operable Unit (BGOU)	C-749 Uranium Burial Ground (SWMU 2)

The FFA includes provisions for combining Five-Year Reviews of RAs as stated in Section XXX:

> Consistent with Section 121(c) of CERCLA, 42 USC § 9621 (c), and in accordance with this Agreement, DOE agrees that if the selected, final RAs for any operable unit, including selected alternatives entailing institutional controls with remedial action, result in Hazardous Substances, pollutants or contaminants, or Hazardous Wastes and Hazardous Constituents remaining at the Site above levels that allow for unlimited use and unrestricted exposure in accordance with Section 300.430(f) (4) (ii) of the NCP, DOE will submit to EPA and KNREPC* a review of the RAs no less often than once every five (5) years (Five-Year Review) after the initiation of such RAs (i.e., date of issuance of final-ROD) for as long as the site remains on the NPL to assure that human health and the environment are being protected by the RAs being implemented. To facilitate the Five-Year Review process for multiple OUs, the Five-Year Reviews shall be synchronized as follows: reviews which are required for RA OUs will be conducted every five years starting from the initiation of the RA for the first OU. Every five years thereafter, all subject OU RAs which were started prior to the next Five-Year Review date, shall be included in the next Five-Year Review. For OU RAs which started after the most recent Five-Year Review, the level of the review shall be commensurate to the completeness of the RA and the quantity of operation and maintenance data collected.
>
> If, based on the Five-Year Review, it is the judgment of EPA or KNREPC that additional action or modification of a RA is appropriate in accordance with Sections 104, 106 or 120 of CERCLA, 42 USC § 9604, 9606, or 9620, the RCRA Permits or KRS 224 Subchapter 46, then EPA or KNREPC shall require DOE to submit a proposal to implement such additional or modified actions, which shall be subject to review and approval by EPA and KNREPC.
>
> *KNREPC now is called the Kentucky Energy and Environment Cabinet.

DOE is the lead agency for these response actions, and EPA and KDEP provide regulatory oversight pursuant to the FFA. This fourth synchronized Five-Year Review contains reviews of completed projects. The triggering action for this review is the five-year anniversary of the third synchronized Five-Year

Review conducted at the Paducah Site [*Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-1289&D2 (DOE 2014a)].

This fourth synchronized Five-Year Review is used to accomplish the following [DOE 2002a (unnumbered)]:

1. Evaluate whether the remedy is operational and functional;

2. Evaluate those assumptions critical to the effectiveness of remedial measures or the protection of human health and the environment (e.g., land use, site conditions, applicable standards) made at the time of the remedial decision to determine, given current information, whether these assumptions are still valid;

3. Determine what corrective measures are required to address any identified deficiencies; and

4. Evaluate whether there are opportunities to optimize the long-term performance of the remedy or reduce lifecycle costs.

EPA Region 4 issued a policy in April 1998 for assuring the long-term effectiveness of land use controls (LUCs) at federal facilities (Johnston 1998). The Paducah Site subsequently developed a site-specific Memorandum of Agreement (MOA) and Land Use Control Assurance Plan (LUCAP) (DOE 2000a). The Paducah Site LUCAP specifies that decision documents approved prior to the effective date of the MOA in which LUCs were selected as part of the remedy will be analyzed for the effectiveness of the LUCs during the ROD Five-Year Reviews. EPA issued guidance in 2011, OSWER Directive 9355.7-18 (EPA 2011), which provided recommendations for conducting five-year reviews for the institutional control (LUC) component of remedies in a manner similar to the review of engineering or other remedy components. The effectiveness of the institutional controls or LUCs is addressed in this fourth synchronized Five-Year Review. The Paducah Site LUCAP also requires that DOE notify EPA and KDEP in writing of any major changes in land use at least 60 days prior to the initiation of such changes. This notification will include the following:

- An evaluation of whether the anticipated land use change will pose unacceptable risks to human health and the environment or negatively impact the effectiveness of the remedy;

- An evaluation of the need for any additional RA(s) resulting from the anticipated land use changes; and

- A proposal for any necessary changes to the selected RA and identification of documentation requirements (e.g., ROD amendments, ROD Explanation of Significant Differences, RCRA permit modification, etc.) for the proposed changes.

Deed restrictions were verified at the McCracken County, Kentucky, courthouse.

The review of the completed response actions was conducted during December 2017 through February 2018 for the period extending from January 2013 through December 2017. DOE and its deactivation and remediation (D&R) contractor, Four Rivers Nuclear Partnership, LLC, (FRNP) conducted the reviews. Chapter 4 of this report identifies the locations of the actions that were reviewed. Components of this review are as follows:

- Document review
- Data review

- Site inspection
- Interviews of personnel responsible for specific aspects of some of the response actions
- Five-Year Review Report development and review

These components are described in more detail in Chapter 22.

Protectiveness statements are developed after the technical review is completed and the following questions are answered:

- Question A: Is the Remedy Functioning as Intended by the Decision Documents?

- Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives (RAOs) Used at the Time of the Remedy Selection Still Valid?

- Question C: Has Any Other Information Come to Light That Could Call into Question the Protectiveness of the Remedy?

2. SITE CHRONOLOGY

Table 2.1 contains key dates that are important to the environmental response program of the Paducah Site.

Table 2.1. Chronology of Significant Site Events at the Paducah Site

Date of Action	Response Description	Site/Project Name	OU	WAG	SWMU	Media	Response Type
1952	PGDP begins enriching uranium for nuclear fuel reactors.	N/A	N/A	N/A	N/A	N/A	N/A
1964–1965, 1979	The Paducah Site conducts cylinder drop tests using trichloroethene (TCE) pit (later to be designated SWMU 91).	N/A	GWOU	N/A	91	Ground-water	N/A
Aug–1988	Off-site* groundwater contaminants are discovered in neighboring residential wells. DOE immediately provided a temporary water supply. Initiated construction activities to supply municipal water.	N/A	GWOU	N/A	N/A	Ground-water	N/A
Nov–1988	Agreed Consent Order is signed.	N/A	N/A	N/A	N/A	N/A	N/A
Aug–1991	Kentucky Hazardous Waste Management Permit and EPA Hazardous and Solid Waste Amendments Permits are first effective.	N/A	N/A	N/A	N/A	N/A	N/A
May–1993	The Paducah Site applies for listing on NPL.	N/A	N/A	N/A	N/A	N/A	N/A
Jul–1993	Implemented institutional controls (fencing/posting) for off-site contamination in surface water, outfalls, and lagoons.	Exterior drainage ditches	SWOU	18 and 25	58–69, 168, 171, 199	Surface water	ICM
Jul–1993	Issued ROD to initiate control of the source and mitigate the spread of the high concentration portion (TCE) of the Plume.	Northwest Plume	GWOU	26	201	Ground-water	Interim Remedial Action (IRA)
Mar–1994	Issued ROD that instituted action to treat certain facility effluent and control the migration of contaminated sediment associated with the NSDD.	NSDD	SWOU	25	59	Surface water	IRA
May–1994	The Paducah Site is placed on NPL.	N/A	N/A	N/A	N/A	N/A	N/A
Aug–1994	Action Memorandum (AM) approved for extended municipal water line to residents potentially affected by off-site groundwater contamination.	Water Policy	GWOU	26	201, 202	Ground-water	Non-time-critical removal action (NTCRA)
Jun–1995	Issued ROD to initiate hydraulic control of high concentration area (TCE) within the Northeast Plume.	Northeast Plume	GWOU	26	202	Ground-water	IRA
Aug–1995	Northwest Plume Groundwater System (NWPGS) begins operation.	Northwest Plume	GWOU	26	201	Ground-water	IRA

Table 2.1. Chronology of Significant Site Events at the Paducah Site (Continued)

Date of Action	Response Description	Site/Project Name	OU	WAG	SWMU	Media	Response Type
Sept–1995	The ROD selected an impermeable cap to reduce leachate migration from surface infiltration, groundwater monitoring, and institutional controls. Through agreement of the parties, an impermeable cap was not constructed (WAG 22 Post-ROD Change, October 23, 1996). This change also will be documented in the Final Remedial Decision for the C-749 Uranium Burial Ground.	C-749 Uranium Burial Ground	BGOU	22	2	Soil and Ground-water	IRA
Feb–1997	Northeast Plume Groundwater System begins operation.	Northeast Plume	GWOU	26	202	Ground-water	IRA
Feb–1998	FFA is signed with EPA and KDEP.	N/A	N/A	N/A	N/A	N/A	N/A
Jul–1998	First Five-Year Review is completed for Northwest Plume Action.	Northwest Plume	GWOU	26	201	N/A	IRA
Aug–1998	First Five-Year Review is completed for Water Policy.	Water Policy	GWOU	26	201, 202	N/A	N/A
Aug–1998	Issued ROD for *in situ* treatment of TCE-contaminated soils using the Lasagna™ technology.	Cylinder Drop Test Area	GWOU	27	91	Soil	IRA
Aug–1998	Issued ROD for installation of rip-rap along creek bank to prevent direct contact, implementation of institutional controls, and long-term monitoring and enhancement of existing cap to reduce leachate migration from surface infiltration.	C-746-K Sanitary Landfill	SWOU	1 & 7	8	Surface water and sediment	IRA
Aug–2000	First Five-Year Review is completed for BGOU.	Burial Ground	BGOU	22	2, 3	Soil and ground-water	N/A
Aug–2000	First Five-Year Review is completed for SWOU.	Surface Water	SWOU	**	**	Surface water	N/A
Dec–2001	Lasagna™ or Cylinder Drop Test Area remedial operations are completed.	Cylinder Drop Test Area	GWOU	27	91	Soil	IRA
Aug–2002	Initiated removal of process equipment and piping for C-410 Decontamination and Decommissioning (D&D).	C-410 Infrastructure Removal	D&D	30	478	Building structures	NTCRA
Sep–2002	RA for Sections 1 and 2 of the NSDD.	NSDD	SWOU	25	59	Sediment and soil	IRA
Dec–2003	First synchronized Five-Year Review is issued.	All applicable projects	Applies to all activities associated with all OUs.				

Table 2.1. Chronology of Significant Site Events at the Paducah Site (Continued)

Date of Action	Response Description	Site/Project Name	OU	WAG	SWMU	Media	Response Type
Aug–2005	Issued ROD for *in situ* treatment of TCE source areas in the Upper Continental Recharge System (UCRS) and Regional Gravel Aquifer (RGA) located in the southeast and southwest corners of the C-400 Building using ERH technology.	C-400 ERH	GWOU	6	11 & 533	Ground-water	IRA
Dec–2005	Initiate removal, characterization, and disposal of building structure and contents.	C-402 Limehouse, C-405 Incinerator	D&D	30	480 & 55	Building structures	NTCRA
Nov–2008	Second synchronized Five-Year Review is issued.	All applicable projects	Applies to all activities associated with all OUs.				
Apr–2009	AM approved for the removal of contaminants associated with sediment in Sections 3, 4, and 5 of the NSDD and Kentucky Pollutant Discharge Elimination System (KPDES) Outfalls 001, 008, 010, 011, and 015, and associated internal ditches and areas of the Paducah Site.	Surface Water On-site Sediment Removal	SWOU	N/A	58; 69; 63; 66; 67; 68 and associated internal ditches and areas (including SWMUs 92 and 97)	Sediment and soil	NTCRA
May–2009	AM approved for the removal of lead-contaminated soil at the C-218 Firing Range (SWMU 181). Removal of contamination within the respective SWMU boundaries of C-410-B (SWMU 19). Removal of contamination within the respective SWMU boundaries of C-403 (SWMU 40).	Soils Inactive Facilities Removal	Soils	N/A	19, 40, & 181	Soil	NTCRA
Nov–2009	Issued addendum to document a change in scope of the C-410 removal action to (1) expand the scope of the existing NTCRA to include facility structure demolition to the slabs and disposition of demolition debris and (2) allow the nonprocess systems to remain in place and to remove these systems at the same time the building is demolished using heavy equipment such as an excavator with shears.	C-410 Infrastructure Removal	D&D	30	478	Building structures	NTCRA

Table 2.1. Chronology of Significant Site Events at the Paducah Site (Continued)

Date of Action	Response Description	Site/Project Name	OU	WAG	SWMU	Media	Response Type
May–2010	Issued the AM for the decommissioning of the C-340 Metals Plant and C-746-A East End Smelter, which entailed the demolition of C-340-A, -B, and -C structures as well as the C-746-A East End Smelter. The slabs and soils underlying these structures will be addressed in future CERCLA response actions.	C-340 Decommis-sioning and C-746-A, East End Smelter	D&D	N/A	477 and 137	Building structures	NTCRA
Sept–2010	Issued an Explanation of Significant Differences to the ROD for the IRA of Northwest Plume to increase contaminant mass removal and enhance capture near the southern extraction wells (EWs) that were closer to the sources. The Northwest Plume Groundwater Treatment System was optimized by placing existing southern EWs on standby and installing two new EWs east of original southern extraction field.	Northwest Plume	GWOU	26	201	Ground-water	IRA
Mar–2012	Issued ROD for: Oil Landfarm—*In situ* source treatment using deep soil mixing with interim LUCs. C-720 Building Northeast Spill Site-A—*In situ* source treatment using enhanced *in situ* bioremediation with interim LUCs or long-term monitoring with interim LUCs based upon remedial design support investigation (RDSI) results. C-720 Building Southeast Spill Site—*In situ* source treatment using enhanced *in situ* bioremediation with interim LUCs or long-term monitoring with interim LUCs based upon RDSI results.	Southwest Plume	GWOU	N/A	1 & 211-A & 211-B	Soil	RA
Aug–2013	Third synchronized Five-Year Review is issued.	All applicable projects	Applies to all activities associated with all OUs.				
Nov–2015	Issued an Explanation of Significant Differences to the ROD for the IRA of the Northeast Plume. The Northeast Plume Containment System (NEPCS) was optimized by replacing the two existing EWs with two new EWs in the upgradient high concentration portion of the plume and installing new treatment units to remove volatile organic compounds (VOCs) from the extracted groundwater.	Northeast Plume	GWOU	26	202	Ground-water	IRA

Table 2.1. Chronology of Significant Site Events at the Paducah Site (Continued)

Date of Action	Response Description	Site/Project Name	OU	WAG	SWMU	Media	Response Type
Sep–2016	Issued remedial action completion report (RACR) for Oil Landfarm RA—*in situ source treatment using deep soil mixing with interim LUCs*.	Southwest Plume	GWOU	N/A	1	Soil	IRA
Sep–2016	Removed liquid and sludge to the extent practicable within the acid neutralization tank. Filled the tank with flowable fill.	Soils Inactive Facilities Removal	Soils	N/A	27	Liquid and sludge	Time-critical removal action
Aug–2017	Reprioritization of DOE mission-related activities at the Paducah Site.	C-400	C-400 Complex OU	6	11, 40, 47, 98, 203, 480, and 533	Ground-water and soil	MOA

N/A = not applicable
*Off-site is defined as off DOE property, unless otherwise noted.
**The 2000 Five-Year Review for SWOU addresses the surface water associated with 39 SWMUs.

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3. BACKGROUND

3.1 PHYSICAL CHARACTERISTICS

The Paducah Site is located in western Kentucky, approximately 10 miles west of the city of Paducah, and approximately 3.5 miles south of the Ohio River (Figure 3.1). The total acreage of land held by DOE at the Paducah Site is 3,556 acres. The industrial portion of the Paducah Site is approximately 628 acres located within a fenced security area. Surrounding the industrial portion of the reservation is the WKWMA.

PGDP is situated near the New Madrid Seismic Zone, which is a seismically active region. Geophysical investigations of the Paducah Site identify the south extension of high-angle northeast-trending faulting in the bedrock beneath the Paducah Site that likely is associated with the Fluorspar Area Fault Complex of southern Illinois. Inferred age of faulting is consistent with age of faulting in southern Illinois. The Barnes Creek Fault Zone of southern Illinois (approximately 7.5 miles northeast of PGDP), if extended sufficiently southward below the Mississippi Embayment, most likely would pass under or near PGDP (on the east side). Another southern Illinois fault zone that could pass below or near PGDP (possibly on the west side) is the Massac Creek Structure of the Hobbs Creek Fault Zone (approximately 8 miles northeast of PGDP). Two recent, major seismic field studies have been conducted at the Paducah Site. These area field investigations are at the site of a potential CERCLA waste disposal facility, called Site 3A, (DOE 2004) and a field investigation in support of the expansion of the current C-746-U Solid Waste Landfill (KRCEE 2006). Site 3A is located immediately south of the PGDP security-fenced area, DOE 2004) and the C-746-U Landfill is located 1 mile north of the PGDP security-fenced area, (KRCEE 2006). These field studies identified subsurface faulting, exhibiting both normal and reverse displacement from the carbonate bedrock extending upward and into the Continental Deposits, in both locations.

Specifically, the Site 3A investigation (DOE 2004) identified a series of faults beneath Site 3A. For most of the faults beneath Site 3A, relative movement along the main fault plane is normal, with the downthrown side to the east. These normal faults, along with their associated splays, form either a series of narrow horst and graben features or divide the local sediments into a series of rotated blocks. Several of the faults extend through the Porters Creek Clay and into the materials underlying the surficial loess. Three of these faults extend to within approximately 20 ft of the ground surface. Age dating analysis of soil core samples at these locations determined that the latest faulting was pre-Holocene age at both sites (DOE 2018).

More recently, a review of results from seismic (shear wave) and electrical resistivity (dipole-dipole) experiments inferred that the groundwater TCE plumes at PGDP is aligned with the general orientation of an underlying Paleozoic fault system (Almayahi and Woolery 2018). This inference is consistent with alignment of the Northwest Plume with a series of imaged grabens identified by Blits, Woolery, Macpherson, and Hampson in 2008.

Several groundwater-bearing zones are present in the area of the Paducah Site. The primary water-bearing units, in order of increasing depth, are the UCRS, the RGA, and the McNairy Formation (Figure 3.2). The RGA has been identified as the uppermost aquifer at the Paducah Site (MMES 1992). The RGA is the dominant groundwater flow system at the Paducah Site and contains the on-site and off-site contaminant plumes.

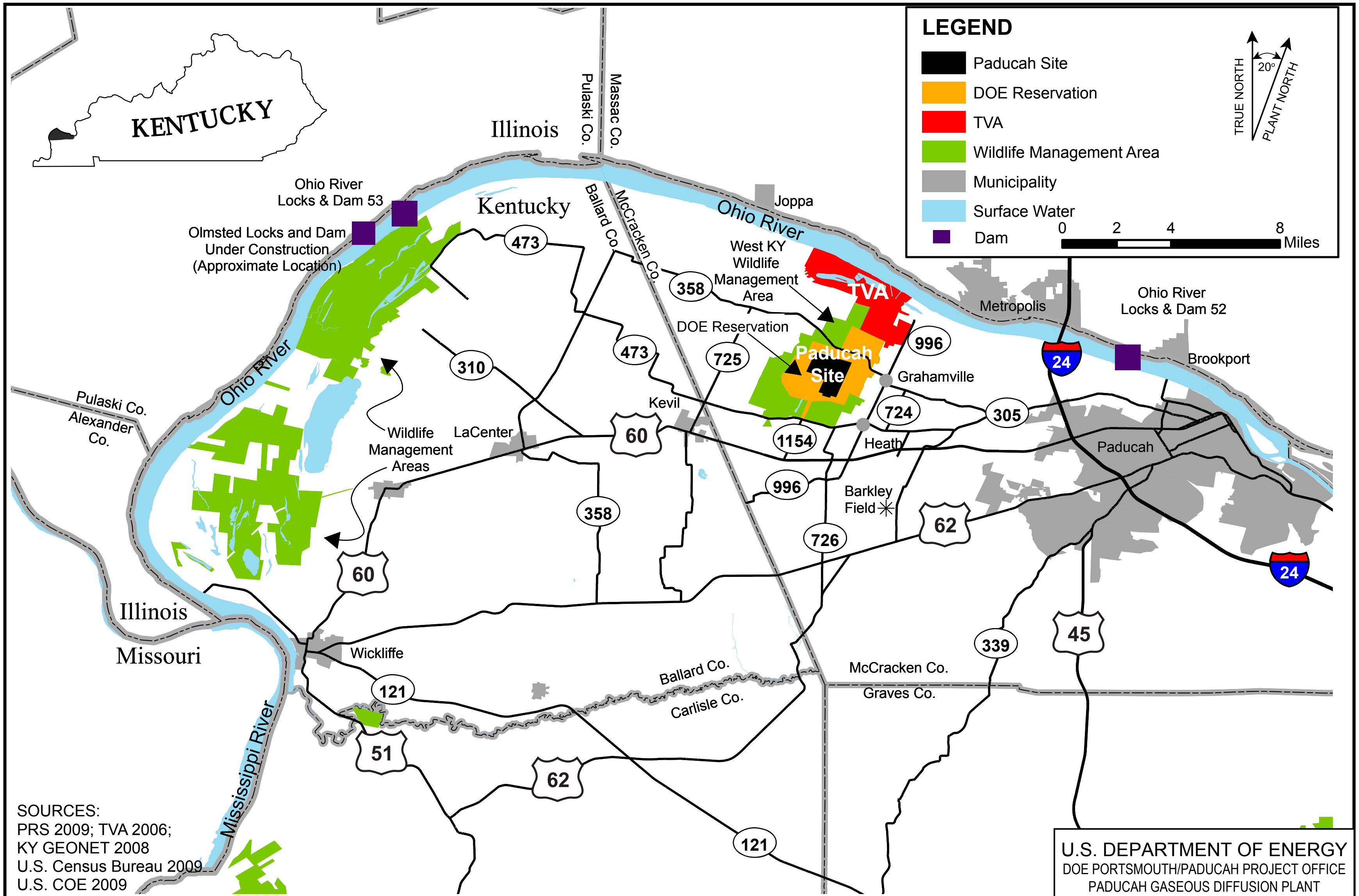
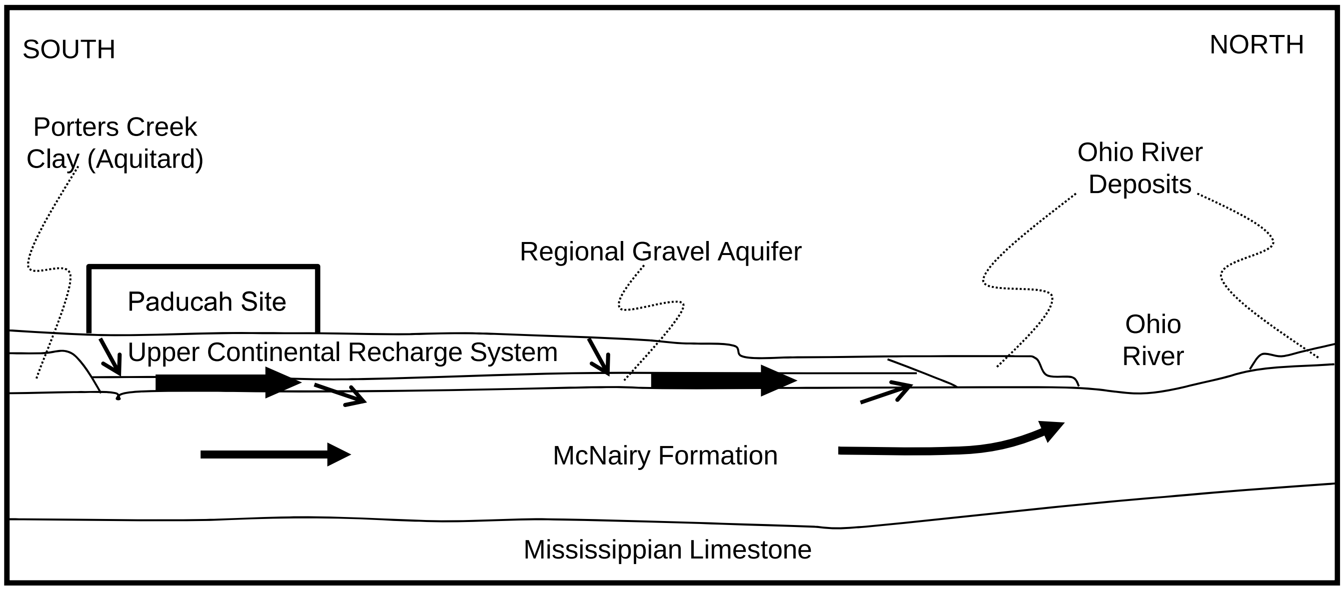


Figure 3.1. Paducah Site Location

FOUR RIVERS NUCLEAR PARTNERSHIP, LLC



Arrows indicate groundwater flow direction

Vertical Exaggeration = 10X

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

FOUR RIVERS NUCLEAR PARTNERSHIP, LLC

Figure 3.2. Water-Bearing Zones in the Paducah Site Area

Groundwater flow is predominately vertically downward in the UCRS, providing recharge to the RGA. Rainfall infiltration and leakage from the Paducah Site water utilities account for most of the recharging water. In general, the depth to the UCRS water table is less than 20 ft in the western half of the Paducah Site industrial area (as shallow as 5 ft in some areas) and as much as 40 ft in the northeastern corner.

The RGA typically has a relatively high hydraulic conductivity and serves as the dominant flow system in the area. Hydraulic gradients direct groundwater flow in the RGA laterally to the north where the regional groundwater systems discharge into the Ohio River. Additionally, discharges of contaminated groundwater to surface water occur at seeps in Little Bayou Creek. The groundwater in these seeps contains contaminants associated with the Northwest Plume.

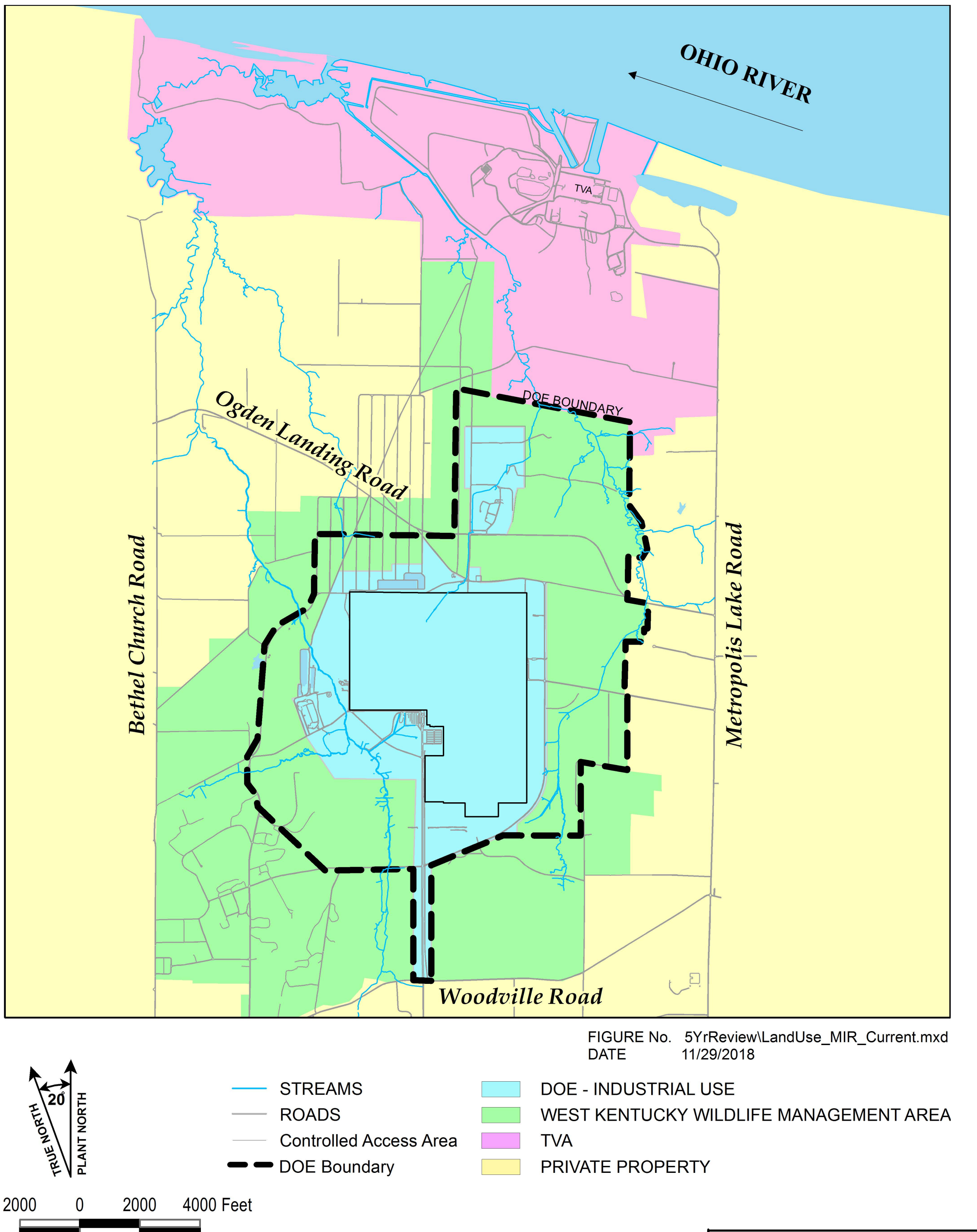
Silts and fine sands of the McNairy Formation, found beneath the RGA sediments, form the lower confining unit to the shallow aquifer system. The regional groundwater flow direction in the McNairy Formation is toward the Ohio River. Vertical hydraulic gradients in the McNairy Formation are downward beneath the Paducah Site industrial area, but upward near the Ohio River. The Porters Creek Clay is a confining unit to groundwater flow south of the Paducah Site industrial area. A shallow water table flow system (the Terrace Gravel flow system) is developed in gravels that overlie the Porters Creek Clay south of the Paducah Site industrial area and underlies the C-746-K Sanitary Landfill. Discharge from the Terrace Gravel flow system provides baseflow to Bayou Creek and underflow to the UCRS under the Paducah Site industrial area.

3.2 LAND AND RESOURCE USE

Uranium enrichment operations began at the Paducah Site in 1952, and the complex became fully operational in 1955. Hazardous, nonhazardous, and radioactive wastes have been generated, stored, and disposed of at the Paducah Site. The industrial portion of the Paducah Site, designated as secured (i.e., fenced and patrolled) industrial land use, includes numerous buildings and offices, support facilities, equipment storage areas, and active and inactive waste management units. The Depleted Uranium Hexafluoride (DUF_6) Conversion Project located at the Paducah Site converts DUF_6 stored at Paducah into a more stable chemical form suitable for beneficial reuse or disposal. The United States Enrichment Corporation (USEC) leased site facilities from DOE and operated the PGDP from 1992 to 2013. In 2014, USEC terminated its lease agreement with DOE for operation of the PGDP and returned the leased facilities to DOE. DOE retains ownership of all facilities and retains responsibility for managing the disposition of legacy waste material and environmental cleanup. DOE currently holds a license with the Commonwealth of Kentucky for certain portions of the WKWMA. Portions of both the DOE Reservation and WKWMA occupy land that once was part of the Kentucky Ordnance Works, a trinitrotoluene production facility in operation between 1942 and 1946. The entire WKWMA covers approximately 6,823 acres. The land licensed to the WKWMA is designated as recreational and is used extensively for outdoor recreation such as hunting and fishing. DOE property not leased to WKWMA and outside the security area is classified as on-site, unsecured (i.e., not fenced) industrial. Figure 3.3 is a map showing the land use areas surrounding the Paducah Site.

North of the DOE Reservation and WKWMA is the Shawnee Fossil Plant, operated by the Tennessee Valley Authority (TVA). This TVA property is designated as industrial.

Private property surrounds the DOE Reservation, WKWMA, and TVA. This property is mostly rural and agricultural. Residents and businesses in the surrounding area are served by a municipal water supply and private wells (if not subject to restriction under DOE’s Water Policy). The municipal water supply is serviced by the West McCracken Water District. The district’s water source is the Ohio River upstream of DOE Reservation.



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PADUCAH GASEOUS DIFFUSION PLANT

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Figure 3.3. Land Use in Proximity to the Paducah Site

As noted above, the Paducah Site is located approximately 10 miles west of Paducah, Kentucky, in the western part of McCracken County [population approximately 65,000 (DOC 2011)]. The total population within a 50-mile radius of the Paducah Site is approximately 534,000. Based on population data from the 2010 census, approximately 104,000 people live within 20 miles of the Paducah Site and homes are scattered along rural roads around the site. The population of Paducah, based on the 2010 U.S. Census, is 26,307. The closest communities to the Paducah Site are the unincorporated towns of Grahamville and Heath which are 1.24 and 1.86 miles east of the PGDP, respectively. The nearest schools are Heath Elementary and Middle Schools. These are 1.86 miles southeast of PGDP near the Heath community. The nearest hospitals are located in Paducah. The Paducah Site is near the following major roads: U.S. Highway 60 and Kentucky Highways 358, 725, and 996. Additional major roads at greater distance are Interstate 24 and U.S. Highway 62. A rail spur serves the Paducah Site and connects to the Illinois Central Gulf Railroad. The nearest airport is Barkley Regional Airport located approximately 3.7 miles southeast of the Paducah Site. Metropolis, Illinois, and Kevil, Kentucky, are the nearest municipal areas and are shown as urban residential land use (see Figures 3.1 and 3.3).

The Ohio River is navigable along its entire length, and near the Paducah Site has a downstream connection to the Mississippi River and an upstream connection to the Tennessee River. The Olmsted Locks and Dam (which began operations on September 6, 2018) controls the Ohio River stage at the Paducah Site. In addition, the Kentucky Lock and Dam is located on the Tennessee River near its confluence with the Ohio River (see Figure 3.1). The Paducah Site is located in the western portion of the Ohio River basin, approximately 15 miles downstream of the confluence of the Ohio River with the Tennessee River and approximately 35 miles upstream of the confluence of the Ohio River with the Mississippi River. Locally, the Paducah Site is within the drainage areas of the Ohio River, Bayou Creek (also known as Big Bayou Creek), and Little Bayou Creek.

PGDP is situated on the divide between Little Bayou and Bayou Creeks (Figure 3.4). Bayou Creek is a perennial stream on the western boundary of PGDP that flows generally northward to the Ohio River. Little Bayou Creek becomes a perennial stream at the east outfalls of the Paducah Site industrial area and extends northward to the Ohio River. Most of the flow within Bayou and Little Bayou Creeks is from process effluents or surface water runoff from the Paducah Site industrial facility.

3.3 HISTORY OF CONTAMINATION

Historical activities at the Paducah Site have generated various nonhazardous, hazardous, and radioactive wastes that have been managed, stored, and/or disposed of by different methods. These activities have, in some cases, resulted in the release of contaminants to the environment. The primary contaminants of concern (COCs) at the Paducah Site are technetium-99 (Tc-99), TCE, polychlorinated biphenyls (PCBs), and uranium.

In August 1988, TCE, an organic solvent, and Tc-99, a beta-emitting radionuclide, were detected in four private wells north of the Paducah Site. DOE placed potentially affected residences/businesses on alternate water supplies and began an intensive monitoring and investigation program to define the extent and temporal variations of the groundwater contaminant plumes. Since that time, several investigations and response actions have taken place (see Table 2.1 for listing of significant site events).

The contaminant, Tc-99, is a man-made radionuclide created as a byproduct of the fission of uranium. Initially, Tc-99 was introduced to the PGDP in 1953 as a contaminant in feed material during a program in which spent nuclear reactor fuel was fed into the gaseous diffusion processes.

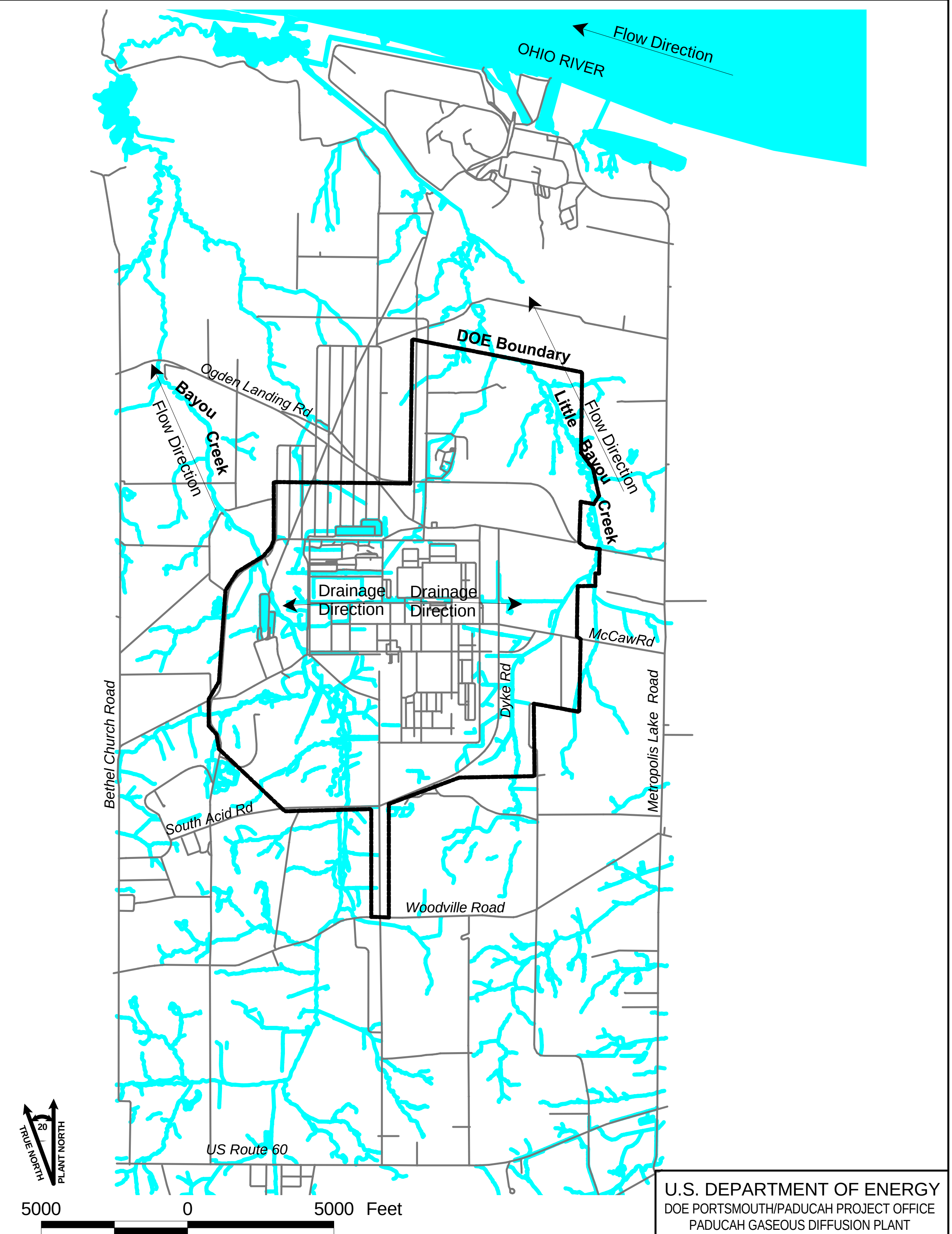

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Figure 3.4. Surface Water Features in the Vicinity of the Paducah Site

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TCE had been used as a cleaning solvent at uranium enrichment plant since its construction. In the C-400 Building, process piping and equipment from the cascade system were cleaned with TCE. In 1986, TCE was found to have been discharged inadvertently (apparently for many years) from a sump pump in the degreaser area of C-400 to a storm sewer and was found to have leaked into the soil. Other potential sources of TCE releases at the Paducah Site are the TCE degreaser at the C-720 Building and switchyard transformers that were washed with TCE. Reportedly, TCE also was used in the Kellogg Building during PGDP construction. Waste TCE was disposed of in on-site landfills and in a historical landfarming operation. In the Paducah Site cylinder drop tests, TCE was placed into a pit and used as a refrigerant in tests to determine cylinder integrity (Chapter 7). The Paducah Site ceased use of TCE in 1993.

PCBs have been found in sediment and fish downstream of the Paducah Site. PCBs have been used extensively as an insulating, nonflammable, thermally conductive fluid in electrical capacitors and transformers at the Paducah Site. The large switchyards that service the process buildings included PCB-filled transformers. PCBs also have been used as flame retardants (on the gaskets of diffusion cascades in other sections of the plant), as a hydraulic fluid, and are used in paints on equipment that is subject to high temperatures. PCBs have been released to the environment from spill sites throughout the industrial complex that resulted from specific transformer ruptures and as part of general operations over the years.

Uranium, thorium, and transuranic elements (i.e., plutonium and neptunium) were detected in off-site sediments near the Paducah Site in 1988 (MMES 1989). Results ranged from approximately 2.5 to over 200 times background. Many of these sediments have been removed (Chapter 16) (DOE 2011a). Sources of uranium releases are general plant operations.

3.4 INITIAL RESPONSE

After the discovery of groundwater contamination in 1988, DOE placed potentially affected residences and businesses on an alternate water supply and began an intensive monitoring and investigation program to define the extent of contamination. The Paducah Site was proposed for the NPL on May 10, 1993, and listed on May 31, 1994.

DOE’s first objective was to reduce immediate risks to off-site residents. DOE implemented plume control actions at the NWPGS and the NEPCS, and surface water institutional controls to reduce further the risks posed to human health and environment by releases from the Paducah Site.

After addressing immediate off-site risks, DOE identified potential areas of contamination at the Paducah Site (e.g., burial grounds, spill sites, and container storage areas) as SWMUs and areas of concern. DOE then grouped most of the SWMUs and areas of concern into WAGs, based upon common characteristics such as similar contaminants or type of media affected and gave highest priority to those WAGs with the greatest potential for contributing to off-site contamination. Subsequently, DOE began conducting response activities to address the contamination.

In August 1998, DOE, EPA, and the Commonwealth of Kentucky agreed to restructure the remedial strategy for the Paducah Site. This restructuring reflected the accomplishment of sitewide remedial objectives through an OU approach based on the primary exposure pathways and applied to the site Environmental Remediation Program.

Site cleanup activities were divided as follows: (1) pre-PGDP shutdown scope, (2) post-PGDP shutdown scope, and (3) Comprehensive Site Operable Unit (CSOU) scope. The pre-PGDP shutdown scope was associated with media-specific OUs initiated prior to shutdown of uranium enrichment operations (i.e., Pre-PGDP shutdown Activities). The source areas for the pre-PGDP shutdown scope were grouped into five media-specific OUs as follows:

- D&D OU,
- GWOU,
- BGOU,
- SWOU, and
- Soils OU.

In October of 2014, USEC terminated its lease agreement for operation of PGDP and returned the leased facilities to DOE. Some of these previously leased facilities contain SWMUs that had not been readily accessible during USEC operation. Because DOE now has control of the formerly leased facilities, DOE has reassessed site cleanup priorities to identify areas offering the greatest opportunity to address significant sources of environmental media contamination. As a result, in 2016, DOE identified a comprehensive characterization and final response action of the C-400 Cleaning Building and its adjacent areas, hereafter referred to as the C-400 Complex, as its highest cleanup priority at the site. The C-400 Complex contains numerous SWMUs and is the largest source of off-site TCE groundwater contamination. The implementation of the C-400 Complex as Paducah DOE's highest cleanup priority has resulted in resequencing of other cleanup work at the site to align with the new cleanup priorities and revised time frames projected for implementation. The FFA senior managers signed an MOA for the C-400 Complex under the FFA for the Paducah Site, on August, 8, 2017, to document key aspects of the new strategy.

The new strategy from the MOA includes the following:

- Addition of the C-400 Complex OU with enforceable milestones and planning dates for all the CERCLA activities under the OU, including the out-year enforceable milestone for the C-400 RA field start;

- Integration of the pre- and post-PGDP shutdown projects and schedules into the overall cleanup scope of the FFA;

- Continuation of the C-720 Building Northeast Spill Site (SWMU 211-A) groundwater RA; and

- Resequencing of all other projects (e.g., CERCLA Waste Disposal Alternatives, BGOU, Soils OU, Dissolved-Phase Plumes OU, SWOU, and CSOU).

Under the new strategy, the site cleanup OUs are integrated and no longer distinguish between pre- and post-PGDP scope. Completion of these OUs is required to achieve delisting of the site from the NPL and the decommissioning of the plant. Prior to final deletion from the NPL, partial delisting may occur if conditions are met to support potential property transfers. The currently defined OUs (DOE 2019a) consist of the following:

- C-400 Complex OU,
- GWOU,
- SWOU,
- Soils OU,
- Soils and Slabs OU,
- BGOU,
- D&D OU,
- Lagoons OU,
- DUF_6 Footprint Underlying Soils OU, and
- CSOU.

The Site Management Plan (SMP) identifies the actions that have been reviewed as part of this fourth synchronized Five-Year Review as IRAs or removal actions (with the exception of Southwest Plume). Each of these interim actions will be subject to further evaluation to support long-term protectiveness for future final decisions. The final action to support NPL delisting will consist of the CSOU, which will evaluate residual risks and ensure all actions taken to date, when considered collectively, are protective of human health and the environment from a sitewide perspective. The actions reviewed under this fourth synchronized Five-Year Review will have these follow-up actions:

Five-Year Review Actions	**Follow-on Action**
GWOU: Northwest Plume	Dissolved-Phase Plumes OU
GWOU: Northeast Plume	Dissolved-Phase Plumes OU
GWOU: Cylinder Drop Test Area	Dissolved-Phase Plumes OU
GWOU: Water Policy	Dissolved-Phase Plumes OU
GWOU: C-400	C-400 Complex OU
GWOU: Southwest Plume	Dissolved-Phase Plumes OU
SWOU: NSDD Source Control	SWOU
SWOU: NSDD Sections 1 and 2	SWOU
SWOU: C-746-K Sanitary Landfill	CSOU
SWOU: Fire Training Area	CSOU
SWOU: ICM	SWOU
SWOU: On-Site Sediment	SWOU
BGOU: C-749 (SWMU 2)	BGOU (SWMUs 2 and 3) Final Action

The timing and sequencing for implementation of activities associated with the OUs are based on regulator expectations; risk-based decision-making; compliance with other programs; technical considerations associated with GDP transition/turnover; funding projections; mortgage reduction; and demonstrated progress toward completing the environmental management (EM) mission. The SMP documents the schedule of actions for the OUs.

The objective of grouping the sources and areas of contamination into these OUs is to provide a more comprehensive framework to assess sitewide risks, identify and prioritize response actions, and develop integrated cleanup solutions that will reduce any unacceptable risk across the primary exposure pathways through which human health and the environment may be affected. To support implementation of this strategy, the source areas and affected media within each OU have been subjected to a binning process to further segregate the source areas into various categories, including candidate areas designated as a high priority for a response action, areas requiring additional characterization/risk evaluation, and source areas associated with Paducah Site operations. Current examples of actions for high-priority areas include the ongoing implementation of the Water Policy; and the source action for TCE and other VOC contamination at the C-400 Cleaning Building area, which is now identified as the C-400 Complex OU.

In order to keep residents and the community informed of the remedial efforts taking place at the Paducah Site, DOE established a Citizen's Advisory Board (CAB) in September 1996. This board is composed of people who reflect the diversity of gender, race, and interests of persons surrounding the Paducah Site. The mission statement of the CAB, as stated in *Paducah Gaseous Diffusion Plant Citizens Advisory Board Operating Procedures* (Approved on October 21, 2010), is as follows:

> The mission of the Environmental Management (EM) Site-Specific Advisory Board (the Board or Citizens Advisory Board [CAB]) at the Paducah Gaseous Diffusion Plant (PGDP) is to provide meaningful opportunities for collaborative dialogue among the surrounding communities of the PGDP, EM, and the U.S. Department of Energy (DOE) Paducah Site Office (PSO). The Board is chartered under the EM Site-Specific Advisory Board Federal Charter. At the request of the Assistant Secretary or the Field Manager, the Board may provide advice and recommendations concerning the following EM site-specific issues: clean-up standards and environmental restoration; waste management and disposition; stabilization and disposition of non- stockpile nuclear materials; excess

facilities; future land use and long term stewardship; risk assessment and management; and clean-up science and technology activities. The Board may also be asked to provide advice and recommendations on any other EM project or issue. The Board ensures early ongoing community access to information (and its interpretation and implications) and dialogue that improves the quality of the decision making process of EM.

The full CAB meets on odd numbered months to hear from persons working on relevant environmental efforts, listen to and discuss input from concerned citizens, form advice and recommendations to submit to DOE, and formulate recommendations to DOE about how to conduct clean-up actions. The CAB has working sessions on even numbered months. All meetings are open to the public in accordance with the organization's bylaws. The Paducah Community Relations Plan (DOE 2018a) describes how DOE will provide opportunities for the public to become involved in FFA-related decisions at PGDP and outlines how the parties to the agreement will coordinate public participation prescribed by the FFA.

3.5 BASIS FOR TAKING ACTION

Exposures to soil, sediment, surface water, and groundwater are associated with risks that exceed EPA's risk management criteria either for industrial or residential exposure scenarios. Prior to implementation of the DOE Water Policy the risks were highest for exposures to contaminants in private wells. Other risks were due to recreational exposures in creek sediments and industrial exposures to process drainages. Additional information regarding the potential risks associated with potential areas of contamination at the Paducah Site, contaminants by media, and results of site investigations (SIs) are included in the following sections. Table 3.1 contains the COCs by media addressed by the actions included in this fourth synchronized Five-Year Review.

Table 3.1. COCs by Media

Groundwater	
Organics	*Radionuclides*
1,1-Dichloroethene	Technetium-99
cis-1,2-Dichloroethene	
Chloroform	
Trichloroethene	
Vinyl chloride	
Soils/Sediment and Surface Water	
Metals	*Organics*
Aluminum	Total polycyclic aromatic hydrocarbons (PAHs)
Antimony	Total PCBs
Arsenic	
Barium	*Radionuclides*
Beryllium	Americium-241
Cadmium	Cesium-137
Chromium	Neptunium-237
Copper	Plutonium-239/240
Iron	Technetium-99
Lead	Thorium-230
Manganese	Thorium-232
Mercury	Uranium-234
Nickel	Uranium-235
Selenium	Uranium-238
Silver	
Thallium	
Uranium	
Vanadium	

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4. RESPONSE ACTIONS

The 13 sites with response actions that require five-year reviews, the OU with which each site is associated, and the name used in previous five-year reviews are listed in Table 4.1. The location of each action reviewed within this document is shown on Figure 4.1, along with the latest available plume map, which shows the TCE plumes based on 2016 data.

Table 4.1. Site/Project with Response Actions Taken at the Paducah Site

Chapter	Site/Project Name Used in This Report	Operable Unit	Project Name Used in Previous Five-Year Reviews
5	Northwest Plume	GWOU	Northwest Plume
6	Northeast Plume	GWOU	Northeast Plume
7	Cylinder Drop Test Area or Lasagna™	GWOU	SWMU 91
8	Water Policy	GWOU	Water Policy
9	C-400 Electrical Resistance Heating	GWOU	GWOU C-400 ERH
10	Southwest Plume	GWOU	Southwest Plume
11	NSDD Source Control	SWOU	NSDD Source Control
12	NSDD Sections 1 and 2	SWOU	NSDD Sections 1 and 2
13	C-746-K Sanitary Landfill	SWOU	WAGs 1 and 7, SWMU 8
14	Fire Training Area	SWOU	WAGs 1 and 7, SWMU 100
15	Surface Water ICMs	SWOU	Surface Water ICMs
16	Surface Water On-site Sediment Removal	SWOU	Surface Water On-site Sediment Removal
17	C-749 Uranium Burial Ground	BGOU	WAG 22, SWMU 2

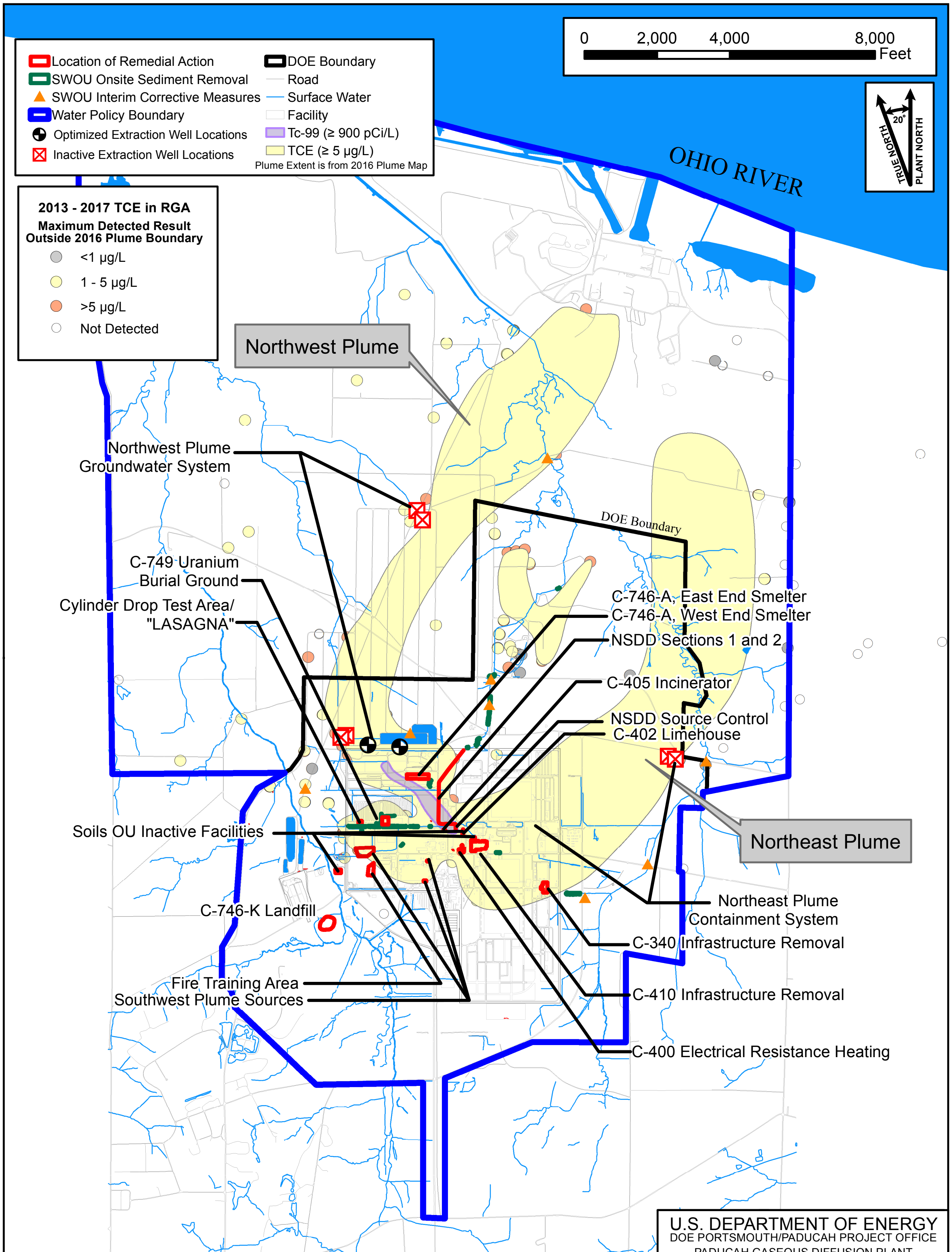

Figure 4.1. Locations of Removal and Remedial Actions Taken at PGDP

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5. NORTHWEST PLUME

After the initial discovery of off-site contamination at the Paducah Site in August 1988, DOE conducted an SI to identify the nature and extent of the contamination. The investigation, documented in the *Results of the Site Investigation, Phase I, Phase II* (CH2M HILL 1991; CH2M HILL 1992), determined that the groundwater contamination is spreading generally northward toward the Ohio River in multiple plumes. The most prominent of the plumes, containing both TCE and Tc-99, is the Northwest Plume (SWMU 201).

Outside of the immediate vicinity of its source areas on DOE Property, the Northwest Plume is restricted to the RGA, which occurs in a thick gravel unit and adjacent thin sands at depths of approximately 60 to 100 ft over most of the length of the plume. The extent of the Northwest Plume (and Northeast and Southwest Plumes, SWMUs 202 and 210) is well known through several DOE investigations. DOE maintains a monitoring well (MW) network to detect trends in the plume. The Northwest Plume underlies land licensed by DOE to the West Kentucky Wildlife Management Agency, land owned by TVA, and privately owned land that is sparsely populated. Some contaminated groundwater from the Northwest Plume discharges in seeps in Little Bayou Creek on TVA property. The Ohio River is the regional discharge point for groundwater flow in the RGA.

The overlying soils consist of thick silt units with lesser interbedded sand and gravel deposits that isolate the plume from potential human and ecological exposure. A vapor intrusion study of the downgradient Northeast and Northwest Plume areas determined that vapor intrusion does not pose a concern for area residences (DOE 2016a). DOE maintains a Water Policy (evaluated in Section 8) that controls access to the groundwater. Physically, access is controlled, for example, by padlocks on wells. Administratively, access is controlled through a license agreement process with landowners with and without residential wells in the area of the plume. DOE provides access to municipal water and pays reasonable municipal water bills for the majority of residents, which further limits any access to the contamination of the Northwest Plume.

Figure 5.1 illustrates the extent of the off-site Northwest Plume, the two EW fields, which began operation in 1995 for the NWPGS, and an optimized EW field (consisting of two wells), which began operation in 2010. Figure 5.2 is a comparison of the plumes between 2000 and 2016, which is the latest available plume map (FPDP 2017a). The downgradient limit of the Northwest Plume is near the Ohio River and at seeps in Little Bayou Creek.

5.1 REMEDY SELECTION

EPA and DOE, with the concurrence of the Commonwealth of Kentucky, agreed to a ROD for an IRA for the Northwest Plume on July 22, 1993 (DOE 1993a). This IRA consisted of the installation and maintenance of two EW fields (consisting of four EWs) for a period of two years to initiate control of the high-concentration zone of TCE and Tc-99 in the Northwest Plume. A water treatment facility was constructed to treat effluent from the EWs. The NWPGS has continued to operate since August 1995.

The *Record of Decision for Interim Remedial Action of the Northwest Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/06-1143&D4, delineated the RA as follows (DOE 1993a):

> The contaminated groundwater will be extracted at two locations. The first location, immediately north of the plant on DOE property, is intended to control the source. The second groundwater extraction location is off-site of the DOE reservation at the northern tip of the most contaminated portion of the plume [greater than 1,000 µg/L of

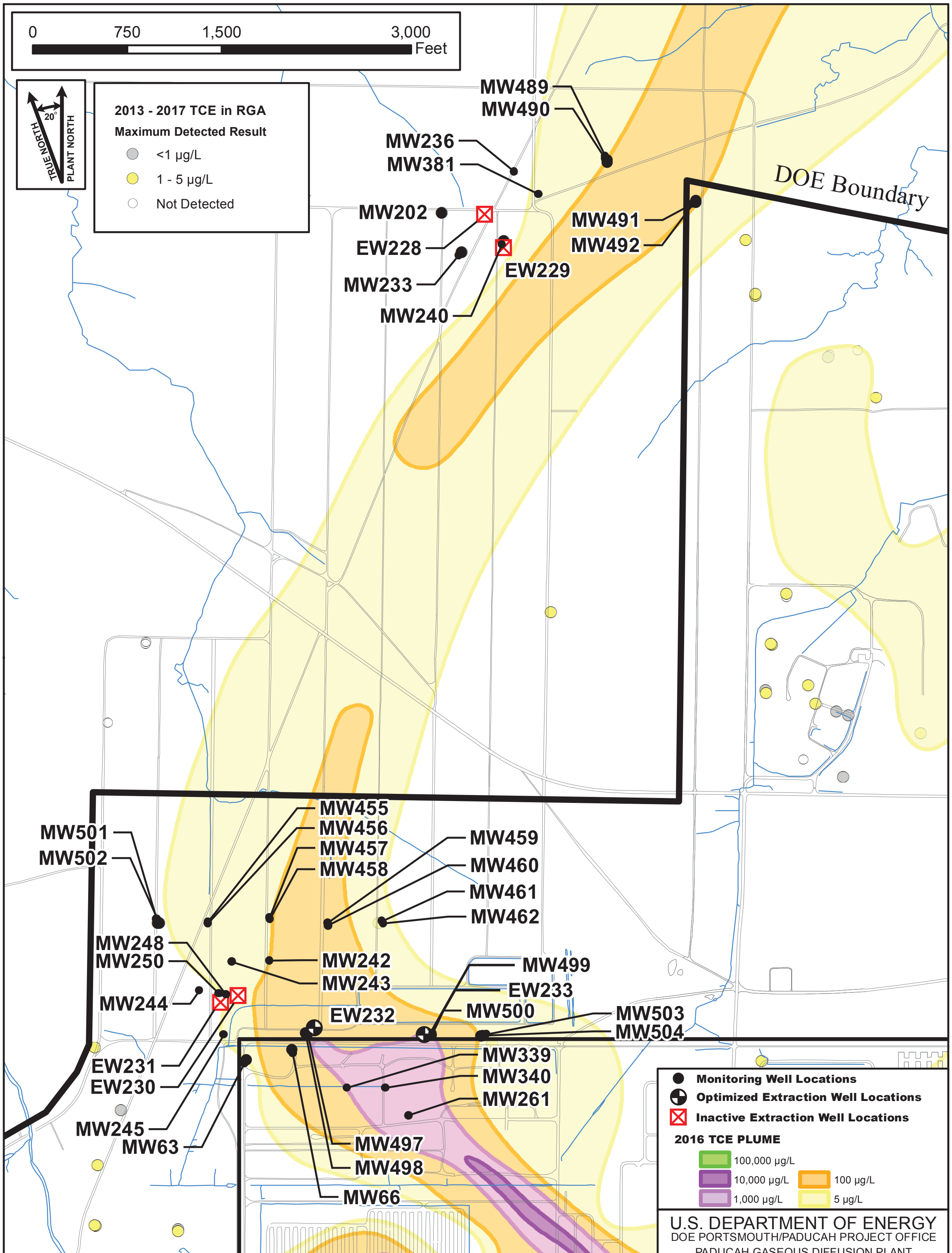

Figure 5.1. Northwest Plume EW Fields with 2016 TCE Plume Map

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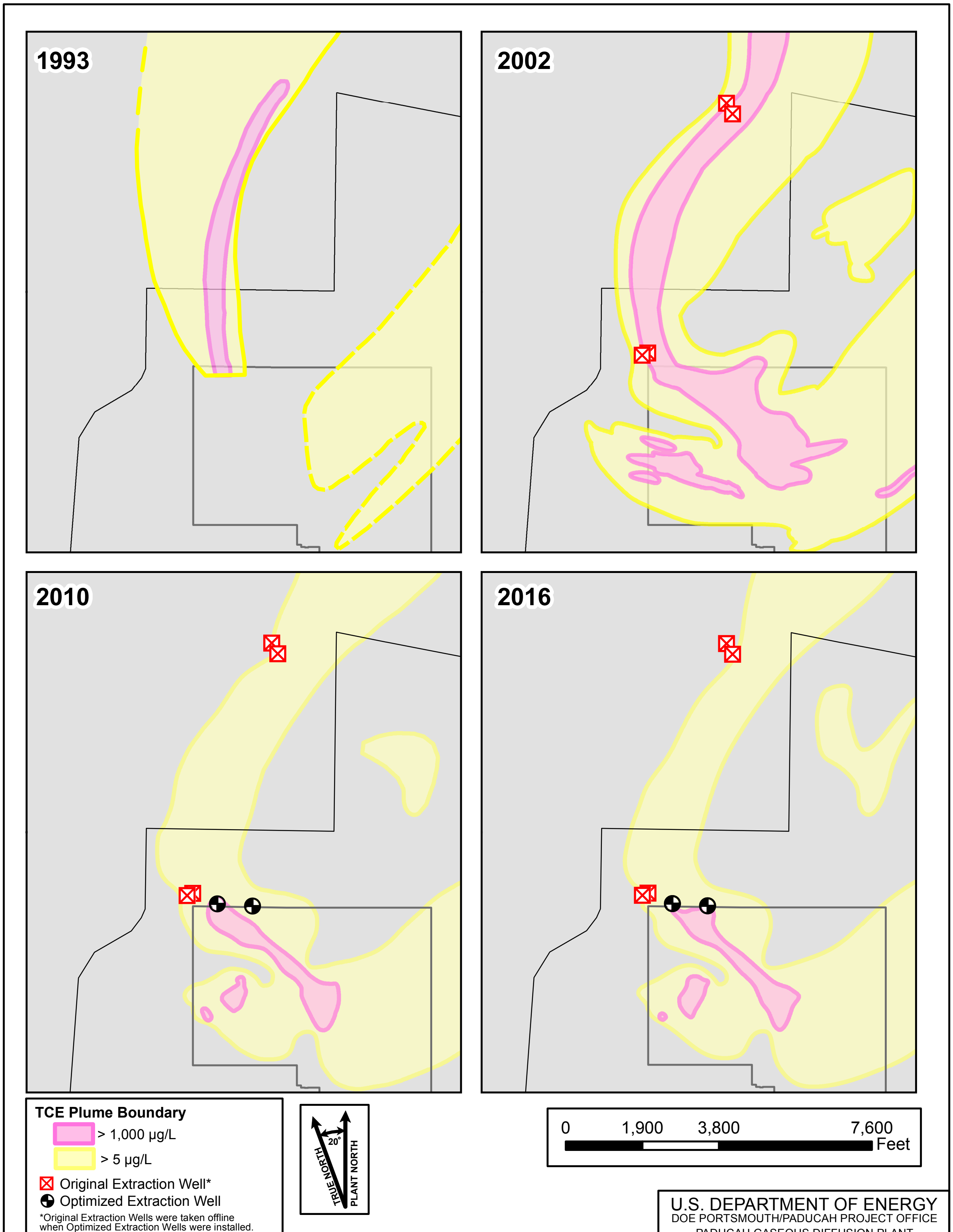

Figure 5.2. TCE Plumes as Interpreted for 1993, 2002, 2010, and 2016

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trichloroethylene (TCE)]. The contaminated groundwater will be pumped at a rate to reduce further contribution to contamination northwest of the plant without changing hydraulic gradients enough to mobilize dense nonaqueous-phase liquids (DNAPLs) or significantly affect other plumes. This pumping rate may be modified during operation to optimize hydraulic containment by adjusting flow from the extraction wells and to support subsequent actions.

The extracted groundwater will be collected in a manifold and piped to the treatment system, which will consist of two ion exchange units in parallel followed by an air stripper with treatment for off-gas emissions. This technology provides the treatment to the COCs (TCE and Tc-99). The target level for treatment of TCE is 5 ppb and 900 pCi/L for Tc-99.

The amount of treated water discharged will be limited by the flow capacity of the skid mounted treatment units. The treated water will be discharged through KPDES Outfall 001.

The interim action also includes implementation of a treatability study to evaluate an innovative technology. The innovative technology to be studied involves the potential utilization of iron filings as a viable alternative to pump-and-treat technology for groundwater treatment.

The remedy does not address source remediation, however; the remedy will address continuing release from a DNAPL principal threat source area.

Cleanup levels and RAOs are not specifically stated because the principal goal of this interim action is to decrease the risk by mitigating the spread of the high concentration portion of the Northwest Plume, retarding the migration of the contaminants emanating from the source area.

5.2 REMEDY IMPLEMENTATION

The remedial design was issued in May 1993 (MMES 1993a), and the remedial action work plan (RAWP) was issued one year later (DOE 1994b). The construction of the facility was performed in two phases. The first phase was the installation of MWs and EW fields. The second phase of work was the installation of the treatment facility and all internal equipment, and the subsurface pipelines to transport the contaminated water through the WKWMA to the treatment system. All of the construction was completed in May 1995, with calibration and operational preparedness through August 27, 1995. The NWPGS began pump-and-treat operations on August 28, 1995.

The interim action, construction completed in 1995, included the following:

- Four EWs and associated monitoring network with two EWs located at the north end of the high concentration zone and two EWs located immediately north of the Paducah Site facility;

- Double-walled subsurface pipelines with leak detection equipment to transport the contaminated water to the treatment facility;

- Active treatment equipment located in the facility including an equalization (EQ) tank, dual sand filter unit, low-profile air stripper, activated carbon treatment units, two double ion exchange units, and an on-line volatile organic analyzer; and

- Support equipment installed in the facility including backwash tank, settling tank, sludge handling equipment, air compressor, and filter press.

DOE issued an *Explanation of Significant Differences for the Interim Remedial Action of the Northwest Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/06-1481&D2, in August 1996 that proposed modifying the original RA (DOE 1996a). The three propositions in the document were as follows: (1) elimination of the activated carbon filters, (2) reversal of the sequence of the two treatment units (ion exchange unit and air stripper), and (3) elimination of the iron filings treatability study (DOE 1996a). At that time, DOE determined that the remedy would remain protective of human health and the environment and would meet the applicable or relevant and appropriate requirements (ARARs) identified in the ROD and additional ARARs introduced by the modifications. The additional ARARs triggered by the reversal of the treatment units are identified in the Explanation of Significant Differences document, approved by EPA on November 18, 1996. The Northwest Plume RA continues to comply with these ARARs. Although removing the carbon filters would not result in violation of Clean Air Act standards, DOE withdrew its proposal to eliminate the carbon filters in response to public comments.

In February and March 2006, DOE Headquarters conducted a Sitewide Remedy Review at the Paducah Site. The Sitewide Remedy Review report recommended that DOE expand the monitoring and characterization program, provide for an independent assessment to optimize the Northwest Plume and Northeast Plume IRAs, and evaluate natural attenuation processes further. At DOE's request, the U.S. Army Corps of Engineers led a Remediation System Evaluation of the Northeast and Northwest Plume Extraction Systems during October 2006. The review team concluded that the Northwest Plume IRA should be modified to terminate extraction at the two northern EWs and increase total extraction in the vicinity of the southern EWs. DOE issued *Explanation of Significant Differences to the Record of Decision for the Interim Remedial Action of the Northwest Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0343&D2, in December 2010 to document the agreement of the FFA parties to discontinue pumping in the northern EWs and the construction of two new EWs to the east of the original extraction locations in the south well field to capture more efficiently contaminant mass associated with the Northwest Plume (DOE 2010a). The new EWs began operation in August 2010.

5.3 SYSTEMS OPERATIONS/OPERATIONS AND MAINTENANCE

Operations and maintenance (O&M) for the NWPGS are conducted in accordance with the *Operation and Maintenance Plan for the Northwest Plume Groundwater System Interim Remedial Action at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1253&D4/R5 (DOE 2010b). The latest revision (September 2010) was prepared to support the Northwest Plume IRA Optimization. Routine and preventive maintenance is conducted in accordance with the *Paducah Plume Operations Maintenance, Calibration, and Testing Plan*, CP2-ER-0046/FR1 (FPDP 2017b).

Since initial operations, the frequency of repair to the system has been normal and routine. The Northwest Plume treatment system had processed 2,223,034,123 gal of water, as of December 31, 2017. Mass balance evaluations indicate that the treatment system has removed approximately 43,158 lb (3,564 gal) of TCE.

The costs associated with the O&M of the NWPGS and the NEPCS (discussed in Chapter 6) are tracked jointly and have been since fiscal year (FY) 2002. The cost of both systems for the five-year reporting period is $3.23M, or an average of $645K per year. This average annual O&M cost of $645K is less than the combined original estimates of $1.5M to $2.0M for the NWPGS and $240K for the NEPCS; the reduction is due primarily to efficiencies gained through continued long-term operation. The total operation cost for both the NWPGS and the NEPCS was $31.83M by the end of December 2017.

Beginning in August 2010, as part of the optimization of the NWPGS, withdrawal switched from the original four EWs (with a combined withdrawal of approximately 220 gal/minute) to withdrawal from two new EWs (operating at a pumping rate of approximately 100 gal/minute each).

The activated carbon units are changed routinely due to contaminant loading. Other than a modernization project in 2015 and 2016, few other major modifications to the C-612 Treatment Facility (i.e., replacement of primary equipment) have been needed. Operation of the NWPGS was down 48 days (May 12, 2015, through June 29, 2015) for upgrades to the treatment facility and was down 92 days (November 17, 2015, through February 16, 2016) to allow reconfiguration of the ion exchange system. The function of the ion exchange system was transferred to a treatment trailer located adjacent to the C-612 Building. The trailer contains four tanks of ion exchange resin. Otherwise, the Northwest Plume IRA treatment system has continued to operate as intended during the 2013–2017 period.

5.4 PROGRESS SINCE LAST FIVE-YEAR REVIEW

The 2013 Five-Year Review contained the following statement of protectiveness for the Northwest Plume IRA (DOE 2014a).

> The remedy for the Northwest Plume is protective of human health and the environment in the short-term. Exposure pathways that could result in unacceptable risk are being controlled; however, additional actions, as part of the Dissolved-Phase Plumes OU, need to be evaluated for long-term protection.
>
> The objective of this IRA is to initiate control of the source and mitigate the spread of contamination in the Northwest Plume. The optimization of the Northwest Plume IRA is intended to increase VOC mass removal and enhance the contaminant capture in the vicinity of the existing south wellfield located immediately north of the plant. In addition, successful control of the plume, in combination with existing controls (alternate water supply, monitoring, etc.), ensures protection during the period of the interim response.

The 2013 Five-Year Review contained the following recommendation.

> Additional action, if necessary, for long-term protection should be evaluated and documented in the final decision document for the Dissolved-Phase Plume.

DOE has continued to evaluate the effectiveness of the NWPGS. Downgradient TCE and Tc-99 levels in the Northwest Plume have decreased in some MWs and increased in others in response to the adjusted pumping centers. In general, the extent of dissolved-phase TCE greater than the maximum contaminant level (MCL) (5 ppb) has declined. The long-term benefit of the optimization of the IRA will require additional time to be evaluated fully.

5.5 SITE INSPECTION

A site inspection of the Northwest Plume Pump-and-Treat System was conducted on December 5, 2017, by a member of the Five-Year Review team. The currently active system includes the C-612 Treatment Facility and the south, optimized wellfield (EW232/EW233). The treatment facility is located just outside the northwest corner of the perimeter fence of the Paducah Site industrial area, but within the security buffer zone. The EW232/EW233 field is located east of the treatment facility (just north of the facility perimeter fence and within the security buffer zone) and close to the C-616-E and C-616-F lagoons.

The C-612 Treatment Facility is a preengineered metal building with one vehicular entrance and two pedestrian entrances. The exterior of the building appears in good condition, with no signs of damage, rust, or deterioration. The area around the building is maintained well, including timely mowing and weed trimming. A chain-link security fence that is in good condition encloses the building.

All treatment process equipment is located within the building and an adjacent treatment trailer. Groundwater treatment equipment inside includes a sand filter unit, an air stripper, and a carbon filtration unit. The four ion exchange columns are located in the treatment trailer. The interior of the building and the treatment trailer is clean, free of clutter and debris, and maintained well. Access-controlled areas within the building and trailer are clearly marked and identified. Process piping in the facility is identified properly as to content and flow direction, adequately supported, and in a well-maintained condition. There are no signs of leaks or deterioration. Process control panels are maintained well, with all components clearly identified and labeled. All electrical power and control panels are labeled properly. The building contains a wet-type fire sprinkler system that is monitored constantly via a supervisory control and data acquisition system by the Paducah Site Fire Services Department.

Well vaults for both the currently operating EWs and the original south wellfield EWs (in standby mode) are maintained properly. The optimization EWs are operating as intended, with minimal maintenance required. During this fourth synchronized Five-Year Review period, there has been no need for downhole maintenance in the EWs (e.g., video inspection or rehabilitation).

5.6 TECHNICAL ASSESSMENT

The primary objective of the Northwest Plume IRA is to initiate an action to mitigate spread of the high concentration zone of TCE and Tc-99 contamination of the Northwest Plume. Monitoring data indicate that this RA has reduced contaminant concentrations in the Northwest Plume since operations began in 1995. The action described in the ROD is not intended or expected to return groundwater quality to MCLs.

5.6.1 Question A: Is the Remedy Functioning as Intended by the Decision Documents?

Yes. The original north and south EW fields operated nearly continuously since the start of pumping on August 28, 1995, through August 27, 2010, when operation of the new south EW field (EW232 and EW233) began. Influent and effluent monitoring of the aboveground groundwater treatment system shows that the treatment system is effectively reducing the contaminant levels of the extracted water to target levels that are approved for release to surface water. Tc-99 levels in the effluent began rising in 2008 (due to loading of the ion exchange resin) and increased to approximately 65 pCi/L in November 2015), when the effluent stream was rerouted through a mobile treatment unit. The Tc-99 levels immediately declined below the lower detection limit and remained at 17.4 pCi/L or less through 2017.

Figure 5.3 shows contaminant level trends in each of the optimization EWs. Targets for the average levels of TCE and Tc-99 in effluent continue to be met (Table 5.1), as indicated from the latest semiannual reporting period of January 1, 2017, to June 30, 2017 (DOE 2017b). The target concentrations for these contaminants are 5 μg/L TCE and 900 pCi/L Tc-99.

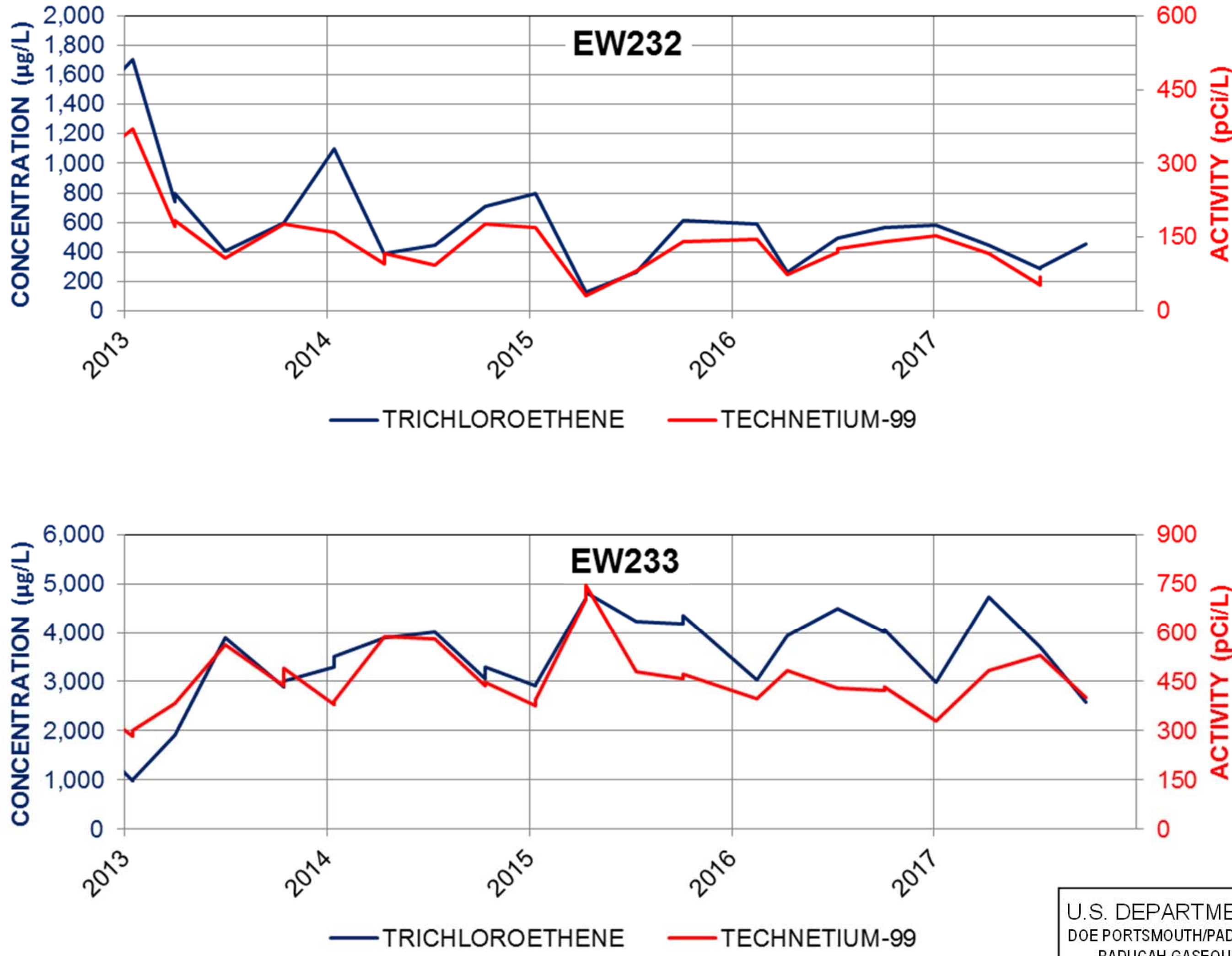

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Figure 5.3. Contaminant Trends in the Optimization Wellfield EWs (EW232 and EW233)

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Table 5.1. NWPGS Influent and Effluent Concentrations

	TCE (μg/L)			Tc-99 (pCi/L)		
	High	**Low**	**Average**	**High**	**Low**	**Average**
Influent	2,860	1,610	2,106	318	250	278
Effluent	4.29	1.49	2.31	15.9	-10.9	-0.332

Groundwater flow modeling for the optimization study predicted 99.99% capture of the mass of TCE flux in the Northwest Plume at the facility security fence using the optimization EWs that were installed in 2010. Comparison of groundwater analyses of TCE and Tc-99 for the 2013 through 2017 period from upgradient MWs (MW261 and MW340, upgradient MWs with the highest TCE and Tc-99 levels) and from downgradient MWs (MW458, MW460, and MW462, downgradient MWs with highest TCE levels and high Tc-99 levels) demonstrate that the EWs have reduced contaminant levels significantly in the RGA (Figure 5.4). Table 5.2 summarizes TCE and Tc-99 levels in the optimization wellfield for 2010, when groundwater extraction began at EW232 and EW233, compared with levels reported during the Five-Year Review period.

MW261 and MW340, located in the core of the Northwest Plume and upgradient of both the original and optimization EW fields (see Figure 5.1), have continued to yield water with elevated levels of TCE and Tc-99 (ranging from 6,000 to 13,000 μg/L TCE and 1, 300 to 1,390 pCi/L Tc-99 during the 2013 through 2017 period) (see Figure 5.4). TCE levels in both wells generally declined during the 2013 through 2017 period.

Downgradient MWs for the optimization wellfield (EW232/EW233) (see Figure 5.1) document reduced contaminant levels, overall, in the core of the Northwest Plume, as intended by the ROD; however, increasing TCE levels in MW460 may be an indication of capture of downgradient groundwater impacted by site contaminants in response to drawdown of the aquifer, or increasing TCE levels may indicate limited plume bypass of the optimization EW wellfield.

Table 5.2. Summary of Contaminant Levels at the Optimization EW Field (EW232 and EW233)

	TCE Concentration (μg/L)				Tc-99 Activity (pCi/L)			
		2013–2017				2013–2017		
Well	**Max 2010**	**Average**	**Max**	**Reduction Trend?**	**Max 2010**	**Average**	**Max**	**Reduction Trend?**
MW63[a]	74	5	8	Yes	26.5	7.3	22.2	No. Stable
MW66[a]	2,600	790	1,310	Yes	853	236	466	Yes
MW497	17	492	773	No	18	139	206	No
MW498	9,900	355	2,400	Yes	1,190	83	466	Yes
MW499	180	401	540	No	484	270	415	Yes
MW500	160	434	610	No	340	327	497	Uncertain
MW503	240	84	140	Yes	22	246	509	No
MW504	1.4	1.1	2.78	No. Stable	20	5	15[b]	Yes

[a] Upgradient well
[b] All Tc-99 analyses for the period of 2013-2017 were non-detect, with the highest non-detect result of 15 pCi/L reported.

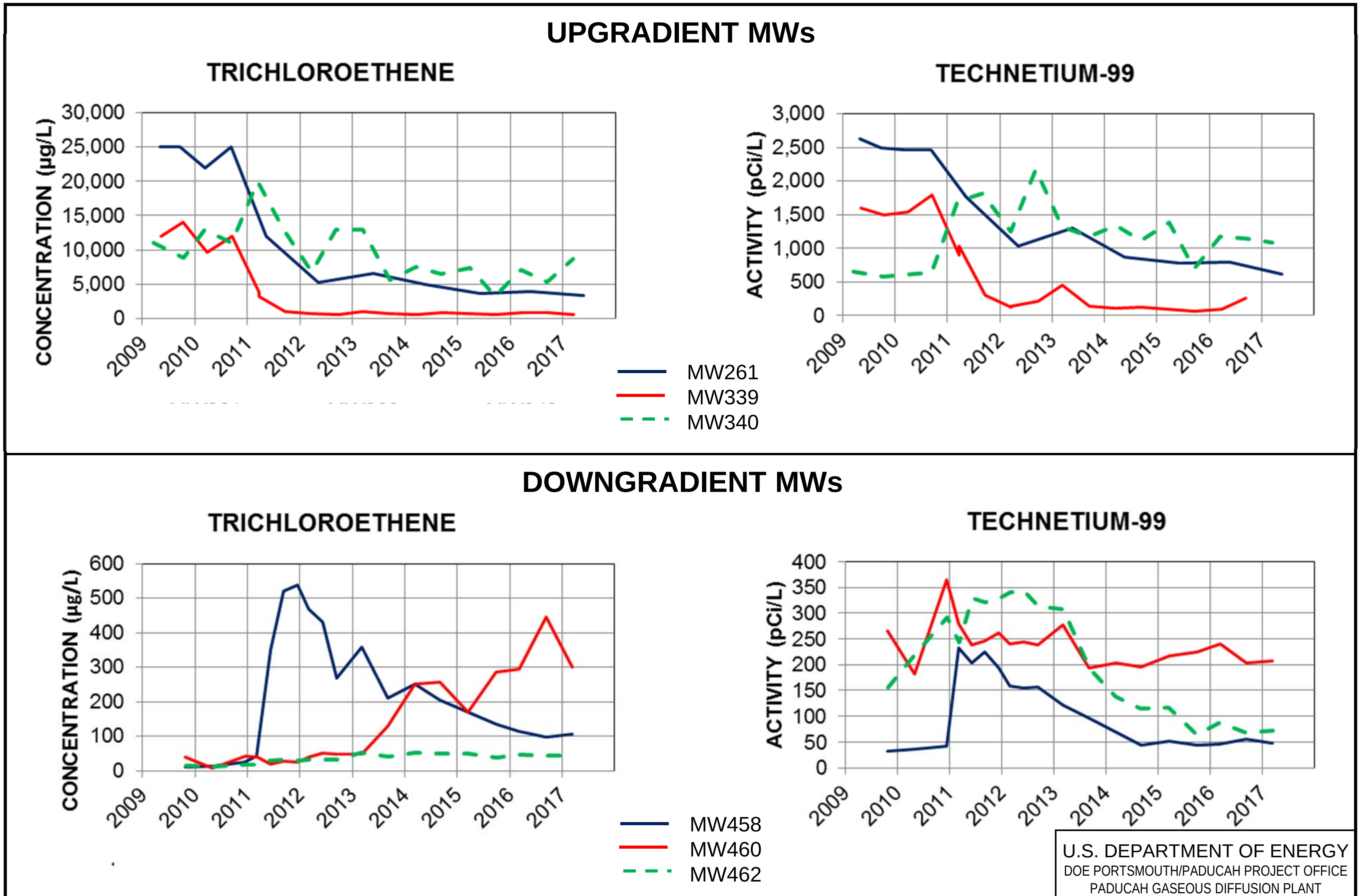

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Figure 5.4. Upgradient vs Downgradient Contaminant Levels

DOE performed a MW upgrade project during the period October 2009 through February 2010, which resulted in the installation of 38 new MWs in the area of the Northwest Plume. A membrane interface probe (MIP) was used to characterize the location of the centroid of the Northwest Plume along four transects and optimize the location of many of these wells. Results of a MIP transect to the east of the north wellfield, which began operation in 1995 (EW228/EW229 wellfield), documented that the centroid of the Northwest Plume had migrated to the east of the north wellfield. RGA MW cluster MW489/MW490 was placed in the centroid of the Northwest Plume (in 2010) and MW cluster MW491/MW492 was placed to the east of the centroid (see Figure 5.1). Together with MW381 (now located on the west side of the centroid), the analyses of groundwater samples from these wells document the contaminant trends in the area of the former north wellfield.

Contaminant levels in the area of the north wellfield have continued to decline. For the period 2013 through 2017, contaminant levels were 5 µg/L or less TCE and 32 pCi/L or less Tc-99 in MW202, MW233, MW236, and MW240. Contaminant levels also declined in MW489 and MW490 during the period to less than 110 µg/L TCE and 80 pCi/L Tc-99. Table 5.3 and Figure 5.5 document the contaminant trends in the area of the north wellfield.

Table 5.3. Summary of Contaminant Levels in the Area of the North EW Field (EW228 and EW229) for the Periods 1995, 2009, and 2017

	Maximum Levels			Contaminant Trends	
Well*	**1995**	**2009**	**2017**	**Through 2009**	**2009–2017**
	TCE Concentration (µg/L)				
MW202**	150	1UJ	1U	Reduction	Steady
MW233**	810	7	1	Reduction	Steady reduction
MW236**	1470	32	2	Increase 1998 – 2006, then reduction	Steady reduction
MW240	1800	8	1J	Reduction	Near steady reduction
MW489		240	50	Not applicable	Steady reduction
MW490		340	76	Not applicable	Steady reduction
MW491		76	51	Not applicable	Reduction, then increase
MW492		47	72	Not applicable	Slight reduction, then increase
	Tc-99 Activity (pCi/L)				
MW202**	126	20	8U	Reduction	Near steady
MW233**	509	-2U	-9U	Reduction	Near steady
MW236**	936	24	-2U	Increase 1998 – 2006, then reduction	Near steady reduction
MW240	1106	1U	-8U	Reduction	Near steady
MW489		111	29	Not applicable	Near steady reduction
MW490		83	15U	Not applicable	Near steady reduction
MW491		77	88	Not applicable	Slight increase
MW492		54	84	Not applicable	Rise, then slight decline

Gray shading denotes monitoring wells installed in 2009.
J = estimated value U = analyte analyzed for, but not detected
*MW381 had no analyses during the 2013–2017 reporting period. It is not included in the table.
**MW202, MW233 and MW236 are upgradient wells.

The thick interval of relatively low-permeability silt that overlies the Northwest Plume reduces the potential for transport of VOC vapors from the Northwest Plume to the surface. A vapor intrusion study of the downgradient Northeast and Northwest Plume areas determined that vapor intrusion does not pose a concern for area residences (DOE 2016a). Moreover, the NWPGS has reduced significantly the VOC levels in the off-site plume and is anticipated to reduce off-site contaminant levels further with continued operation. While operation of the NWPGS is an interim action with no established cleanup levels, the NWPGS is effectively protective in conjunction with other Paducah Site actions (notably the Water Policy, discussed in Chapter 8).

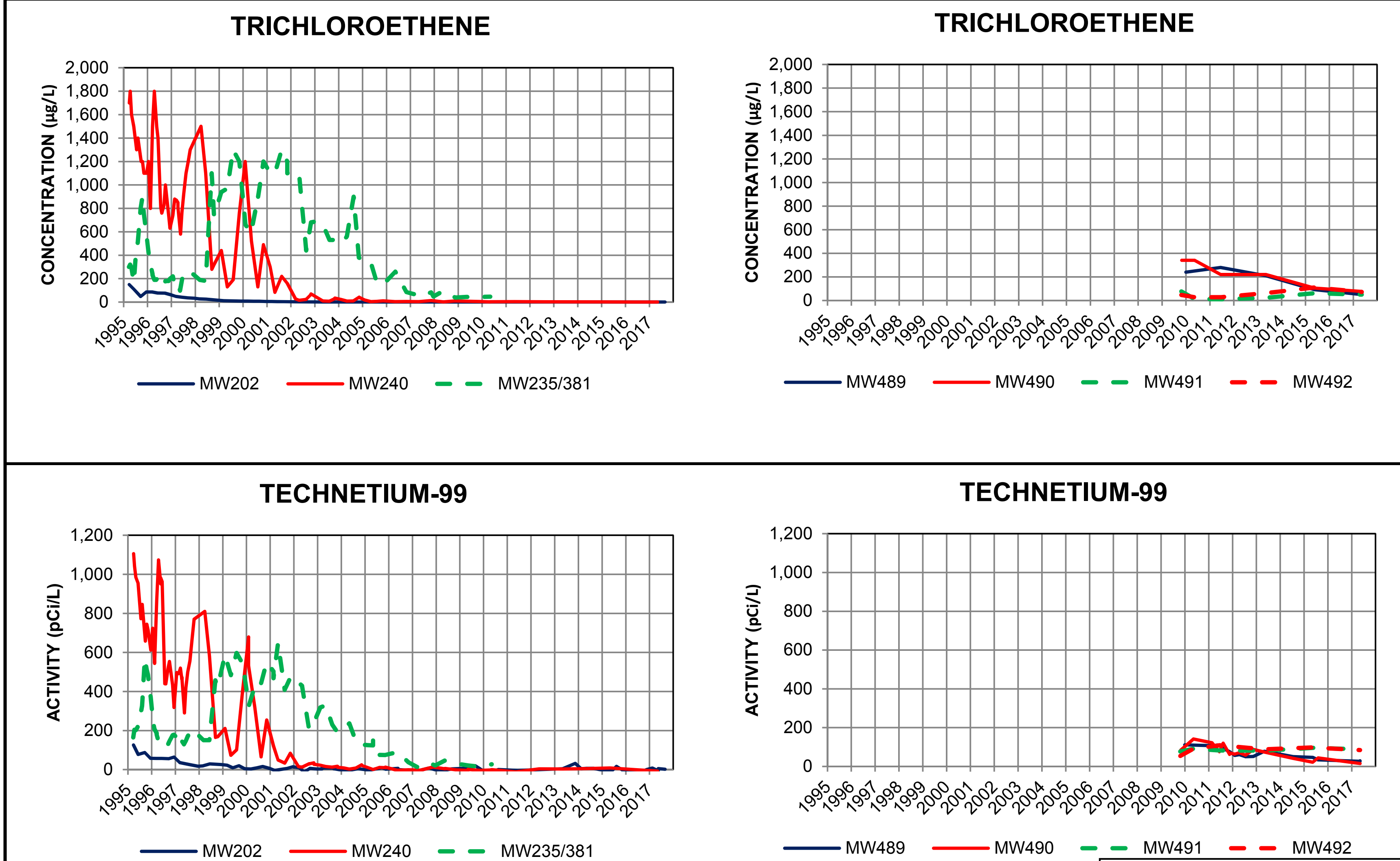

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Figure 5.5. Contaminant Trends in MWs Located Proximal to the EW228/EW229 Wellfield

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Current operations that include implementation of the wellfield optimization appear to have maintained the effectiveness of the Northwest Plume IRA. O&M of the NWPGS are efficient because costs are lower than anticipated in the Northwest Plume Interim ROD. Increasing TCE levels in downgradient MW460 (lower RGA) may be an indication of capture of downgradient groundwater impacted by site contaminants in response to drawdown of the aquifer, or increasing TCE levels may indicate limited plume bypass of the optimization EW wellfield. (While the EW screens extend across the middle and lower depths of the RGA, the EW pumps are set in the middle RGA. Dissolved phase TCE concentrations at the base of the RGA may be escaping capture.) There are no other indicators of potential issues for the system. Institutional controls associated with the Northwest Plume interim ROD are DOE's Water Policy (evaluated in Section 8) and Surface Water ICM (evaluated in Section 15). The Water Policy and Surface Water ICM effectively limit exposure to the downgradient Northwest Plume.

RAs will be implemented beginning in 2023 (1st Quarter of FY 2024) to minimize further migration from the C-400 Complex (source area). Remaining contaminant plumes will be addressed in the Dissolved-Phase Plumes OU. Reviews of documents, groundwater monitoring data, and the results of the site inspection all indicate the EW Fields are retarding the migration of contaminants emanating from the source area; therefore, its function is consistent with the objective in the ROD. The treatment system is functioning as designed.

5.6.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of the Remedy Selection Still Valid?

The exposure assumptions used to develop the Public Health and Ecological Assessment (PHEA) included both current exposures (industrial worker) and potential future exposures (future resident using groundwater and future industrial worker). The MCL for TCE remains 0.005 mg/L, as it was during the original remedy selection; however, the original remedy was intended only to control high concentration portions of the plume and was based on the assumption that there is no current exposure pathway because institutional controls restrict access to the contaminated groundwater. There are no risk-based cleanup levels or MCLs required for this project. There have been no changes to the exposure pathways due to institutional controls that restrict access to the contaminated groundwater; therefore, the exposure assumption (no exposure) is still valid.

Cleanup levels and RAOs are not specifically stated because the principal goal of this interim action is to decrease the risk by mitigating the spread of the high concentration portion of the Northwest Plume, thus retarding the migration of the contaminants emanating from the source area.

There are no changes in standards identified as ARARs in the ROD that impact the protectiveness of the remedy. Additionally, there are no newly promulgated standards that might apply or be relevant and appropriate to the site that affect the protectiveness of the remedy. Finally, there are no changes in advisories, criteria, or guidance identified as to be considered (TBC) in the ROD that impact the protectiveness of the remedy. The following changes were identified, but do not impact the protectiveness of the remedy:

- DOE O 5400.5 has been superseded by DOE O 458.1.
- DOE O 5480.11 was cancelled and was superseded by DOE G 441.1-1C.
- DOE O 5480.3 was cancelled and was superseded by DOE O 460.1C.
- 401 *KAR* 5:029(2) references have been moved to 401 *KAR* 10:029(2).

The Northwest Plume underlies land controlled by DOE and the TVA Shawnee Fossil Plant and sparsely populated areas between the two reservations. DOE maintains a Water Policy (evaluated in Section 8) that controls access to the groundwater. Physically, access is controlled, for example, by padlocks on wells.

Administratively, access is controlled through a license agreement process with landowners with and without residential wells in the area of the plume. DOE provides access to municipal water and pays reasonable municipal water bills for the majority of residents, which further limits access to contamination in the Northwest Plume. Exposure assumptions used in the ROD regarding future domestic use of groundwater off DOE property remain valid. There have been changes to the risk assessment methodology, but the protectiveness of the remedy was not affected.

The current groundwater data indicate that assumptions underlying the remedy selection in the ROD still are valid. There have been no new contaminants or new understanding of geologic conditions identified.

5.6.3 Question C: Has Any Other Information Come to Light That Could Call into Question the Protectiveness of the Remedy?

Since the institution of the IRA, seeps of contaminated water originating from the Northwest Plume have been identified in Little Bayou Creek. The Surface Water ICM (evaluated in Section 15) limits human access to the contaminated water. TCE levels in the seeps are declining. The ecological risks associated with the seeps have not been fully evaluated.

No other information has come to light that would call into question the protectiveness of the remedy.

5.6.4 Technical Assessment Summary

The operational data and the site inspection indicate that the mechanical components of the remedy are functioning as intended by the ROD.

The Northwest Plume IRA now consists of groundwater extraction at one location immediately outside the north Paducah Site facility fence. This EW field is intended to control the source of groundwater contamination to the Northwest Plume. Contaminant levels in the area of the previous north EW field (EW228/EW229) have decreased significantly since the initiation of the Northwest Plume IRA, and they are continuing to decline with the operation of the optimization EW field (EW232/EW233). The remedy remains protective.

5.7 ISSUES

The Northwest Plume (SWMU 201) IRA, designed to initiate hydraulic control of the high TCE concentration of the Northwest Plume, saw increases in TCE levels in a downgradient monitoring well.
Increasing TCE levels in downgradient MW460 may be an indication of capture of downgradient groundwater impacted by site contaminants in response to drawdown of the aquifer or increasing TCE levels may indicate limited plume bypass of the optimization EW wellfield.

6. NORTHEAST PLUME

After the initial discovery of contamination at the Paducah Site in August 1988, DOE conducted a site investigation to determine the extent of contamination. The investigation, documented in the *Results of the Site Investigation, Phase I, Phase II* (CH2M HILL 1991; CH2M HILL 1992), determined that the groundwater contamination is spreading generally northward toward the Ohio River in multiple plumes. Results of a follow-up groundwater monitoring investigation presented in the *Northeast Plume Preliminary Characterization Summary Report*, DOE/OR/07-1339V1&D2, delineated numerous plumes within the RGA that coalesce to form the Northeast Plume (SWMU 202) (DOE 1995a). One of these plumes was a zone of high TCE concentration (TCE concentrations exceeding 1,000 µg/L) that emanates from the eastern portion of the facility and extends off DOE property. Figure 6.1 depicts the aerial extent of the Northeast Plume based on the latest available plume map from 2016 (FPDP 2017a).

6.1 REMEDY SELECTION

Because of the risks related to off-site migration from on-site contaminant sources, DOE initiated an IRA for the Northeast Plume. DOE signed the Northeast Plume ROD June 13, 1995; EPA signed June 15, 1995 (DOE 1995b). KDEP conditionally concurred with the selected remedy June 5, 1995. The ROD identified the selected remedy, outlined the performance objectives, and provided rationale for the remedy selection.

The following are the major components of the selected RA.

- Installation of EWs and transfer pumps that were to be located at the northern end of the high-concentration TCE portion of the Northeast Plume. At the time of the ROD's preparation, the high-concentration portion had a TCE concentration greater than 1,000 µg/L. The pumping rate selected in the ROD was approximately 100 gal per minute, which was enough to initiate hydraulic control, but not change groundwater gradients.

- Implementation of a treatment system that consisted of process water cooling towers that already were located at the Paducah Site facility and would be used to volatilize the TCE and 1,1-dichloroethene (DCE) before the treated water was discharged to KPDES Outfall 001. The water was to be collected and pumped to the top of the tower and trickle down over slats that increased the surface area of the water and transit time spent in contact with the atmosphere. This resulted in volatilization of contaminants, while the temperature of the water approached that of the ambient atmosphere.

- Two treatability studies also were included to evaluate the use of photo catalytic oxidation for the treatment of TCE in vapor phase and *in situ* treatment of TCE-contaminated groundwater.

Although the Northeast Plume ROD does not identify RAOs for the action, the ROD documents the following goal.

> The primary objective of this interim remedial action is to implement a first-phase remedial action as an interim action to initiate hydraulic control of the high concentration area within the Northeast Plume that extends outside the GDP security fence.

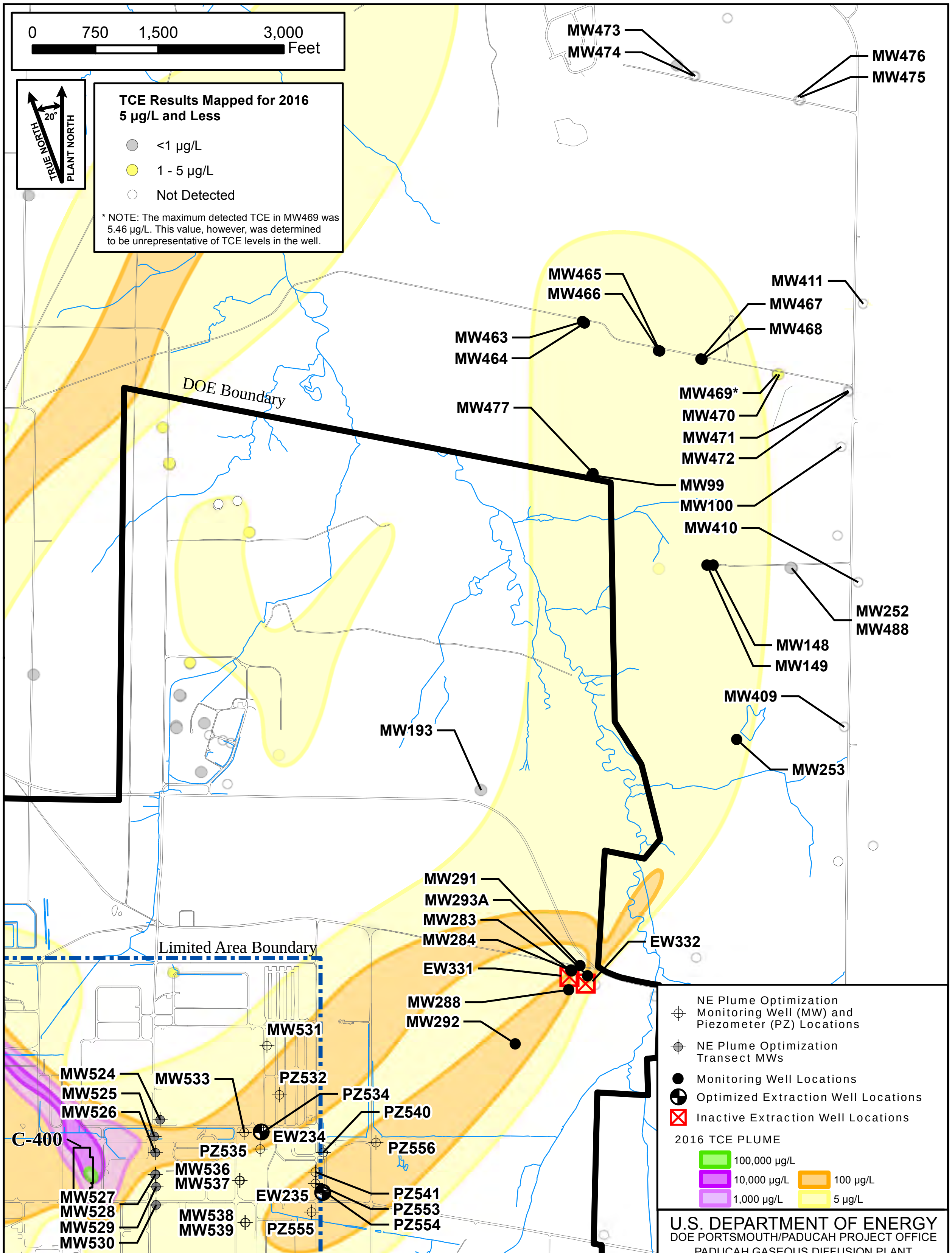

Figure 6.1. Northeast Plume EW Field with 2016 TCE Plume Map

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The ROD was supported by a PHEA. In the PHEA, TCE is listed as the primary Paducah Site-related contaminant found in groundwater off DOE property. The *Summary of Comparative Analysis of the Interim Alternatives* (Section 2.8 of the ROD) discusses risk relative to nearby communities and workers associated with the construction and operation of the source control systems. No cleanup levels were identified in the ROD.

The *Explanation of Significant Differences to the Record of Decision for the Interim Remedial Action of the Northeast Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-1291&D2, (DOE 2013a) expanded the goal as follows:

> The Northeast Plume IRA optimization project is to serve as an interim measure to remove TCE and 1,1-DCE mass and enhance capture of the Northeast Plume contamination in the vicinity of the eastern edge of PGDP industrial facility and to reduce further migration off-site.

This goal was reiterated in a 2015 update of the Explanation of Significant Differences (DOE 2015b).

6.2 REMEDY IMPLEMENTATION

Following the signing of the ROD on June 15, 1995, DOE began the remedial design process for the selected remedial alternative. Minor modifications to the RA were required during the design phase. These minor modifications included the following:

- Removing the sand filter,
- Adding an EQ tank,
- Increasing pumping rate from 100 gpm to 170 gpm, and
- Postponing indefinitely the two treatability studies.

The rationale for removing the sand filtration system was based on the lack of suspended solids in the groundwater. Should suspended solids increase, the current treatment system configuration would allow for addition of a sand filter. No sand filter has been needed to date. An EQ tank was added to equalize water flow. The average combined pumping rate for the original Northeast Plume EWs during the period of this fourth synchronized Five-Year Review was approximately 200 gpm.

DOE issued a Notice to Proceed with construction on April 5, 1996, and construction of the Northeast Plume pump-and-treat system was completed in December 1996. Major equipment installed for this project included two EWs capable of producing a combined maximum discharge of 260 gpm, a 20,000-gal underground fiberglass-reinforced plastic EQ tank, and a submersible transfer pump capable of producing a maximum discharge of 263 gpm. This process equipment was installed along with associated piping, valves, and fittings. The construction of the facilities was documented in the *Postconstruction Report for the Northeast Plume Interim Remedial Action at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1555&D1, and was issued February 7, 1997 (DOE 1997a). The *Postconstruction Report* presents the summary of the construction activities for the RA. Operation of the NEPCS began February 28, 1997.

In February and March 2006, DOE Headquarters conducted a Sitewide Remedy Review at the Paducah Site. The Sitewide Remedy Review report recommended optimization of the Northeast Plume and Northwest Plume IRAs (DOE 2006). At the request of DOE, the U.S. Army Corps of Engineers led a Remediation System Evaluation of the Northeast and Northwest Plume Extraction Systems at the Paducah Site during October 2006 (DOE 2007a). The review team concluded that the interim goal of the

Northeast Plume IRA, to control migration of water contaminated by > 1,000 μg/L TCE, had been achieved. The review team's main recommendation concerning the NEPCS was that the system be placed in standby mode, with continued detection monitoring to assess the potential reappearance of TCE concentrations above 1,000 μg/L.

Cessation of uranium enrichment operations at the Paducah Site by USEC in June 2013 resulted in the loss of operation of the C-637 Cooling Towers that acted as the air stripper and provided further need to optimize the NEPCS with the use of an alternate treatment unit that could air strip the VOC contamination. Installation of the first treatment unit as an alternate treatment method to the C-637 Cooling Towers was completed on September 4, 2013, when routine operations of the new treatment unit were initiated. Installation of the treatment unit resulted in a new CERCLA outfall discharge point (CERCLA Outfall 001) located downstream of KPDES Outfall 002.

The FFA parties evaluated the Sitewide Remedy Review recommendation and related conclusions in the following:

- The 2003, 2008, and 2013 CERCLA Five-Year Reviews (DOE 2003a, DOE 2009a, and DOE 2014a);
- *Review Report: Groundwater Remedial System Performance Optimization at PGDP, Paducah, Kentucky* (DOE 2007a); and
- The FY 2012 SMP (DOE 2012a).

The parties agreed to an optimization of the NEPCS, which was documented in a MOA for Resolution (DOE 2015c). Primary initiatives of the MOA for Resolution were as follows:

- Upgradient relocation of the two EWs and operation of two treatment units;[5]
- Construction of up to two new CERCLA outfalls for discharge of the treated groundwater (one treatment unit and CERCLA outfall already were in use); and
- Construction and maintenance of an optimized MW network, including a transect of MWs located approximately 600 ft east of the C-400 Building. These transect MWs were to be used to assess the impact of the optimized NEPCS on contaminant migration from source areas, including impacts to the groundwater flow divide located east of the C-400 Building.

The optimized NEPCS consists of the two new EWs (EW234 and EW235), the two associated treatment units (using one CERCLA outfall), and installation of an additional 14 MWs and 8 piezometers to evaluate performance and effectiveness of the optimized EWs. Included in the system of 14 MWs, with single screens, were 7 new RGA MWs in a north-south transect located approximately 600 ft east of the C-400 Building (see Figure 6.1). Sampling results from the transect MWs were used to establish baseline TCE and Tc-99 levels in the area of their installation and will be used to assess impacts of the EWs on contaminant migration from source areas, including impacts to the groundwater divide east of the C-400 Building. The transect MWs were installed first (August 2016) to expedite the collection of baseline (preoperation) monitoring results. Based on the first 2 quarters of monitoring data, the FFA parties concurred on proceeding with construction of the remaining project components. Existing EWs, pipelines, and facilities not utilized as part of the optimized NEPCS were placed into a standby condition. EW331

[5] The extraction of the Northeast Plume mass from the new EWs (EW234 and EW235), located upgradient of the former EWs (EW331 and EW332) and in the vicinity of the eastern boundary of the facility, is intended to remove VOC mass in the contaminated groundwater from the higher concentration portion of the Northeast Plume and control the amount of plume mass migrating off-site.

and EW332 are being kept in good working condition until the FFA parties agree that maintenance no longer is necessary, and final disposition (including well abandonment) is determined.

6.3 SYSTEMS OPERATIONS/OPERATIONS AND MAINTENANCE

For the 2013 through 2017 period, O&M activities for the NEPCS were conducted in accordance with the *Operations and Maintenance Plan for the Northeast Plume Groundwater Containment System Interim Remedial Action at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1535&D3, (DOE 2002b) and subsequent updates (most recently DOE 2017d). The O&M Plan provides an overview of the activities required to operate and maintain the treatment system to meet DOE, EPA, and Commonwealth of Kentucky policies and statutes. Since operation began, the NEPCS has processed approximately 1,743,066,892 gal of water as of December 31, 2017. The treatment system has removed approximately 3,852 lb (318 gal) of TCE.

The costs associated with the O&M of the NEPCS and the NWPGS (which were addressed in Chapter 5) are tracked jointly and have been since FY 2002. The combined cost for both systems for the five-year reporting period is $3.23M, or an average of $645K per year. This average annual O&M cost of $645K is lower than the combined original estimates of $1.5M to $2.0M for the NWPGS and $240K for the NEPCS; the reduction is due primarily to efficiencies gained through continued long-term operation. The total operation cost for both the NEPCS and the NWPGS was $31.83M at the end of December 2017.

Because of the loss of use of the C-637 Cooling Towers associated with conclusion of uranium enrichment operations by USEC, the NEPCS did not operate for a period of 16 days (May 22 through June 4, 2013), while contractors completed the pipeline tie-in to the first alternate treatment unit, and for a period of 67 days (June 29 through September 3, 2013), until routine operations could begin in the first alternate treatment unit. A failure of the transfer pump (pumping from the EWs to the treatment system) shut down the NEPCS for a 44-day period during December 2013 and January 2014 and a 28-day period during January 2015. Withdrawal switched from the original two EWs (with a combined withdrawal of approximately 195 gpm) to the two optimization EWs (with a combined withdrawal of approximately 275 gpm) beginning on October 11, 2017. For the period July 2017 through October 2017, the NEPCS had an average operational efficiency of approximately 50% as the result of planned shutdowns of the system during construction, final tie-ins, and operational testing of the optimized NEPCS. Otherwise, the Northeast Plume IRA treatment system continued to operate as intended during the 2013–2017 period, with an overall operational efficiency of 85.6%.

6.4 PROGRESS SINCE LAST FIVE-YEAR REVIEW

The 2013 Five-Year Review states the following:

> The remedy for the Northeast Plume is protective of human health and the environment in the short-term. Exposure pathways that could result in unacceptable risk are being controlled; however, additional actions, as part of the Dissolved-Phase Plume OU, need to be evaluated for long-term protection.

The previous Five-Year Review noted that the FFA parties recommended optimization of the NEPCS to increase TCE and 1,1-DCE mass removal and to enhance the contaminant capture in the Northeast Plume in the vicinity of the eastern edge of the Paducah Site facility. Moreover, an evaluation of the results of the optimization of the NEPCS with field testing and use of the sitewide groundwater flow model was needed to understand the performance of the new EWs.

Construction of the optimized NEPCS was completed during the period of this fourth synchronized Five-Year Review and routine operation began on October 10, 2017. A field test of the hydraulic containment of the NEPCS will occur in early 2018, consistent with the schedule established in the current O&M Plan (DOE 2017d). DOE completed an update of the groundwater flow model, with the support of the Paducah Site Groundwater Modeling Working Group, in 2017 (DOE 2017e). The groundwater flow model results are consistent with the operations and monitoring data of the Northeast Plume Optimization Project at the time of this review.

6.5 SITE INSPECTION

A site inspection of the NEPCS facilities was made on December 5, 2017. Participants included the program integration manager, the facility manager, and a member of the Five-Year Review team.

The standby facility, which consists of the two original EWs, a pumping station, associated piping, electrical power and control systems, security fencing and gates, and interconnecting gravel access roads, is located south and west of the intersection of Ogden Landing Road (KY Hwy 358) and Little Bayou Creek and northeast of the Paducah Site (Figure 6.1).

The optimized NEPCS consists of two EWs (EW234 and EW235) and two associated treatment units. EW234 is located within the facility security fence, near the intersections of 20th Street and Vermont Avenue. Its treatment unit (C-765) is located outside the security-fenced area and east of EW234, off Dyke Road. EW235 is located immediately outside the security fence and immediately north of McCaw Road. Its treatment unit (C-765-A) is located in a graveled staging area immediately to the south of EW235 and McCaw Road. Both treatment units discharge to a facility effluent ditch through CERCLA Outfall 001, which is downstream of KPDES Outfall 002. Figure 6.2 shows the location of the NEPCS components.

For the standby facility, the main access road into the area is secured by a chain-link gate. The facility manager reported that the gate is locked at all times, except when O&M personnel are in the area. The gate is in good condition and serves its intended function. All the roads in the area appear to be maintained well and are in good condition.

The two standby EWs are located approximately 200 ft apart. Each well is located in an underground concrete vault with a hinged aluminum lid. A chain-link security fence surrounds each well, with an access gate that is locked to prevent unauthorized entry. The vaults are in good condition and are free of foreign debris. The security fences around each well also are in good condition. The immediate area around each fenced location was mowed and is maintained well. During this inspection, both wells appeared to be functional, if needed.

The pumping station, which consists of a large underground EQ tank, a discharge pump and associated piping, and electrical power and control panels, also is enclosed completely in a chain-link security fence, with an access gate at one end. All aboveground piping is insulated to prevent freezing. All of the exposed piping and insulation and electrical power and control panels are in good condition and properly labeled.

Only minor repairs and routine maintenance typically were required when EW331 and EW332 were operational. Shutdowns for repairs had been infrequent; NEPCS had been shutdown 44 days during December 2013 and January 2014 and 28 days during January 2015 when a transfer pump failed, which moved water from the EWs to the treatment facility. A summary of both routine and nonroutine maintenance is reported in the DOE Paducah Site FFA Semiannual Progress Report. In accordance with

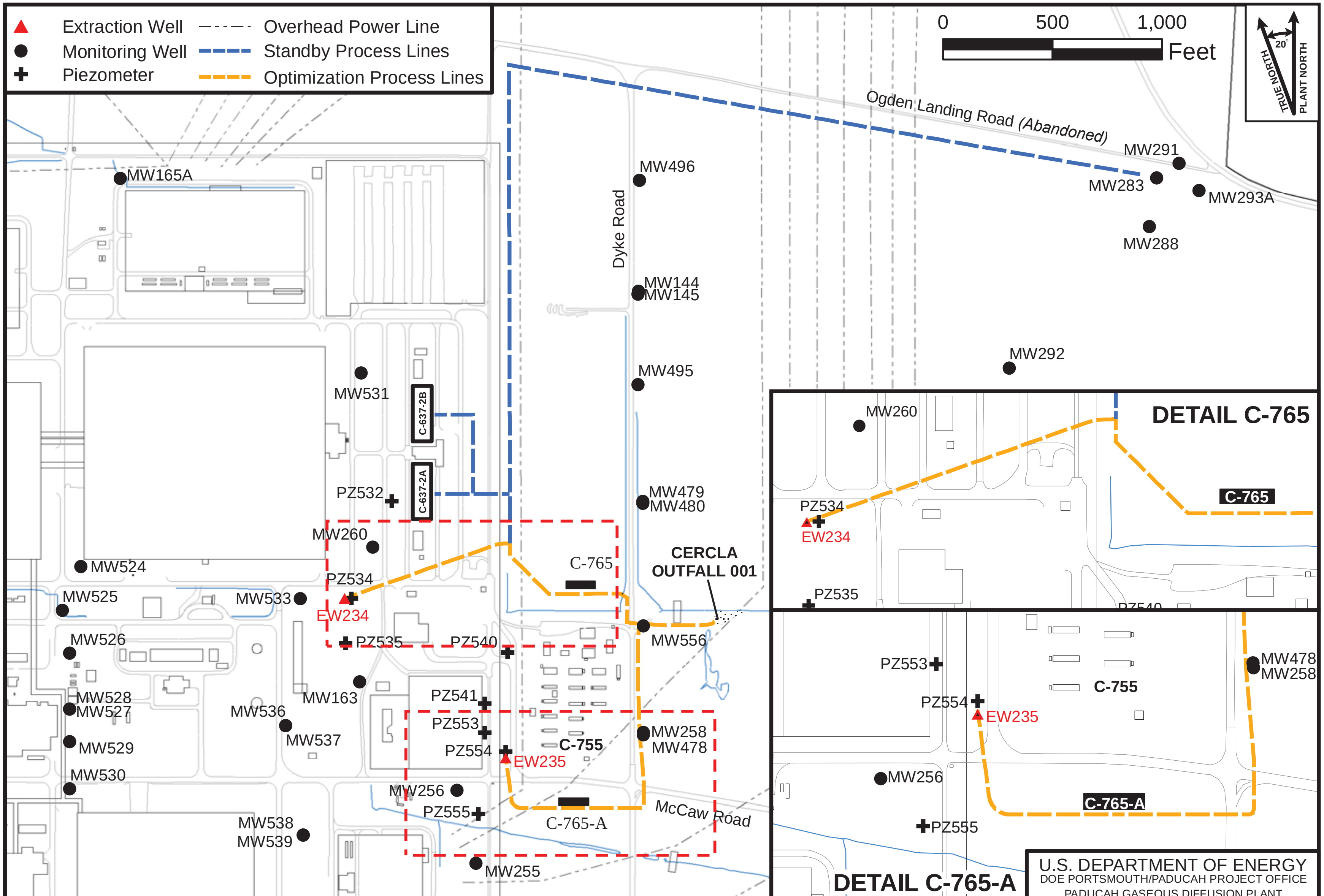

Figure 6.2. Location of MWs, EWs, and the NEPCS Relative to the Paducah Site

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the substantive requirements of the ARARs cited in the ROD, tank tightness and leak tests were conducted successfully in 2013 on the Northeast Plume EQ tank and high density polyethylene transfer lines. A hydrostatic test of the currently operating system and attached pipeline was performed in 2017. No leaks were identified during the tests.

At both operating EWs, the wells with their valves and sample ports, are housed in a locked concrete well vault with a hinged aluminum lid. The well vaults are in good condition and free of foreign debris. Components are labeled. Above ground electrical power and control panels are adjacent to each well vault. Access roads and grounds are well maintained.

The two treatment units are similar, each housing piping and valves, bag filters, and an air stripping treatment unit. System controls and communication equipment is also located in the treatment trailers. All components are well organized and labeled. The facilities are kept clean and neat.

Operation of the optimized NEPCS began October 10, 2017. By October 30th, the EWs and treatment systems were in continuous operation, with only minor repairs and routine maintenance required during the remainder of the Five-Year Review period.

Aside from downtime for construction, NEPCS EWs have operated as intended with little maintenance required during the 2013 through 2017 period.

6.6 TECHNICAL ASSESSMENT

The NEPCS is an IRA to control the high concentration area of the Northeast Plume that extends outside the facility security fence and to track contaminant migration to assess the IRA's performance. Monitoring data indicate that this RA has reduced contaminant concentrations in the Northeast Plume since operations began in 1997. The action described in the ROD is not intended or expected to return groundwater quality to MCLs.

6.6.1 Question A: Is the Remedy Functioning as Intended by the Decision Documents?

Yes. The original EWs (EW331 and EW332) began operation on February 28, 1997; the optimization EWs (EW234 and EW235) began operation on October 11, 2017 (Figure 6.2). Trends of TCE concentrations in groundwater of the original Northeast Plume EW field monitoring system clearly show that TCE levels were being reduced by the pump-and-treat system (Table 6.1).

Table 6.1. Summary of TCE Concentration in the Northeast Plume EW Field

	TCE Concentration (µg/L)			Concentration Trends	
	Maximum		Range		
Well	1997	2003	2017	Through 2003	2004–2017
MW283	1,300	150	41-56	Reduction	Near steady reduction
MW291	1,400	150	29-34	Reduction	Near steady reduction
MW294/293A	2,000	810	82-182	Reduction	Near-steady reduction
MW288*	1,600	470	130–154	Reduction	Near steady reduction
MW292*	1,300	550	145–161	Initial increase, then reduction	Near steady reduction

*MW288 and MW292 are upgradient wells.

The only other COC presented in the ROD is 1,1-DCE. Since the ROD was signed, laboratory reporting limits for 1,1-DCE decreased from 25 to 50 µg/L to 5 to 10 µg/L. This change resulted in the first detections of 1,1-DCE in samples from the original wellfield Northeast Plume EQ tank (12 and 25 µg/L) in 2007; since February 2009, 1,1-DCE concentrations have ranged from 5 to 11 µg/L. The 1,1-DCE present in the plume was being captured by the original NEPCS.

Too little time has passed to assess the effectiveness of the optimized NEPCS. During this fourth synchronized five-year review reporting period, TCE levels in the EW234 have ranged from 188 to 243 µg/L. TCE levels in nearby MWs (MW260 and MW533) have ranged from 89 to 403 µg/L. TCE levels in EW235 have ranged from 150 to 163 µg/L and in nearby MWs (MW256 and MW478) from 152 to 330 µg/L.

With the exception of shutdowns due to construction, operational efficiency of the original wellfield (actual run time compared to 100% run time) typically exceeded 85%, often averaging better than 95% over a three-month period. For the period 2003 through 2017, TCE concentrations in the original EWs remained near steady, declining to approximately 100–120 µg/L. Tc-99 levels increased to approximately 40 pCi/L[6] in EW231 because continued operation of the EWs had pulled Tc-99-contaminated groundwater from the area of the industrial complex (Figure 6.3).

TCE levels in all MWs and EWs associated with the original Northeast Plume Groundwater System exhibited declining trends since 2003 (Figures 6.3 and 6.4). The data indicate that the EWs were effective at controlling the high-concentration core of the Northeast Plume and that the TCE levels within the upgradient Northeast Plume were declining.

DOE installed 28 MWs near the east facility security fence and in downgradient reaches of the Northeast Plume as part of the October 2009 through February 2010 MW upgrade project. A MIP was used to characterize the location of the centroids of the Northeast Plume near the east facility security fence to optimize the location of these wells. Results from these MWs were incorporated into the latest update of maps of the Paducah Site plumes [for calendar year (CY) 2016] (see Figure 6.1). As part of the Northeast Plume Optimization Project, DOE installed 22 MWs and piezometers for performance monitoring. The locations of these MWs and piezometers are also shown on Figure 6.1. Sampling data for 7 of the MWs were available to be incorporated into the plume map update.

The IRA is intended to control the north end of the high concentration core of the Northeast Plume (1,000 µg/L and greater TCE). Monitoring data from throughout the plume document that the Northeast Plume TCE concentrations have diminished and are significantly less than 1,000 µg/L. Consistent with the sitewide strategy, which includes control of the migration of groundwater contamination from the site, DOE has optimized the location of the operating EWs and continues to operate the NEPCS. The TCE concentrations in the effluent of the original treatment system continued to meet the target levels (Table 6.2).

[6] The current drinking water limit of 900 picocuries per liter (pCi/L) Tc-99, as calculated by EPA, is based on the MCL for man-made beta and photon emitters in drinking water to a target annual dose to the total body or organ of 4 mrem/yr. This calculation was based on biokinetic models and data from National Bureau of Standards Handbook 69, published in 1963. Since that time, additional dosimetric research has been performed with more advanced biokinetic models. In 2011, DOE published the "DOE Standard: Derived Concentration Technical Standard (DOE-STD-1196-2011," which provides concentration standards for public consumption of drinking water that equate to an effective dose of 100 mrem/yr. The 2011 standards are based on current biokinetic and dosimetric methodologies which utilize both gender and age specific physiological parameters for Reference Man found in International Committee on Radiation Protection Publication 72 (ICRP 1996) and Publication 89 (ICRP 2002). In addition, the most current information on energies and intensities of radiation emitted by the various radionuclides found in International Commission on Radiological Protection (ICRP) Publication 107 (ICRP 2008) also were used in the derivation of the DOE concentration standards. The published derived concentration standard (DCS) for Tc-99 in drinking water is 4.4E-5 microcuries per milliliter (µCi/ml) or 44,000 pCi/L. As this value indicates, the concentration that will yield an effective dose of 100 mrem/yr from the ingestion of drinking water, the value to yield an effective dose of 4 mrem/yr is calculated by multiplying the DCS by 4% or 0.04. This calculation yields a value of 1,760 pCi/L. While the historically calculated value of 900 pCi/L continues to be utilized by EPA as the concentration based MCL for Tc-99, when calculated using current methods, a larger value is yielded. When 900 pCi/L is evaluated using the methods outlined in the DOE standard, it equates to an effective dose of 2 mrem/yr or ½ of the EPA MCL for public consumption of drinking water.

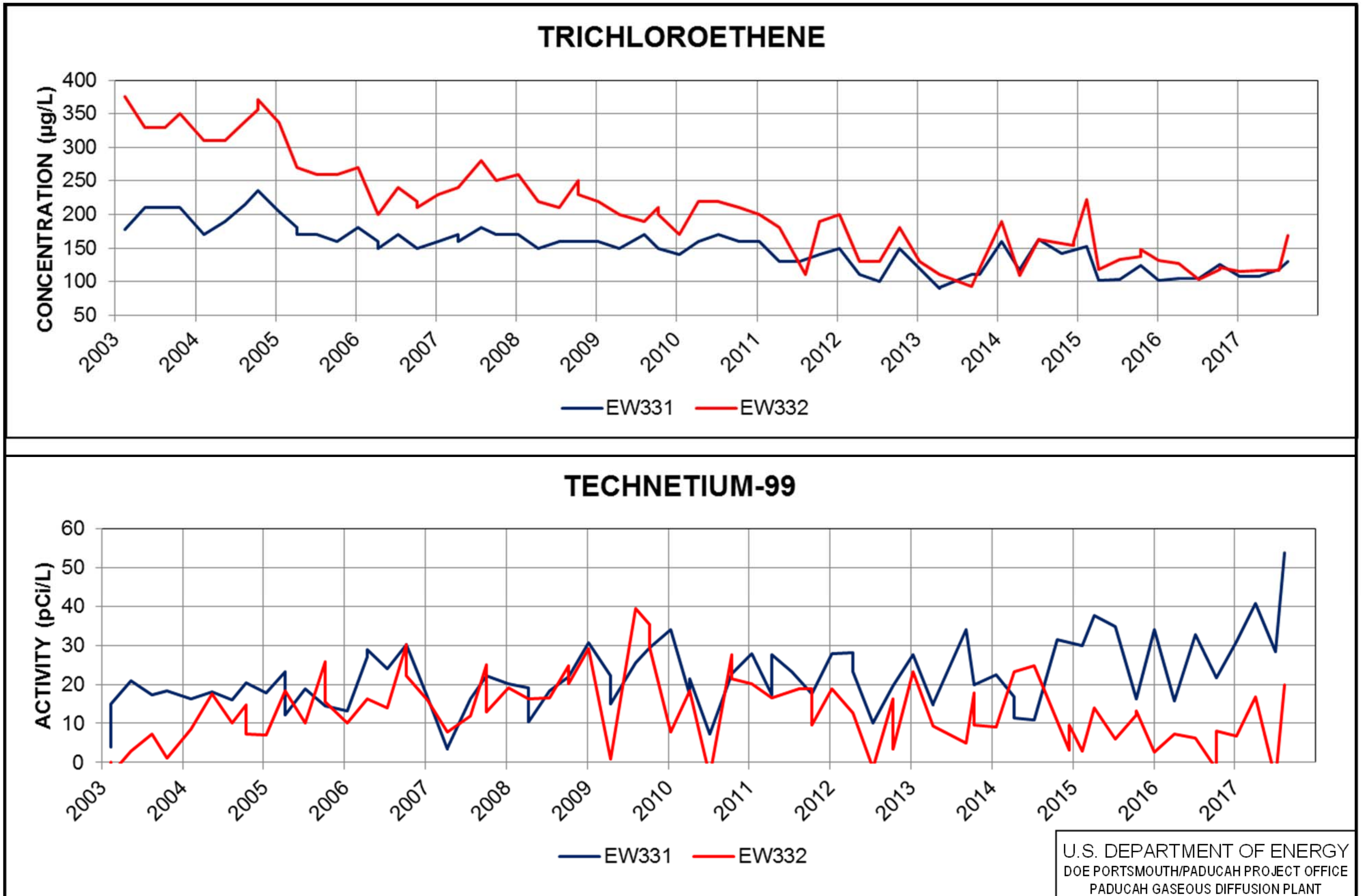

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Figure 6.3. Contaminant Trends in EW331 and EW332

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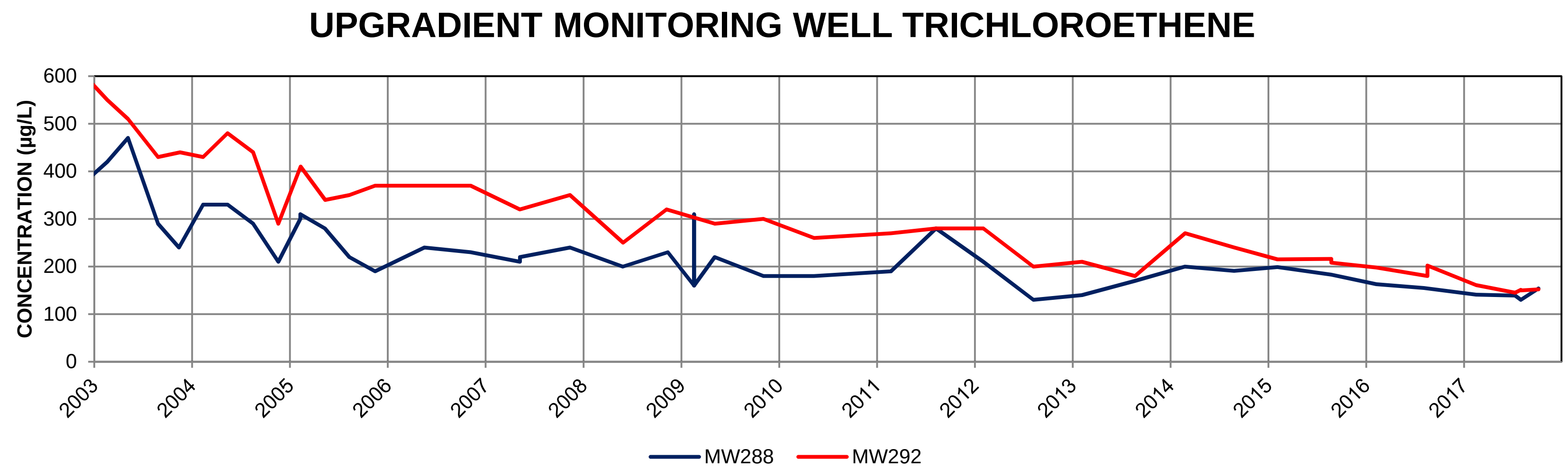

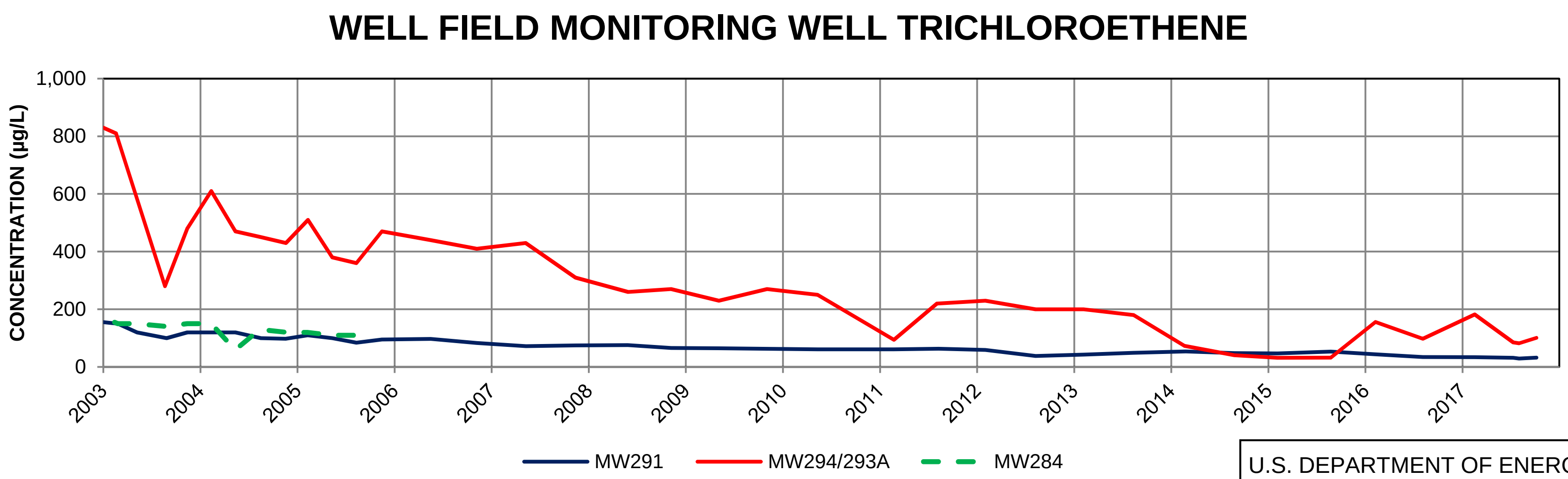

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Figure 6.4. TCE Trends in the Northeast Plume

Table 6.2. NEPCS Influent and Effluent Concentrations for the Period January 1, 2013, through October 10, 2017

	TCE (µg/L)		
	High	Low	Average[a]
Influent	170	96	126
Effluent[b]	15	< 1	4

[a] Average is calculated as an arithmetic average.
[b] Values for CERCLA Outfall (C001). High, Low, and Average values for the Cooling Tower Effluent were < 1.

This review of data and the site inspection indicate that the remedy as implemented by the original EWs was functioning, as described in the ROD, and the objectives had been met. Insufficient time has passed to assess the effectiveness of the optimized EWs. DOE continues to operate the NEPCS to control off-site migration of contaminated groundwater, consistent with the sitewide strategy. No changes in the physical conditions of the site have occurred that would affect the value of the remedy. The action inherently benefits downgradient areas by limiting the advance of the plume. Reviews of groundwater monitoring data and the results of the site inspection all indicate that the Northeast Plume Groundwater System has functioned as designed. The optimization of the NEPCS is expected to increase the rate of contaminant mass removal by the remedial system.

6.6.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of the Remedy Selection Still Valid?

The exposure assumptions used to develop the PHEA included both current exposures (industrial worker) and potential future exposures (future resident using groundwater and future industrial worker). The MCL for TCE remains 0.005 mg/L as it was during the original remedy selection; however, the original remedy was intended to control only high concentration portions of the plume and was based on the assumption that there is no exposure pathway because the Water Policy (as discussed in Chapter 8) prevents access to the contaminated groundwater. There are no risk-based cleanup levels or MCLs required for this project. There have been no changes to the exposure pathways due to the Water Policy (as discussed in Chapter 8) that restricts access to the contaminated groundwater; therefore, the exposure assumption (no exposure) is still valid.

The goals identified for the Northeast Plume, to initiate hydraulic control of the high concentration area that extends outside the facility security fence (from the ROD) and to remove TCE and 1,1-DCE mass and enhance capture of the Northeast Plume in the vicinity of the eastern edge of PGDP industrial facility and to reduce further migration off-site (from the Explanation of Significant Differences), remain valid.

There are no changes in standards identified as ARARs in the ROD that impact the protectiveness of the remedy. The ROD identified a chemical-specific ARAR for discharge of TCE to the creek of 81 µg/L, as controlled by the KPDES Permit; however, the water quality criterion was lowered to 30 µg/L. The 2015 Explanation of Significant Differences (DOE 2015b) established up to two CERCLA outfalls for discharge of TCE to the creek with the same 30 µg/L water quality criterion. The discharges from the Northeast Plume treatment never have exceeded this lower value; therefore, this change in standards has no impact on the protectiveness of the remedy. Additionally, there are no newly promulgated standards that might apply or be relevant and appropriate to the site that affect the protectiveness of the remedy. The following changes were identified, but do not impact the protectiveness of the remedy:

- References to 401 *KAR* 5:029(2) and 5:031 have been changed to 401 *KAR* 10:029(2) and 10:031, respectively.

- Reference to 401 *KAR* 63:022 was replaced with 401 *KAR* 63:020; however, guidance from the Kentucky Division of Waste Management (KDWM) states that existing sources subject to 63:022 can continue to be regulated against that standard until the Cabinet determines that it no longer is protective (e.g., major modification to existing system). The continued use of 401 *KAR* 63:022 does not impact the protectiveness of the remedy.

The Paducah Site's Northeast Plume underlies land controlled by DOE and sparsely populated areas northeast of the facility and borders on residences (to the east) located along Metropolis Lake Road. DOE maintains a Water Policy (evaluated in Section 8) that controls access to the groundwater in the area of the plume through a license agreement process with landowners and by providing household water supply to the area residents. Exposure assumptions used in the ROD regarding future domestic use of groundwater off DOE property remain valid. There have been changes to the risk assessment methodology, but the protectiveness of the remedy was not affected.

The current groundwater data indicate that assumptions underlying the remedy selection in the ROD still are valid. There have been no new contaminants or new understanding of geologic conditions identified.

6.6.3 Question C: Has Any Other Information Come to Light That Could Call into Question the Protectiveness of the Remedy?

No other information has come to light that would call into question the protectiveness of the remedy.

6.6.4 Technical Assessment Summary

The operational data and the site inspection indicate that the mechanical components of the remedy are functioning as intended by the ROD.

The optimized Northeast Plume IRA consists of groundwater extraction from two EWs located within and near the facility security fence and in the high concentration cores of contamination of the Northeast Plume. This optimized EW field is intended to control migration of the high-concentration core of TCE contamination off the DOE property and to maximize VOC mass recovery. The NEPCS 2015 update of the Explanation of Significant Differences (ESD) requires the following (DOE 2015b).

- Installation (at a minimum) of five new RGA monitoring wells in a north-south transect approximately 600 feet east of C-400 Building (exact locations to be determined by the FFA parties as part of the finalization of the RAWP). These transect monitoring wells will be used to assess the impact of groundwater extraction wells on contaminant migration from source areas, including impacts to the groundwater divide east of C-400 Building.

- If contaminant concentrations in any transect well's quarterly samples are determined to be increasing and may double above the established baseline within a year of the quarterly samples showing an increase, then potential changes in groundwater flow or source impacts (e.g. rising contaminant concentrations in the NE Plume, source migration, etc.) will be further examined and the FFA parties will consider adjustments (e.g. adjusting extraction well pumping rates) for the optimized NE Plume interim action to minimize these potential impacts.

- If the measures taken by the FFA parties (e.g. adjusting extraction well pumping rates) do not result in decreased or stabilized concentrations at the transect monitoring wells, or if such adjustments reduce the effectiveness of the optimized extraction wells or if Tc-99 concentrations continue to increase and are detected at twice their baseline concentration in any one (or more) of the transect wells for two consecutive quarters, then DOE must notify EPA and KDEP within 30 days of receiving sampling results or one of the other aforementioned conditions occurring. After EPA and KDEP have been notified, the FFA parties will discuss and evaluate options to address continued increase of groundwater concentrations and plume expansion.

- Within 1 year from the notification, DOE shall submit an ESD and RAWP Addendum as the Primary documents to undertake modification to the existing CERCLA Interim Remedial Action pursuant to the FFA to address the contaminated groundwater plume expansion and to prevent Tc-99 at levels above the MCL from further being pulled within the NE Plume.

- The FFA parties will discuss whether to temporarily suspend operation of one or both of the extraction wells while determining the modifications to the CERCLA Interim Remedial Action to prevent further plume expansion.

- If a determination is made to shut down the optimized pump and treat system either before a modification to the Interim Remedial Action or as part of a modification to the Interim Action, then DOE shall reinstate implementation of the NE Plume Interim Remedial Action (Interim ROD 1995). DOE shall keep the extraction wells associated with the NE Plume Interim Remedial Action in good working condition until the FFA parties agree the maintenance is no longer necessary.

Contaminant levels downgradient of the EW field have decreased since the initiation of the Northeast Plume IRA and are continuing to decline. The thick interval of relatively low-permeability silt that overlies the Northeast Plume should reduce the potential for transport of VOC vapors from the Northeast Plume to the surface. A vapor intrusion study of the downgradient Northeast and Northwest Plume areas determined that vapor intrusion does not pose a concern for area residences (DOE 2016a). While operation of the NEPCS is an interim action, it is effectively protective in conjunction with other Paducah Site programs (notably the Water Policy).

6.7 ISSUES

None.

7. CYLINDER DROP TEST AREA OR LASAGNA™ TECHNOLOGY DEMONSTRATION

The Cylinder Drop Test Area (SWMU 91) encompasses approximately 1.7 acres and is located in the extreme west-central area of the facility on the southern edge of the C-745-B Cylinder Yard. Figure 7.1 illustrates the location of Cylinder Drop Test Area. Drop tests were conducted from late 1964 until early 1965 and in February 1979. These tests were used to demonstrate the structural integrity of the steel cylinders that were used to store and transport uranium hexafluoride (UF_6). Prior to the drop test, the cylinders were cooled by immersing them in a solution of dry ice and TCE that was in an open below-ground-surface pit. After the cylinders were chilled, a crane lifted and then dropped them onto a concrete and steel pad to simulate worst-case transportation accidents. The TCE was not removed from the pit after the tests and eventually vaporized or leaked into the surrounding shallow soil and groundwater. The likely maximum quantity lost to the surrounding soil is approximately 1,635 L (430 gal). Additional information regarding the nature and extent of contamination is presented in the *Results of the Site Investigation, Phase II*, KY/SUB/13B-97777C, P-03 1991/1 (CH2M HILL 1992), and the *Preliminary Site Characterization/Baseline Risk Assessment/Lasagna^{TM} Technology Demonstration at Solid Waste Management Unit 91 of the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, KY/EM-128 (LMES 1996a).

Results of the initial investigations conducted at the Cylinder Drop Test Area indicated that organic contaminants were present in both soil and groundwater at the unit. The maximum concentration of TCE in subsurface soil was 1,523 mg/kg, and in shallow groundwater it was 943 mg/L. The area of TCE contamination was approximately 6,000 ft^2, and the average TCE concentration was 84 mg/kg. The sampling results indicated that TCE had migrated below the water table in the UCRS, but had not fully penetrated the aquitard above the RGA. Contamination was present in the subsurface soils to an approximate depth of 45 ft below ground surface (bgs).

7.1 REMEDY SELECTION

In 1993, the Cylinder Drop Test Area was selected as the site of an innovative technology demonstration. The technology, known as Lasagna^{TM}, uses electroosmosis to move shallow groundwater and contaminants contained in fine-grained or clayey soils. Contaminants are treated by passing contaminated groundwater through in-ground treatment cells. The success of the initial 120-day demonstration (Phase I), which began in January 1995, led to a full-scale demonstration (Phase IIA) that was conducted from August 1996 through July 1997. Sampling and analytical results from the Phase I study are reported in the *Preliminary Site Characterization/Baseline Risk Assessment/Lasagna^{TM} Technology Demonstration at Solid Waste Management Unit 91 of the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, KY/EM-128 (LMES 1996a). During the second phase of the technology demonstration, the average TCE concentration in the demonstration area soil was reduced by 95%. Post-test soil sampling conducted for the Phase IIA demonstration indicated that Lasagna^{TM} would achieve the cleanup goals. The results of the Phase IIA demonstration are discussed further in the *Lasagna^{TM} Soil Remediation: Innovative Technology Summary Report* [LMES 1996b (unnumbered)].

DOE then selected Lasagna^{TM} for full-scale remediation of the Cylinder Drop Test Area and documented this decision in the *Record of Decision for Remedial Action at Solid Waste Management Unit 91 of Waste Area Group 27 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/06-1527&D2 (DOE 1998a), with EPA approval and KDEP concurrence, September 1998. The ROD identified the selected remedy, outlined the performance objectives, and provided rationale

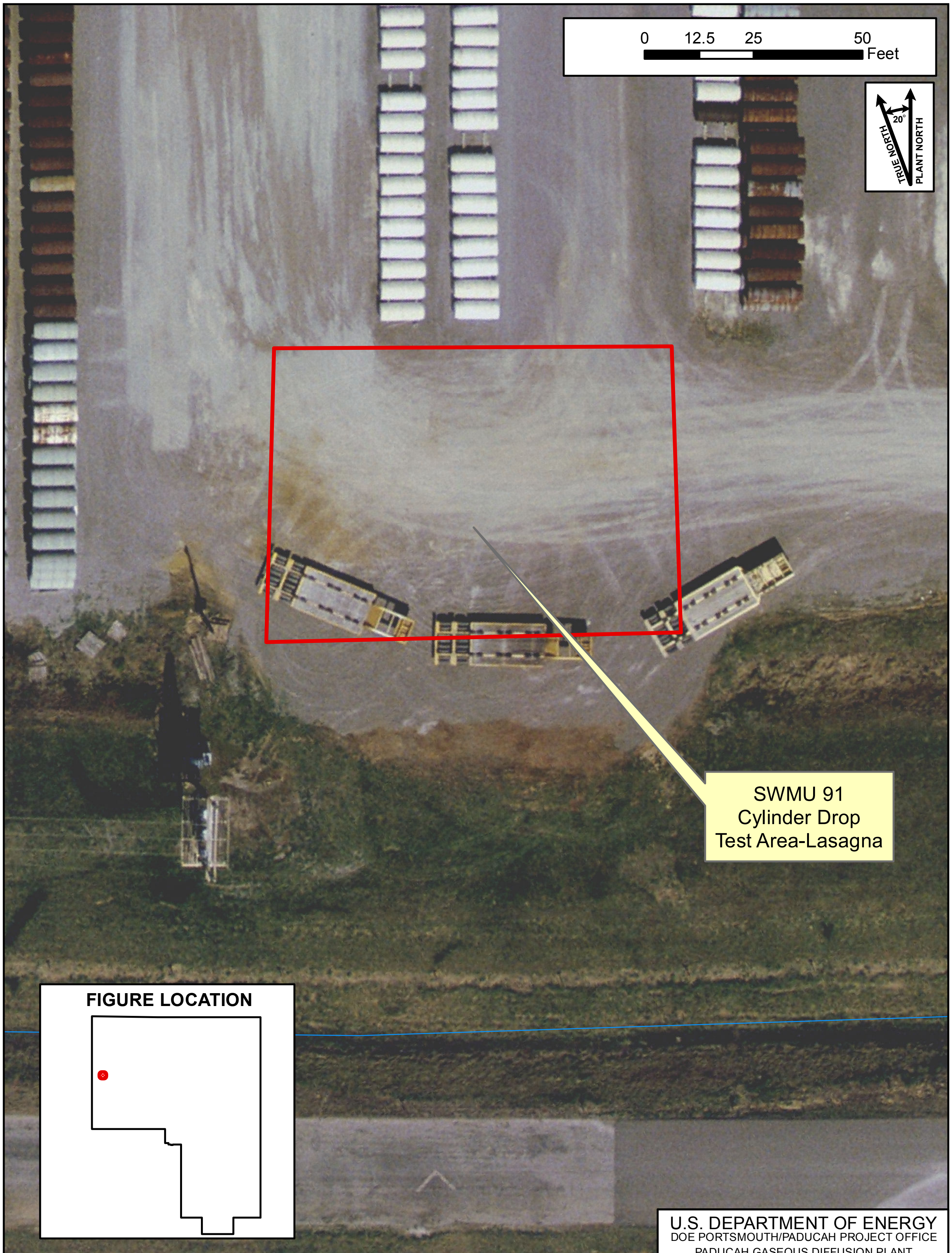

Figure 7.1. Location of Cylinder Drop Test Area

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for the remedy selection. The remedy consisted of treatment of contaminated soil pore water by the Lasagna™ electroosmosis technology. The RAO was to mitigate migration of TCE beyond the SWMU boundary through the groundwater by the soil leaching pathway. Reduction of the concentration of TCE in soil to at least 5.6 mg/kg, reduced the potential for future releases to groundwater that could pose a threat to human health and the environment at the nearest point of exposure (POE) in groundwater. The following are the specific components of the selected remedy (DOE 1998a).

- Treatment zones that contain reagents that either decompose the TCE to nontoxic products or adsorb the TCE and make it immobile.

- Electrodes (a cathode and an anode) that, when energized, move contaminants (i.e., TCE) into or through the treatment zones and heat the soil. The contaminated water in the soil pores flows from the anode, through treatment zones, and toward the cathode.

- A water management system that recycles and returns the water that accumulates at the cathode back to the anode for acid-base neutralization.

The ROD specified that the Lasagna™ system operate for two years, but, if necessary to meet the clean-up objectives, the operation might be continued until cleanup levels are reached. The ROD also included a contingency action to use *In Situ* Enhanced Soil Mixing in the event that the Lasagna™ technology by itself was incapable of achieving cleanup objectives. Additional information regarding the selected remedy is presented in the ROD for the Cylinder Drop Test Area (DOE 1998a).

7.2 REMEDY IMPLEMENTATION

All phases of the Lasagna™ technology demonstration have been completed. In March 1999, a contract was awarded for installation and operation of the full-scale remediation (Phase IIb) using the Lasagna™ technology. The remedial design report (RDR) to support construction was issued in May 1999 and construction began in August 1999. The construction was completed and operations began in December 1999. The *Post-Construction Report for the Lasagna™ Phase IIb In-Situ Remediation of Solid Waste Management Unit 91 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1856&D1, (DOE 2000b) documents the remedial construction process. The construction phase also included collection of soil samples to establish a baseline of contamination in the system area prior to remediation.

The remedial system operated from December 1999 through December 2001. The results of post-cleanup verification sampling indicated the average concentration of TCE was 0.38 mg/kg, with a maximum concentration of 4 mg/kg. The Lasagna™ remedial action reduced the TCE soil concentrations well below the RAO of 5.6 mg/kg average concentration.

The system operated continuously for the first several months. After the soil temperature reached 194°F, the system was put into pulse mode to prevent overheating of the soil. Pulse-mode operations consisted of energizing the system for one to four days and then shutting it down for several days to allow the soil to cool. Soil samples were collected in August of 2000 and in August of 2001. Due to mechanical problems, the system was shut down for approximately eight weeks beginning in August 2001. A number of additional operational problems were encountered during the operational phase and are detailed in the *Final Remedial Action Report for Lasagna™ Phase IIb In-Situ Remediation of Solid Waste Management Unit 91 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-2037&D1 (DOE 2002c). The Commonwealth of Kentucky and EPA approved the final remedial action report on October 31, 2002.

Lasagna^{TM} verification sampling and analysis were conducted in April 2003 and confirmed that the remediation objective was met. Details of the Lasagna^{TM} verification sampling and analysis are included in the *Addendum to the Final Remedial Action Report for Lasagna^{TM} Phase IIb In-Situ Remediation of Solid Waste Management Unit 91 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-2067&D2 (DOE 2003b).

The Lasagna^{TM} equipment and site were demobilized on September 30, 2002. The remediation site has been returned to its original condition. The total cost of the implementation of the Lasagna^{TM} remediation (i.e., post-ROD activities) was $3.96M (DOE 2002c).

7.3 SYSTEMS OPERATIONS/OPERATIONS AND MAINTENANCE

There is no O&M for this remedy.

7.4 PROGRESS SINCE LAST FIVE-YEAR REVIEW

The remedy for the Cylinder Drop Test Area remains protective of human health and the environment in the short-term. Exposure pathways that could result in unacceptable risk, such as groundwater, are being controlled (e.g., Water Policy, DOE 1994b).

There have been no previous issues or recommendations for the Cylinder Drop Test Area. The site remains unchanged since the performance of the 2013 Five-Year Review, and no new actions have occurred.

7.5 SITE INSPECTION

A site inspection was conducted on December 6, 2017, by a team of individuals supporting five-year review preparation. The site includes bare ground with some grass area south of the C-745-B Cylinder Yard: part of the area underlies a portion of the gravel cylinder yard. No construction or operations activities were being conducted at the time of the site inspection, and no erosion or disrepair was noted for the area. Several semitrailers were parked over the southern portion of treatment area, but there was no indication that the semitrailers were detrimental to the treatment area.

7.6 TECHNICAL ASSESSMENT

The remedy was designed to be protective of future groundwater use (from the RGA) at the fence line of the facility by meeting the TCE MCL value of 5 µg/L. The MCL for TCE remains at 5 µg/L.

The residual concentrations of TCE in soil (post-remediation verification sampling) were an average 0.38 mg/kg, less than one-tenth of the original level calculated to be protective of groundwater in the ROD, with a maximum of 4.5 mg/kg (DOE 2002c); therefore, the remedy employed is protective. No additional post-remediation sampling and analysis have been performed since the completion of the remedial action.

7.6.1 Question A: Is the Remedy Functioning as Intended by the Decision Documents?

Yes. The remedy is functioning as designed. The reduction of TCE concentrations in soil is protective of future groundwater use at the nearest POE.

In 2011, EPA revised the cancer slope factors and toxicity data for TCE. The 2011 Paducah Site no further action (NFA) level was based on a more conservative KDEP cancer slope factor and had an industrial screening value of 0.0619 mg/kg for the excavation worker at 1E-06 (DOE 2011b). Using these screening levels, the mean concentration corresponds to 6E-06 risk using the Paducah Site/KDEP value. The maximum value at the Cylinder Drop Test Area corresponds to 6.5E-06 risk using this same value. Based on a comparison of the 2017 Paducah Site screening values (i.e., 2.26 mg/kg for toxicity and 30.9 for cancer using the EPA slope factor and excavation worker exposure factors) and the measured concentrations of TCE in soil after the remediation was completed, the effectiveness of the remedy for soil remains protective for future groundwater use at the fence line of the facility.

7.6.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of the Remedy Selection Still Valid?

Yes. DOE remains in control of the property that the Cylinder Drop Test Area encompasses, and the land use remains industrial with no groundwater use on DOE property. The facility's excavation/penetration permit program requires formal authorization prior to performance of all excavations and other intrusive activities; therefore, the exposure assumptions used in the ROD remain valid.

The soil cleanup level (Table 7.1) established in the ROD to be protective of groundwater at the POE was met.

Table 7.1. Chemical-Specific Standards for the Cylinder Drop Test Area Lasagna™ Technology Demonstration

Contaminant	Media	Cleanup Level	Basis
Trichloroethene	Soil	5.6 mg/kg	MCL of 5 µg/L at POE

There have been changes to the risk assessment methodology, but the protectiveness of the remedy was not affected (see Section 7.6.1).

There are no changes in standards identified as ARARs in the ROD that impact the protectiveness of the remedy. Additionally, there are no newly promulgated standards that might apply or be relevant and appropriate to the site that affect the protectiveness of the remedy. Finally, there are no changes in TBCs identified in the ROD that impact the protectiveness of the remedy.

The RAO used at the time of remedy selection still is valid.

7.6.3 Question C: Has Any Other Information Come to Light That Could Call into Question the Protectiveness of the Remedy?

There have been no new contaminants or new understanding of geologic conditions identified. No other information has come to light that would call into question the protectiveness of the remedy.

7.7 ISSUES

None.

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8. WATER POLICY

Upon detecting TCE and Tc-99 in private wells located north of the Paducah Site in August 1988, DOE immediately placed potentially affected residences/businesses on alternate water supplies and began an intensive monitoring and investigation program to define the extent and temporal variations of the groundwater contaminant plumes. DOE developed the Paducah Site Water Policy in accordance with the *Engineering Evaluation/Cost Analysis for the Water Policy at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/06-1142&D3, (EE/CA) (DOE 1993b), and the *Action Memorandum for the Water Policy at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/06-1201&D2 (DOE 1994b).

The actions associated with the remedy selections of the Northwest and Northeast Plumes (SWMUs 201 and 202, respectively) mitigate the continued migration of the higher concentration portion of the plumes. The Water Policy response action mitigates risk that could be posed by residents using contaminated groundwater.

No significant changes have occurred during the 2013–2017 period.

8.1 REMEDY SELECTION

The Paducah Site Water Policy states, "It is the intent of the PGDP Environmental Restoration Program to offer municipal water service in accordance with this Policy to all existing private residences and businesses within the projected migration area of the contaminated groundwater originating at PGDP (affected area)." With the adoption of the Water Policy, DOE focused its groundwater monitoring program on the Water Policy Boundary and adjacent areas that might be affected if and when the plume migrates or expands. Figure 8.1 is a map of the 5 µg/L TCE groundwater contaminant plume boundaries (adapted from the FPDP 2017b) and the Water Policy boundary as of 2017.

In June 1994, DOE signed the AM for the Water Policy. The AM contains the following regarding the purpose of the Water Policy:

> The purpose of long-term remedial action is to eliminate, reduce, or control risks to human health and the environment. Implementation of this removal action is consistent with that purpose. Potential threats to public health require attention prior to initiation of long term remediation. This action prohibits exposure to contaminated water from residential wells until a permanent remedy has been successfully completed, or other actions have formally been deemed appropriate.[7]

The AM included the following conditions.

- DOE offered to provide municipal water to all existing residences and businesses within the affected area surrounding the Paducah Site. They also offered to pay for installation of water supply mains and connection of those residences and businesses that were not connected to a public water supply at that time. These residences and businesses were responsible for cooperating and working with the West McCracken Water District to connect the water supply.

[7] It should be noted that signing of the agreement is voluntary, and that 65% of the residents have signed the agreement that specifies that the property owner will not drill new water supply wells or use existing water wells.

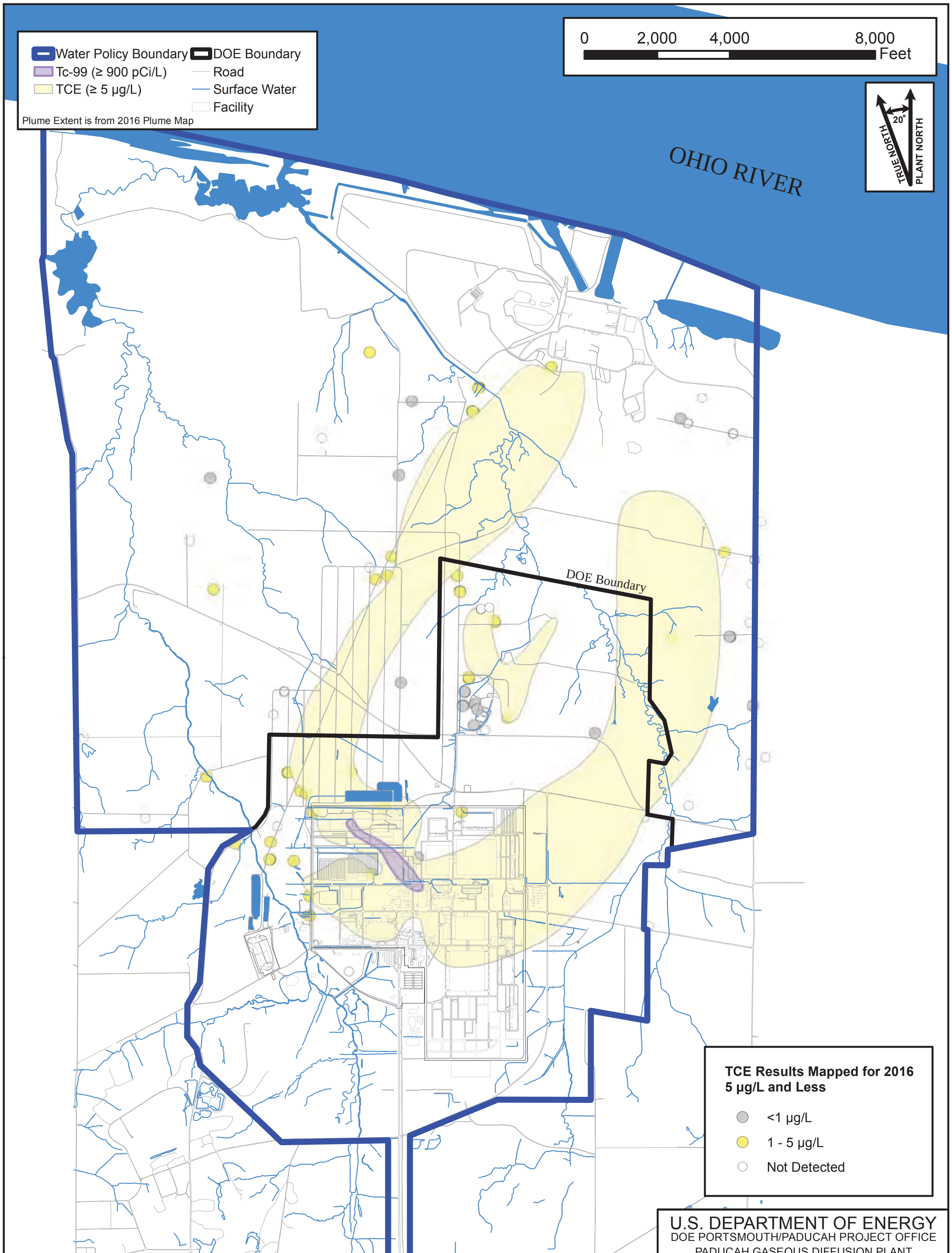

Figure 8.1. Location of Water Policy Boundary

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- DOE offered to pay the reasonable costs of water bills in the affected area through December 1997, at which time the Water Policy was to be reevaluated and a decision made whether to continue, modify, or eliminate it. The definition of "reasonable cost of water consumption" for residents was based on the historical usage of each owner's well. Water usage increases caused by increases in agricultural water use, livestock water use, or subdivision of property were not to have been reimbursed.

- Each household or business in the Water Policy Box (affected area) was asked to sign an agreement with DOE that delineated the responsibilities of each property owner and DOE. The agreements specify that the property owner will not drill new water supply wells or use existing water wells, and that Paducah Site personnel are permitted access to the property for sampling purposes. Paducah Site personnel installed locks to prevent unauthorized use of the existing water wells.

- DOE samples existing residential water supply wells and MWs to track migration of groundwater contaminant plumes. Additional MWs are installed as required for other environmental restoration programs.

The EE/CA also specified the need to conduct a five-year review (DOE 1993b).

8.2 REMEDY IMPLEMENTATION

DOE has obtained Water Policy agreements with 65% of residents located within the Water Policy Boundary. West McCracken Water District records indicate that all residents have chosen to use municipal water; however, some landowners have chosen not to sign the license agreements. The following approach was implemented to manage the DOE Water Policy.

- Water bills are reviewed monthly looking for abnormal bills and residents are notified by mail.

- A comprehensive review at the McCracken County Property Valuation Administrator's office is conducted once per year, and the website is accessed several times per year to determine property ownership and recent sales.

- An inspection program of the caps and locks installed on residential wells on properties with a license agreement verifies the wells are nonoperational.

- As License Agreements are set to expire, property owners are contacted prior to the expiration date to request a renewal.

- In accordance with the AM, DOE evaluates requests from new residents/business within the Water Policy Boundary for DOE to pay water bills on a case-by-case basis. The AM states that new residences/businesses that are offered access to a municipal water supply at their own expense within the affected area will not be provided free water under this policy, and that exceptions to this policy may be made on a case-by-case basis.

- Ten out of 47 residential wells (21%) located in the Water Policy Box are sampled. In addition, there are 20 MWs located on private property that are sampled periodically.

- As noted in the 2013 Five-Year Review, DOE continues to reevaluate the Water Policy removal action implementation, with respect to the license agreement usage and payment of current water bills.

8.3 SYSTEMS OPERATIONS/OPERATIONS AND MAINTENANCE

DOE paid for water supply line extensions of the West McCracken Water District into the Water Policy Box. Total capital construction cost for implementation of the Water Policy was $1,027,781. The average annual cost to implement the Water Policy program is $170K. This includes an average of $60K for annual water bill payments, $90K for annual management of the program, and $20K for land access and/or monitoring rights for sampling wells on private property. This sampling is for monitoring groundwater inside the Water Policy Box via DOE-owned and installed groundwater MWs or sampling of privately owned residential wells that are located outside the Water Policy Box. The estimated annual cost for sampling associated with this remedy is approximately $37K.

DOE regularly collects groundwater samples from the area in the Water Policy Box and expanded the residential well monitoring from 2008. Beginning in December of 2012, 11 residential wells are sampled annually and 8 residential wells, along with 14 other MWs, are sampled quarterly (DOE 2018c). The interval of sampling of each well within the water box has been adjusted to characterize temporal variations within the plumes and to confirm migration paths near the northwestern and northeastern boundaries. DOE reports the results of groundwater monitoring in its Annual Site Environmental Report.

8.4 PROGRESS SINCE LAST FIVE-YEAR REVIEW

The 2013 Five-Year Review had the following issue and recommendation.

> Issue: All potentially affected residents within the Water Policy have been provided access to municipal water and have been provided an opportunity to sign license agreements to have their monthly water bills paid in return for commitments not to use their wells. Not all current landowners have signed license agreements for their properties; therefore, the potential exists that current and possibly new landowners could use their groundwater.
>
> Recommendation: DOE will optimize the remedy to ensure that all landowners are educated about the potential contamination in their groundwater. An annual educational fact sheet will be sent to each address within the Water Policy Box. The fact sheet would outline the potential risk associated with the groundwater and inform residents within the Water Policy Box of the groundwater remediation. Land ownership also will be reviewed at the McCracken County Property Valuation Assessment office annually to search for new owners of land parcels within the Water Policy Box. The newly identified owners will be contacted and given information concerning the contaminated groundwater. Raising the education and awareness levels about the potential risk associated with the groundwater will reduce the likelihood that residents could use their groundwater.

EPA, in letter dated September 30, 2014, requested that additional information be collected to support the protectiveness determination of the Water Policy Removal Action. EPA's letter stated the following:

> …The potential for current and new landowners using their groundwater is identified as an issue in the FYR. The recommendation to address the issue is for DOE to educate all landowners through an annual educational fact sheet, and contact and inform new landowners about the contaminated groundwater. These actions may reduce risk but will not eliminate the risk to residents using contaminated groundwater.

In addition, based on groundwater data from off-site wells, a potential risk for vapor intrusion exists for off-site residents located above the TCE groundwater plume. EPA expects the vapor intrusion risk is small given TCE groundwater concentrations. However, DOE must demonstrate whether vapor intrusion is a risk to residents through a vapor intrusion study. Until DOE demonstrates that all residents located above the contaminated groundwater plume are not using groundwater and vapor intrusion is not occurring into residential properties, the protectiveness statement should be "deferred".

Based on the information provided in the subject document and additional data provided by DOE, EPA has made the following determination for the Water Policy Removal Action:

The protectiveness determination of the removal action for the Water Policy cannot be made at this time until further information is obtained. Further information will be obtained by taking the following actions: DOE demonstrates that all residents located above the contaminated groundwater plume are not using groundwater from their wells, and a vapor intrusion study is conducted if current groundwater data indicate a study is warranted. It is expected that these actions will be completed 1.5 years from the signature date of this letter, at which time a protectiveness determination will be made.

DOE has completed the following actions.

- The annual Water Policy Educational Fact Sheet, Attachment C1 in the 2013 Five-Year Review, was mailed to area residents/businesses within the Water Policy Box, with the recipient listed as "Current Resident" on January 27, 2016. DOE will coordinate future annual educational fact sheets with EPA/KDEP by providing a copy of the educational fact sheet seven calendar days in advance of mailing. Should EPA/KDEP require additional review time, EPA/KDEP will make a timely request within the seven-day review period. Annual education fact sheets will be prepared during the first quarter of each CY, unless another time is agreed to by the FFA parties. Comments received will be addressed, as appropriate, prior to issuing the fact sheet to the public.

- DOE conducted a review of land ownership records at the McCracken County Property Valuation Office in August–September 2017. No new landowners were identified during this review. Using this review to supplement current records, the educational mailer for 2018 is being drafted and will be sent to all known addresses (residential and business) within the Water Policy Area; each will be addressed to "Current Resident."

- The Water Policy Vapor Intrusion Screening Study Report was submitted as Attachment C2 to the 2013 Five-Year Review. It was approved by KDEP on November 8, 2017, and EPA on November 14, 2017. The study stated the following conclusion. "The groundwater samples collected were analyzed, and no detectable VOCs were found above the project's detection limit of 1 μg/L. Based upon the failure to detect VOCs in UCRS groundwater, the very low permeability of the UCRS matrix, the low VOC concentrations in the underlying RGA, and the review of the vapor intrusion guidance, this vapor intrusion screening study determined that an additional vapor intrusion study (i.e., a detailed investigation) is not warranted in the Water Policy Area."

- The demonstration that residents located over the 5 μg/L or greater TCE plume, which is the Safe Drinking Water Act MCL for TCE, are not using groundwater was included as Attachment C3 (dated October 2017) of the 2013 Five-Year Review. It was approved by KDEP on November 8, 2017, and EPA on November 14, 2017.

The 2013 review had the following protectiveness statement in Appendix C.

> The remedy for the Water Policy currently protects human health and the environment by institutional controls in the short-term. Exposure pathways that could result in unacceptable risk are being controlled; however, additional actions, as part of the dissolved-phase plume remedial actions, need to be evaluated for long-term protection. The Dissolved-Phase Plumes Record of Decision, which is part of the Groundwater Operable Unit, is scheduled for 2029; implementation of any necessary response actions for dissolved-phase groundwater contamination is scheduled by 2031.

8.5 SITE INSPECTION

The site inspection was conducted by the Five-Year Review team and included a drive through the Water Policy Box looking for any changes or observances of possible water well usage. None were noted.

8.6 TECHNICAL ASSESSMENT

The primary objective of the removal action is to prevent local residents from using contaminated groundwater by providing municipal water to residences and businesses and eliminating the use of private water wells.

A review of license agreements and water bills was conducted as part of this technical assessment during December 2017–January 2018. DOE pays the water bills for the majority of users. The extent of the groundwater contaminant plumes continue to be monitored. DOE has secured legal agreements, known as license agreements, with 58 of 89 landowners within the area affected by the Water Policy. Thirty-one landowners have not signed license agreements; however, DOE still pays their municipal water bills. Two landowners have requested and agreed with DOE to pay their own water bill. The two landowners who have requested this, were informed of the risk associated with consuming the groundwater. The third annual Water Policy Educational Fact Sheet was mailed to area residents/businesses within the Water Policy Box, with the recipient listed as “Current Resident” during March 2018. An inspection program checks residential wells on properties that have a license agreement to ensure that they remain nonoperational. Of the remaining landowners, the following summarizes the circumstances.

- Sixteen landowners historically have refused to sign a license agreement; however, land ownership is tracked. Historically is defined as four or more consecutive years of refusal/unresponsiveness.

- Four properties currently are in estate, and the new owners have not been identified legally to take possession of the properties. The D&R contractor will track these properties until a new owner is identified and notify DOE to verify whether a license agreement should be offered.

- Four landowners have been unresponsive for fewer than four years and currently have expired license agreements. The D&R contractor will attempt to contact these residents to obtain new license agreements.

- Four properties are vacant lots; the four landowners have not requested or been offered a license agreement by DOE to date. For one of these four properties, the landowner historically had been unresponsive, and the structure has been demolished.

- One property has a new owner identified (property was in estate previously).

Two landowners have not been offered a license agreement by DOE. The Action Memorandum required DOE to provide municipal water to all existing residences and businesses within the affected area surrounding PGDP. Additionally, DOE has performed the following activities to ensure residents are not using groundwater wells.

- Verified there are 11 landowners who own parcels located over the 5 µg/L or greater TCE plumes.

- Verified that water bills have been reviewed monthly to identify any changes in usage per procedure. Water bills were reviewed to identify any decrease in usage that could suggest a resident's change from use of municipal water to groundwater. A review of water bill data shows continuing use of municipal water and no decrease that would suggest a resident's use of groundwater for all potentially affected properties.

- Reviewed records for properties situated over the 5 µg/L or greater TCE plumes to determine whether those parcels had residential wells, DOE caps and locks, and/or license agreements.

- Reviewed the Kentucky water well database to ensure no additional groundwater wells have been installed over the 5 µg/L or greater TCE plumes. The Kentucky database for water wells was reviewed and the installation of new wells has not been reported within the Water Policy Boundary. The database may be accessed using the following link: http://kgs.uky.edu/kgsweb/datasearching/Water/WaterWellSearch.asp. The search option that identifies the area of interest with a center point and radius was used. GIS was employed to identify a centroid to the north extent of the Water Policy Box where a domestic well potentially could have been drilled. A search was used for all reported wells within radii of both 2 and 3 miles of the centroid and sorted the databases by both "Construction Date" and "AKGWA Number." Both databases, using the 2 mile radius and the 3 mile radius, identified the same 53 wells, which are MWs.

- Conducted visual assessment of properties overlying or immediately downgradient of the 5 µg/L or greater TCE plumes. For the seven landowners with a current Water Policy license agreement, each was contacted to gain access to the site to confirm no residential well is being used and to check that the well remained caped and locked, as applicable. For the four landowners without a current Water Policy license agreement, a drive-by assessment was conducted to document any evidence of water well usage. No evidence was found of water well usage, and it was verified that DOE pays the water bills.

- Mailed the annual Water Policy Fact Sheet to residents/businesses within the Water Policy area based on the recommendation from the 2013 Five-Year Review in 2016 (January 27, 2016) and 2017 (March 31, 2017).

The monitoring of groundwater in and around the Water Policy Box confirms that the groundwater plumes have not migrated beyond the current Water Policy boundaries at the MCL for the COCs and indicates that the current Water Policy Box still is protective.

8.6.1 Question A: Is the Remedy Functioning as Intended by the Decision Documents?

Yes. The Water Policy removal action is meeting the objectives specified in the AM by providing municipal water to the residents of the affected area (the Water Policy Box). The action continues to eliminate the exposure pathway to the groundwater, which is supported by monthly water usage data provided by the West McCracken County Water District, indicating that residents are utilizing the municipal water. An annual Water Policy Educational mailer is sent to all addresses within the Water

Policy Box to ensure that all landowners are educated about the potential contamination in their groundwater.

8.6.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of the Remedy Selection Still Valid?

Yes. The exposure assumptions used in the AM remain valid. There have been changes to the risk assessment methodology, but the protectiveness of the remedy was not affected. There have been no new contaminants identified.

The current groundwater data indicate that assumptions underlying the remedy selection still are valid.

No cleanup levels were established in the AM because the scope of the removal action was to supply potable water to residences and businesses within the area surrounding the Paducah Site that could be affected by migration of groundwater contamination originating from the facility. The purpose of this action is to reduce any potential public health hazard that might result from exposure to groundwater contaminants.

There are no changes in standards identified as ARARs in the AM that impact the protectiveness of the remedy. Additionally, there are no newly promulgated standards that might apply or be relevant and appropriate to the site that affect the protectiveness of the remedy. Finally, there are no changes in TBCs identified in the AM that impact the protectiveness of the remedy.

The RAO used at the time of remedy selection still is valid.

8.6.3 Question C: Has Any Other Information Come to Light That Could Call into Question the Protectiveness of the Remedy?

No. The remedy remains protective by providing municipal water to the residents of the affected area (the Water Policy Box). Monitoring data demonstrate that the plume has not migrated beyond the boundaries of the Water Policy Box. DOE has obtained Water Policy agreements with 65% of residents located within the Water Policy Boundary that prohibit use of groundwater.

No other information has come to light that would call into question the protectiveness of the remedy.

8.6.4 Technical Assessment Summary

The Water Policy Box eliminates potential pathways of exposure to the public by providing municipal water to potentially affected residents and businesses within the Water Policy Box. The Water Policy remains effective for the purpose for which it was intended.

8.7 ISSUES

None.

9. C-400 ELECTRICAL RESISTANCE HEATING

The C-400 Cleaning Building is located near the center of the industrial section of the Paducah Site. The building is bounded by 10th and 11th Streets to the west and east, respectively, and by Virginia and Tennessee Avenues to the north and south, respectively. Figure 9.1 shows the location of the C-400 Cleaning Building and immediate area.

Historically, some of the primary activities associated with the C-400 Building have been cleaning machinery parts, decontaminating the interiors of used UF_6 cylinders, disassembling and testing cascade components, and laundering work clothes. The building also has housed various other processes and activities, including recovery of precious metals and treatment of radiological waste streams.

In June 1986, a routine construction excavation along the 11th Street storm sewer revealed TCE soil contamination. The cause of the contamination was determined to be a leak in a drain line from the C-400 Building's basement sump to the storm sewer. The area of contamination became known as the C-400 TCE Leak Site and was given the designation of SWMU 11. The C-400 TCE Leak Site and the C-400 Building has been the subject of several investigations since then. Significant occurrences of TCE-contaminated soil and groundwater were detected during the WAG 6 Remedial Investigation (RI). Some results indicated the presence of TCE as a DNAPL. TCE was identified in two hydro stratigraphic units: the UCRS and the RGA. At C-400, the UCRS extends from surface to approximately 56 ft to 66 ft bgs. The RGA extends from the bottom of the UCRS to the top of the McNairy, with a thickness range of approximately 25 ft to 36 ft.

After the discovery of the C-400 TCE Leak Site in June 1986, some of the soils were excavated in an attempt to reduce the contamination in the area. Approximately 12 yd^3 of TCE-contaminated soil was drummed for off-site disposal. The excavation was backfilled with clean soil, and the area was capped with a layer of clay. A 2003 Six-Phase Heating Treatability Study removed over 22,000 lb of TCE (approximately 1,900 gal) from the subsurface in a 43-ft diameter treatment area near the southeast corner of the C-400 Building (Figure 9.2). Approximately 5,378 yd^3 of contaminated soil and subsurface aquifer were treated.

9.1 C-400 CLEANING BUILDING REMEDIATION ACTIVITIES

The success of the Six-Phase Heating Treatability Study conducted in 2003 lead to an interim ROD signed in 2005 that required mass removal of TCE source material within the UCRS and RGA using ERH. The scope of the interim remedy for the C-400 source action was limited to accessible areas located around the outside perimeter of the east and southwest portions of the C-400 Building due to ongoing USEC operations that occupied the C-400 Building.

Implementation of the ERH remedy was designed using a two-phase approach. Phase I was completed in 2010 and focused on selected treatment areas around C-400 (east and southwest areas) where the majority of the TCE was confined to the UCRS. Phase I removed approximately a combined 6,525 lb of TCE (535 gal) from the east and southwest treatment areas.

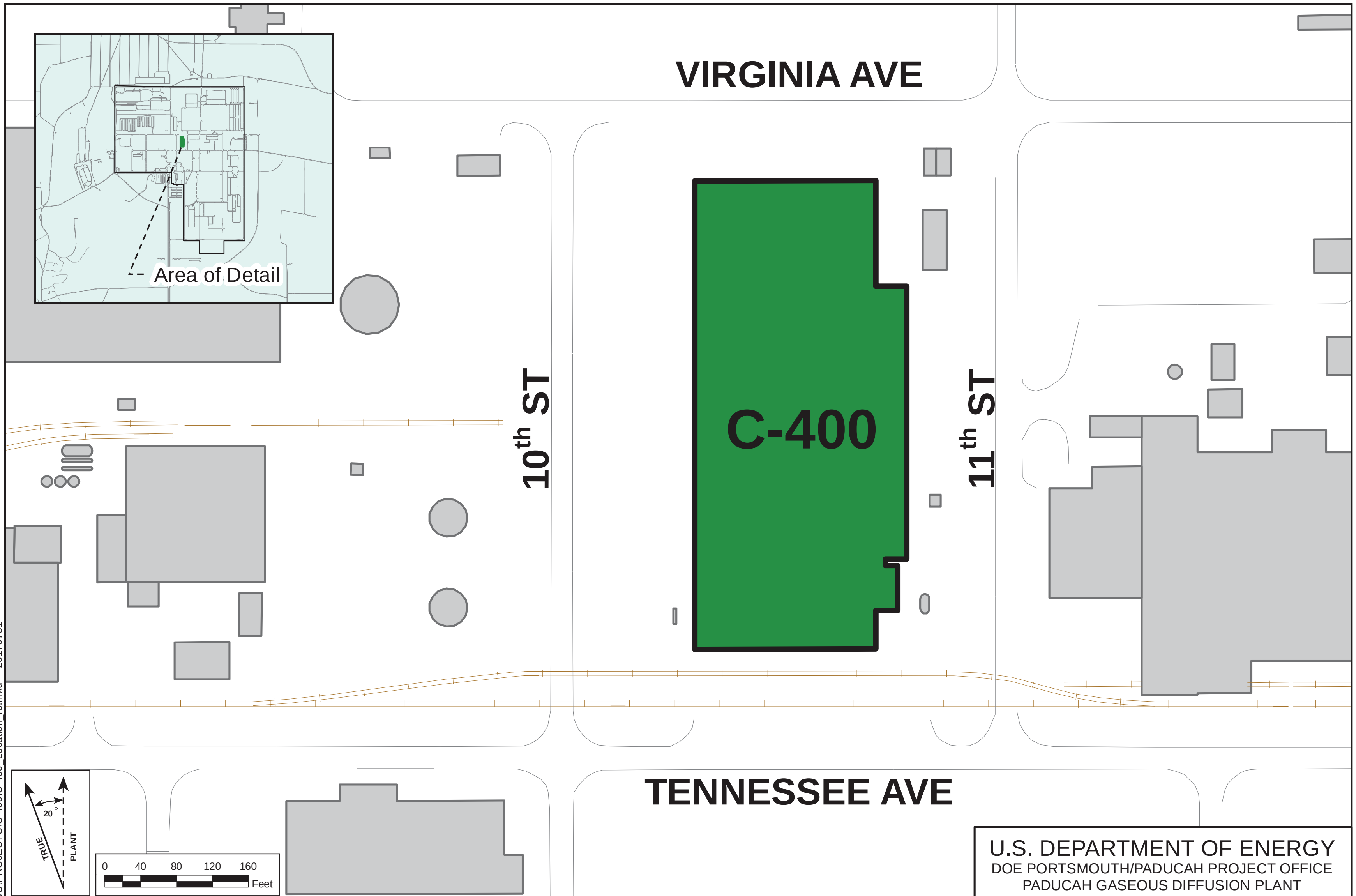

Figure 9.1. Location of C-400 Cleaning Building

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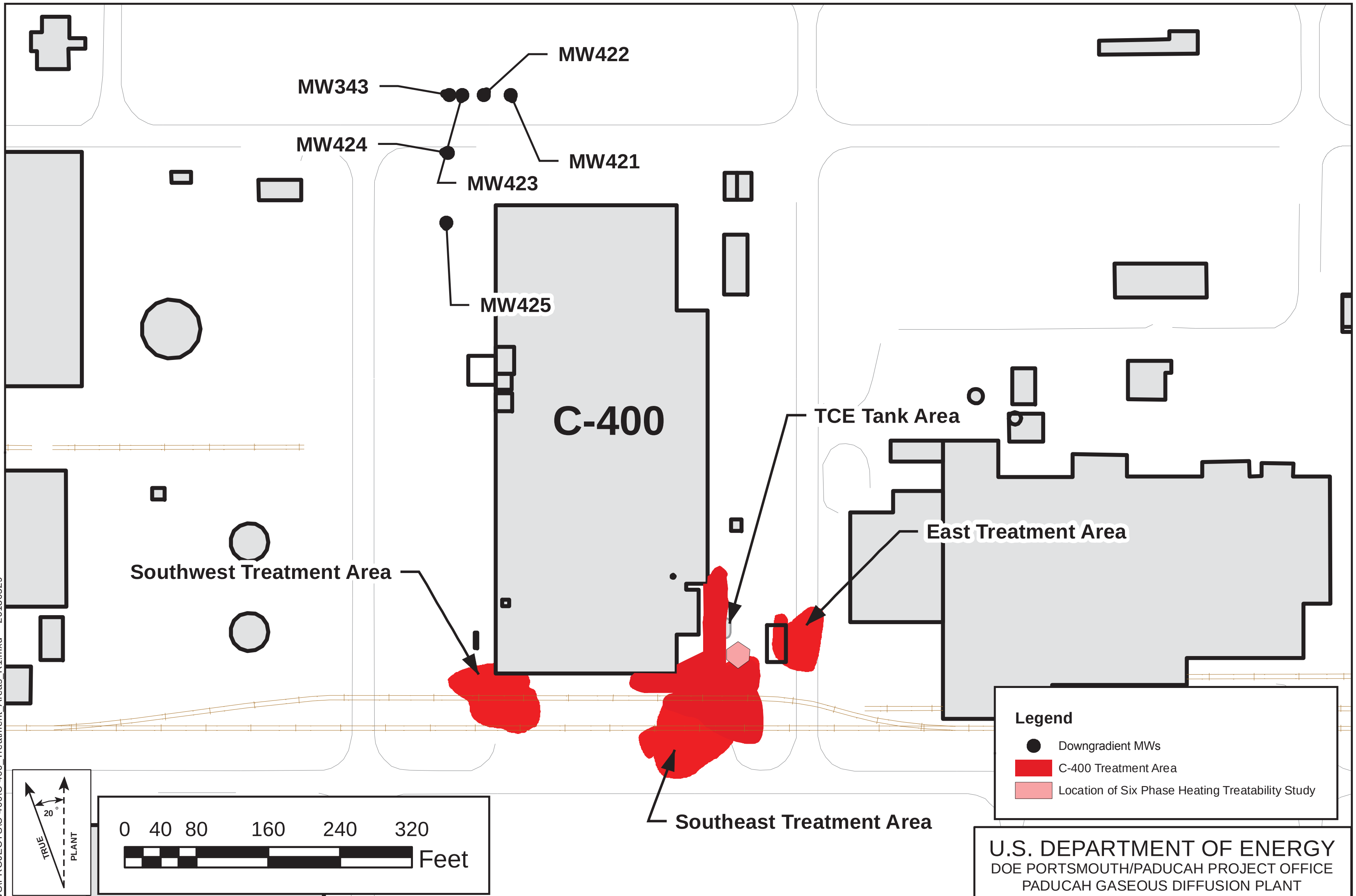


Figure 9.2. C-400 Treatment Areas

An important objective of Phase I was to evaluate the heating performance of the ERH design in the underlying RGA down to the McNairy Formation. During implementation of Phase I, temperature goals were not attained in the lower RGA in the southwest treatment area. Because of the inability of ERH to reach target temperatures in the lower RGA without significant changes to the base design, the FFA parties agreed to divide Phase II (southeast area) into Phase IIa (using ERH to address the UCRS and upper RGA to a depth of 60 ft bgs) and Phase IIb (using a technology to be decided to address the lower RGA). Phase IIa operations were completed successfully in fall of 2014. Phase IIa removed approximately 13,871 lb of TCE (1,137 gal) from the southeast treatment area.

To help evaluate applicable technologies for potential use in the lower RGA in the Phase IIb area, a Steam Treatability Study was performed in 2015 to obtain data specific to understanding the behavior of steam injected into the RGA under variable injection scenarios. The Steam Treatability Study Report—*Treatability Study Report for the C-400 Interim Remedial Action Phase IIb Steam Injection Treatability Study at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-2202&D2, (DOE 2016b)—demonstrated the technology would be technically implementable in the hydrogeological conditions tested, although several uncertainties remained regarding the full nature and extent of the Phase II source area, particularly whether a portion of the source extends beneath the C-400 Building and whether contamination was mobilized upgradient or downgradient of the study area.

Prior to moving forward with implementation of the IRA, DOE approached EPA and the Commonwealth of Kentucky Energy and Environment Cabinet and proposed reprioritization of the DOE mission at the Paducah Site based on the return of the enrichment facilities (including C-400); the need to perform work in a comprehensive manner at the C-400 Complex; and the expected impacts of anticipated future funding limitations across the DOE Complex. In June 2016, DOE provided a written proposal for the entire C-400 Complex that included acceleration of the investigation and cleanup of the C-400 Complex for all sources of contamination associated with and underlying the C-400 Building. This action would address the remaining VOC source in the Phase IIb area. On August 8, 2017, the FFA senior managers signed a MOA for the C-400 Complex that will be implemented as a separate OU identified as the C-400 Complex OU (DOE 2017f). As a result, the prior work performed under the C-400 IRA for Phase I and Phase IIa will be documented in a RACR for the C-400 IRA.

On September 28, 2017, the FFA senior managers signed a second MOA agreeing that the C-400 Cleaning Building IRA ROD was complete, resolving a 2016 formal dispute (DOE 2017c). Thereafter, DOE prepared a RACR (DOE/LX/07-2417&D1) and submitted the RACR to the FFA parties in February 2018 for review and approval. As of the end of 2017, the C-400 Cleaning Building is undergoing deactivation with only deactivation workers present in the building on a regular basis.

9.2 REMEDY SELECTION

Following the WAG 6 RI (DOE 1999a) and the GWOU Feasibility Study (FS) (DOE 2001a), a ROD was finalized for an IRA at C-400, *Record of Decision for Interim Remedial Action for the Groundwater Operable Unit for the Volatile Organic Compound Contamination at the C-400 Cleaning Building at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-2150&D2/R2 (DOE 2005a). The ROD determined that TCE (as free-phase DNAPL and dissolved-phase) is present in the UCRS and the RGA within the footprint of the C-400 Cleaning building area, and is considered a principal threat source material. The ROD also documented the selection of ERH as the preferred technology to address the source area contaminated with TCE and other VOCs.

The C-400 ERH action included the design, installation, operation, and subsequent decommissioning of ERH systems to heat discrete (vertical and horizontal) intervals of the subsurface source zone resulting in volatilization, removal, and recovery of VOCs from the C-400 treatment area. The remediation goal for this interim action, as documented in the ROD (DOE 2005a), was to operate the ERH system until monitoring indicated that heating had stabilized in the subsurface and that recovery of TCE, as measured in the recovered vapor, diminished to a point at which the recovery rate was constant (i.e., recovery is asymptotic). The following were the major components of the selected remedy:

- An RDSI to delineate further the areal and vertical extent of the contamination in the C-400 Cleaning Building area to optimize design of the remedial system;

- Removal and treatment of TCE and other VOCs from the contaminant source zone in the UCRS and RGA at the C-400 Cleaning Building area using ERH. The operation of ERH would cease when monitoring indicates that heating had stabilized in the subsurface and when recovery diminished to a point at which the rate of removal of TCE, as measured in the recovered vapor, became asymptotic; and

- Implementation, maintenance, enforcement, and reporting of LUCs on the C-400 Cleaning Building area; and continuation of groundwater monitoring of the free-phase DNAPL and dissolved-phase plumes because some contamination would remain in place following the IRAs.

The ERH technology consisted of installing electrodes in the subsurface, energizing them, and heating the subsurface to volatilize contaminants in the groundwater and soil. The volatilized contaminants were captured by aboveground equipment and processed for disposal as hazardous waste.

The ROD stipulated that the LUCs include the following activities:

- Placement of Property Record Notices to alert anyone searching property records to the information about contamination and the interim response action for the C-400 Cleaning Building area. The language comprising the Property Record Notice would be filed with the McCracken County Clerk, in accordance with state law, within 120 days of regulatory approval of the Land Use Control Implementation Plan (LUCIP);

- Deed restrictions (1) to limit use of the property to industrial activities, (2) to prevent exposure of groundwater to industrial workers, and (3) to restrict drinking or other interest(s) being created in the DOE property that is the subject of this interim action, including but not limited to, liens, mortgages, leases, easements, licenses, profits, servitudes, covenants or life estates; or before any actual transfer of such property. Deed restrictions were to be recorded with the McCracken County Clerk, in accordance with applicable state and federal law;

- Administrative controls in the form of an "excavation/penetration permit program" that would require a worker to obtain formal authorization prior to excavating or performing other intrusive activities in the C-400 Cleaning Building area; and

- Access controls, as necessary, to ensure protectiveness following the RA.

The RAOs in the ROD were as follows:

- Prevent exposure to contaminated groundwater by on-site industrial workers through institutional controls (e.g., excavation/penetration permit program);

- Reduce VOC contamination (primarily TCE and its breakdown products) in UCRS soil at the C-400 Cleaning Building area to minimize the migration of these contaminants to RGA groundwater and to off-site points of exposure; and

- Reduce the extent and mass of the VOC source (primarily TCE and its breakdown products) in the RGA in the C-400 Cleaning Building area to reduce the migration of the VOC contaminants to off-site points of exposure.

9.3 REMEDY IMPLEMENTATION

The RDSI was completed in August 2006 (DOE 2005b) and, coupled with data from previous investigations, delineated the areas of high TCE concentration more accurately, thereby allowing the design team to optimize placement of ERH electrodes, vapor recovery wells, and other subsurface components.

In 2007, DOE commissioned an independent technical review (ITR) of the C-400 90% RDR (ITR 2007). The 2007 ITR team consisted of subject matter experts from DOE, the environmental remediation field, and EPA. The ITR team published their report in October 2007, *Review Report: Building C-400 Thermal Treatment 90% Remedial Design Report and Site Investigation, PGDP, Paducah Kentucky*, WSRC-STI-2007-00427 (ITR 2007). Observations and recommendations from ITR team members helped shape the final design and led to the phased deployment strategy.

Remedial Design Report, Certified for Construction Design Drawings and Technical Specifications Package, for the Groundwater Operable Unit for the Volatile Organic Compound Contamination at the C-400 Cleaning Building at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/LX/07-0005&D2/R1, was issued in July 2008 (DOE 2008a).[8] The design incorporated two phases to mitigate the risks and uncertainties associated with large scale deployment of ERH in the highly permeable RGA.

Construction of Phase I was initiated in December 2008 and was completed in December 2009. Testing concluded in March 2010 and normal remedial operations were initiated. Operations continued through September 2010 when TCE concentrations in recovered vapor had dropped to asymptotic levels, at which time pulsed operations were initiated. Pulsed operations ended in October 2010 and power to the electrodes was turned off. Vapor extraction continued for approximately five weeks to facilitate subsurface cooling.

Phase I targeted the shallow UCRS formation (20–60 ft bgs) in the east and southwest source areas (Figure 9.2) with ERH and also served as a pilot test, in the southwest treatment area, to determine if ERH would be a viable technology to heat the lower RGA formation to the TCE/water co-boil target temperatures required to remediate source zones in the lower RGA.

Phase I data indicated that ERH was ineffective in treating the lower RGA based on the RDR criteria (DOE 2008a) and that modifying the ERH design to overcome design deficiencies would be cost prohibitive. Therefore, the FFA parties decided to divide Phase II (southeast treatment area) into two subphases (Phase IIa and Phase IIb). Phase IIa would target the UCRS and Upper RGA soils (20–60 ft bgs) for ERH thermal treatment and Phase IIb would target the lower RGA for an alternate treatment technology to be based on future treatability studies.

[8] The C-400 LUCIP was issued in February 2008 and was attached as an appendix to the C-400 RDR (DOE 2008a).

Phase IIa construction began in September 2012 and was substantially complete in May 2013; at that time, start up and shakedown testing began. Testing was completed and operations commenced at the end of July 2013. Heating operations ceased (soil vapor extraction continued) in early October 2014, and all system operations ended on November 5, 2014.

9.4 SYSTEMS OPERATIONS/OPERATIONS AND MAINTENANCE

Phase IIa drilling and subsurface completion of ERH components (electrodes, multiphase EWs, temperature monitoring strings, vacuum piezometers, and water-level monitoring instruments) were completed in March 2013 (refer to Figure 9.3 for ERH well locations). The Soil Vapor and Groundwater Treatment System (SVGTS) modifications were completed in May 2013. System testing concluded on July 22, 2013, and normal operations began.

Normal operations continued until November 2013, at which time operational difficulties were experienced with the newly installed steam regenerated carbon adsorption skid unit and unseasonably cold weather. Freezing temperatures resulted in extensive damage to system process piping, instrument sensing lines, valves, fitting, and other items, necessitating replacement or repair. Normal operations resumed January 14, 2014, and continued through July 2014 when TCE concentrations in recovered vapor had dropped to asymptotic levels.

Pulsed operations were initiated on July 28, 2014. The strategy for the pulsing operations was intended to maximize removal of the remaining contaminants from the Phase IIa treatment area by maximizing extraction from the wells and by varying the pressure levels within the subsurface. To maximize the extraction from individual wells, a pattern was initiated that consisted of operating half of the wells while the remaining half was shut down. To vary subsurface pressures, the extraction rates were reduced or increased concurrently with varying the power levels to the electrodes. The process then was repeated for two cycles. Pulsed operations ended on September 14, 2014, and power to the electrodes was turned off on October 9, 2014, to allow the subsurface to cool down. The SVGTS remained operational to continue mass removal during the cool down period. The SVGTS continued to operate through November 5, 2014, at which time operations ceased, and the RA portion of Phase IIa project was considered complete.

O&M activities during Phase IIa were conducted in accordance with the *Operations and Maintenance Plan for Phase IIa of the Interim Remedial Action for the Volatile Organic Compound Contamination at the C-400 Cleaning Building at the Paducah Gaseous Diffusion Plant, Paducah,* DOE/LX/07-1285&D2 (2013b). The Phase IIa treatment system removed approximately 13,871 lb (1,137 gal) of TCE, at a cost of approximately $26.7M.

Phase IIa heating continued over a 341-day period prior to the commencement of pulsed operations. During that time, operation of the electrodes was interrupted (power failures and other system problems) for approximately 61 days (18% of the time). Temperature plots in the treatment areas document that the three most significant downtime events, occurring in September 2013, December 2013/January 2014, and February 2014, had an impact on heating and extended the time needed to reach target temperatures. Operation of the SVGTS was interrupted for approximately 125 days (37% of the time), primarily because of mechanical failure of system components due to freeze damage as a result of unseasonably cold weather events that occurred in late 2013/early 2014.

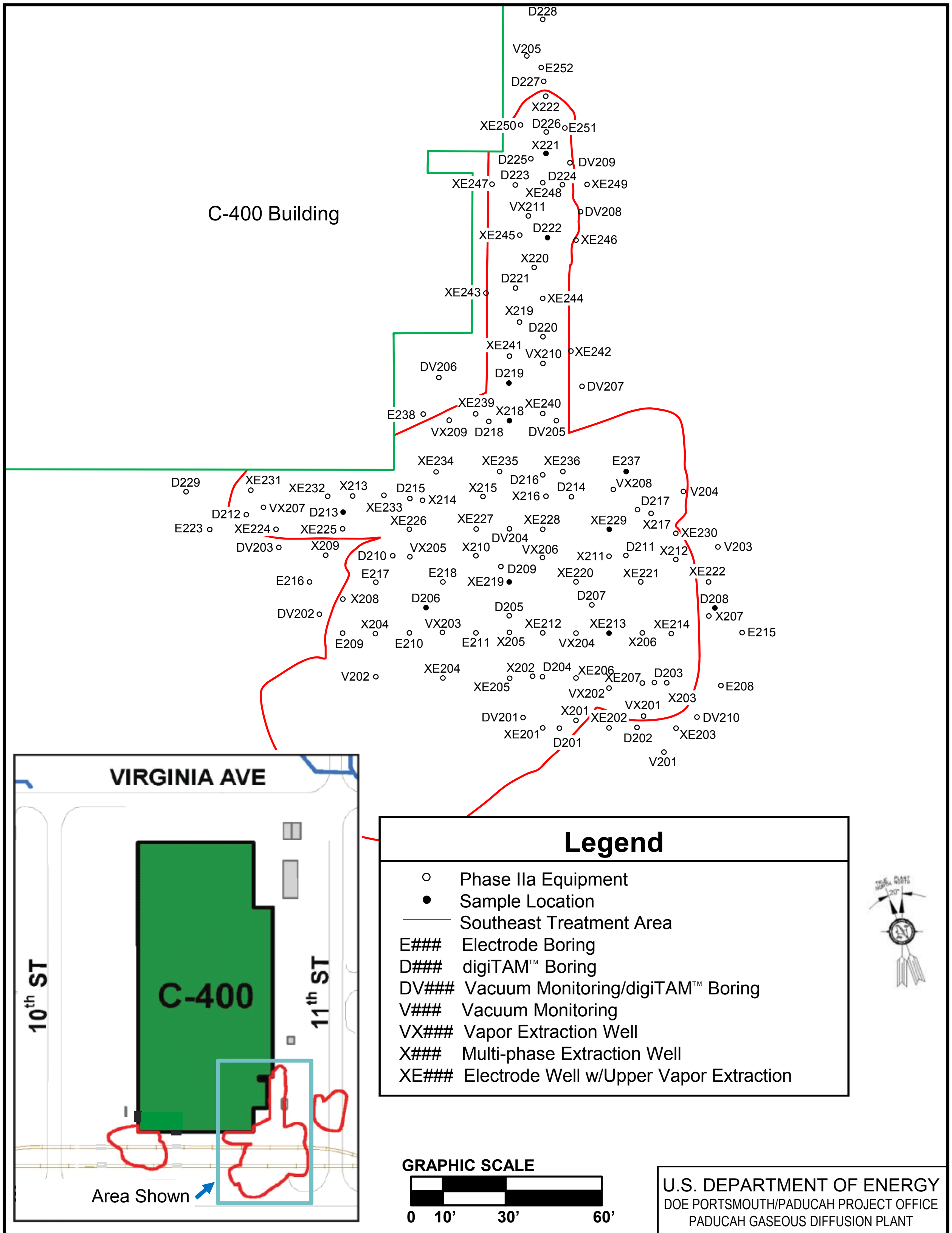


Figure 9.3. Southeast Area ERH Well Location Map

9.5 PROGRESS SINCE LAST FIVE-YEAR REVIEW

During the period addressed by this fourth synchronized Five-Year Review, DOE completed the C-400 IRA remedy, by completing the Phase IIa RA in the UCRS and upper RGA. In addition, DOE plugged and abandoned all ERH wells installed during Phase I and IIa. Extraction wells and contingency wells were abandoned by over-drilling and extracting the well casing and grouting the borehole from the bottom to the surface. All other ERH wells were abandoned by removing sensors, where present, and grouting the casing from the bottom to within 5 ft bgs with high temperature cement grout. Where the ERH wells were constructed with fiberglass pipe, the shallow fiberglass pipe was pulled or perforated prior to grouting the well.

Electrodes were abandoned in place (per an EPA-approved Class IV Underground Injection Control well plugging procedure modification variance) by filling the upper 2 ft of the electrode boring with grout and cutting off the electrode water injection and return lines 2 ft bgs and plugging the lines with stainless steel screws.

Because Phase I showed that ERH was unable to reach target temperatures in the lower RGA without extensive changes to the base design, DOE, with the participation of the other FFA parties, conducted a steam treatability study to evaluate whether steam is a viable remedial alternative to treat the lower RGA (DOE 2013b). During the fourth synchronized Five-Year Review period, USEC shut down enrichment operations and returned control of the Paducah Site leased facilities to DOE and opened the door to performing a full RA at the C-400 Complex. The FFA parties agreed to terminate the IRA and initiate a full RA of the C-400 Complex OU, as outlined in the 2017 MOA. A RACR was prepared, that detailed the completion of Phase I and Phase IIa ERH activities.

9.6 SITE INSPECTION

A site inspection was conducted for the C-400 IRA area on December 20, 2017. The inspection was conducted by DOE and included representatives from the Five-Year Review team, DOE support contractor, and KDEP.

During the inspection some minor debris was noted within the area of review (empty water bottles and plastic sheeting), overall appearance of the grounds and treatment system was good.

Inspection involved a walkdown of the grounds and of the SVGTS and associated groundwater treatment system tent enclosure areas used during the IRA. The SVGTS was not in use at the time of the walkdown. No issues were noted during the walkdown inspection.

During August 2017, the D&R contractor performed a LUCIP inspection of the C-400 ERH IRA area. The inspection revealed no evidence of land use changes or prohibited activities (e.g., unauthorized groundwater well installation, use of groundwater, trenching, or other excavation other than that approved by the site's excavation/penetration permit program). The C-400 area Property Record Notice was filed with the McCracken County Clerk in 2009. DOE has not transferred any of the property covered by the C-400 ROD (previously or during the review period), so deed restrictions were not applicable.

9.7 TECHNICAL ASSESSMENT

The C-400 ROD is an IRA to reduce the mass of TCE and other VOCs in the source soils and groundwater in the UCRS and RGA at the C-400 area. Monitoring data indicate that this RA has reduced the contaminant mass in the Phase I and Phase IIa areas by implementation of ERH in the UCRS and upper RGA. Phase I data show that ERH, as currently configured, is ineffective in the lower RGA.

Now that Phase I and Phase IIa remedial activities are complete (subject to review and approval of the RACR), the project is transitioning from an IRA confined to the accessible areas outside of the C-400 Cleaning Building to a comprehensive RA for the entire C-400 Complex OU.

9.7.1 Question A: Is the Remedy Functioning as Intended by the Decision Documents?

Phase IIa ERH removed approximately 13,871 lb of TCE (1,137 gal), which was a small fraction of the original RDR estimate of TCE in the southeast treatment areas (631,984 lb/51,802 gal) (DOE 2008a). The original estimate of TCE for the southeast treatment areas was based on a faulty conceptual model and overestimated the amount of TCE that was present. The Phase IIa RDR revised the estimated volume of TCE DNAPL in the southeast treatment areas to 7,320–85,400 lb (600–7,000 gal), approximately 7.5 times less than originally postulated (DOE 2012b). Phase IIa accounted for only a portion of the Phase II TCE DNAPL zone. Phase IIb lower RGA TCE DNAPL volumes now will be addressed in the pending C-400 Complex OU ROD.

Phase IIa baseline operational and postoperational soil and groundwater samples were collected to support analysis of the efficiency of removal of TCE by the ERH RA. The difference in soil baseline and postoperational TCE (and TCE breakdown products) levels was intended to be a direct measure of the percent reduction of TCE. Soil samples were collected during installation of the ERH wells [electrode, digital temperature sensor (digiTAM™), and EW borings], along with locations between electrodes and EWs, in order to characterize pretreatment soil TCE levels. Postoperational samples were collected from locations adjacent to baseline soil borings to characterize residual TCE levels subsequent to the operation of the ERH electrodes.

Soil baseline and postoperational samples were collected from 18 locations, with 104 paired soil sampling sets, in the southeast area (refer to Table 9.1 and Figure 9.4). Comparing the baseline to the postoperational soil sample results shows a 99.8% reduction in concentration, shifting the average TCE concentration of 93,918 µg/kg to 200 µg/kg. Groundwater baseline and postoperational samples were collected from 10 locations (10 paired groundwater sampling sets) in the southeast area (refer to Table 9.2 and Figure 9.4). Comparing the baseline to the postoperational groundwater sample results shows a 99.3% reduction in TCE concentration, shifting the average concentration of 107,740 µg/L to 709 µg/L. These data demonstrate significant mass reduction within the UCRS and upper RGA in the southeast treatment area and achievement of the second and third RAOs.

Table 9.1. Southeast Treatment Area Baseline and Postoperational Soil Sampling TCE Results[a]

Location	Depth (ft bgs)	Baseline Result (µg/kg)[b]	Postoperational Result (µg/kg)[b]	Baseline—Post-operational (µg/kg)	Reduction[c] (%)
D206	0–10	29	1	28	96.6
D206	10–20	127	1	126	99.2
D206	20–30	1,140	1	1,139	99.9
D206	30–40	966	< 2	964	99.8
D206	40–52	8,190	4	8,186	100.0
D206	52–60	579	2	577	99.7

Table 9.1. Southeast Treatment Area Baseline and Postoperational Soil Sampling TCE Results[a] (Continued)

Location	Depth (ft bgs)	Baseline Result (µg/kg)[b]	Postoperational Result (µg/kg)[b]	Baseline—Post-operational (µg/kg)	Reduction[c] (%)
D208	0–10	< 6	< 1	5	83.3
D208	10–20	118	10	108	91.5
D208	20–30	674	79	595	88.3
D208	30–40	6,170	51	6,119	99.2
D208	40–52	1,080	385	695	64.4
D208	52–60	156	17	139	89.1
D213	0–10	3,950	4	3,946	99.9
D213	10–20	5,520	2	5,518	100.0
D213	20–30	13,300	1	13,299	100.0
D213	30–40	1,750	< 1	1,749	99.9
D213	40–52	9,660	23	9,637	99.8
D213	52–60	723	26	697	96.4
D214	0–10	2,790	233	2,557	91.6
D214	10–20	77,770	85	77,685	99.9
D214	20–30	31,700	9	31,691	100.0
D214	30–40	87,900	11	87,889	100.0
D214	40–52	47,000	3	46,997	100.0
D214	52–60	994,000	1	993,999	100.0
D216	0–10	73	164	-91	-124.7
D216	10–20	135	5	130	96.3
D216	20–30	1,410	1	1,409	99.9
D216	30–40	320	8	312	97.5
D216	40–50	6,220	84	6,136	98.6
D216	50–60	68,900	10,100	58,800	85.3
D219	0–10	2,450	5	2,445	99.8
D219	10–20	4,800	2	4,798	100.0
D219	20–30	874	< 95	779	89.1
D219	30–40	264	2	262	99.2
D219	40–52	15,000	4	14,996	100.0
D219	52–60	461	3	458	99.3
D221	0–10	2,110	21	2,089	99.0
D221	10–20	861	< 1	860	99.9
D221	20–30	256	1	255	99.6
D221	30–40	356	< 1	355	99.7
D221	40–52	5,420	11	5,409	99.8
D221	52–60	23,800	43	23,757	99.8
D222	0–10	1,850	15	1,835	99.2
D222	10–20	471	2	469	99.6
D222	20–30	1,510	1	1,509	99.9
D222	30–40	2,030	1	2,029	100.0
D225	0–10	13	2	11	84.6
D225	10–20	9	< 1	8	88.9
D225	20–30	3	1	2	66.7
D225	30–40	161	1	160	99.4
E213	0–10	1,100	3	1,097	99.7
E213	10–20	1,400	1	1,399	99.9
E213	20–30	790	1	789	99.9
E213	30–40	2,300	1	2,299	100.0
E213	40–52	300	1	299	99.7
E213	52–60	< 1	4	-3	-300.0

Table 9.1. Southeast Treatment Area Baseline and Postoperational Soil Sampling TCE Results[a] (Continued)

Location	Depth (ft bgs)	Baseline Result (µg/kg)[b]	Postoperational Result (µg/kg)[b]	Baseline—Post-operational (µg/kg)	Reduction[c] (%)
E219	0–10	1,400	85	1,315	93.9
E219	10–20	3,500	7	3,493	99.8
E219	20–30	6,400	38	6,362	99.4
E219	30–40	21,000	< 1	20,999	100.0
E219	40–52	88,000	8	87,992	100.0
E219	52–60	32,000	54	31,945	99.8
E229	0–10	140,000	7,850	132,150	94.4
E229	10–20	57,700	19	57,681	100.0
E229	20–30	45,500	1	45,499	100.0
E229	30–40	5,620,000	5	5,619,995	100.0
E229	40–52	156,000	1	155,999	100.0
E229	52–60	21,600	31	21,569	99.9
E237	0–10	21,400	< 1	21,399	100.0
E237	10–20	18,500	148	18,352	99.2
E237	20–30	11,900	2	11,898	100.0
E237	30–40	7,380	77	7,303	99.0
E237	40–52	975	5	970	99.5
E237	52–60	56,000	12	55,988	100.0
SB63	0–10	6	1	5	83.3
SB63	10–20	18	< 1	17	94.4
SB63	20–30	133	1	132	99.2
SB63	30–40	164	2	162	98.8
SB63	40–52	10	< 1	9	90.0
SB63	52–60	2,620	1	2,619	100.0
SB64	0–10	1,650	69	1,581	95.8
SB64	10–20	2,080	3	2,077	99.9
SB64	20–30	13,300	3	13,297	100.0
SB64	30–40	22,100	3	22,097	100.0
SB64	40–52	8,820	1	8,819	100.0
SB64	52–60	286,000	406	285,594	99.9
SB65	0–10	7,610	15	7,595	99.8
SB65	10–20	2,700	2	2,698	99.9
SB65	20–30	19,700	3	19,697	100.0
SB65	30–40	4,500	< 1	4,499	100.0
SB65	40–52	6,320	9	6,311	99.9
SB65	52–60	30,500	54	30,446	99.8
SB66	0–10	5,880	18	5,862	99.7
SB66	10–20	70,900	54	70,846	99.9
SB66	20–30	90,100	97	90,003	99.9
SB66	30–40	7,370	1	7,369	100.0
SB66	40–52	1,800	1	1,799	99.9
SB66	52–60	411,000	4	410,996	100.0
SB67	0–10	3,910	158	3,752	96.0
SB67	10-20	161	1	160	99.4
SB67	20–30	732	4	728	99.5
SB67	30–40	7,190	< 1	7,189	100.0
SB67	40–52	548,000	1	547,999	100.0
SB67	52–60	462,000	22	461,978	100.0
count		104	104		
average (µg/kg)		93,918	200	Average Reduction % = 99.8[d]	

Table 9.1. Southeast Treatment Area Baseline and Postoperational Soil Sampling TCE Results[a] (Continued)

Location	Depth (ft bgs)	Baseline Result (µg/kg)[b]	Postoperational Result (µg/kg)[b]	Baseline—Post-operational (µg/kg)	Reduction[c] (%)
minimum (µg/kg)		1	1		
maximum (µg/kg)		5,620,000	10,100		
count < 70 µg/kg		9	89		
counts nondetectable		2	13		

[a] Only the locations that have both a baseline and postoperational sample are included.
[b] Nondetectable included at stated detection level.
[c] Reduction percentage = (baseline result-post operations result)/baseline result × 100.
[d] This value is based on the average result values.

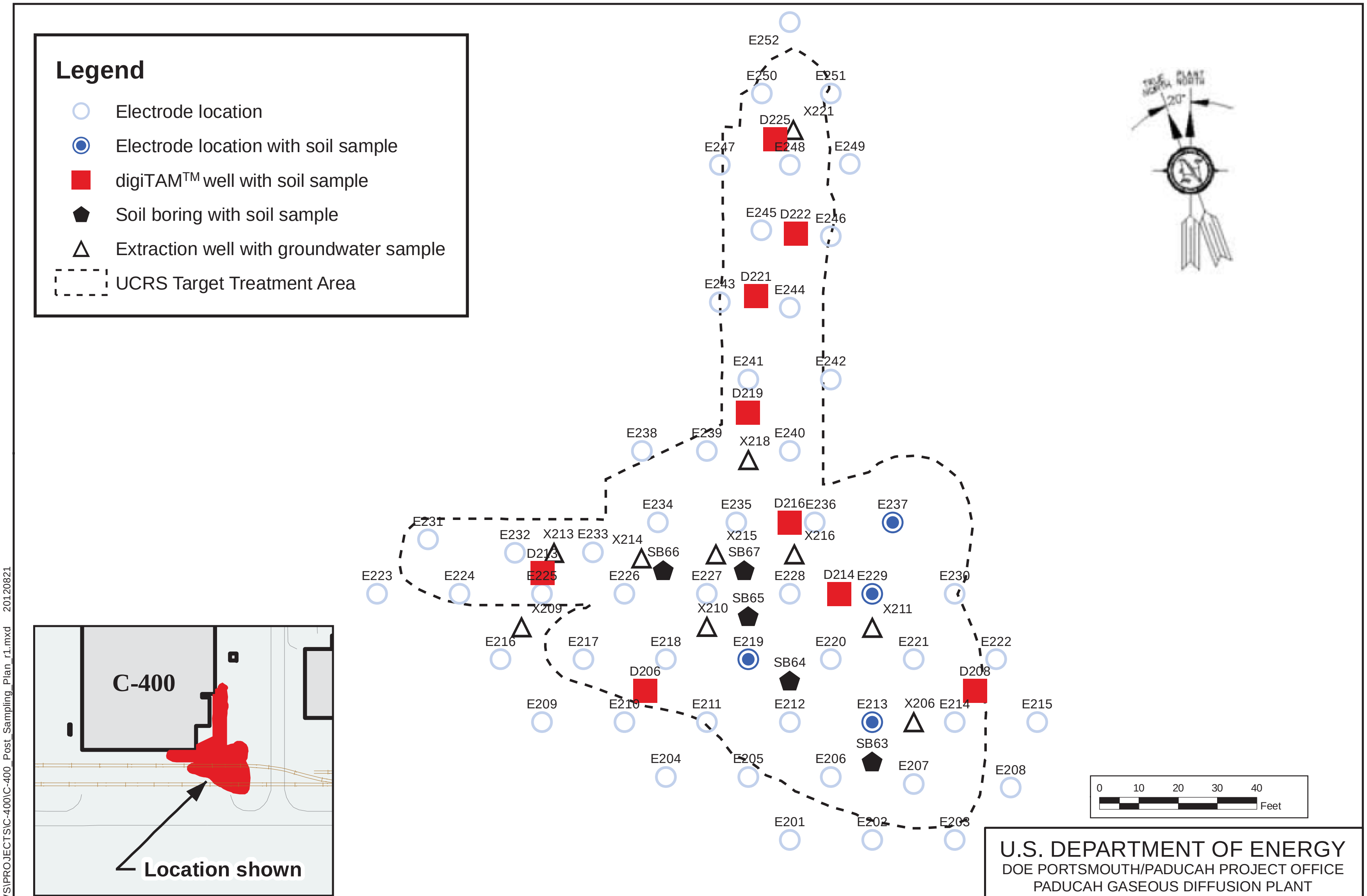


Figure 9.4. C-400 Phase IIa Postoperations Soil and Groundwater Sample Location Map

Modified from RAWP, DOE/LX/07-1271&D2/R3

Table 9.2. Phase IIa Southeast Treatment Area Baseline and Postoperations Groundwater Sampling Results

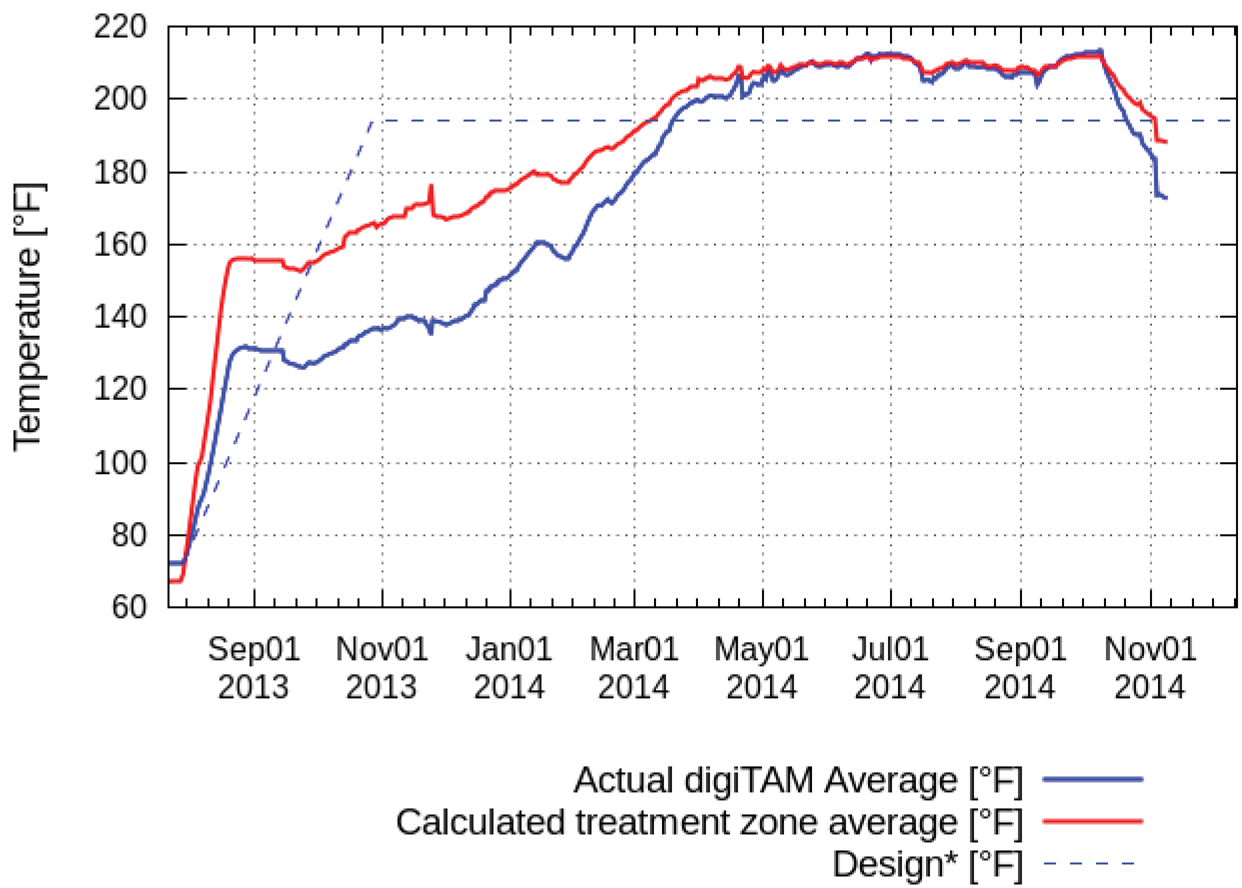
LOCATION ID	SAMPLE INTERVAL (Upper RGA)			
	Baseline TCE Results (µg/L)	Post-operations TCE Results (µg/L)[a]	Baseline Minus Post-operational (µg/L)	Reduction %
X206	100,000	1,800[b]	98,200	98.2
X209	5,900	110	5,790	98.1
X210	6,500[b]	69	6,431	98.9
X211	350,000	440	349,560	99.9
X213	23,000	270	22,730	98.8
X214	75,000	37	74,963	99.9
X215	100,000	140	99,860	99.9
X216	260,000	2,500	257,500	99.0
X218	120,000	1,200	118,800	99.0
X221	37,000	520	36,480	98.6
average (µg/L)	107,740	709	Average Reduction % = 99.3[c]	
minimum (µg/L)	5,900	37		
maximum (µg/L)	350,000	2,500		
count < 70 µg/L	0	2		
counts nondetectable	0	0		

[a] Groundwater pump raised from 68 ft bgs to 60 ft bgs for collection of postoperations groundwater samples per RAWP (DOE 2013c).
[b] The greater of the regular result and field duplicate result is presented.
[c] This value is based on the average result values.

Target temperatures were attained in the southeast treatment area at depths targeted for VOC removal, indicating that the ERH design was adequate for thermal treatment of the UCRS and upper RGA. Figures 9.5 and 9.6 summarize actual-verses-design temperature curves and average digiTAM™ temperatures by depth as documented during Phase IIa operations.

Six RGA groundwater MWs provide characterization of TCE and Tc-99 levels near the Phase II source zones southeast of the C-400 Building (Figure 9.7). The selected wells can be divided into two groups by the maximum of contaminant levels; greater maximum of contaminant levels in MW156, MW405 Port 5, and MW408 Port 5, and lesser maximum of contaminant levels in MW155, MW406 Port 5, and MW407 Port 4. Figure 9.8 graphically compares the analytical data from 2008–2012 period to the current review period (2013-2017). TCE and Tc-99 levels trend higher between 2013 and 2015 [which closely corresponds to the period of Phase IIa ERH operations and the steam treatability study (DOE 2016b)]. Contaminant levels decrease significantly, thereafter, through the end of the review period in December 2017.

Historically, TCE levels are markedly highest in MW408 Port 5, as noted by the TCE spike of 1,400,000 µg/L observed in September 2012. Thereafter, the MW408 Port 5 TCE levels drop below 100,000 µg/L, in December 2013, and continue to decline to below 10,000 µg/L for the remainder of the current review period.



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PADUCAH GASEOUS DIFFUSION PLANT

FOUR RIVERS NUCLEAR PARTNERSHIP, LLC

Figure 9.5. C-400 Phase IIa Actual and Design Temperature Curves

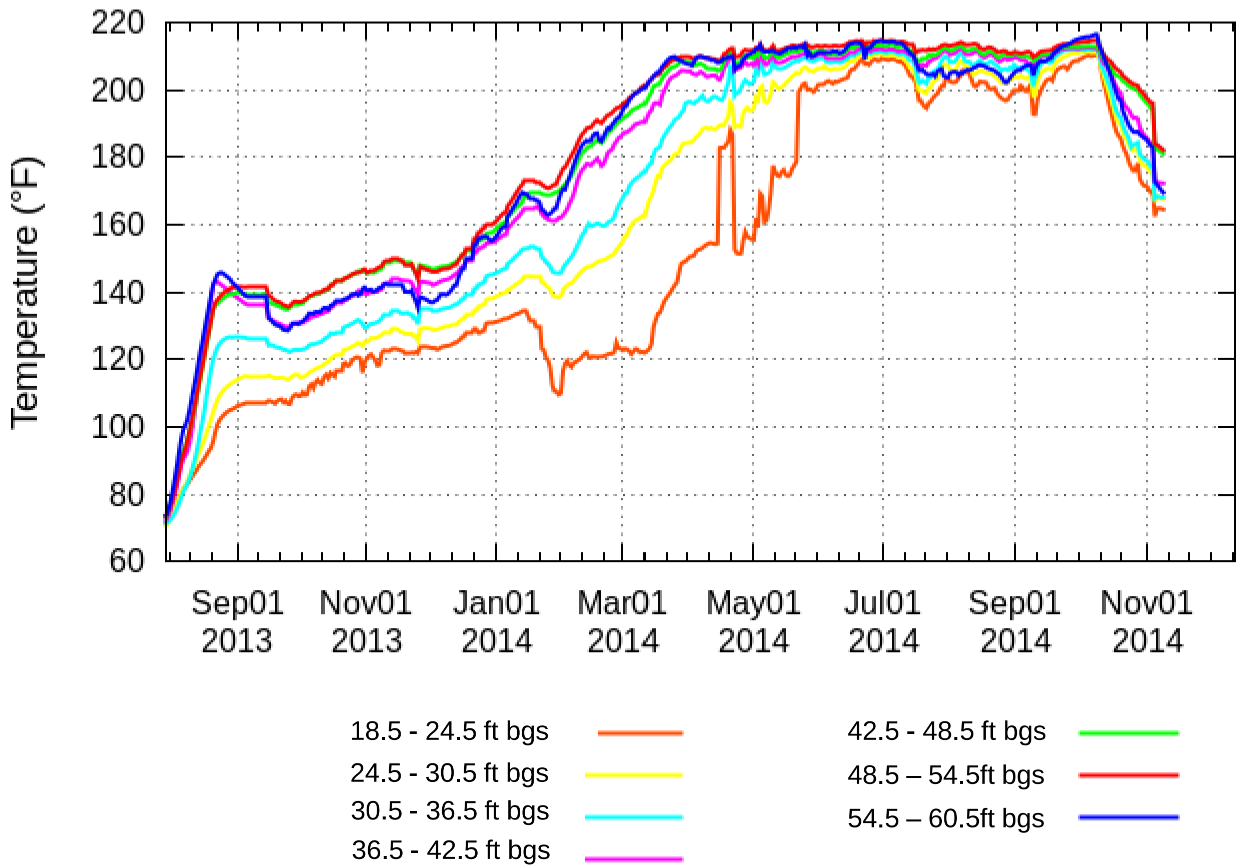

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Figure 9.6. C-400 Phase IIa Average digiTAM^{TM} Temperature by Depth

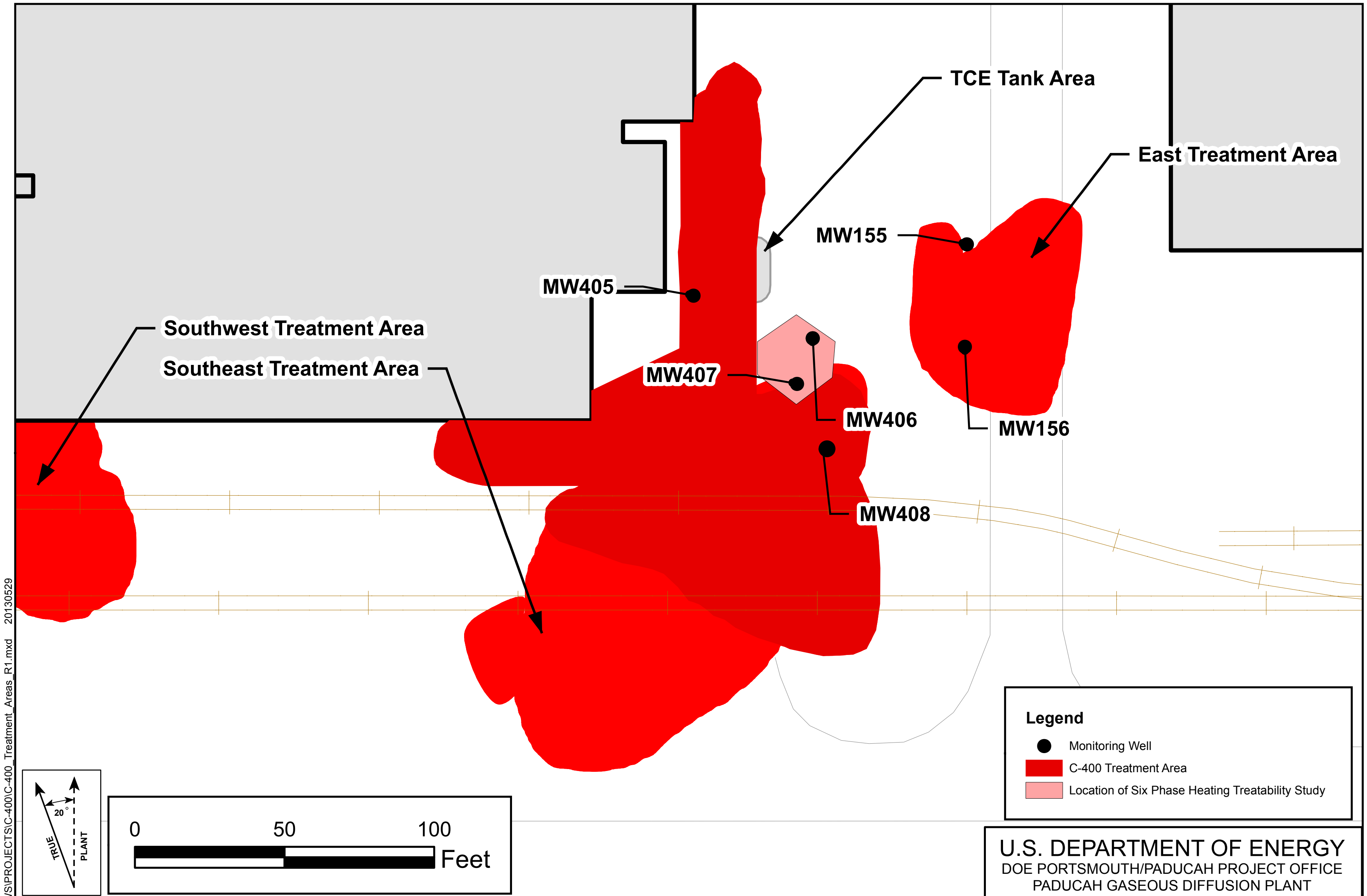

Figure 9.7. MWs near the Phase II Source Zones

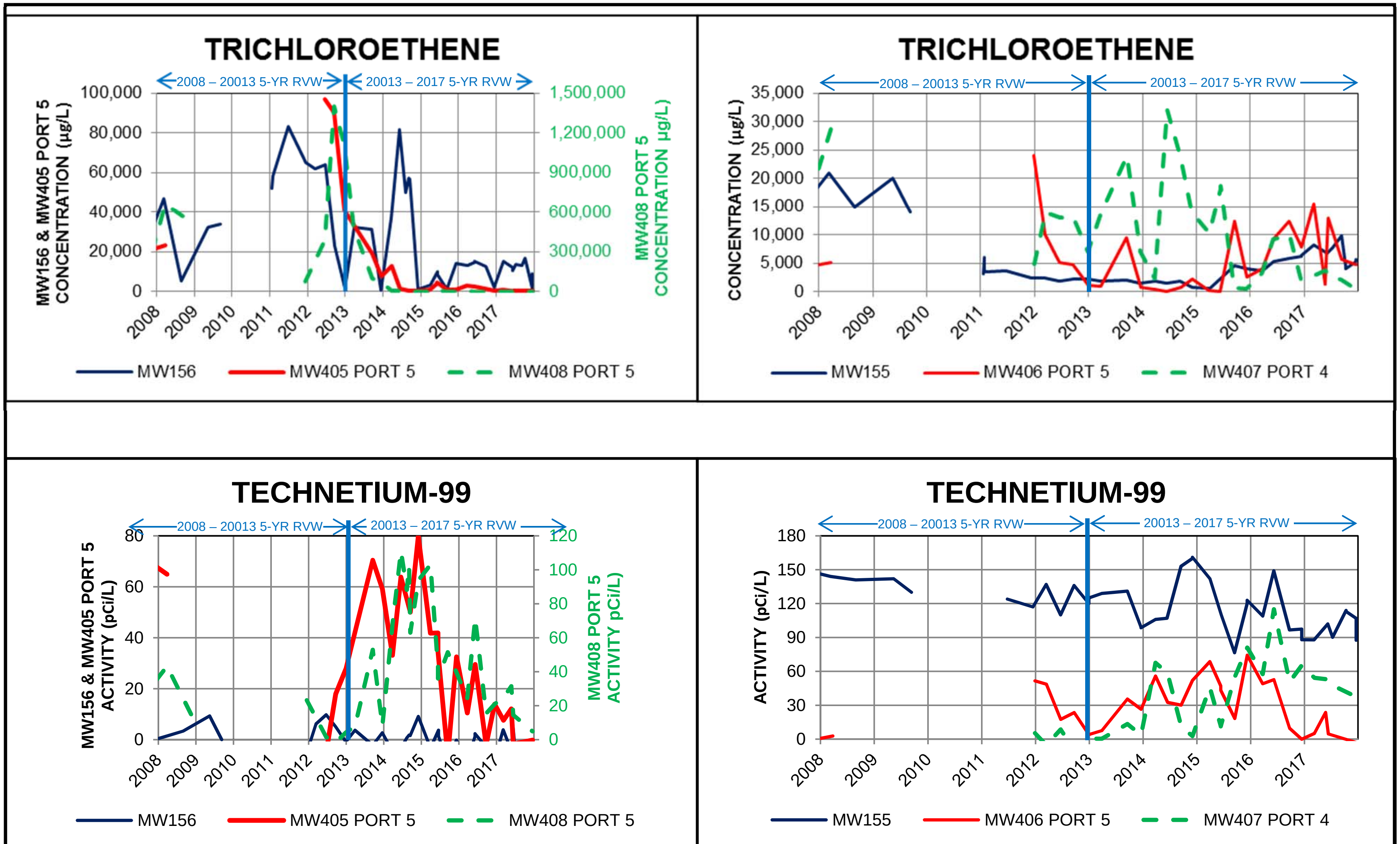

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Figure 9.8. Contaminant Trends in MWs Located Near C-400 Phase II Source Zones

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DOE installed five nested MWs—MW421, MW422, MW423, MW424, and MW425 (refer to Figure 9.2 for well locations)—across the northwest corner of the C-400 Cleaning Building in June 2009. The wells were screened in the middle and lower RGA intervals to monitor dissolved contaminant trends from C-400 source areas(s). In general, the level of dissolved TCE is greatest at the base of the RGA (Port 3/lower screen in each of the well nests). Levels of Tc-99 commonly are greatest in the Port 1/top screen of the well nests.

Figure 9.9 graphically compares the analytical data from 2008–2012 period to the current review period (2013-2017). It appears TCE and Tc-99 levels are declining in the vicinity of the northwest corner of the C-400 Cleaning Building (Figure 9.2). Average TCE levels have declined from approximately 60,000 µg/L to approximately 40,000 µg/L. Tc-99 levels have declined from an approximate average of 10,000 µg/L to an approximate average of 8,000 µg/L.

9.7.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of the Remedy Selection Still Valid?

The exposure assumptions used to develop the risk assessment included both current exposures (on-site industrial and excavation worker and off-site recreational) and potential future exposures (future on-site resident and off-site resident using groundwater at the DOE property boundary). The objective at the C-400 project is to reduce VOC source mass to the extent practicable, and no specific risk-based level or MCL was established as a cleanup criterion for the project.

The goals identified for the C-400 ROD remain valid: (1) to implement institutional controls to prevent on-site industrial worker exposure and (2) to reduce source mass of TCE and other VOCs to reduce migration to off-site points of exposure.

There are no changes in standards identified as ARARs in the ROD that impact the protectiveness of the remedy. The following changes were identified, but do not impact the protectiveness of the remedy:

- References to 401 *KAR* 5:029(2) have been changed to 401 *KAR* 10:029(2).
- DOE O 5400.5 has been superseded by DOE O 458.1.

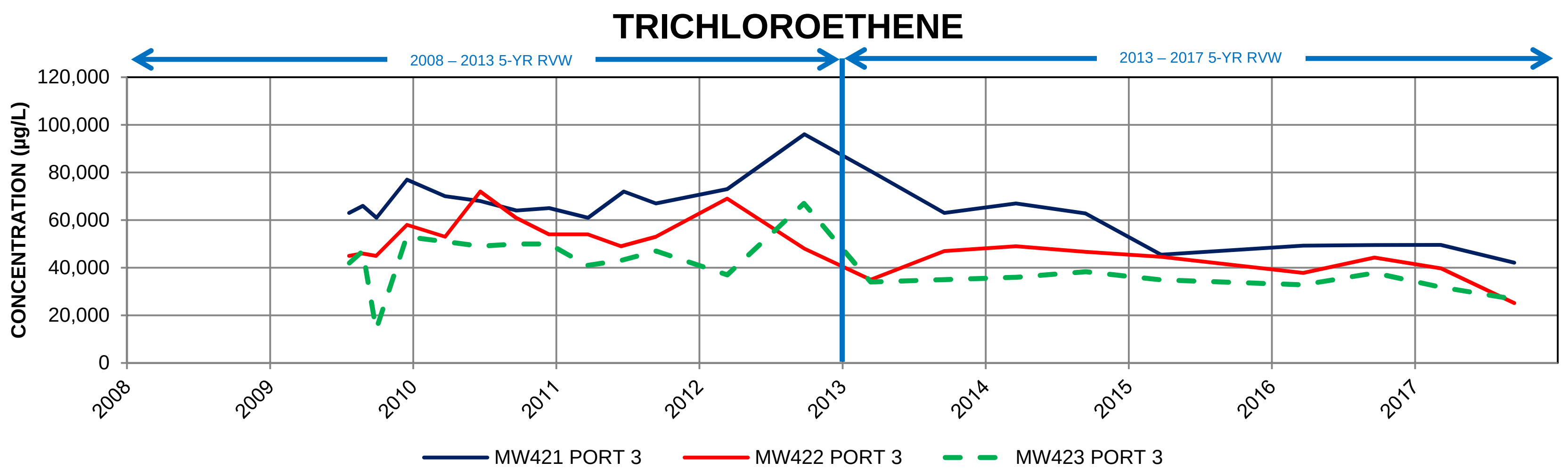
Additionally, there are no newly promulgated standards that might apply or be relevant and appropriate to the site that affect the protectiveness of the remedy.

C-400 is located within the facility security fence and other administrative controls that prevent unauthorized access to the site. Exposure assumptions used in the ROD remain valid regarding current restrictions on use of groundwater within DOE property. Changes to the risk assessment methodology have been made but the protectiveness of the remedy was not affected.

The current groundwater data indicate that assumptions underlying the remedy selection in the ROD still are valid. There have been no new contaminants or new understanding of geologic conditions identified.

9.7.3 Question C: Has Any Other Information Come to Light That Could Call into Question the Protectiveness of the Remedy?

No other information has come to light that would call into question the protectiveness of the remedy.



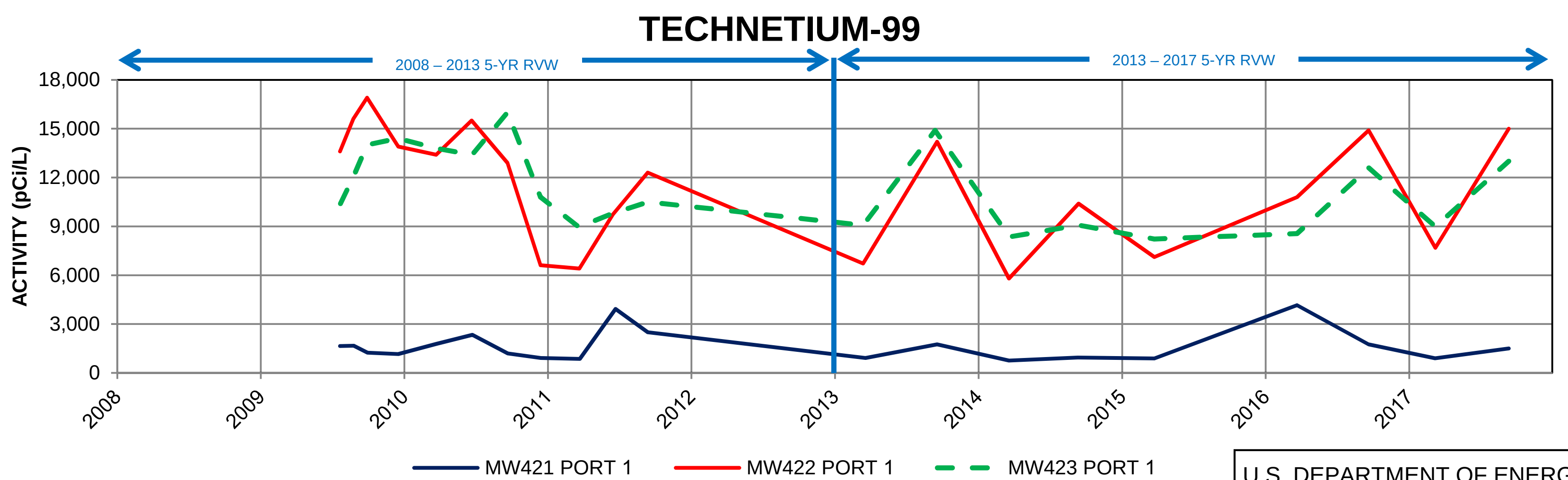


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Figure 9.9. Contaminant Trends in MWs Located on the North Side of C-400

9.7.4 Technical Assessment Summary

The Phase IIa ERH action effectively prevents on-site industrial worker exposure and removed UCRS and upper RGA VOC (primarily TCE and its breakdown components) mass in the southeast treatment area associated with historical TCE releases as documented in the WAG 6 RI. This IRA is protective of the site worker.

DOE, with the participation of the other FFA parties, is initiating a C-400 Complex OU, which will include selection of a remedy for the Phase IIb Scope.

9.8 ISSUES

None.

10. SOUTHWEST PLUME

The Southwest Plume consists of groundwater in the RGA contaminated primarily with TCE and is located west of the C-400 Building and south of the larger groundwater contamination area identified as the Northwest Plume (SWMU 201). Sources to the Southwest Plume included in this action are the Oil Landfarm (SWMU 1), the C-720 Building TCE Northeast Spill Site (SWMU 211-A), and the C-720 Building TCE Southeast Spill Site (SWMU 211-B) (see Figures 10.1, 10.2, and 10.3).

DOE conducted an SI of the Southwest Plume and four potential source areas in 2004 [*Site Investigation Report for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-2180&D2/R1 (DOE 2007b)]. Then a Focused FS for the Southwest Groundwater Plume VOC Sources (Oil Landfarm and C-720 Building Northeast and Southeast TCE Spill Sites) was developed (DOE 2011c).

The scope of this project is to implement selected remedies for three of the known VOC sources to the Southwest Plume. This project is included in this fourth synchronized Five-Year Review with summaries of activities consistent with the progress of the project up to the date of the review. The ROD was signed in April 2012; therefore, just over five years from the initial ROD is included in this evaluation. The RA implementation at the Oil Landfarm was completed in 2017, with approval of the *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 (Solid Waste Management Unit 1), at Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-2405&D2 (DOE 2017g). The implementation of RAs at the C-720 Building TCE Northeast and Southeast Spill Sites (SWMU 211-A and SWMU 211-B) are ongoing.

10.1 REMEDY SELECTION

The response actions selected in this ROD provide for timely remediation of VOCs at the Southwest Plume sources. Deep soil mixing at the Oil Landfarm volatilized contaminants in the UCRS groundwater and UCRS soils. The volatilized contaminants were captured by vacuum in a shroud that extended over the auger zone and lead to aboveground equipment for processing and later disposal as hazardous waste.

The ROD designated the high concentration TCE soils and residual TCE DNAPL as principal threat waste. The following are the RAOs in the ROD (DOE 2005a).

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

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

3. Prevent exposure to non-VOC contamination and residual VOC contamination through interim LUCs within the Southwest Plume source areas (i.e., the Oil Landfarm and the C-720 Building Northeast and Southeast Spill Sites) pending remedy selection as part of the Soils OU and the GWOU.

4. Reduce VOC migration from contaminated subsurface soils in the treatment areas at the Oil Landfarm and the C-720 Building Northeast and Southeast Sites so that contaminants migrating from the treatment areas do not result in the exceedance of MCLs in the underlying RGA groundwater.

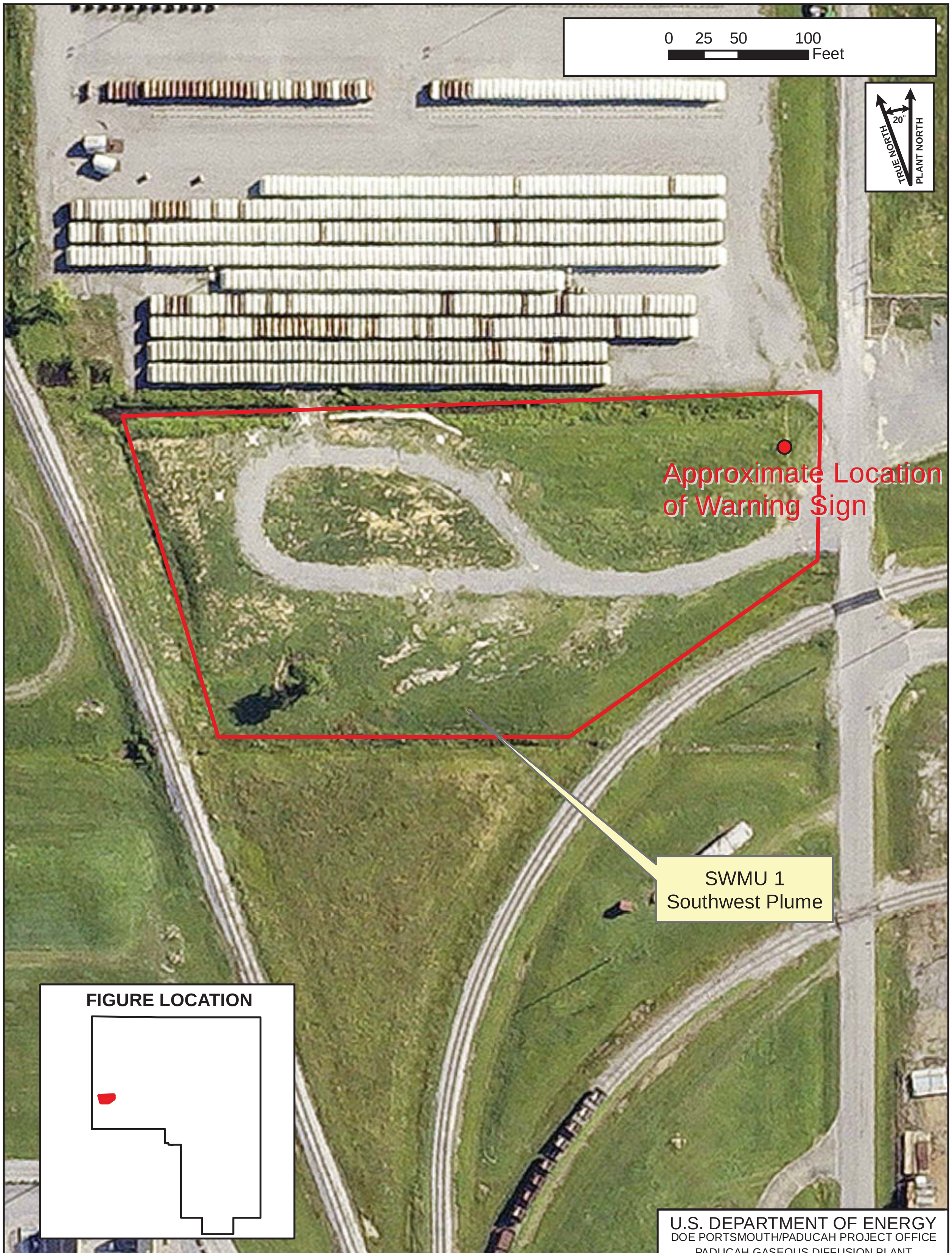

Figure 10.1. Location of the Oil Landfarm

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Figure 10.2. Location of the C-720 Building Northeast Spill Site

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Figure 10.3. Location of the C-720 Building Southeast Spill Site

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Oil Landfarm

The ROD for the Oil Landfarm implemented *in situ* source treatment using deep soil mixing with interim LUCs. The ROD also required an RDSI, which was implemented in 2012 to collect additional soil samples to determine the extent and distribution of VOCs in the UCRS for treatment and supported completing the remedial design (DOE 2012c).

The Oil Landfarm RA included, in addition to the RDSI, implementation of deep soil mixing with injection of steam and zero-valent iron (ZVI), confirmatory sampling, site restoration, and groundwater monitoring. The remediation goal for TCE (the primary VOC) and other COCs for this Oil Landfarm action, as documented in the ROD (DOE 2012c), was to reduce average VOC levels in the UCRS soil to below the following cleanup goals.

VOC	UCRS Soil Cleanup Level (μg/kg)
TCE	73
1,1-DCE	130
cis-1,2-DCE	600
trans-1,2-DCE	1,080
Vinyl chloride	34

The interim LUCs for the Oil Landfarm consisted of the Paducah Site's excavation-penetration permit program and placement of warning signs.

C-720 Building Northeast and Southeast Spill Sites

The ROD called for a Final Characterization of the two C-720 Building Spill Sites. From this additional data, the FFA parties were to select either enhanced *in situ* bioremediation with interim LUCs or long-term monitoring with interim LUCs as the remedy (DOE 2012c). The alternative actions contained the following components.

Enhanced *In Situ* Bioremediation

- Field characterization/RDSI
- Enhanced *in situ* bioremediation system
- Groundwater monitoring
- Confirmatory sampling for VOCs
- Secondary waste management
- Site restoration
- Interim LUCs

Long-Term Monitoring

- Field characterization/RDSI
- Groundwater monitoring
- Interim LUCs

The interim LUCs, for the C-720 Building TCE Northeast and Southeast Spill Sites, consisted of the site's excavation/penetration permit program and warning signs.

The selection of the RA for the C-720 Building sites was to be based upon the results collected in the Field Characterization/RDSI, a comparison of current and historical VOC contaminant levels, and an estimation of the time required to achieve cleanup goals. The remediation goal for TCE (again, the primary VOC) and other VOCs for the actions at the C-720 Building TCE Northeast and Southeast Spill Sites was to reduce average VOC levels in the UCRS soil to below the following levels to achieve cleanup goals.

VOC	UCRS Soil Cleanup Level (μg/kg)
TCE	75
1,1-DCE	137
cis-1,2-DCE	619
trans-1,2-DCE	5,290
Vinyl chloride	570

10.2 REMEDY IMPLEMENTATION

Oil Landfarm

The Oil Landfarm RDSI was the initial task performed in implementing the RA. It was performed in 2012 just prior to the start of this reporting period in accordance with the RDSI Characterization Plan contained in the *Remedial Design Support Investigation Characterization Plan for the C-747-C Oil Landfarm and C-720 Northeast and Southeast Sites at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0350&D1 (DOE 2012d). The RDSI data collected was used during this reporting period to complete development and attain approval of the remedial design for the soil mixing RA contained in *Remedial Design Report In Situ Source Treatment Using Deep Soil Mixing for the Southwest Groundwater Plume Volatile Organic Compound Source at the C-747-C Oil Landfarm (Solid Waste Management Unit 1) at the Paducah Gaseous Diffusion Plant*, Paducah Kentucky, DOE/LX/07-1276&D2/R1 (DOE 2013d). The *Remedial Action Work Plan for In Situ Source Treatment by Deep Soil Mixing of the Southwest Groundwater Plume Volatile Organic Source at the C-747-C Oil Landfarm (Solid Waste Management Unit 1) at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-1287&D2/A1/R1, (DOE 2014b) provided additional implementation requirements.

The field implementation of the RA began on April 10, 2015. The *in situ* source treatment performed was by deep soil mixing of 258 soil columns (8-ft diameter) supplemented by hot air/steam injection with vapor extraction and vapor-phase treatment, followed by ZVI and guar gum injection. Contaminants treated as part of the RA included TCE, *cis*-1,2-DCE, *trans*-1,2-DCE, 1,1-DCE, and vinyl chloride. The RA recovered an estimated 24 ± 12 gal of solvents total with a 95% confidence interval. In addition to that quantity recovered, the action left ZVI (estimated at 958,395 lb) in place to continue to provide passive treatment for any remaining VOC contamination. The recovered VOC contamination was captured on approximately 20,000 lb of activated carbon that was regenerated by the manufacturer for reuse. Lime soil stabilization, grading, and restoration of the excavated site; management and disposition of accrued waste; and post-remedial field sampling were performed following soil mixing.

Post-remedial field sampling included 11 soil borings that were sampled for VOCs at 5-ft intervals (see Figure 10.4, Post-Treatment Soil Borings and MW Locations). Eight soil borings were drilled in the soil-mixed treatment area to assist in determining attainment of soil cleanup values for the UCRS soils mixed. The TCE cleanup level for the RA is 73 ppb. The TCE concentrations for the 8 pre- and post-mixing borings in the mixed zone show the cleanup level was attained for all of those borings, with a 99.3% overall arithmetic average reduction (excluding duplicates) in TCE soil contamination. Those results are shown graphically in Figure 10.5. Figure 10.6 shows the maximum TCE soil concentrations pre-treatment versus post-treatment. Six MWs also were constructed adjacent to the treatment area to provide long-term monitoring to determine the effectiveness of the remedy. A more detailed analysis of the field implementation of the soil mixing RA, field changes, lessons learned, and test results is contained in the RACR for the project, *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 (Solid Waste Management Unit 1), at Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-2405&D2 (DOE 2017g). Deep soil mixing of the final (258th) soil column was completed on

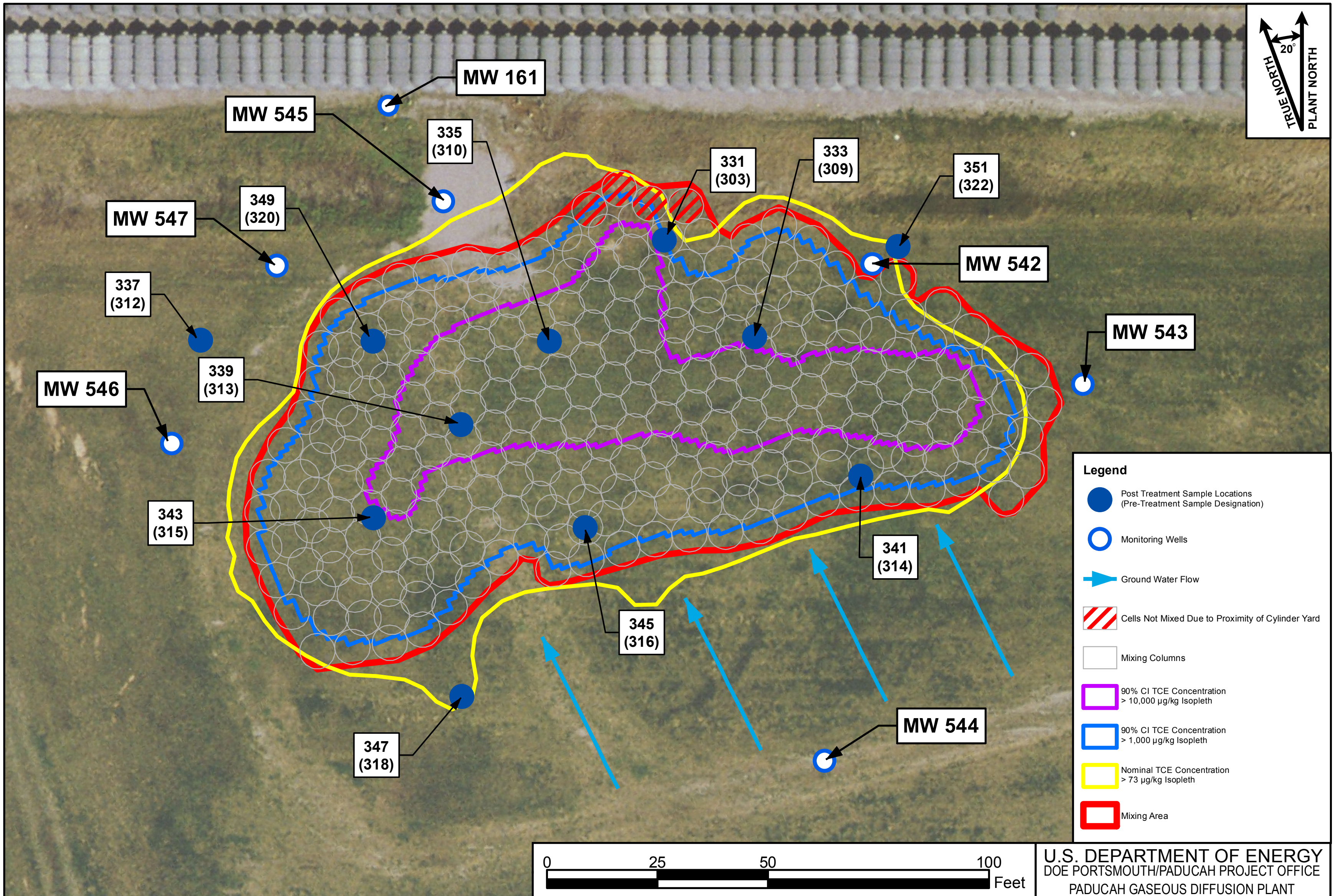

Figure 10.4. Post-Treatment Soil Borings and MW Locations

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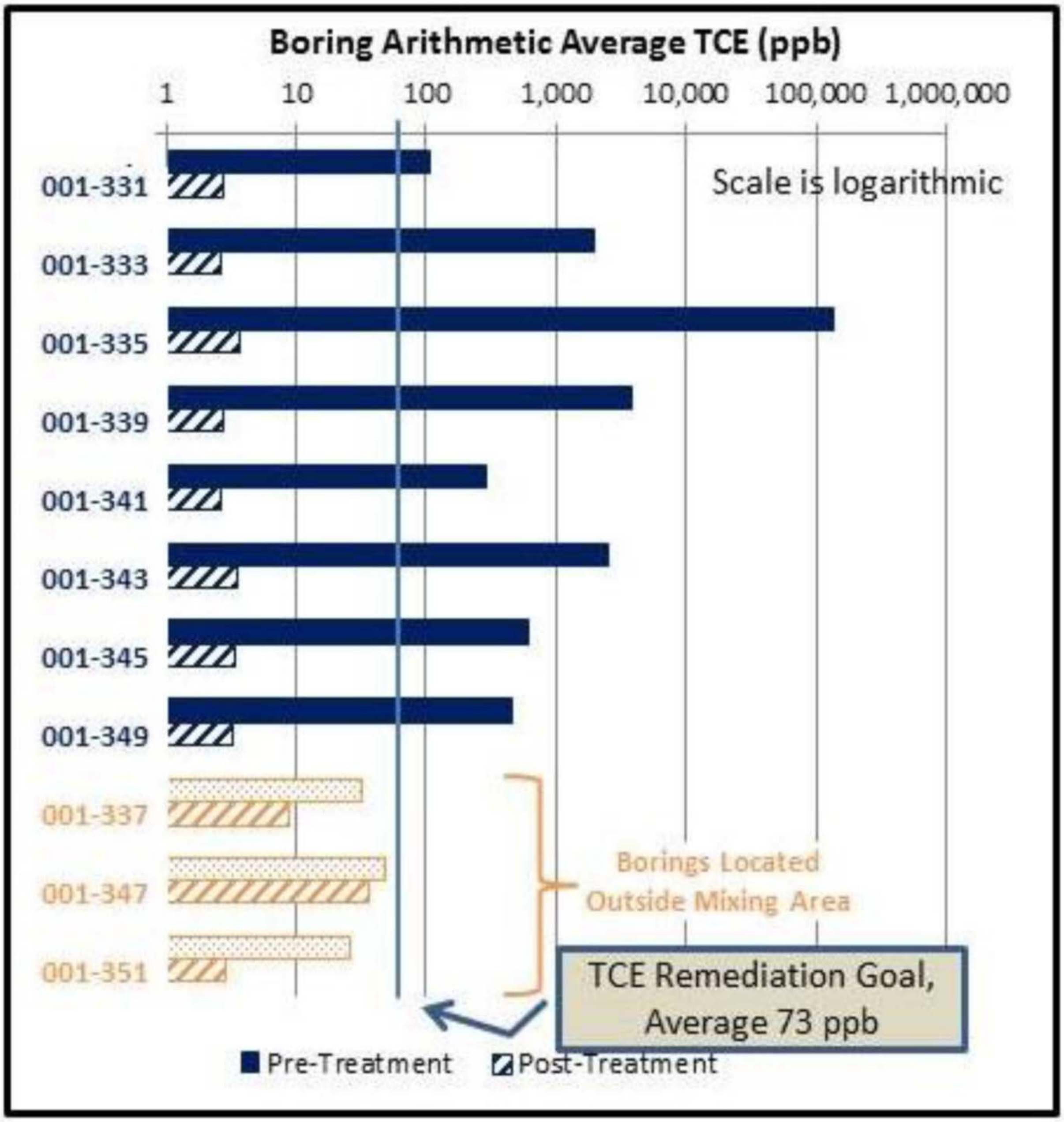

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Figure 10.5. Arithmetic Average TCE Concentrations in Pre- and Post-Mixing Soil Borings (DOE 2017h)	FOUR RIVERS NUCLEAR PARTNERSHIP, LLC

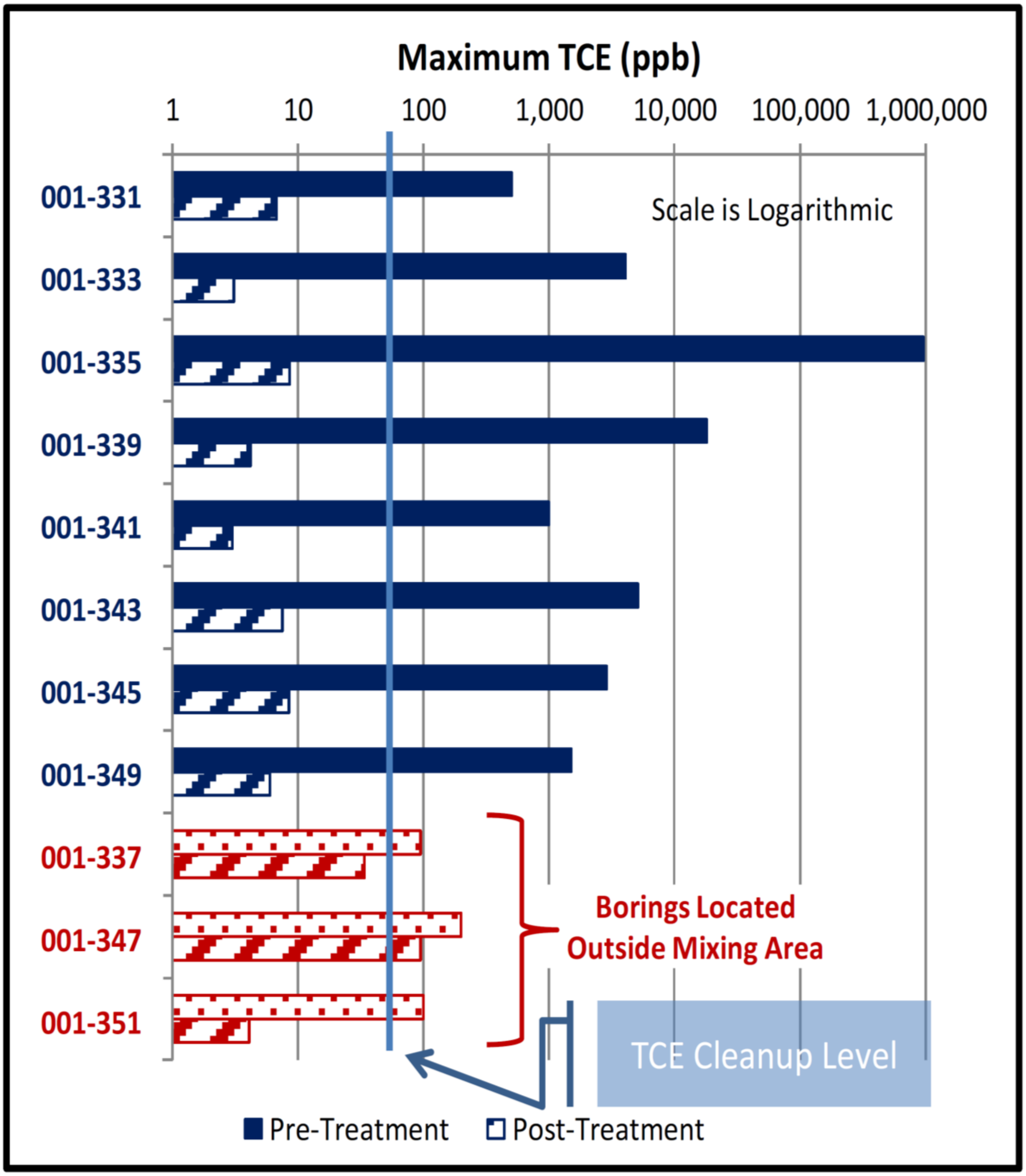

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Figure 10.6. Maximum TCE Concentrations in Pre- and Post-Mixing Soil Borings (DOE 2017h)

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October 8, 2015, while complete field demobilization along with waste disposal was completed in September 2016.

The Oil Landfarm RA also includes interim LUCs that consist of the excavation/penetration permit program and placement of warning signs to provide notice and warning of environmental contamination. The interim LUCs portion of the RA has been implemented.

<u>SWMU 211-A and SWMU 211-B</u>

Implementation of the selected remedial action has not been initiated during this fourth synchronized Five-Year Review reporting period for either of the C-720 Building TCE Northeast or Southeast Spill Sites. Well installation and soil sampling for the Final Characterization/RDSI, as required by the ROD, were completed in fall of 2012. A D1 *Final Characterization Report for the Solid Waste Management Units 211-A and 211-B Volatile Organic Compound Source for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-1288&D1, (DOE 2013e) was developed to document the findings and to support the remedy selection as required by the ROD. Additional evaluation by the FFA parties resulted in development of a D2 Final Characterization Report (DOE 2013f). DOE issued a letter notification, *Final Characterization Notification for Solid Waste Management Unit 211-A and Solid Waste Management Unit 211-B at the Paducah Gaseous Diffusion Plant, Paducah Kentucky*, PPPO-02-1979222-13B, on July 10, 2013 (DOE 2013g). This Final Characterization Notification identified DOE's recommendation for the remedy selection for both of the C-720 Building TCE Northeast and Southeast Spill Sites as long-term monitoring with interim LUCs (Alternative 2).

EPA requested additional groundwater data for the RGA to support the basis for the final selected remedy (EPA 2013). EPA issued an additional work request (EPA 2014), as provided for in the FFA, to collect the additional groundwater data as a follow-on phase of the RDSI. Negotiations among DOE, KDWM, and EPA followed to determine the type and location of groundwater sampling required to address the remaining concerns. A series of decision rules was developed by the FFA parties to provide a framework for analyzing the sample results upon collection and analysis. The additional sampling and analysis plan was documented in Appendix C of *Addendum to the Remedial Design Work Plan for Solid Waste Management Units 1, 211-A, and 211-B Volatile Organic Compound Sources for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, Sampling and Analysis Plan*, DOE/LX/07-1268&D2/R2/A1 (DOE 2015d). The groundwater sample collection and analysis were performed in 2015.

Following collection of additional groundwater data, the results of that effort were included in *Addendum to the Final Characterization Report for Solid Waste Management Units 211-A and 211-B Volatile Organic Compound Sources for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-1288&D2/A1 issued in December, 2015 (DOE 2015e). After additional evaluation by the FFA parties, the *Addendum to the Final Characterization Report for Solid Waste Management Units 211-A and 211-B Volatile Organic Compound Sources for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/071288&D2/A1/R1 (DOE 2016c) was issued in April 2016. EPA issued letter FFS-16-0251 on May 25, 2016 (EPA 2016) indicating that EPA is not able to approve the *Addendum to the Final Characterization Report for Solid Waste Management Units 211-A and 211-B Volatile Organic Compound Sources for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-1288&D2/A1/R1.

At the close of the reporting period for this fourth synchronized Five-Year Review, the FFA parties have not reached agreement for implementing either Alternative 2 or Alternative 8, as contained in the ROD, for either of the C-720 Building TCE Northeast or Southeast Spill Sites. Interim LUCs, however, are included in both possible alternatives. The interim LUCs that consist of the excavation/penetration permit program and placement of warning signs to provide notice and warning of environmental contamination have been implemented.

10.3 SYSTEMS OPERATIONS/OPERATIONS AND MAINTENANCE

<u>Oil Landfarm</u>

The ROD documents the estimated time frame for attaining the groundwater protection remediation goal within the Oil Landfarm and outside the treatment area is expected to be approximately 68 years (DOE 2012c). The soil mixing with ZVI RA is an *in situ* treatment system that is complete once the mixing action has been performed and the ZVI attenuates COCs. Beyond, the ZVI, the RA does not include a period of O&M after the ceasing of soil mixing. There are two periodic items that were included in the ROD that are continuing requirements:

1. Periodic sampling of groundwater MWs, as listed in the RAWP (DOE 2014b); and

2. Inspect interim LUCs (signs) annually until a final remedy is selected as part of a subsequent OU that addresses the relevant media.

<u>MW Sampling Analytical Results</u>

The RAWP included direction for the installed MW network for the soil mixed area to be sampled on a quarterly schedule for the first year following installation and then semi-annually for the second year following installation. Thereafter, the FFA parties would determine which wells to continue sampling for the Oil Landfarm COCs and the periodicity of the sampling. At the time of production of this fourth synchronized Five-Year Review, the Oil Landfarm MW network consists of seven MWs (Figure 10.4) which are these:

- MW161,
- MW542,
- MW543,
- MW544,
- MW545,
- MW546, and
- MW547.

Table 10.1 contains the COC analytical results obtained from the five samples collected thus far since the cessation of soil mixing and installation of the MW network. The data contained in Table 10.1 indicate, as of the last sampling in this reporting period, all wells contained in the network contain at least one COC that would prevent attainment of RAO 4. As indicated in the ROD, however, the attainment of the groundwater protection remediation goal is expected to require approximately 68 years. As of the end of this reporting period, it has been approximately two years since soil mixing was completed.

Table 10.1. Oil Landfarm MW Network RGA Groundwater Sample Results

Analyte/Sample Date (M-Yr)	Jun-16	Sep-16	Dec-16	Mar-17	Jun-17
Monitoring Well: MW161 (middle RGA—µg/L)					
Trichloroethene	7900	2350	1160	921	703
cis-1,2-Dichloroethene	672	413	339	103	70.6
trans-1,2-Dichloroethene	3.78	ND	ND	ND	3.40
1,1-Dichloroethene	73.5	25.0	10.7	6.60	ND
Vinyl Chloride	1.85	ND	ND	ND	ND
Monitoring Well: MW542 (upper RGA—µg/L)					
Trichloroethene	95.7	119	87.3	119	109
cis-1,2-Dichloroethene	568	230	104	111	94.8
trans-1,2-Dichloroethene	ND	ND	ND	ND	ND
1,1-Dichloroethene	3.60	2.75	2.86	2.32	2.72
Vinyl Chloride	ND	33.4	47.5	33.7	52.2
Monitoring Well: MW543 (upper RGA—µg/L)					
Trichloroethene	702	569	438	377	227
cis-1,2-Dichloroethene	456	283	200	313	173
trans-1,2-Dichloroethene	0.71	ND	0.61	ND	ND
1,1-Dichloroethene	24.0	29.9	28.2	8.76	6.36
Vinyl Chloride	0.53	ND	ND	ND	ND
Monitoring Well: MW544 (upper RGA—µg/L)					
Trichloroethene	236	215	717	889	846
cis-1,2-Dichloroethene	56.3	52.6	184	285	335
trans-1,2-Dichloroethene	ND	ND	ND	ND	ND
1,1-Dichloroethene	1.77	1.85	5.80	4.50	ND
Vinyl Chloride	ND	ND	ND	ND	ND
Monitoring Well: MW545 (upper RGA—µg/L)					
Trichloroethene	20.2	20.5	1.34	7.84	9.46
cis-1,2-Dichloroethene	736	49.6	35.2	124	118
trans-1,2-Dichloroethene	ND	ND	ND	ND	0.84
1,1-Dichloroethene	3.30	ND	ND	1.24	1.98
Vinyl Chloride	ND	94.8	23.7	55.5	95.4
Monitoring Well: MW546 (upper RGA—µg/L)					
Trichloroethene	963	354	500	17.7	34.7
cis-1,2-Dichloroethene	345	353	401	770	228
trans-1,2-Dichloroethene	ND	ND	ND	ND	ND
1,1-Dichloroethene	5.33	2.25	3.90	ND	ND
Vinyl Chloride	0.86	ND	ND	27.6	424
Monitoring Well: MW547 (upper RGA—µg/L)					
Trichloroethene	3340	1730	1320	1480	1310
cis-1,2-Dichloroethene	286	160	117	160	130
trans-1,2-Dichloroethene	0.51	ND	ND	ND	ND
1,1-Dichloroethene	28.0	15.8	12.8	12.7	8.60
Vinyl Chloride	0.52	ND	ND	ND	ND

Notes:
ND indicates non-detect for the analyte.
If duplicate or second sample was available for the month indicated, the highest analyte value was listed.

C-720 Building Northeast and Southeast Spill Sites

O&M cannot be assessed at this time for the C-720 Building Northeast and Southeast Spill Sites.

10.4 PROGRESS SINCE LAST FIVE-YEAR REVIEW

Oil Landfarm

The RA for Southwest Plume VOC sources at the Oil Landfarm was completed during this reporting period. The site has entered into a period of monitoring and attenuation needed to attain the remaining RAOs. The RACR for the Oil Landfarm RA was approved by the FFA parties in January 2017.

C-720 Building Northeast and Southeast Spill Sites

The only site remedial activity during this reporting period at the C-720 Building TCE Northeast and Southeast Spill Sites has been performance of the Field Characterization/RDSI and two rounds of additional sampling. A decision regarding the selection of the remedy for the C-720 Building TCE Northeast and Southeast Spill Sites awaits additional evaluation by the FFA parties.

10.5 SITE INSPECTION

Oil Landfarm

Site inspection of the Oil Landfarm was made on December 20, 2017, by a team of individuals supporting the five-year review preparation. The site was grass-covered with no apparent surface water ponding on the soil mixing area or significant erosion. The access road was in good repair. There was no construction or other operational activities being conducted at the Oil Landfarm at the time of the inspection. The inspection revealed no major changes to physical site conditions since RA field operations were completed or changes to land use or expected land use at the Oil Landfarm. Interim LUCs consisting of placement of warning signs and the sites' excavation/penetration permit program were in place to prevent exposure to the site contaminants.

C-720 Building Northeast and Southeast Spill Sites

C-720 Building Northeast Spill Site: A site inspection was conducted on December 20, 2017. The C-720 Building Northeast Spill Site includes a grass covered area, with a former railroad bed located to the north and a concrete drive to the south that abuts the north side of the C-720 Building. No construction or operations activities were being conducted at the time of the site inspection, and no erosion or disrepair was noted for the area. Interim LUCs consisting of placement of warning signs and the sites' excavation/penetration permit program were in place to prevent exposure to the site contaminants.

C-720 Building Southeast Spill Site: The site inspection of the Southeast Spill Site also was conducted on December 20, 2017. The C-720 Building Southeast Spill Site includes a concrete parking area directly adjacent to the south edge of the C-720 Building. No construction or operations activities were being conducted at the time of the site inspection. Several automobiles were parked on the area that is underlain by the C-720 Building TCE Southeast Spill Site. There was no apparent damage from the presence of the parked automobiles. Interim LUCs consisting of placement of warning signs and the sites' excavation/penetration permit program were in place to prevent exposure to the site contaminants.

10.6 TECHNICAL ASSESSMENT

Oil Landfarm

During this fourth synchronized five-year review reporting period, the RA was implemented at the Oil Landfarm along with postoperational soil sampling and MW installation. The soil mixing RACR also was completed during this period.

C-720 Building Northeast and Southeast Spill Sites

The remedial activities for the C-720 Building TCE Northeast and Southeast Spill Sites during the period of this fourth synchronized Five-Year Review included completion of a RDSI and preparation of *Final Characterization Report for Solid Waste Management Units 211-A and 211-B Volatile Organic Compound Sources for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-1288&D2 (DOE 2013f), and collection of additional groundwater data and development of the *Addendum to the Final Characterization Report for Solid Waste Management Units 211-A and 211-B Volatile Organic Compound Sources for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-1288&D2/A1/R1 (DOE 2016c). At the end of this reporting period, RAs for the C-720 Building TCE Northeast and Southeast Spill Sites currently are being discussed further by the FFA parties.

10.6.1 Question A: Is the Remedy Functioning as Intended by the Decision Documents?

Oil Landfarm

The soil mixing with ZVI action has been completed for approximately two years. Based on the postremediation soil sampling and limited groundwater sampling performed thus far, the remedy appears to be functioning as intended. The ZVI is expected to continue to treat residual VOC contamination that may be migrating with groundwater to the RGA. Interim LUCs are in place and are functioning to control exposures.

C-720 Building Northeast and Southeast Spill Sites

The remedy for the Southwest Plume VOC sources at the C-720 Building TCE Northeast and Southeast Spill Sites had not been implemented at the close of this reporting period; therefore, the function of this portion of the remedies cannot be assessed at this time. Interim LUCs, however, are in place and are functioning to control exposures.

10.6.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of the Remedy Selection Still Valid?

Oil Landfarm and the C-720 Building Northeast and Southeast Spill Sites

The exposure assumptions used to develop the risk assessment included both current exposures (on-site industrial and excavation worker and off-site recreational) and potential future exposures (future on-site resident using groundwater at the SWMU boundary). The MCL for TCE remains 0.005 mg/L (and the MCLs for other COCs, *cis*- and *trans*-1,2 DCE, vinyl chloride, and 1,1-DCE remain unchanged) as it was during the original remedy selection. The basis and the numerical cleanup levels established in the Southwest Plume ROD are included in Table 10.2 for both the Oil Landfarm and the C-720 Building TCE Northeast and Southeast Spill Sites.

Table 10.2. Chemical-Specific Standards for the Southwest Plume

Contaminant*	Media	Cleanup Level-Oil Landfarm	Cleanup Level-C-720 Building TCE Northeast and Southeast Spill Sites	Basis
Trichloroethene	Soil	73 µg/kg	75 µg/kg	Calculated soil cleanup levels protective of groundwater at POE
1,1-Dichloroethene	Soil	130 µg/kg	137 µg/kg	Calculated soil cleanup levels protective of groundwater at POE
cis-1,2-Dichloroethene	Soil	600 µg/kg	619 µg/kg	Calculated soil cleanup levels protective of groundwater at POE
trans-1,2-Dichloroethene	Soil	1,080 µg/kg	5,290 µg/kg	Calculated soil cleanup levels protective of groundwater at POE
Vinyl chloride	Soil	34 µg/kg	570 µg/kg	Calculated soil cleanup levels protective of groundwater at POE

*Chloroform was a COC, but no cleanup level was established.

The RAOs identified for the Southwest Plume VOC sources ROD remain valid for the targeted sources.

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

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

3. Prevent exposure to non-VOC contamination and residual VOC contamination through interim LUCs within the Southwest Plume source areas (i.e., Oil Landfarm and the C-720 Building Northeast and Southeast Spill Sites) pending remedy selection as part of the Soils OU and the GWOU.

4. Reduce VOC migration from contaminated subsurface soils in the treatment areas at the Oil Landfarm and the C-720 Building Northeast and Southeast Sites so that contaminants migrating from the treatment areas do not result in the exceedance of MCLs in the underlying RGA groundwater.

There are no changes in standards identified as ARARs in the ROD that impact the protectiveness of the remedy. Additionally, there are no newly promulgated standards that might apply or be relevant and appropriate to the site that affect the protectiveness of the remedy. The following changes were identified, but do not impact the protectiveness of the remedy:

- DOE O 5400.5 (II)(5)(c)(6), 5400.5 (II)(5)(c)(1), and 5400.5(IV)(4)(d) have been superseded by DOE O 458.1.

The Southwest Plume VOC source zones are located within the facility security fence and other administrative controls that prevent unauthorized access to the site. Exposure assumptions used in the ROD regarding current restrictions on use of groundwater within DOE property remain valid.

The current groundwater data indicate that assumptions underlying the remedy selection in the ROD still are valid for the targeted sources.

10.6.3 Question C: Has Any Other Information Come to Light That Could Call into Question the Protectiveness of the Remedy?

Oil Landfarm

No other information has come to light that would call into question the protectiveness of the remedy implemented at the Oil Landfarm.

C-720 Building Northeast and Southeast Spill Sites

As a result of additional data collection at both the C-720 Building Northeast and Southeast Spill Sites, the FFA parties have entered into discussions concerning implementation of the selected remedy. Further discussion is included above in Section 10.2, “Remedy Implementation.” At the close of this fourth synchronized Five-Year Review reporting period, the discussions had identified the following:

- The resulting site conceptual model for the C-720 Building Northeast Spill Site remains consistent with the site conceptual model contained in the signed ROD. The additional Field Characterization/RDSI data identified the presence of additional source material in the UCRS west of the original UCRS source area (east side). Since the site conceptual model remains consistent, application of the remedies in the signed ROD remain applicable, but require agreement of the FFA parties for implementation.

- The resulting site conceptual model for the C-720 Building Southeast Spill Site was identified to be inconsistent with the site conceptual model contained in the signed ROD. Additional data indicates that VOC source material is present in the RGA beneath the C-720 Building. The signed ROD recognized VOC source material in only the UCRS soils; therefore, the FFA parties will enter into discussions that may lead to:

  — Modification of the ROD to defer remedy selection at the C-720 Building Southeast Spill Site pending decommissioning of the C-720 Building, or

  — Application of one of the alternative remedies in the signed ROD.

10.7 ISSUES

None.

11. NSDD SOURCE CONTROL

The NSDD originates within the north central portion of the Paducah Site industrial area and joins with Little Bayou Creek to the north of the facility. Figure 11.1 illustrates the location of the NSDD Source Control. Historically, the NSDD received wastewater from the C-400 Cleaning Building that housed equipment for decontamination, metal etching and plating, metals recovery, radioactive materials stabilization and recovery, uranium trioxide production, diffusion process equipment testing, and uranium tetrafluoride (UF_4) pulverization. Additional sources of runoff to the ditch include the C-600 Steam Plant, the C-335 and C-337 Process Buildings, the C-635 Cooling Tower, and the C-535 and C-537 Switchyards. As a consequence, the soil and sediment in the ditch were contaminated with radionuclides, metals, and PCBs. Over the years, fly ash and coal dust from the C-600 Steam Plant and sediment from the ditch watershed had nearly filled the NSDD, causing the ditch to overflow onto an adjacent stretch of 10th Street during heavy rains.

11.1 REMEDY SELECTION

In March 1994, DOE and EPA, with the concurrence of KDEP, signed a *Record of Decision for Interim Action Source Control at the North-South Diversion Ditch at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/06-1213&D3, as an initial step toward addressing sitewide problems (DOE 1994c).

The PHEA found that the critical exposure pathway is related to the off-site migration of on-site contaminant sources (CH2M HILL 1992). The PHEA also recommended action to eliminate migration of these contaminants off-site. The NSDD ROD also stated there was potential for exposure of site maintenance personnel to the contaminants within the ditch through routine maintenance activities. The personnel potentially were exposed to unacceptable risk via direct gamma radiation from contaminated sediment and soil; dermal contact with soil, sediment, and debris; inhalation of resuspended particulate during mowing; and incidental ingestion of contaminated surface water, soil, and sediment. The source control RA, discussed in this section, and the response actions for Sections 1 and 2 (SWMU 59), as discussed in Chapter 12, eliminated exposure pathways. In addition, aquatic organisms living in the NSDD likely were at risk from adverse effects that could reduce populations. Predators of aquatic organisms also may have been at equivalent levels of risk due to bioaccumulation of PCBs.

No formal RAOs were presented in the NSDD ROD; however, the principal goals of the interim action were the following:

- Mitigate the introduction of contaminants into the NSDD;
- Decrease the migration of contaminants already present in the NSDD; and
- Decrease the potential for direct contact with the contaminated material.

The IRA consisted of the following activities:

- Installing an ion exchange system in the C-400 Building;

- Rerouting effluent from the C-400 Building from the NSDD to Outfall 008;

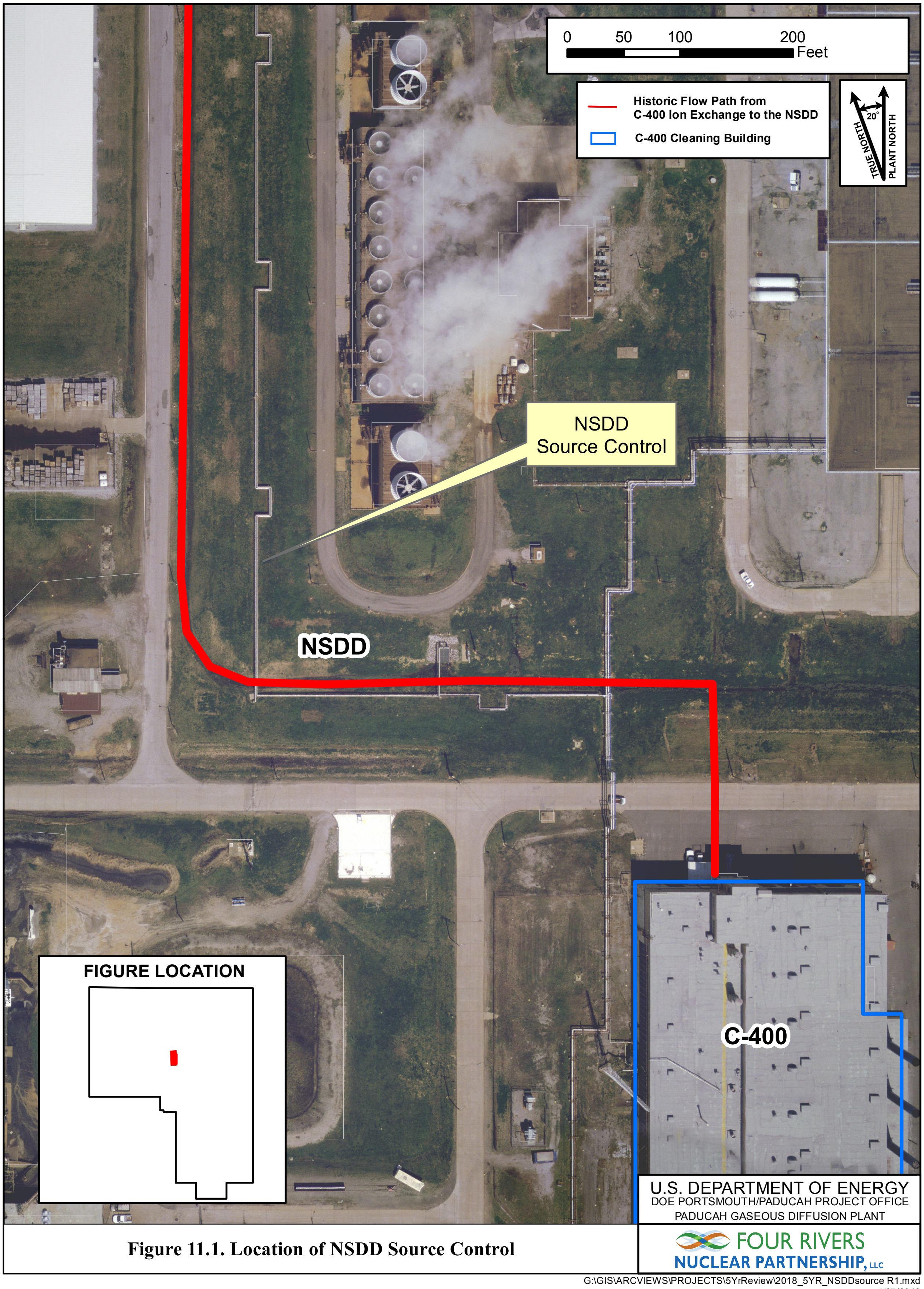

Figure 11.1. Location of NSDD Source Control

- Constructing an aboveground pipe and lift stations (C-400-L and C-616-L) and pumping NSDD flow along the aboveground pipeline to the existing C-615-K Lift Station;

- Removing fly ash from the C-600 Steam Plant ash pile runoff by constructing settling lagoons and then pumping the supernatant in the lagoons into the piping that replaced the southern part of the NSDD channel;

- Constructing a gabion to trap sediment and reducing the potential for sediment transport off-site from the NSDD; and

- Installing warning signs on both sides of the NSDD inside the security fence from Virginia Avenue to the C-616-C Lift Station to provide notice of elevated levels of radionuclides, metals, and PCBs in the area. These signs were removed upon successful completion of the response action for the NSDD Sections 1 and 2, which is discussed in Chapter 12.

11.2 REMEDY IMPLEMENTATION

DOE completed the IRA during August 1995 (DOE 1995c). Lagoons constructed at the C-600 Steam Plant eliminated fly ash deposition in the NSDD. Also, the discharge from the C-400 ion exchange system was routed to the Outfall 008 storm water drain, thereby eliminating discharges from the C-400 Building to the NSDD. This change in design, routing to Outfall 008 instead of Outfall 001, was documented in the *Interim Measure Report and Operation and Maintenance Plan for the North/South Diversion Ditch Interim Corrective Measures at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-4125&D1 (DOE 1995c), which was issued in December 1995. Section 3.1, Modification to the Original Design and/or the Approved Work Plan, of the referenced document states:

> A scope change was encountered during construction, which regarded the discharge pipe from the collection tank (C-400-B) located in building C-400. The discharge pipe (drain) that was to be used to discharge the collection tank water to the NSDD was to be routed through a man-hole, which during construction was identified as SWMU 203. SWMU 203 was included in the August 25, 1995 SWMU assessment report submitted to EPA and the state. Since the discharge line would be releasing clean water, the resolution was to reroute the 140 foot discharge line (pipe) out the west side of building C-400 and into a storm water drain. The discharge water will be transferred through the storm water drainage system to Outfall 008.[9]

Since completion of the NSDD Source Control IRA, a second ROD for an IRA at the NSDD was signed on September 25, 2002, which is discussed in Chapter 12.

11.3 SYSTEMS OPERATIONS/OPERATIONS AND MAINTENANCE

The O&M requirements were documented previously in the *Operation and Maintenance Plan for the Surface Water Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1904&D1 (DOE 2000c), but now are documented in *Operation and Maintenance Plan for Sections 1 and 2 of the North-South Diversion Ditch at the Paducah Gaseous Diffusion Plant, Paducah,*

[9] The term "clean" is referring to water that has been treated by the C-400 ion exchange system. If water had been discharged into the manhole (SWMU 203) as planned, there would be the possibility of contamination being washed into the NSDD by the C-400 discharge water.

Kentucky, DOE/OR/07-2057&D2 (DOE 2005c). The primary activities associated with O&M include the following:

- Inspecting lift stations weekly (fully automated) to ensure the lift station screens remain clean, the lift stations are operational, and the pipeline is not leaking;

- Activating heat tracing installed on the aboveground piping in the fall and deactivating it in the spring and inspecting weekly;

- Inspecting quarterly the warning signs that were put in place when the ROD was developed; and

- Mowing the area adjacent to the pipeline and warning signs twice during the summer months.

Until 2013, USEC enriched uranium at the Paducah Site to supply nuclear fuel to electric utilities worldwide. The operations of the C-400 ion exchange system and discharges from it were conducted according to a memorandum of understanding between USEC and DOE until October 2014, at which time, USEC terminated its lease agreement with DOE and returned the leased facilities. Subsequent to delease of the property, C-400 operations have closed. The ion exchange system no longer is needed, and it had been removed prior to the end of CY 2017. The O&M Plan will be revised to reflect the current status.

The C-400-L Lift Station is located on the north side of the NSDD near its upper reach close to the intersection of 10th Street and Virginia Avenue. It is included in the radiological boundary posting along the NSDD. With the exception of a gravel walkway, access to the station electrical control panels and the east side of the lift station is restricted. The lift station is in good condition and appears to be functioning normally. During this inspection, there were no visible indications that the street or walkways along the ditch have been flooded in the recent past. The inlet grating to the lift station was free of excessive debris, although there was some standing water in front of the inlet grating. The lift station did not run during this inspection, due to minimal water flow in the ditch. The electrical power and control panels and associated conduits located just east of the lift station are in good condition. In 2017, one of the two pumps in the C-400-L Lift Station was replaced. The previous pump was found not to be functional during an inspection.

The C-616-L Lift Station is located on the south side of Virginia Avenue and north of the C-600 Steam Plant. This lift station collects coal pile runoff and fly ash settling basin water from C-600. Water from the fly ash settling basins enters the station through underground piping from the basins. Coal pile runoff is routed into the west side of the lift station by a trench. This lift station was under the control and operation of USEC prior to DOE’s assuming ownership in 2014. The Sections 1 and 2 O&M Plan will be revised to reflect DOE's responsibility for operation of the C-616-L and C-615-K Lift Stations. During this inspection, the lift station was functioning as designed. There were no indications of water overflow in the vicinity of the lift station. Water levels in the settling basins were normal. Power and control panels associated with the lift station are rusting, but intact.

The discharge piping from the C-400-L and C-616-L Lift Stations, which is mounted on abovegrade concrete and steel pipe supports, originally routed water around the more contaminated southern-most reaches of the NSDD to a point just south of Outfall 001. To facilitate the remediation of Sections 1 and 2 of the NSDD, this piping was extended, both aboveground and underground, to a point just north of the C-616-L Lift Station inlet. The piping appears in good condition, with no evidence of leaks, and is performing as designed. The aboveground piping insulation was in good condition and intact; the metal jacket covering was not rusted or deteriorated.

A gabion with a nonwoven, geotextile filter was installed at the existing C-615-K Lift Station located on the east side of 10th Street and north of the C-400-L and C-616-L Lift Stations. This sediment trap was installed to reduce the potential for sediment transport off-site (i.e., outside the existing security fence) from the NSDD. During this inspection, the gabion appears to be in good condition and is functioning as designed.

The costs associated specifically with O&M activities are not accounted for separately, because they are performed as part of the facilitywide, long-term surveillance and maintenance and environmental monitoring programs.

11.4 PROGRESS SINCE LAST FIVE-YEAR REVIEW

The 2013 Five-Year Review determined that the exposure pathways for the NSDD Source Control that could result in unacceptable risk were being controlled; therefore, they were protective of human health and the environment (DOE 2014a). The following is from the 2013 review.

> The remedy for the NSDD Source Control is protective of human health and the environment. Exposure pathways that could result in unacceptable risk are being controlled. This project is not a final action and was not designed to return the areas to unrestricted use.

There have been no previous issues or recommendations for the NSDD Source Control. The site remains unchanged as described in the 2013 Five-Year Review, and no new actions have occurred.

11.5 SITE INSPECTION

On December 14, 2017, a site inspection of the following facilities associated with the NSDD IRA was conducted by a team supporting the five-year review preparation: (1) the C-400-L Lift Station and associated piping (Figure 11.2), (2) the C-616-L Lift Station and associated piping (Figure 11.3), and (3) the gabion installed at the C-615-K Lift Station (Figure 11.4). The signs that had been posted along the southern reaches of the ditch were removed after the remedial response for Sections 1 and 2 (Chapter 12) was completed. There was no excessive debris over the gabion screens. The aboveground piping was in good condition, the insulation was intact, and the metal jacket covering was not rusted or deteriorated. The lift stations appear to be functioning properly. The facility manager participated as part of the inspection team and did not have any concerns.

Figure 11.2. C-400-L Lift Station

Figure 11.3. C-616-L Lift Station and C-400-L Piping

Figure 11.4. Gabion Structure

11.6 TECHNICAL ASSESSMENT

The ion exchange system was installed in the C-400 Cleaning Building to treat elevated levels of radionuclides in effluent being released from the C-400-B Storage Tank. USEC leased the C-400 Building and its operations from DOE in 1993. The C-400 ion exchange system effluent was routed to the USEC-operated C-400 Cleaning Building collection tank, where it was stored until the treatment levels were assessed. The wastewater was repeatedly processed through the uranium precipitation and ion exchange systems until a point of diminishing return was reached (i.e., until the percentage of reduction becomes insignificant with subsequent treatments). The final concentration in the treated water was contingent upon the initial concentration. After treatment, the water either was recycled in C-400 Building processes or was discharged via Outfall 008. Because the effluent discharge from the C-400 Building was treated until a point of diminishing return was reached and was rerouted to Outfall 008 during the design phase, the introduction of contaminants into the NSDD from the C-400 Building was eliminated completely.

DOE monitors surface water at Outfall 008 quarterly as a part of its Environmental Monitoring Program. Outfall 008 was monitored for VOCs, PCBs, metals, anions/cations, and radionuclides from 2005 to 2010, and the outfall was monitored for VOCs and PCBs from 2011 to September 1, 2017. The maximum

Tc-99 detection during this review period was 5.89 pCi/L, which is less than the accepted standards. Since September 1, 2017, Outfall 008 has been monitored for PCBs, TCE, uranium, and Tc-99.

Two concrete settling lagoons, the C-600 Fly Ash Lagoons, were used to keep coal-pile water runoff out of the NSDD, thereby lowering the levels of sediment being deposited in the NSDD. Coal no longer is used at the site. With the installation of the two lift stations, C-400-L and C-616-L, and associated aboveground and underground pipelines to bypass the NSDD, the introduction of contaminants from the C-600 Steam Plant has been eliminated completely.

A gabion with a nonwoven, geotextile filter was installed to minimize sediment transport off-site from the NSDD. The gabion is functioning as designed.

11.6.1 Question A: Is the Remedy Functioning as Intended by the Decision Documents?

Yes. Based upon the site inspection, the NSDD IRA is meeting the remedial objectives as stated in the ROD. Inspections of the lift stations and heat tracing (as needed) occur weekly and are reviewed by the facility manager. Mowing the area adjacent to the pipeline occurs a minimum of two times during the summer months.

11.6.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of the Remedy Selection Still Valid?

DOE remains in control of the property that the NSDD Source Control encompasses and the land use remains industrial; therefore, the exposure assumptions used in the ROD remain valid.

Changes in risk assessment methodology subsequent to approval of the ROD have been significant; however, these changes are not pertinent because the remedy relied on two components: (1) restricting access through use of signs and (2) mitigating contaminant discharge to the ditch through treatment. Neither of these components is related to changes in risk methodology. There have been no new contaminants or new understanding of geologic conditions identified.

No cleanup levels were established in the ROD because the selected remedy did not include excavation and removal of the impacted soils.

The 1998 Five-Year Review found that jurisdictional wetlands had been identified in the NSDD after the ROD had been signed (in 1994). Because the wetlands were not identified prior to signing the ROD, ARARs for the protection of wetlands were not included in the ROD. They were added by the 2003 Five-Year Review. DOE has complied with all identified requirements during implementation of the RA.

There are no changes in standards identified as ARARs in the ROD that impact the protectiveness of the remedy. Additionally, there are no newly promulgated standards that might apply or be relevant and appropriate to the site that affect the protectiveness of the remedy. Finally, there are no changes in TBCs identified in the ROD that impact the protectiveness of the remedy. The following changes were identified in during the 2013 Five-Year Review, but do not impact the protectiveness of the remedy.

- DOE O 5400.5 has been superseded by DOE O 458.1.
- DOE O 5480.11 was cancelled September 29, 1995, and was superseded by DOE G 441.1-1C.
- DOE O 5480.4 was cancelled.

- Moved 401 *KAR* 5:029(2) and 401 *KAR* 5:031(4) to 401 *KAR* 10:029(2) and 401 *KAR* 10:031(4), respectively. The pollutant list that was under 401 *KAR* 5:031(4)(5) was consolidated with a similar table under 401 *KAR* 5:029(5) into a consolidated table in 401 *KAR* 10:031(6)(1). None of the changes, however, would impact the protectiveness of the remedy.

The RAOs used at the time of remedy selection still are valid.

11.6.3 Question C: Has Any Other Information Come to Light That Could Call into Question the Protectiveness of the Remedy?

No other information has come to light that would call into question the protectiveness of the remedy.

11.6.4 Technical Assessment Summary

The Sections 1 and 2 O&M Plan requires weekly inspections and inspections following a storm event to ensure that the screens of the lift stations remain clean; that all of the lift stations are operational; and that the pipeline is not leaking. The principal goals of the interim action were the following:

- Mitigate the introduction of contaminants into the NSDD;
- Decrease the migration of contaminants already present in the NSDD; and
- Decrease the potential for direct contact with the contaminated material.

The interim action is functioning as designed; therefore, it is protective of human health and the environment.

11.7 ISSUES

None.

12. NSDD SECTIONS 1 AND 2

The NSDD originates within the north-central portion of the Paducah Site industrial area and joins with Little Bayou Creek to the north of the facility. Figure 12.1 illustrates the location of the NSDD Sections 1 and 2 (SWMU 59). Historically, the NSDD received wastewater from the C-400 Cleaning Building that houses equipment for decontamination, metal etching and plating, metals recovery, radioactive materials stabilization and recovery, uranium trioxide production, diffusion process equipment testing, and UF_4 pulverization. Additional sources of runoff to the ditch include the C-600 Steam Plant, the C-335 and C-337 Process Buildings, the C-635 Cooling Tower, and the C-535 and C-537 Switchyards. As a consequence, the soil and sediment in the ditch were contaminated with radionuclides, metals, and PCBs. Over the years, fly ash and coal dust from the C-600 Steam Plant and sediment from the ditch watershed had nearly filled the NSDD causing the ditch to overflow during heavy rains onto an adjacent stretch of 10th Street.

According to the NSDD ROD, there was potential for exposure of industrial worker to the contaminants within the ditch through routine maintenance activities (DOE 2002d). The personnel were exposed to unacceptable risk via direct gamma radiation from contaminated sediment and soil; dermal contact with soil, sediment, and debris; inhalation of resuspended particulate during mowing; and incidental ingestion of contaminated surface water, soil, and sediment. The source control RA (as discussed in Chapter 11) and the response actions for Sections 1 and 2 eliminated exposure pathways.

12.1 REMEDY SELECTION

Risks associated with the NSDD are presented in *Record of Decision for Interim Remedial Action at the North-South Diversion Ditch at the Paducah Gaseous Diffusion Plant, Paducah Kentucky*, DOE/OR/07-1948&D2. According to the NSDD ROD, there was potential for exposure of site maintenance personnel to the contaminants within the ditch through routine maintenance activities (DOE 2002d).

The RAOs for Phase II were as follows:

- Prevent future discharge of process waste to the NSDD;
- Reduce the risk to industrial workers and ecological receptors from exposure to contaminated surface soil, sediment, and surface water to acceptable levels by eliminating direct exposure to contaminated media at the NSDD; and
- Prevent future on-site (i.e., inside the existing security fence) run-off from being transported off-site (i.e., outside the existing security fence) via the NSDD.

The LUC objective identified to assure the protectiveness of the preferred alternative for Sections 1 and 2 of the NSDD is as follows:

- Sections 1 and 2 (Industrial areas)—Restrict unauthorized access, restrict unauthorized excavations or penetrations below prescribed contamination cleanup depth, and restrict uses of the area that are inconsistent with the assumed industrial use (i.e., to prevent recreational and/or residential use).

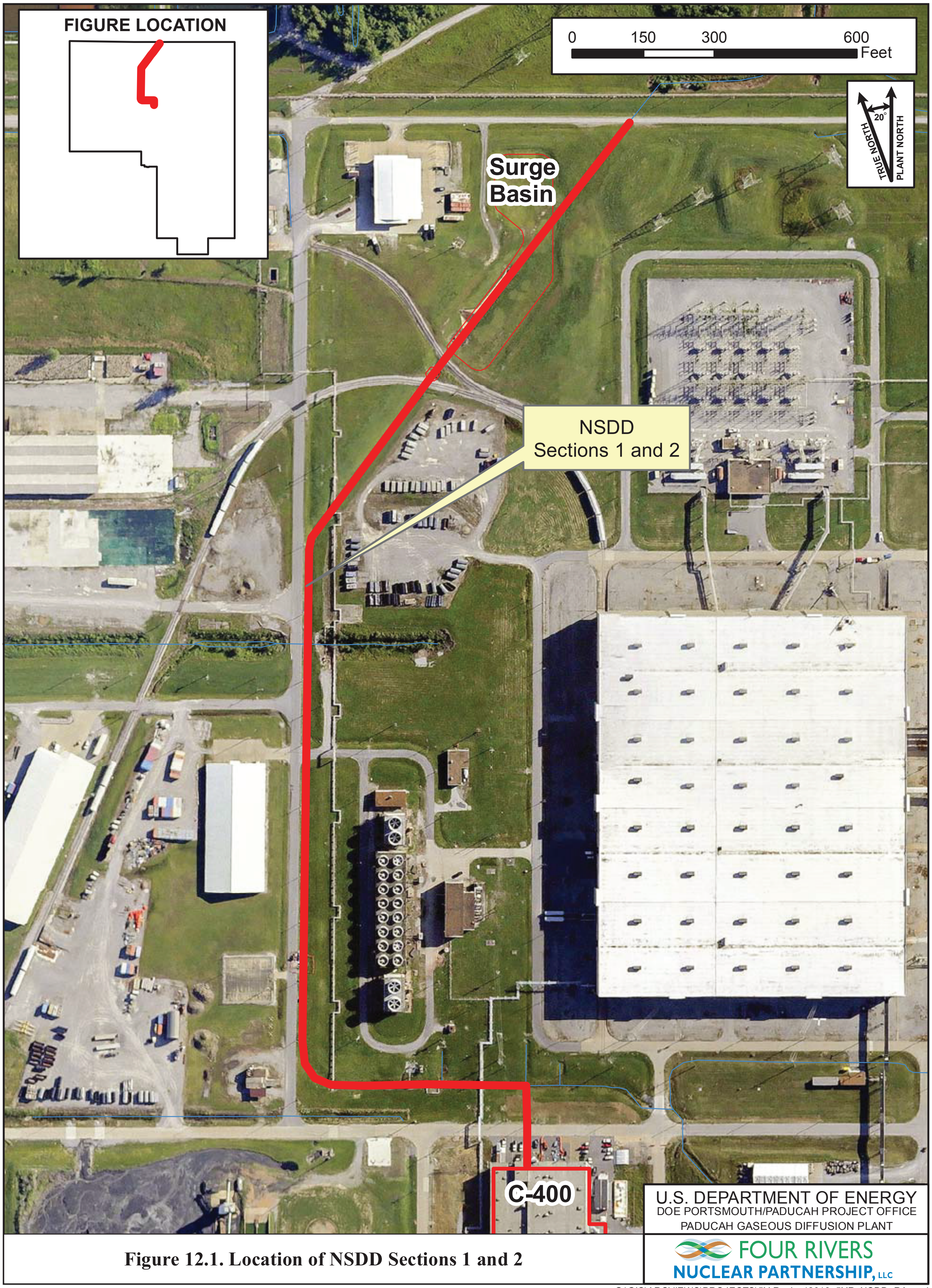

Figure 12.1. Location of NSDD Sections 1 and 2

12.2 REMEDY IMPLEMENTATION

A remedy for Sections 1 and 2 of the NSDD was implemented and completed in 2004. During the planning phases of this response action, additional waste characterization efforts were initiated at the direction of the KDWM. These extra sampling activities included field analyses for PCBs and volatile organics in soil. These analyses ensured that waste soils met the waste acceptance criteria (WAC) for the C-746-U Landfill.

As part of the implementation of the NSDD Sections 1 and 2 Project, EPA required an evaluation of the C-746-U Landfill to ensure that waste from the NSDD that was disposed of there would not pose unacceptable risks to human health and the environment. This requirement was provided in a letter dated April 24, 2003, (EPA 2003) and stated the following:

> "…because the disposal in the landfill from the NSDD interim action is expected to leave levels of contamination – both within the remediated NSDD area and on-site in the C-746-U Landfill disposal area – above levels that allow for unrestricted use and unlimited exposure, the Five-Year Reviews required to ensure protectiveness of this action must examine conditions in both these areas to insure that the entire action remains protective."

The C-746-U Landfill is a contained landfill, as defined in Kentucky regulations at 401 *KAR* 47:005. The landfill meets the technical standards found in 401 *KAR* 47:080, 401 *KAR* 48:050, and 401 *KAR* 48:070 to 401 *KAR* 48:090, and DOE's D&R contractor has procedures in place to ensure that no wastes are disposed of in the landfill that do not meet the WAC for this facility. This includes soil waste from the NSDD and other areas of the Paducah Site. One aspect of the WAC is the "authorized limits" for waste with *de minimis* levels of radiological contamination to be disposed of in the C-746-U Landfill, as described in *Risk and Performance Evaluation of the C-746-U Landfill at the Paducah Gaseous Diffusion Plant, Paducah Kentucky*, DOE/OR/07-2041&D2/R1 (DOE 2003c). The results of this study are summarized as follows:

> These results indicate that the total volume of SWMU 59 excavation can be placed in the landfill and that this placement may adversely impact the balance between the percentage of volume taken and the percentage of contaminant inventory limit taken by ^{237}Np but no other contaminants. It must be cautioned that these results are dependent upon the quality of the data set used to generate the average contaminant concentrations. If these data do not represent areas and volumes within SWMU 59 with higher contaminant concentrations, then the results may be biased low. However, if these data come from sampling biased towards areas of suspected higher contamination, then the results may be biased high. Sampling during waste disposition will be used to address this uncertainty.

Waste characterization activities resulted in all of the excavated soil being disposed of in the C-746-U Landfill. No contaminant levels exceeded threshold criteria that would have caused the waste to be designated as RCRA-hazardous, Toxic Substances Control Act-regulated, or above the authorized limits of the C-746-U Landfill. The amount of waste that might add to the inventory of hazardous constituents or radioisotopes in the landfill is tracked by the DOE Portsmouth/Paducah Project Office health physicist. This is done through documentation prepared for all waste disposed of in the C-746-U Landfill, referred to as "landfill packages." These packages are reviewed to determine if the waste they describe may have minute quantities of radiological contamination. If that is the case, then the radiological data are analyzed to determine an estimated inventory of each isotope that will be associated with that landfill package. The estimates based on projected weights and volumes are compared against actual weights and volumes disposed of to ensure that the inventory does not exceed the projections. The inventory allowed for disposal in the C-746-U Landfill is that amount that can be disposed of without exceeding a 1 mrem/yr dose to any member of the general public. This tracking method has ensured that disposal of wastes from the NSDD and other CERCLA-derived wastes do not pose unacceptable risks to human health and the environment.

Figures 12.2 and 12.3 show "before and after" views of the NSDD Sections 1 and 2. The total cost of excavation of Sections 1 and 2, construction of the detention basin, and disposal of approximately 3,200 yd^3 of soil in the C-746-U Landfill was $12.2M, according to the *Remedial Action Completion Report for the North-South Diversion Ditch Sections 1 and 2 at the Paducah Gaseous Diffusion Plant, Paducah Kentucky*, DOE/OR/07-2195&D2 (DOE 2005d).

Figure 12.2. NSDD Sections 1 and 2 before Remedial Action

Figure 12.3. NSDD and Gabion Structure

A residual risk evaluation was prepared as a result of a recommendation in the 2008 CERCLA Five-Year Review to determine if the remedy for Sections 1 and 2 of the NSDD could be optimized (e.g., risks were at a level that would support modification of institutional controls and/or cessation of five-year reviews). The evaluation showed that the cleanup goals of the ROD were met.

12.3 SYSTEMS OPERATIONS/OPERATIONS AND MAINTENANCE

Because the excavation exceeded the cleanup criteria set forth in the ROD, long-term maintenance of the clay cover is not required to eliminate exposure pathways. The excavated and lined ditch is maintained as part of the Paducah Site's ongoing grounds maintenance program, and the cost is not tracked separately.

12.4 PROGRESS SINCE LAST FIVE-YEAR REVIEW

The 2013 Five-Year Review protectiveness statement follows:

> The remedy for the NSDD Sections 1 and 2 is protective of human health and the environment in the short-term. Exposure pathways that could result in unacceptable risk are currently being controlled. This project is not a comprehensive final action for

> SWMU 59. In order to establish long-term protectiveness, additional action will be evaluated and selected, as necessary, under the SWOU.

The 2013 Five-Year Review had the following recommendation:

> Based on the residual risk evaluation concluding that the remaining contamination poses minimal risk based on the current and reasonably anticipated industrial exposure scenario, a request for modification of the NSDD Land Use Control Implementation Plan (LUCIP) will be submitted for the monitoring of the land use controls (LUCs) to be reduced to once every five years in conjunction with the Five-Year Review. This includes reducing annual verification of administrative controls and annual verification of access to once every five years for the NSDD Sections 1 and 2. In the event there is a major change in land use for the NSDD Sections 1 and 2, an evaluation will be conducted to ensure that the remedy is protective consistent with the PGDP LUCAP. Finally, DOE must comply with the requirements of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 120(h) if the property is transferred.

This recommendation was not implemented. DOE has continued to comply with the NSDD LUCIP concerning the monitoring of the LUCs, annual verification of administrative controls, and annual verification of access.

The site remains unchanged, as described in the 2013 Five-Year Review, and no new actions have occurred.

12.5 SITE INSPECTION

The NSDD site inspection was conducted on December 14, 2017, by the five-year review inspection team and the facility manager. The ditch has been well-maintained; grass was established in the channel, but was not impeding flow. The flow into the surge basin was unimpeded. There was no standing water in the surge basin. The grass cover was well established and had been mowed. There were no visible signs of erosion along the banks of the surge basin. NSDD inspections are ongoing as part of the current D&R contractor's scope.

12.6 TECHNICAL ASSESSMENT

The goals of the remedy were to be implemented by excavating contaminated soil and sediment from the channel of the NSDD and disposing of it in the C-746-U Landfill, if nonhazardous, or at a permitted facility, if RCRA-hazardous, Toxic Substances Control Act-regulated, or greater than authorized limits for the on-site C-746-U Landfill. The WAC at the C-746-U Landfill were met; therefore, all waste soils were disposed of on-site. Upon excavation, a 2-ft clay layer was placed in the NSDD channel to add an extra layer of protection for maintenance workers. The channel was brought to grade with another 2 ft of clean soil and vegetated to prevent erosion. Plugged culverts and a detention basin prevent rainfall from inside the plant from flowing beyond the security fence and transporting potentially contaminated sediment with it.

The clean-up levels for the excavation were met or exceeded at each measurement section; therefore, maintenance of the clay layer to control exposure is not required (DOE 2005d).

The residual risk evaluation used the decisions/assumptions in the ROD; therefore, the industrial worker, under unrestricted use, was the receptor considered when calculating cleanup levels (LATA Kentucky 2012). The residual risk evaluation quantitatively compared the contamination left in place at the base of the NSDD excavation with outdoor and industrial worker risk-based concentrations as if the contamination were on the surface. The evaluation showed that the residual risk to these receptors falls within the EPA risk range (EPA 1999).

12.6.1 Question A: Is the Remedy Functioning as Intended by the Decision Documents?

Yes. The remedy is functioning as designed. The excavation as designed met or exceeded the cleanup criteria. A certification of the LUCIP is provided each year in the SMP. The LUCs to restrict unauthorized access, restrict unauthorized excavation or penetrations below prescribed contamination cleanup depths, and restrict use of the area that is inconsistent with the assumed industrial use (i.e., to restrict recreational and/or residential use) are in place and functioning as intended.

12.6.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of the Remedy Selection Still Valid?

DOE remains in control of the property that NSDD Sections 1 and 2 encompass and the land use remains industrial; therefore, the exposure assumptions used in the ROD regarding disturbance or contact with the contamination remains valid. There have been changes to the risk assessment methodology, but the protectiveness of the remedy was not affected.

The residual risk evaluation shows that the goals of the ROD were met, and the cleanup levels established still are valid (Table 12.1). Table 12.1 shows the cleanup value cited in the NSDD ROD and the new similarly derived risk-based values (DOE 2002d; DOE 2017h). For thorium-230, aluminum, and uranium, the new risk-based values are lower than the cleanup level, but are within an order of magnitude of the cleanup level, so the cleanup level would fall within the same risk range as the new risk-based value [i.e., an excess lifetime cancer risk (ELCR) of 1E-04 or a hazard index (HI) of 3]. The cleanup levels still are protective. There have been no new contaminants or new understanding of geologic conditions identified.

There are no changes in standards identified as ARARs in the ROD that impact the protectiveness of the remedy. Additionally, there are no newly promulgated standards that might apply or be relevant and appropriate to the site that affect the protectiveness of the remedy. Finally, there are no changes in TBCs identified in the ROD that impact the protectiveness of the remedy. The following changes were identified in the 2013 Five-Year Review, but do not impact the protectiveness of the remedy.

- DOE O 5400.5—has been superseded by DOE O 458.1.

- References to 401 *KAR* 5:029(2) and 5:031 have been moved to 401 *KAR* 10:029(2) and 10:031, respectively.

The RAOs used at the time of remedy selection still are valid.

12.6.3 Question C: Has Any Other Information Come to Light That Could Call into Question the Protectiveness of the Remedy?

No other information has come to light that would call into question the protectiveness of the remedy.

Table 12.1. Comparison of Cleanup Levels for NSDD Sections 1 and 2 and New Risk-based Values

Contaminant	Media	Cleanup Level[a] (DOE 2002d)	Risk-based Value[b] (DOE 2017h)
Aluminum	Sediment	139,200 mg/kg	100,000 mg/kg
Antimony	Sediment	11.37 mg/kg	2,800 mg/kg
Arsenic	Sediment	52.3 mg/kg	160 mg/kg
Barium	Sediment	6,870 mg/kg	100,000 mg/kg
Beryllium	Sediment	28.44 mg/kg	13,500 mg/kg
Cadmium	Sediment	639 mg/kg	1,820 mg/kg
Chromium[c]	Sediment	85.2 mg/kg	100,000 mg/kg
Copper	Sediment	14,790 mg/kg	100,000 mg/kg
Iron	Sediment	62,100 mg/kg	100,000 mg/kg
Lead	Sediment	50 mg/kg	800 mg/kg
Manganese	Sediment	2,598 mg/kg	100,000 mg/kg
Mercury	Sediment	29.46 mg/kg	2,100 mg/kg
Nickel	Sediment	7,260 mg/kg	100,000 mg/kg
Selenium	Sediment	2,847 mg/kg	35,100 mg/kg
Silver	Sediment	1,233 mg/kg	35,100 mg/kg
Thallium	Sediment	2.2 mg/kg	70.2 mg/kg
Uranium[d]	Sediment	3,030 mg/kg	1,400 mg/kg
Vanadium	Sediment	99.6 mg/kg	34,500 mg/kg
Total PCBs	Sediment	19.9 mg/kg	29.3 mg/kg
Total PAHs	Sediment	2.12 mg/kg	8.81 mg/kg
Americium-241	Sediment	467 pCi/g	1,320 pCi/g
Cesium-137	Sediment	13.3 pCi/g	40.5 pCi/g
Neptunium-237	Sediment	45.4 pCi/g	131 pCi/g
Plutonium-239	Sediment	563 pCi/g	1,650 pCi/g
Technetium-99	Sediment	227,000 pCi/g	501,000 pCi/g
Thorium-230	Sediment	3,510 pCi/g	1,940 pCi/g
Uranium-234	Sediment	6,880 pCi/g	9,590 pCi/g
Uranium-235	Sediment	81.6 pCi/g	194 pCi/g
Uranium-238	Sediment	313 pCi/g	1,020 pCi/g

[a] Previous cleanup levels were derived from risk-based human health cleanup levels for restricted use of area by an industrial worker and were the lesser of the risk-based and hazard-based values set at targets of ELCR = 1E-04 and HI = 3 or the dose-based human health cleanup levels for restricted use of area by an industrial worker calculated using a target dose of 25 mrem/year, see Section 2.12 and Table 2.13 of the NSDD ROD (DOE 2002d).
[b] New risk-based values are based on the industrial worker action levels (Table A.1) and the dose-based soil screening levels for 25 mrem/year (Table A.8) presented in the 2017 Risk Methods Document (DOE 2017h).
[c] Chromium (III) (insoluble salts)
[d] Uranium (soluble salts)

12.6.4 Technical Assessment Summary

The RA for Sections 1 and 2 of the NSDD is protective of human health and the environment because contaminated soils and sediments were excavated, eliminating the threat of exposure to these media.

Plugging culverts and constructing a detention basin prevent rainfall from flowing off-site (i.e., outside the existing security fence) through the ditch and moving contaminated sediment with it.

The maintenance of the clay cover to prevent exposure is not required because the samples collected from the open excavation indicated that the cleanup goals in the ROD were exceeded along the entire length of the ditch. The clay cover is maintained as part of the overall grounds maintenance program at the Paducah Site.

12.7 ISSUES

None.

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13. C-746-K SANITARY LANDFILL

The C-746-K Sanitary Landfill (SWMU 8) is located southwest of the facility fenced security area and approximately 650 ft southeast of the C-611 Water Treatment Plant. It is situated immediately west of Bayou Creek and north of an unnamed tributary to Bayou Creek. Drainage ditches located along the western and northern edges of the landfill flow to the south into the unnamed tributary and to the east into Bayou Creek, respectively. Figure 13.1 illustrates the location of the C-746-K Sanitary Landfill.

Records indicate that facility operations used the landfill between 1951 and 1981 for disposal of fly ash from the PGDP's coal combustion boilers, uncontaminated combustible waste, and potential radiologically contaminated waste. The fly ash was believed to have been disposed of in trenches excavated 5 to 10 ft bgs. During operations, trenches were cut in the fly ash and used for burning trash. This practice ceased in 1967, after which waste was buried without burning. The waste, consisting mostly of office and kitchen trash and some construction debris, was placed in trenches excavated within the fly ash and covered, when necessary, with additional fly ash or soil fill. In addition to these materials, sludge from the C-615 Sewage Treatment Plant may have been buried at the unit, as it reportedly was used as fill material. Soil boring information indicated that up to 28 ft of fly ash and trash had been placed in the landfill. The landfill was closed in 1982 and covered with a 6- to 12-inch clay cap and an 18-inch vegetative cover.

On January 30, 1992, Paducah Site personnel discovered leachate in a ditch on the southwest side of the landfill. DOE conducted sampling at five leachate seep locations around the landfill. VOCs (TCE; 1,1-DCE; 1,1-dichloroethane; and *trans*-1,2-DCE) and metals (aluminum, iron, manganese, and zinc) were detected above background levels in the leachate samples. The leachate was acidic and the particulate matter in the leachate generally was orange to yellow in color. Precipitation of dissolved metals from the leachate was thought to be causing the orange to yellow staining observed at various points along the creek banks. The condition was deemed to be in noncompliance with the water quality provisions of 401 *KAR* 5:031, which prohibit discharges that produce "objectionable color" into waters of the Commonwealth of Kentucky. On September 15, 1992, the Kentucky Division of Water issued a Notice of Violation to DOE for "unpermitted seepage areas from the C-746-K Sanitary Landfill into waters of the Commonwealth."

As a result of the Notice of Violation, DOE, with the approval of EPA and KDEP, undertook an interim corrective action to address the seeps. To prevent any further release of solids to the unnamed tributary, DOE installed a sandbag dam with a liner in the drainage ditch southwest of the landfill. During the interim action, subsidence of the landfill cap was repaired and recontoured to promote surface water runoff. The actions were completed in October 1992 and have been effective in reducing seepage into the creeks. In addition, a surface water monitoring program was initiated at the landfill to monitor contaminant levels in the leachate and adjacent creeks.

13.1 REMEDY SELECTION

The interim ROD for the C-746-K Sanitary Landfill was signed by DOE on February 20, 1998, and by EPA on August 10, 1998 (DOE 1998b). KDEP concurred with the selected remedy June 24, 1998, as documented in the *Record of Decision for Waste Area Groups 1 and 7 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/06-1470&D3 (DOE 1998b). The RAOs for this unit are as follows:

- Control the release of COCs from the unit,
- Limit direct contact by humans, and
- Reduce overall risks to ecological receptors.

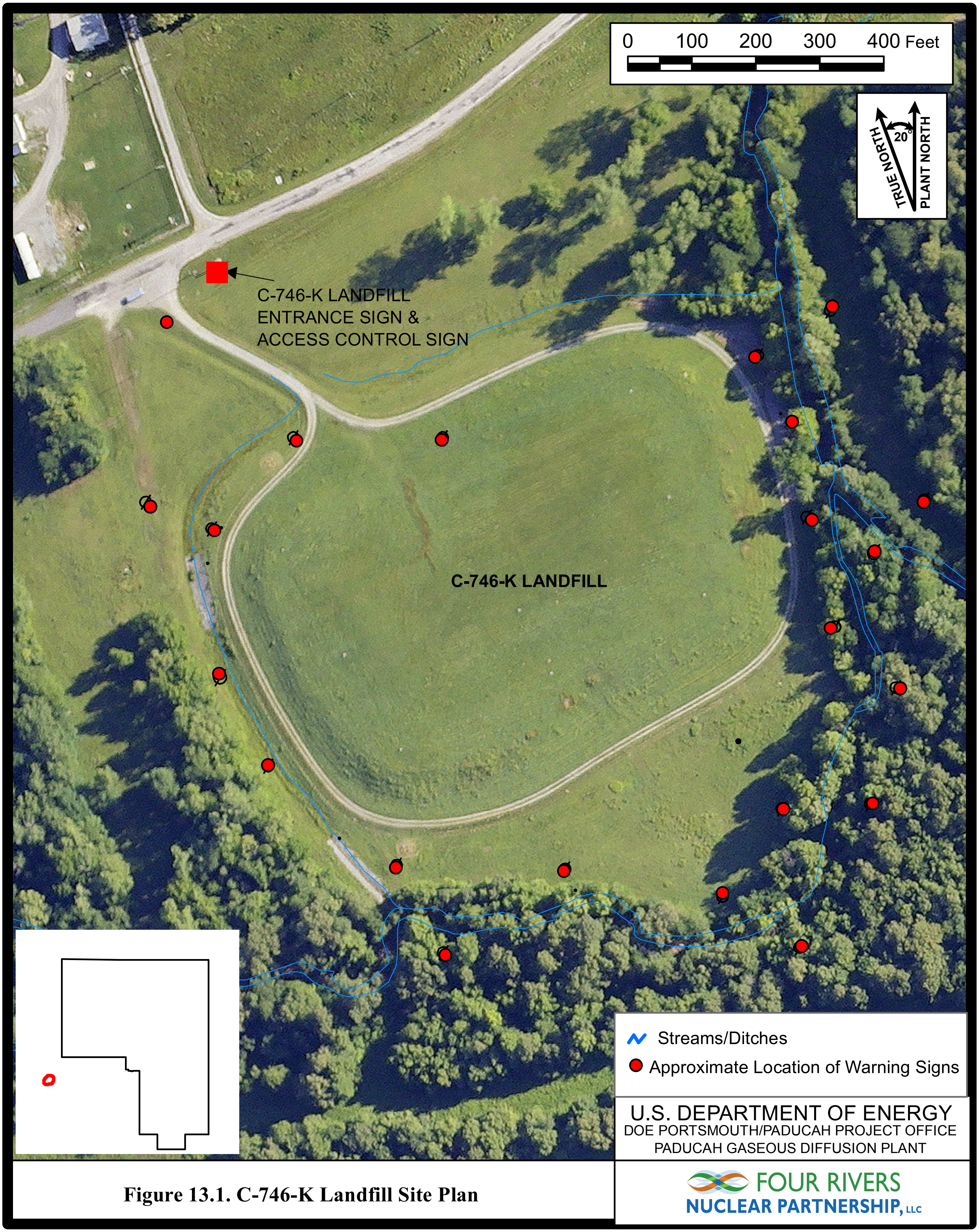

Figure 13.1. C-746-K Landfill Site Plan

Document Name: 2018_C746-K_Signs R2

Date: 4/25/2019

13.2 REMEDY IMPLEMENTATION

The ROD defined and identified the following components of the RA for the C-746-K Sanitary Landfill (DOE 1998b).

- Install warning signs.
- Place riprap.
- Institute a deed notice and restrictions.
- Continue the existing surface water monitoring program.
- Modify the groundwater monitoring program.
- Continue the current landfill cap maintenance program.

Because the ROD for this IRA was signed prior to the effective date of the Paducah Site MOA and LUCAP (DOE 2000a), there is no LUCIP for the LUCs at the C-746-K Sanitary Landfill.

The *Post-Construction Report and Operations and Maintenance Plan for Waste Area Groupings (WAGs) 1 and 7 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1743&D1 (DOE 1999b), documents the RAs taken at the C-746-K Sanitary Landfill (DOE 1999b). The O&M requirements then were revised in the document, *Operation and Maintenance Plan for the Surface Water Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1904&D1 (DOE 2000c). The 2005 SWOU O&M Plan was updated in 2015 [*Operation and Maintenance Plan for the Surface Water Operable Unit at the Paducah Gaseous Diffusion Plan, Paducah, Kentucky*, DOE/OR/07-1904&Dl/R2 (DOE 2015f)], but did not alter the O&M requirements for this action.

The action implemented at the C-746-K Sanitary Landfill satisfies the RAOs stated by limiting human and animal exposure to contaminated sediments and acidic leachate by placing riprap over the seep locations. Further reduction of human risks was accomplished by posting warning signs and by placing a deed notice and restrictions on the C-746-K Sanitary Landfill property.

Surface water monitoring at the C-746-K Sanitary Landfill began in February 1992, following the discovery of leachate in adjacent ditches and creek banks. DOE summarized the monitoring data through October 1992 in the *Work Plan for Interim Corrective Measures at the C-746-K Sanitary Landfill*, DOE/OR/07-1211&D2, and developed the monitoring program that was used until October 1998 (DOE 1992a). Four stations made up the surface water monitoring network. Two stations, 746KTB1 and 746KTB2 (Figure 13.2), located on the adjacent unnamed tributary of Bayou Creek provided upstream monitoring. Two other stations close to the C-746-K Sanitary Landfill, 746K3A and 746K-5, (Figure 13.2) provided downstream monitoring on the adjacent unnamed tributary and Bayou Creek, respectively. The analytical suite for the stream monitoring locations included 13 common metals, arsenic, mercury, uranium, VOCs, PCBs, and pH.

Samples were collected monthly through September 1995 and quarterly thereafter. DOE presented the surface water monitoring results in the FFA Semiannual Progress Report to KDWM and EPA each April and October. In summary, the data demonstrated that water quality at monitoring station C-746-K-3A was impacted by the leachate from the C-746-K Sanitary Landfill, while monitoring station C-746-K-5 appeared to be unaffected. The leachate from the landfill usually contained high levels of dissolved metals, low-levels of dissolved VOCs, and a low pH (2.3 to 3.3 standard pH units).

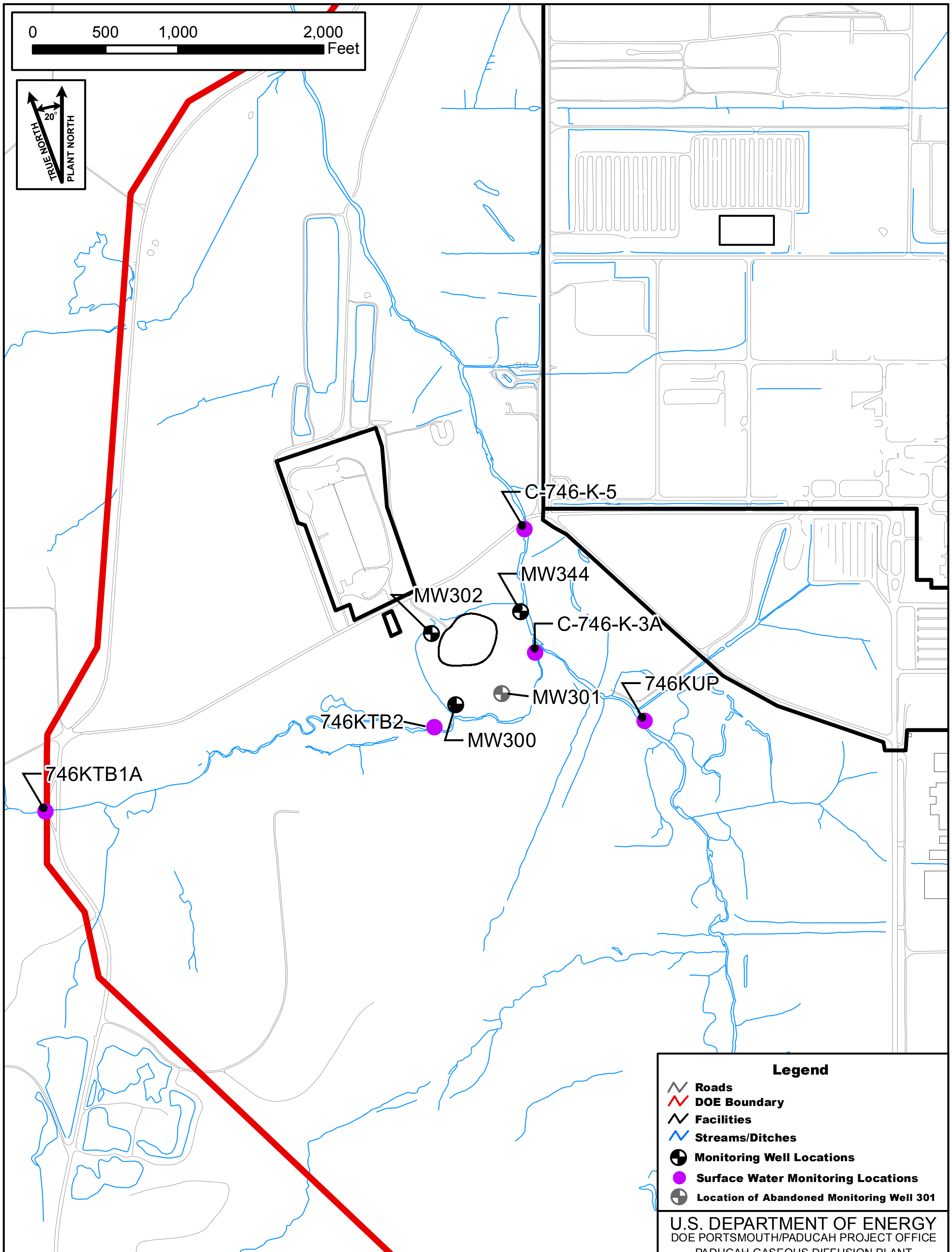

Figure 13.2. Sampling Locations at the C-746-K Sanitary Landfill

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As stipulated in the ROD, the surface water monitoring requirements for the C-746-K Sanitary Landfill were supplanted by a Watershed Monitoring Plan (initially approved October 14, 1998; revised on September 29, 2006; and revised again on February 1, 2010) that was required by the renewed KPDES Permit with an effective date of December 1, 2009. The 2009 KPDES Permit allowed for cessation of the aquatic organism sampling because the creeks had been sampled to the point that further sampling could result in a deleterious effect on the aquatic community. The 2009 KPDES Permit also required that surface water be sampled quarterly for PCBs and TCE only in Bayou Creek. After additional evaluations of the plan and historical data sets, the requirements for metals analysis and aquatic organism sampling were removed through a revised Watershed Monitoring Plan, which was submitted to Kentucky Division of Water on September 27, 2011. Water last was sampled for chemical analysis at the upstream monitoring station on Bayou Creek and the downstream monitoring station on the unnamed tributary to Bayou Creek in 2005 and 2003, respectively. The Watershed Monitoring Plan (1998) included three other interim surface water monitoring stations to assess the C-746-K area. Surface water last was collected for chemical analyses from these stations in 1999. The latest KPDES permit, which became effective September 1, 2017, no longer requires surface water monitoring for the C-746-K Sanitary Landfill.

The remedy identified in the C-746-K Sanitary Landfill ROD included placement of riprap on visible leachate seep locations to minimize the potential for human and animal exposure. The action included covering three leachate seep sites and stabilizing the bank of Bayou Creek on the east side of the C-746-K Sanitary Landfill. Before the leachate seeps were covered, the site was cleared of existing vegetation, and a geotextile fabric layer was placed under a layer of riprap. Construction work for this component of the action began August 5, 1997, and was completed August 12, 1997.

DOE installed warning signs in November 1997 at each of the leachate seep areas and around the landfill. The signs notify the public of the risk associated with the areas. A sign was placed at the entrance of the C-746-K Sanitary Landfill in February 1998. These signs are inspected on a routine basis and are replaced as necessary. Figure 13.1 shows the approximate location of each of these signs.

As specified in the ROD and with the approval of KDWM, two MWs (MW184 and MW303) were abandoned. One new well (MW344) was installed to replace MW303 at the C-746-K Sanitary Landfill in March 1998. The intent of the new well was to detect any contamination that could be migrating from the landfill and traveling along the top of the Porters Creek Clay and into the RGA.

A deed notice and a restriction were placed in the chain of title to the deed of the property to inform potential buyers and/or users of the potential risks to human health and the environment posed by the leachate seeps. The notice and restriction were filed August 24, 1998, with the McCracken County Clerk.

13.3 SYSTEMS OPERATIONS/OPERATIONS AND MAINTENANCE

Two locations in the unnamed tributary and Bayou Creek in the vicinity of the C-746-K Sanitary Landfill are sampled quarterly.

Figure 13.2 shows the three MW locations and the two surface water monitoring locations. The 2013 Five-Year Review noted the shaft of MW301 was buckled so that pump repair/replacement would not be possible and recommended that it be abandoned. The abandonment was completed on August 5, 2014. MW301 was installed in a position comparable to MW300, which typically had higher concentrations. The data from MW300 was determined to represent the worst case scenario for monitoring purposes, which made the abandonment of MW301 acceptable.

Table 13.1 summarizes relevant data for COCs since the last Five-Year Review. The current 2018 Environmental Monitoring Plan (EMP) analytical suite for surface water monitoring includes metals, volatiles, pH, and other field measurements at these two locations (DOE 2018b). Table 13.2 summarizes the latest analyses for the five surface water monitoring stations shown on Figure 13.2. Modification of the Groundwater Monitoring Program in support of the remedy implementation was to generate groundwater data that could be used for future groundwater remediation decision-making purposes. Groundwater monitoring continues under the Paducah Site Groundwater Monitoring Program and is included in the FFA semiannual reports. The reports show that TCE levels in groundwater in MW300 consistently exceed the MCL, and beta activity levels in MW300 and MW301 occasionally exceed the MCL. Arsenic levels are below the MCL, and lead is below the Treatment Technique level.

The costs associated specifically with maintenance of the C-746-K Sanitary Landfill are not tracked separately because they are part of the facilitywide, long-term surveillance and maintenance and environmental monitoring programs.

Table 13.1. Summary of Surface Water Quality Analyses for the C-746-K Sanitary Landfill COCs—2013 through 2017

		Bayou Creek (surface water)	**Unnamed Tributary (surface water)**
Analyte	**Unit**	**C-746-K-5 (downstream)**	**746KTB1A (upstream)**
TCE	µg/L	ND-0.58[a] µg/L	ND-1.51[b] µg/L

[a] Single result was below the detection limit and qualified as estimated on November 10, 2014.
[b] Only detected result during this period.
ND = nondetect

Table 13.2. Summary of Latest Surface Water Monitoring Analyses for the Period 2013 through 2017, Where Available*

Analysis	**Units**	**746KTB1A** (11/2/2017)		**746KTB2** (11/19/2003)		**746KUP** (11/22/2004)		**C-746-K-3A** (1/20/1999*)		**C-746-K-5** (11/2/2017)	
Alkalinity	µg/L	51,000		40,000		18,000				45,000	
Aluminum	µg/L	153		3,360	J	407		2,270	N	47.2	J
Arsenic	µg/L	5	U	10	U	10	U	5	UW	5	U
Barium	µg/L	51.5		59.5		45.7		50		37.4	
Beryllium	µg/L	0.5	U	1	U	1	U			0.5	U
Cadmium	µg/L	1	U	1	U	1	U	1	BUX	1	U
Calcium	µg/L	15,300		11,800		20,100				21.900	
Conductivity	µmho/cm	267		142		219		163		245	
Dissolved Oxygen	µg/L	6,260		8,070		8,750				7,480	
Flow Rate	mgd	0.06		4.14		1.43				2.48	
Hardness ($CaCO_3$)	µg/L			51,000		67,000		49,000			
Iron	µg/L	483		2,130		451		1,760	N	275	
Lead	µg/L	2	U	5	U	5	U	250	U	2	U
Magnesium	µg/L	3,960				3,950		3,340		4,160	
Manganese	µg/L	209				74.5		160		27.5	

Table 13.2. Summary of Latest Surface Water Monitoring Analyses for the Period 2013 through 2017, Where Available* (Continued)

Analysis	Units	746KTB1A (11/2/2017)		746KTB2 (11/19/2003)		746KUP (11/22/2004)		C-746-K-3A (1/20/1999)		C-746-K-5 (11/2/2017)	
Nickel	µg/L	1.19	J	5	U	5	BU	100	U	1.08	J
pH	Std Unit	7.21		7.14		7.5		6.61		6.87	
Polychlorinated biphenyl	µg/L			0.17	U	0.18	UY			0.10**	UY
PCB-1016	µg/L			0.17	U	0.17	UY			0.10**	UY
PCB-1221	µg/L			0.17	U	0.18	UY			0.10**	U
PCB-1232	µg/L			0.17	U	0.14	UY			0.10**	U
PCB-1242	µg/L			0.09	U	0.1	UY			0.10**	U
PCB-1248	µg/L			0.12	U	0.12	UY			0.10**	U
PCB-1254	µg/L			0.1	U	0.07	UY			0.10**	U
PCB-1260	µg/L			0.08	U	0.05	UY			0.10**	UY
PCB-1268	µg/L			0.11	U	0.09	UY			0.10**	U
Potassium	µg/L	4,960		6,660		4,910		5,000	U	2.850	
Sodium	µg/L	31,100		7,070		13,400		10,700		19,200	
Temperature	°F	53.3		55.4		53.2				56.3	
Trichloroethene	µg/L	1	U	1	U	1	U	1	U	1	U
Uranium	µg/L	0.083	J	5	U	1	BU	1	U	0.608	

*Latest earlier data are reported when no analyses are available for the period 2013 through 2017.
**Samples for polychlorinated biphenyl for C-746-K-5 were collected on 8/1/2017.
Gray shading indicates no entry. B = analyte found in associated blank. J = estimated value. N = sample spike recovery not within control limits.
U = analyte analyzed for, but not detected. W = post-digestion spike recovery out-of-control limits. X = other specific flags and footnotes may be required to properly define the results. Y = matrix spike and/or relative percent difference failed acceptance criteria.

13.4 PROGRESS SINCE LAST FIVE-YEAR REVIEW

The summation of the 2013 Five-Year Review protectiveness statement follows: The remedy for the C-746-K Sanitary Landfill is protective of human health and the environment. Exposure pathways that could result in unacceptable risk are being controlled. This project was not a final action and was not designed to return the area to unrestricted use (DOE 2014a).

There have been no previous issues or recommendations for the C-746-K Sanitary Landfill. The site remains unchanged, as described in the 2013 Five-Year Review, and no new actions have occurred. Surface water is monitored in accordance with the EMP and the KPDES Permit.

13.5 SITE INSPECTION

The C-746-K Sanitary Landfill and its immediate surroundings were inspected on December 20, 2017, by members of the Five-Year Review team, the facility manager, and representatives from KDEP, to determine if the required RAs for the C-746-K Sanitary Landfill ROD are being met (DOE 1998b). No concerns were noted at that time.

A sign posted at the entrance to the landfill area clearly identifies the potential human health risks posed by the leachate seeps and contaminated sediments present in the creeks and drainage ditches around the landfill. Additional warning signs are posted at periodic intervals along the west bank of Bayou Creek to the east of the C-746-K Sanitary Landfill and along the north bank of the unnamed tributary to the south of the C-746-K Sanitary Landfill. The signs are in good condition and clearly legible.

Riprap that was placed along the west bank of Bayou Creek for erosion protection and to cover apparent seep sites is in place. Riprap also has been placed at one apparent seep area along the unnamed tributary on the south side of the landfill and the area drainage ditch along the west side. These areas also are in good condition.

The covered and capped area of the landfill is in good condition with a well-established grass cover that appears to drain well. There are no indications that water stands on the cap or side slopes. There are no signs of erosion on the landfill cap or side slopes. The area is maintained well and is mowed regularly. There are seven passive gas vents on top of the landfill that are in good condition and show no signs of leakage or settlement. The service road around the landfill is maintained and in good condition.

13.6 TECHNICAL ASSESSMENT

A conclusion of the risk assessment for the C-746-K Sanitary Landfill was the unit posed unacceptable risk to industrial workers and animals via direct contact with leachate and contaminated sediments. The overall objectives of the C-746-K Landfill ROD were to control the release of COCs from the unit, reducing ecological risks, and to limit human contact.

The current remedy for the C-746-K area includes institutional controls and engineered barriers to prevent exposure, along with groundwater monitoring for potential migration of contaminants off-site. This remedy continues to be protective of human health and the environment by restricting direct exposure.

Additional seeps were noted during the inspections of 2017, and it was determined that sampling of these seeps would occur. KDEP was notified and requested opportunity to split samples of the leachate. The seeps were tracked for several months, and it was determined that the seeps produced insufficient leachate for sample collection.

13.6.1 Question A: Is the Remedy Functioning as Intended by the Decision Documents?

Yes. The remedy is functioning as intended. The riprap, landfill cap, and signs are in place and in good condition. No problems were noted with the landfill's O&M.

13.6.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of the Remedy Selection Still Valid?

DOE remains in control of the property that the C-746-K Sanitary Landfill encompasses and the land use remains industrial. The facility's excavation/penetration permit program requires formal authorization prior to performance of all excavations and other intrusive activities; therefore, the exposure assumptions used in the ROD regarding disturbance or contact with the waste, sediments, and leachate remain valid. There have been changes to the risk assessment methodology, but the protectiveness of the remedy was not affected. There have been no new contaminants or new understanding of geologic conditions identified.

No cleanup levels were established in the ROD because the selected remedy did not include excavation and removal or treatment of the waste and impacted soils.

There are no changes in standards identified as ARARs in the ROD that impact the protectiveness of the remedy. Additionally, there are no newly promulgated standards that might apply or be relevant and appropriate to the site that affect the protectiveness of the remedy. Finally, there are no changes in TBCs identified in the ROD that impact the protectiveness of the remedy. The following change was identified in the 2013 Five-Year Review, but does not impact the protectiveness of the remedy.

- DOE O 5400.5 has been superseded by DOE O 458.1.

The RAOs used at the time of remedy selection still are valid.

13.6.3 Question C: Has Any Other Information Come to Light That Could Call into Question the Protectiveness of the Remedy?

No other information has come to light that would call into question the protectiveness of the remedy.

13.6.4 Technical Assessment Summary

The remedy is functioning as intended by the ROD. ARARs for leachate discharges and radionuclide exposures cited in the ROD have been met. During the 2013–2017 five-year review period, the RA at the C-746-K Sanitary Landfill continued to reduce the potential for human exposure by notifying persons of the potential hazards in the area from contaminants seeping from the landfill. The potential for direct human contact also is reduced by placement of riprap along the seeps and by deed notice and restrictions recorded for the C-746-K Sanitary Landfill, which restrict use of the property.

13.7 ISSUES

None.

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14. FIRE TRAINING AREA

The Fire Training Area (SWMU 100) is located in the southwest corner of the Paducah Site. At the time of the investigation of this area, it consisted of one large rectangular surface burn area, two circular burn pan areas, one circular electric pump area, an elevated and bermed fuel tank area, and two square burn area depressions. The burn areas were unlined and were not bermed. The Fire Training Area has been used since 1982 for staging fire training exercises involving waste oils, fuels, and other combustible liquids. Combustible liquids were not burned in the unlined areas after 1987. Fire training exercises continue to be conducted in the vicinity, but in order to prevent any negative impacts to the environment, no burning is conducted in unlined areas, and flammable liquids no longer are used. Figure 14.1 illustrates the location of the Fire Training Area.

14.1 REMEDY SELECTION

The selected remedy for the Fire Training Area, which depends on the area remaining industrial, was NFA (outside of maintaining institutional controls), as documented in the *Record of Decision for Waste Area Groups 1 and 7 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/06-1470&D3 (DOE 1998b).

14.2 REMEDY IMPLEMENTATION

The remedy selected was NFA, and DOE remains in control of the property that the Fire Training Area encompasses.

14.3 SYSTEMS OPERATIONS/OPERATIONS AND MAINTENANCE

The costs associated specifically with maintenance of the Fire Training Area are not tracked separately because they are part of the facilitywide, long-term surveillance and maintenance and environmental monitoring programs.

14.4 PROGRESS SINCE LAST FIVE-YEAR REVIEW

The summation of the 2013 Five-Year Review protectiveness statement follows: The remedy for the Fire Training Area is protective of human health and the environment. Exposure pathways that could result in unacceptable risk are being controlled. This project is not a final action and was not designed to return the area to unrestricted use.

There have been no previous issues or recommendations for the Fire Training Area. The area remains unchanged as described in the 2013 Five-Year Review, and no new actions have occurred.

14.5 SITE INSPECTION

A site inspection of the Fire Training Area was conducted on December 6, 2017, by a member of the Five-Year Review team. Fire-fighting equipment was present at the facility. Grass was established in the area and appears to be maintained. There were no areas of erosion. The facility manager was consulted with regard to the facility and did not have any concerns.

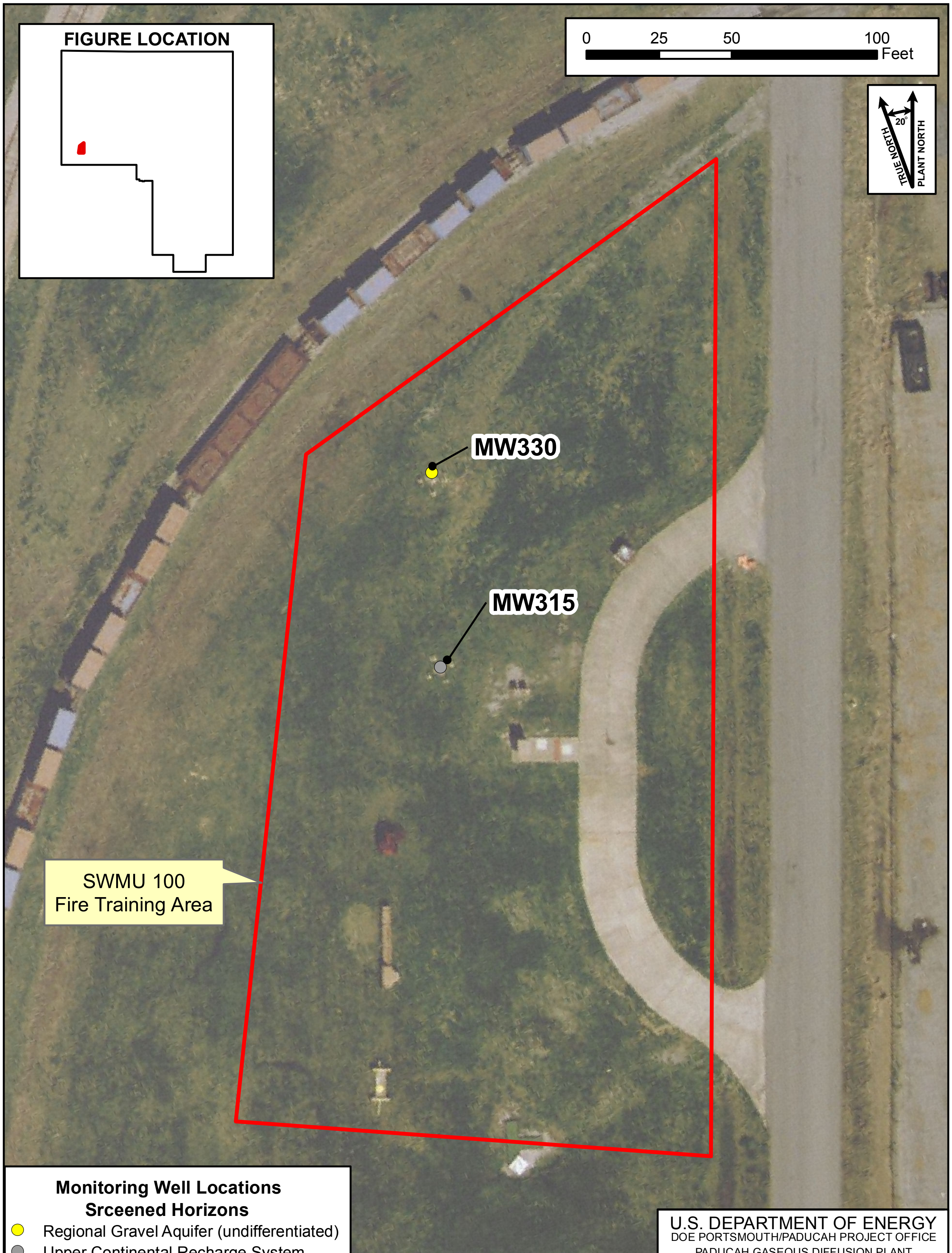

Figure 14.1. Location of the Fire Training Area

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14.6 TECHNICAL ASSESSMENT

There have been no detrimental changes to the Fire Training Area. The NFA decision remains protective. Its current use as a fire-fighters training area shows no apparent harm to the environment. No further action is necessary to protect site workers at the Fire Training Area who are not associated with the fire protection department.

14.6.1 Question A: Is the Remedy Functioning as Intended by the Decision Documents?

Yes. The remedy, specifically the current land use, is functioning as intended.

14.6.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of the Remedy Selection Still Valid?

Yes. DOE remains in control of the property that the Fire Training Area encompasses, and the land use remains industrial. The facility's excavation/penetration permit program requires formal authorization prior to performance of all excavations and other intrusive activities; therefore, the exposure assumptions used in the ROD remain valid. For the Fire Training Area, the WAGs 1 and 7 RI report states that the primary pathway contributing to both the total HI and the total ELCR is dermal contact with sediment (DOE 1996b).

Updates have been made to toxicity values since the 1996 RI, but these updates do not impact the remedy selected adversely. Although there have been changes to the risk assessment methodology, the protectiveness of the remedy has not been affected. There have been no new contaminants or new understanding of geologic conditions identified.

No cleanup levels, RAOs, or ARARs were established in the ROD because the selected remedy was NFA (outside of maintaining institutional controls).

14.6.3 Question C: Has Any Other Information Come to Light That Could Call into Question the Protectiveness of the Remedy?

No other information has come to light that would call into question the protectiveness of the remedy.

14.7 ISSUES

None.

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15. SURFACE WATER INTERIM CORRECTIVE MEASURES

Initial SIs at the Paducah Site indicated that various units were contributing to off-site surface water contamination. The *Results of the Site Investigation, Phase I*, KY/ER-4, (CH2M HILL 1991) give a preliminary description of the nature and extent of contamination and risk associated with the off-site contamination. Phase II [*Results of the Site Investigation, Phase II*, KY/SUB/13B-97777C, P-03 1991/1 (CH2M HILL 1992)] of the investigation further assessed the nature, extent, and risk of off-site contamination and identified and characterized those SWMUs possibly contributing to off-site contamination. Phase II also included the draft PHEA. The results of the SI identified 21 SWMUs that were believed to be contributing to off-site contamination. Of these, nine were identified as contributing primarily to groundwater contamination, nine were identified as contributing primarily to soils and sediment contamination, and three were found to be contributing to both. The contaminants included PCBs, radionuclides [primarily uranium-238 (U-238)] and metals.

Of particular concern at the time were the surface water, sediment, and soils at KPDES outfalls west, north, and east of the facility. These included KPDES Outfalls 001, 002, 003, 010, 011, and 012. Surface-water patterns at the facility at the time that the action took place have changed significantly. The concerns at the time are noted below, along with information on whether that surface water drainage has changed.

15.1 REMEDY SELECTION

In July 1993, DOE implemented an interim measure to reduce potential for exposure to contamination in surface water and sediment in the vicinity of the Paducah Site. The proposed action was documented in the *Interim Corrective Measure Workplan for Institutional Control of Offsite Contamination in Surface Water Outfalls, Creeks, and Lagoons*, DOE-OR 1030 (DOE 1992b). The actions chosen were installation of fencing and posting of signs to warn people in the area of the dangers posed by direct contact with the water and/or sediments.

The objectives of the Surface Water ICMs chosen actions were the following:

- To restrict access by the general public and site personnel to contaminated areas, thus reducing direct exposure and the potential for inadvertent transport of contaminants;
- To restrict access by the general public to contaminated areas for recreational uses;
- To identify contamination areas to the public and site personnel; and
- To monitor water and sediments as part of the KPDES program.

No ARARs were identified for this action in the decision document.

A modification to the work plan, as documented in the approved *Interim Measure Report for Institutional Control of Off-Site Contamination in Surface Water*, DOE/OR/07-1206&D1, had deferred activities on Bayou Creek until additional characterization was performed (DOE 1993c).

15.2 REMEDY IMPLEMENTATION

To achieve the objectives listed, signs and fencing were required for the locations indicated on Figure 15.1. DOE installed fencing and posted warning signs in areas of contamination at eight location areas to prevent direct human contact with contaminated sediments. Each location area was posted with a varying number of signs, dependent upon the area of contamination. These signs are referred to as the Surface Water ICM signs. The *Operations and Maintenance Plan for Institutional Control of Off-site Contamination in Surface Water at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, KY/ER-42, (MMES 1993b) was the original documentation for the O&M activities for the Surface Water ICM.

The language originally proposed was revised in the document, *Operation and Maintenance Plan for the Surface Water Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1904&D1 (DOE 2000c). The O&M requirements were revised again in 2015 to incorporate the recommendation in the 2013 Five-Year Review in the document *Operation and Maintenance Plan for the Surface Water Operable Unit at the Paducah Gaseous Diffusion Plan, Paducah, Kentucky*, (DOE/OR/07-1904&Dl/R2) (DOE 2015f). The recommendation was made to replace the Surface Water ICM signs with the more current language of the environmental indicator (EI) signs. Each sign has been assigned a unique number, thereby allowing the ICM locations to be identified separately for this and subsequent five-year reviews.

Water and sediments were monitored as part of the KPDES program. All KPDES program requirements are specified in the EMP, which is updated on an annual basis.

15.3 SYSTEMS OPERATIONS/OPERATIONS AND MAINTENANCE

The O&M requirements were revised in the *Operation and Maintenance Plan for the Surface Water Operable Unit at the Paducah Gaseous Diffusion Plan, Paducah, Kentucky* (DOE/OR/07-1904&Dl/R2 (DOE 2015f). Signs are inspected semiannually and repaired or replaced, as needed.

Although sampling and assessment of surface water and sediment data are part of the site Environmental Monitoring Program, it is not part of the Surface Water ICM. The results of the Environmental Monitoring Program are reported in the Annual Site Environmental Report.

The environmental responses for the NSDD, Scrap Metal Disposition Project, and SWOU On-site have impacted the Surface Water ICM. These actions included construction projects inside the Paducah Site to prevent transport of contaminated sediment off-site (i.e., outside the existing security fence and off DOE property); and, in 2010, the Surface Water On-site Sediment Removal Project (discussed in Chapter 16) removed areas of contaminated sediment both inside and outside the facility security fence. After September 11, 2001, the Paducah Site instituted a security buffer zone, which prevents members of the public from accessing the locations of some signs (see Figure 15.1 for current areas closed to public access). Considering the limited access that has been imposed at some of the sign locations and the environmental response actions that have taken place, the possibility of long-term exposure of humans to contaminated sediment and surface water is much less than it was when the signs were put in place.

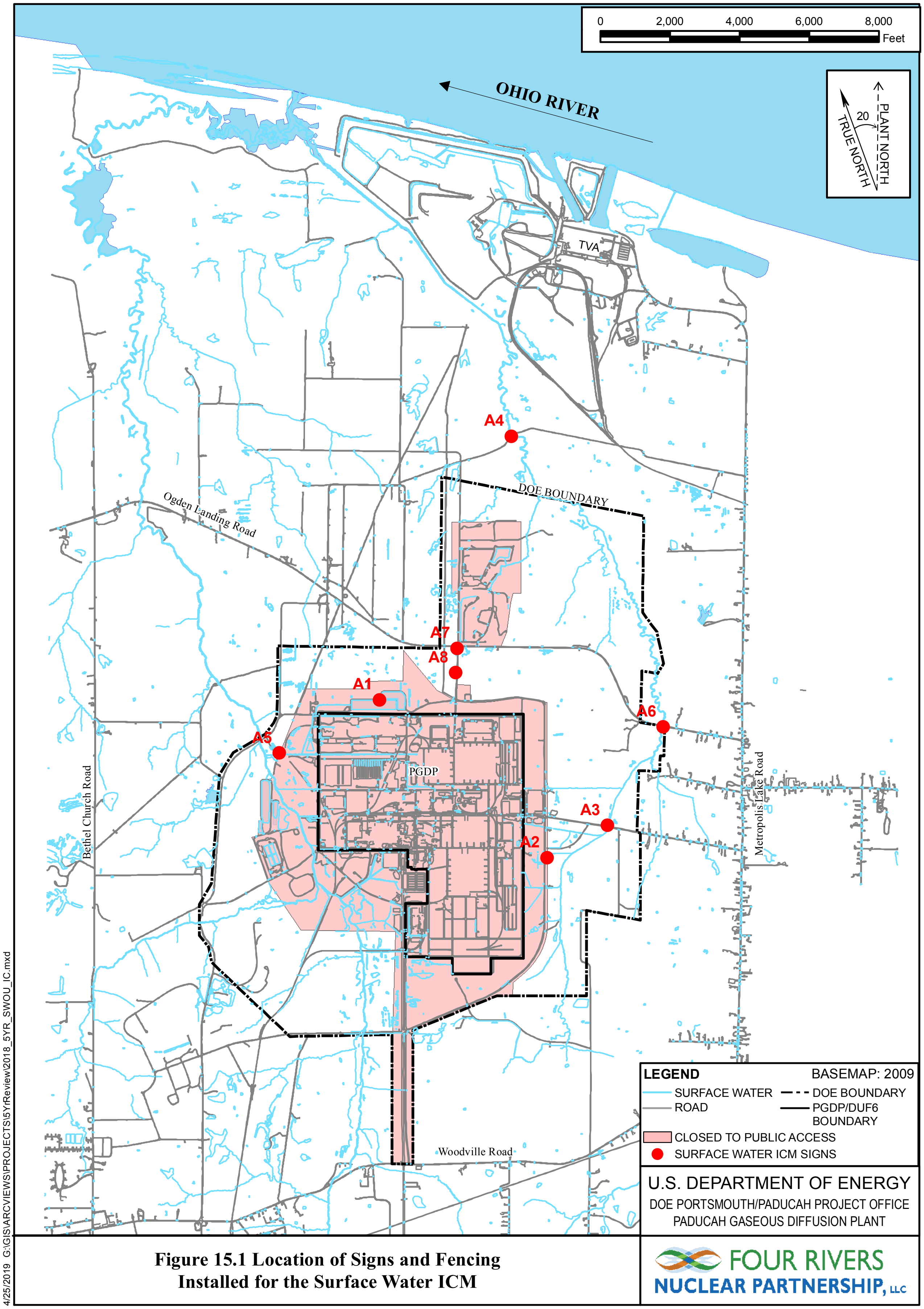

Figure 15.1 Location of Signs and Fencing Installed for the Surface Water ICM

15.4 PROGRESS SINCE LAST FIVE-YEAR REVIEW

The 2013 review contained the following protectiveness statement:

> The remedy for the surface water ICMs currently protects human health and the environment by institutional controls; however, additional actions under the SWOU need to be evaluated for long-term protectiveness.

15.5 SITE INSPECTION

The locations of the signs and fences were inspected on December 13, 2017, by the Five-Year Review team and the facility manager (see Figure 15.2–Figure 15.4 for examples). The ICM signs all were legible. Also, at all locations the Surface Water ICM signs were posted along with “KEEP OUT,” “NO TRESPASSING,” and radiological warning signs. The fences at all locations were in place.

Figure 15.2. Sign and Fencing Installed for the Surface Water ICM

Figure 15.3. Sign and Fencing Installed for the Surface Water ICM

Figure 15.4. Sign and Fencing Installed for the Surface Water ICM

15.6 TECHNICAL ASSESSMENT

Outfalls 002, 010, 011, 012, 013, 019, and 020 drain the eastern boundary of the facility and flow eastward toward Little Bayou Creek. The areas included in the drainage networks for these outfalls are comprised mostly of former plant processes areas and the on-site landfill. In 2010, the Surface Water On-site Sediment Removal (discussed in Chapter 16) removed areas of contaminated sediment, both inside and outside the facility security fence. There have been no construction projects since the last Five-Year Review that would affect drainage in these drainage networks.

Outfall 001 drains the units in the northwest corner of the security-fenced area. The C-613 Sedimentation Basin was constructed as part of the Scrap Metal Disposition Project to capture contaminated sediment that was transported off-site (i.e., outside the existing security fence) while moving heavy equipment inside the C-746-P, C-746-E, and C-746-C Scrap Yards during sorting, segregating, downsizing, and packaging activities and during ongoing and upcoming environmental response actions.

The surface water flowing north of the facility was drained primarily by KPDES Outfall 003, which drained some overflow during storm events from the NSDD. Actions taken by two projects discussed in other chapters of this report, NSDD Source Control (Chapter 11) and NSDD Sections 1 and 2 (SWMU 59) (Chapter 12), have eliminated this outfall. The storm water that drained through NSDD to Outfall 003 when the Surface Water ICM was implemented was diverted to the C-616 treatment facility, and then it is discharged through Outfall 001.

15.6.1 Question A: Is the Remedy Functioning as Intended by the Decision Documents?

Yes. Potential users of creeks, ponds, or streams outside the facility security fence are warned that contact with contaminated water and sediment may pose potential dangers, as detailed in Section 15.5, "Site Inspection." Sediments and water continue to be monitored through the Environmental Monitoring Program in accordance with the KPDES Permit, and results are made available through the Annual Site Environmental Report. Since 2013, the KPDES outfalls associated with DOE's permit have exceeded their permit limits a few times, but overall, remain compliant.

15.6.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of the Remedy Selection Still Valid?

Yes. Land use for the area has not changed. Exposure pathways included direct radiation, ingestion of fish, dermal absorption, ingestion of sediment and water, although specific exposure parameters were not described in the decision document. These exposure pathways still are valid. This interim action did not remove the source of contamination, nor did it prevent biota exposed to the surface water and sediment from becoming contaminated. Changes in risk assessment methodology subsequent to the ROD have been significant. These changes, however, are not pertinent because the remedy relied on two components: (1) access restrictions through use of signs and fences, and (2) continued monitoring of water and sediments as part of the KPDES program. Neither of these components is related to changes in risk methodology.

Toxicity information or specific cleanup criteria were not discussed in the work plan because the selected remedy did not include excavation and removal of impacted soils/sediments. There have been no new contaminants or new understanding of geologic conditions identified.

There were no ARARs identified in the work plan (DOE 1992b).

The RAOs used at the time of remedy selection still are valid.

15.6.3 Question C: Has Any Other Information Come to Light That Could Call into Question the Protectiveness of the Remedy?

No. The NSDD, Sections 3, 4, and 5 (SWMU 58), are part of the Surface Water ICMs. As part of the SWOU On-Site Removal Action Report, a residual risk evaluation was prepared that included these sections of the NSDD (DOE 2011a). Analytical data were compared against current industrial worker no action levels at all locations and recreational user no action levels at the NSDD for soil/sediment presented in *Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/OR/07-1506&D2 (DOE 2001b). The RAO for the removal action was met, which was to ensure direct contact risk at the NSDD for both the current industrial worker and recreational user falls within the EPA risk range. The calculation of cumulative residual risk and hazard indicates that the cleanup goal to achieve to a cumulative ELCR of 1E-05 and a cumulative HI of 1.0 was obtained for the targeted action areas, but did not provide for unlimited use/unrestricted exposure (see Section 16.6.2 for additional information).

No other information has come to light that would call into question the protectiveness of the remedy.

15.6.4 Technical Assessment Summary

This action is meeting the objectives as stated in the decision document by restricting access to the general public and site personnel to contaminated areas; restricting access by the general public to contaminated areas for recreational uses; identifying contamination areas to the public and site personnel; and monitoring water and sediments as part of the KPDES program. This action was not intended to restore the area in which it was implemented to unrestricted use.

15.7 ISSUES

None.

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16. SURFACE WATER ON-SITE SEDIMENT REMOVAL

NSDD Sections 3, 4, and 5 and Outfalls 001, 008, 010, 011, and 015 and their associated internal ditches and areas have been identified as SWMUs under the FFA due to the potential for actual or threatened releases of hazardous constituents. The following are the specific SWMUs.

- SWMU 58—Sections 3, 4, and 5 of the NSDD
- SWMU 63—Outfall 008
- SWMU 66—Outfall 010
- SWMU 67—Outfall 011
- SWMU 68—Outfall 015
- SWMU 69—Outfall 001
- SWMU 92—C-420 PCB Spill
- SWMU 97—C-601 Diesel Spill

The identified contamination was derived from surface water runoff and wastewater from various facility activities conducted at the Paducah Site, and it was determined to pose human health risks from direct contact with contaminated sediments greater than the EPA risk range under some scenarios. Figure 16.1 illustrates the location of the Surface Water On-site Sediment Removal action.

Sections 3, 4, and 5 of the NSDD (SWMU 58) are located outside the security-fenced area on property owned by DOE. The NSDD originates within the north-central portion of the Paducah Site and discharges into Little Bayou Creek north of the facility.

Outfalls 001, 008, 010, 011, and 015 and their associated internal ditches and areas are located both inside and outside the security-fenced area on property owned by DOE. The internal facility ditches that discharge to NSDD and the outfalls were trenched when PGDP was built and became fully operational when PGDP was opened in 1951. Water discharged at each outfall is regulated by a KPDES Permit, and the water quality is tested regularly at established monitoring stations, in accordance with the conditions of the KPDES Permit.

The C-420 PCB Spill was designated as a SWMU due to placement of PCB-contaminated soils as fill from a transformer rupture in 1967. The C-601 Diesel Spill was designated as a SWMU due to a diesel oil spill that occurred on March 9, 1979.

NSDD Sections 3, 4, and 5 and KPDES Outfalls 001, 008, 010, 011, and 015 and their associated internal ditches and areas (including the C-420 PCB Spill and the C-601 Diesel Spill) have been characterized in several investigations. These included the Phase I and Phase II SIs (CH2M HILL 1991; CH2M HILL 1992); various WAG and SWMU RIs, site evaluations, and removal actions; and a 1996 PCB Study by the U.S. Army Corps of Engineers (COE 1996). In 2005, the SI for the SWOU (On-Site) was conducted and focused on the first sequenced response action for on-site portions of the SWOU at the Paducah Site (DOE 2008b). The investigation involved collection of surface soil and sediment samples from various outfalls and their associated internal ditches and storm sewer discharge water to evaluate areas within the SWOU that had the greatest potential for contaminant discharge to creeks surrounding the facility.

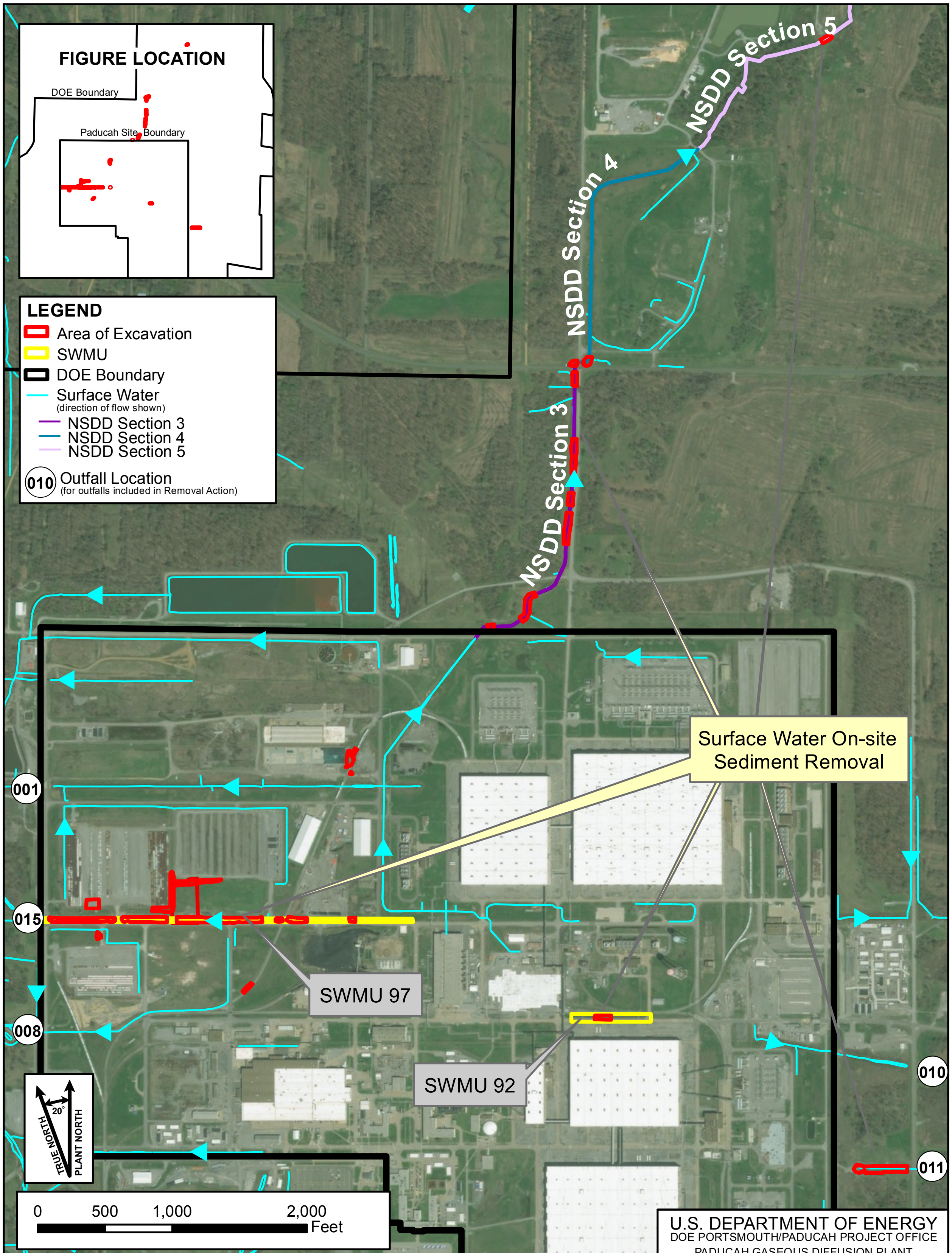

Figure 16.1. Location of Surface Water On-Site Sediment Removal

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16.1 REMEDY SELECTION

The Surface Water On-site Sediment Removal was performed as a NTCRA under the Paducah FFA. The *Action Memorandum for Contaminated Sediment Associated with the SWOU (On-Site) at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0119&D2/R1, (DOE 2009b) documents the NTCRA in specific areas or defined exposure units (EUs) located within KPDES Outfalls 001, 008, 010, 011, and 015 and their associated internal ditches and specific areas or EUs located within the NSDD Sections 3 and 5. Section 4 did not have any identified "hot spots." This action implements excavation and removal of "hot spots" associated with these areas and includes one or more engineering controls to prevent transport of contaminated soils and sediment, as needed, during removal activities.

CERCLA documents that described the logic for this project and the basis for its implementation are as follows: *Engineering Evaluation/Cost Analysis for Contaminated Sediment Associated with the Surface Water Operable Unit (On-Site) at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0012&D2 (DOE 2008c); *Action Memorandum for Contaminated Sediment Associated with the SWOU (On-Site) at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07 0119&D2/R1 (DOE 2009b); and *Removal Action Work Plan for Contaminated Sediment Associated with the Surface Water Operable Unit (On-Site) at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0221&D2/R1 (DOE 2009c).

The following RAOs were consistent with the overall RAOs for the SWOU.

- Ensure direct contact risk at the on-site ditches for the current industrial worker falls within the EPA risk range (EPA 1999).

- Ensure direct contact risk at the NSDD for both the current industrial worker and recreational user falls within the EPA risk range (EPA 1999).

16.2 REMEDY IMPLEMENTATION

The action implemented excavation and removal of areas of known contamination (i.e., soil/sediment) associated with the NSDD Sections 3 and 5 and KPDES Outfalls 001, 008, 010, 011, and 015 and their associated internal ditches and areas (including the C-420 PCB Spill and the C-601 Diesel Spill).

The action was implemented in November 2009 and completed in September 2010 and consisted of the following components.

- Excavated hot spots to a depth of 2 ft to eliminate the risk of human receptors contacting contaminated sediment. Hot spots under this action were identified using a cumulative ELCR of 1E-05 and a cumulative HI of 1.0.

- Collected samples from the bottom of the hot spot to confirm that the specified cleanup levels were achieved, subsequently meeting the project RAOs.

- Verified, consistent with the results of the risk-based cost-benefit analysis, cleanup to the cumulative ELCR of 1E-05 and a cumulative HI of 1.0 following excavation was based upon comparisons between sampling results and chemical-specific ELCR-based and HI-based cleanup levels. The ELCR target used in deriving the cleanup levels was 5E-06. The HI target used in deriving the cleanup levels was 1.0.

- Implemented methods to validate the achievement of the chemical-specific cleanup levels similar to the NSDD Sections 1 and 2 (SWMU 59) remediation.

- Installed temporary, localized engineering controls, including a small storm water retention area, silt fencing, and rock check dams during excavation activities. Installation controlled sediment and contaminant migration from the action.

- Restored (i.e., backfill with clean soil, reseeding, etc.) disturbed acreage to prevent erosion, migration and recontamination.

- Characterized, containerized, transported, and disposed of all equipment and contaminated soil/sediment at an appropriate disposal/storage facility.

- Assessed temporary localized engineering controls and discontinued as appropriate.

- Continued inspection and site maintenance, during and after excavation and restoration, to control erosion until the excavated/restored area was stable.

Figures 16.2 through 16.4 show current views of KPDES Outfalls 001, 010, and 015 and their associated internal ditches and areas. The total cost of excavation and disposing of the approximately 10,160 yd^3 of soil in the C-746-U Landfill and 12,517 yd^3 of soil at Energy*Solutions* was $18,312,363, according to the *Removal Action Report for Contaminated Sediment Associated with the Surface Water Operable Unit (On-Site) at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0357&D2 (DOE 2011a).

The RAOs were attained through removal of identified hot spots and verification of cleanup to a cumulative ELCR of 1E-05 and a cumulative HI of 1.0. The cumulative hazard and cancer risk for the EUs are listed in Table 16.1.

A residual risk evaluation was prepared as part of the Removal Action Report (DOE 2011a). Analytical data were compared against current industrial worker no action levels at all locations and recreational user no action levels at the NSDD for soil/sediment presented in *Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1506&D2 (DOE 2001b). The calculation of cumulative residual risk and hazard indicates that the removal goal of cleanup to a cumulative ELCR of 1E-05 and a cumulative HI of 1.0 was achieved.

This NTCRA was considered complete after the RAOs had been verified as achieved; verification or characterization sampling was performed; engineering and temporary access controls were evaluated and discontinued, as appropriate; the site was restored and determined stable; and treatment, storage, or disposal of contaminated media and waste was completed.

16.3 SYSTEMS OPERATIONS/OPERATIONS AND MAINTENANCE

There is no O&M for this remedy.

Figure 16.2. Outfall 001 Internal Ditches, December 14, 2017 (Looking Northwest)

Figure 16.3. Outfall 010 Internal Ditch and Area, December 14, 2017 (Looking West)

Figure 16.4. Outfall 015 Internal Ditches, December 14, 2017 (Looking West)

Table 16.1. Cumulative ELCR and HI for SWOU EUs

Outfall/NSDD Section	EU	ELCR (Cancer)	HI (Hazard)
INDUSTRIAL WORKER			
Outfall 001	15	4.90E-06	0.1
Outfall 008	11	4.50E-06	0.1
Outfall 010	10	4.30E-06	0.1
Outfall 011	1	3.80E-06	0.3
Outfall 015	2	2.50E-06	0.1
	3	2.20E-06	0.1
	4	1.00E-05	0.2
	7	2.80E-06	0.1
	8	9.20E-06	0.2
Section 3	1	3.90E-06	0.2
	2	5.10E-06	0.1
	3	7.30E-06	0.2
Section 5	8	5.80E-06	0.4
RECREATIONAL USER			
Section 3	1	5.40E-06	< 0.1
	2	5.30E-06	< 0.1
	3	5.80E-06	< 0.1
Section 5	8	1.20E-05	< 0.1

16.4 PROGRESS SINCE LAST FIVE-YEAR REVIEW

The summation of the 2013 Five-Year Review protectiveness statement follows: The remedy for the Surface Water On-site Sediment Removal is protective of human health and the environment in the short-term due to excavation of contaminated sediment/soil and placement of clean soil to meet the cleanup goal. In order to establish long-term protectiveness, additional RAs will be evaluated and selected, as necessary, under the SWOU.

There have been no previous issues or recommendations for the Surface Water On-site Sediment Removal. The area remains unchanged as described in the 2013 Five-Year Review, and no new actions have occurred.

16.5 SITE INSPECTION

A site inspection was conducted on December 6, 12, and 14, 2017, by members of the Five-Year Review team. All areas were grass covered or riprap covered and in good condition. Some signs of erosion were noted near Section 3 of the NSDD on the steep slopes and on portions of the C-601 Diesel Spill area. Standing water also was noted in several locations.

16.6 TECHNICAL ASSESSMENT

The RA for NSDD Sections 3 and 5 and KPDES Outfalls 001, 008, 010, 011, and 015 and their associated internal ditches and areas (including the C-420 PCB Spill and the C-602 Diesel Spill) are protective of human health and the environment because the threat of exposure from direct contact was eliminated by removing the known sources of contamination.

16.6.1 Question A: Is the Remedy Functioning as Intended by the Decision Documents?

Yes. The remedy is functioning as designed. The excavation, as designed, met or exceeded the cleanup criteria. The RAOs for this removal action were achieved by reducing the risk to current industrial workers and recreational users from direct contact by removing known sources of contamination.

16.6.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of the Remedy Selection Still Valid?

The land use has not changed for each area addressed by the removal action and remains either industrial or recreational; therefore, the exposure assumptions used in the AM remain valid (DOE 2009b).

There have been changes to the risk assessment methodology, but the protectiveness of the remedy was not affected as demonstrated by the results of the residual risk evaluation. There have been no new contaminants or new understanding of geologic conditions identified.

Many of the new risk-based values, compared to the cleanup level established in the AM are lower because the exposure factors are higher for the new standards (Table 16.2) (DOE 2009b). The cleanup levels were based on a current industrial worker accessing the ditches 14 days per year. Using exposure factors in the Risk Methods Document (DOE 2017h) and an exposure frequency of 14 days per year, updated standards were derived using the Risk Assessment Information System (RAIS) (RAIS 2018). The updated standards are similar or greater than the cleanup levels (i.e., an ELCR of 1E-05). The cleanup levels still are protective.

There are no changes in standards identified as ARARs in the AM that impact the protectiveness of the remedy. Additionally, there are no newly promulgated standards that might apply or be relevant and appropriate to the site that affect the protectiveness of the remedy. Finally, there are no changes in TBCs identified in the AM that impact the protectiveness of the remedy. The following changes were identified, but do not impact the protectiveness of the remedy.

- DOE O 5400.5 (II)(5)(c)(6), 5400.5 (II)(5)(c)(1), and 5400.5(IV)(4)(d) have been superseded by DOE O 458.1.

The RAOs used at the time of remedy selection still are valid.

16.6.3 Question C: Has Any Other Information Come to Light That Could Call into Question the Protectiveness of the Remedy?

No other information has come to light that would call into question the protectiveness of the remedy.

16.7 ISSUES

None.

Table 16.2. Changes in Chemical-Specific Standards for the Surface Water On-Site Sediment Removal

Contaminant	Media	Cleanup Level[a] (DOE 2009b)	Standard[b] (RAIS 2018)
Arsenic	Sediment	27 mg/kg	143 mg/kg
Beryllium	Sediment	50,000 mg/kg	620,000 mg/kg
Total PCB	Sediment	16 mg/kg	26.2 mg/kg
Americium-241	Sediment	115 pCi/g	537 pCi/g
Cesium-137	Sediment	8 pCi/g	9.62 pCi/g
Neptunium-237	Sediment	22 pCi/g	22.3 pCi/g
Plutonium-239/240	Sediment	108 pCi/g	2,030 pCi g
Technetium-99	Sediment	3,825 pCi/g	113,000 pCi/g
Thorium-230	Sediment	147 pCi/g	2,800 pCi/g
Thorium-232	Sediment	129 pCi/g	2,750 pCi/g
Uranium-234	Sediment	188 pCi/g	4,470 pCi/g
Uranium-235	Sediment	30 pCi/g	36.5 pCi/g
Uranium-238	Sediment	94 pCi/g	148 pCi/g
Uranium	Sediment	227 mg/kg	8,330 mg/kg

[a] Previous standards were derived from risk-based human health cleanup levels for restricted use of area by a current industrial worker and were set at the risk-based target of ELCR = 5E-06 for most COCs and a target of HI = 1.0 for uranium (metal) to achieve cleanup of a cumulative ELCR of 1E-05 and a cumulative HI of 1.0, see Section 3 and Table 1 of the AM (DOE 2009b).

[b] Updated standards are based on a similar exposure frequency of 14 days/year and other industrial worker exposure parameters from the 2017 Risk Methods Document (DOE 2017h). The updated standards were calculated for the risk-based target of ELCR = 5E-06 for most COCs and a target of HI = 1.0 for uranium (metal) using http://rais.ornl.gov/cgi-bin/prg/PRG_search (accessed January 2018).

17. C-749 URANIUM BURIAL GROUND

The C-749 Uranium Burial Ground (SWMU 2) is located in the west-central portion of the facility north of Virginia Avenue and on the western edge of the C-404 Low-Level Radioactive/Hazardous Waste Burial Ground (SWMU 3) (Figures 17.1 and 17.2). The C-749 Uranium Burial Ground was used from approximately 1951 to 1977 for the disposal of uranium and uranium-containing wastes.

17.1 REMEDY SELECTION

The *Record of Decision for Interim Remedial Action at Solid Waste Management Units 2 and 3 of Waste Area Group 22 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/06-1351&D1, was signed in 1995 (DOE 1995d). Because the C-404 Contaminated Burial Ground (SWMU 3) is closed with a RCRA cap and is being addressed by RCRA postclosure permit requirements, the 1995 ROD required NFA for it. For the C-749 Uranium Burial Ground, the interim ROD selected an impermeable cap to reduce leachate migration from surface infiltration, groundwater monitoring, and institutional controls.

DOE conducted an investigation at the C-749 Uranium Burial Ground to provide information needed before the selected interim action was fully implemented and to provide additional data to evaluate a final RA for the C-749 Uranium Burial Ground (DOE 1997b). One of the goals of this investigation was to determine if the waste within the C-749 Uranium Burial Ground was saturated with groundwater. The results of the investigation indicated that the waste within was saturated; therefore, placement of a cap on the C-749 Uranium Burial Ground and the design and construction activities outlined within the ROD were canceled (Hodges 1996). The following are the conclusions of the investigation.

- Uranium and uranium precipitate dissolver sludge, contaminated with TCE from the C-400 Cleaning Building, is the primary component of the buried waste (with minimal, associated PCB oil).

- Migration of contaminants from the waste cell and underlying contaminated soil may have contributed to TCE at the Paducah Site complex boundary in concentrations that exceed both human health risk-based and regulatory (i.e., MCL) preliminary remediation goals; however, modeling indicates that migration of radionuclides is not a concern.

- Lateral movement of groundwater in the UCRS does occur, but not to a significant extent. Vertical transport of TCE is significant, but vertical transport of uranium is not significant.

The RAOs for the interim action were to mitigate migration of uranium and TCE from the C-749 Uranium Burial Ground to groundwater and to prevent disturbance or contact with the buried waste materials. To accomplish this, the selected IRA, Alternative 5, consisted of installation of the following components.

- Once a determination has been made regarding possible groundwater interaction with the buried wastes, a low permeability, multilayered cap may be placed on the C-749 Uranium Burial Ground to reduce infiltration of surface water from precipitation events into and through buried wastes. This also will reduce potential leaching of contaminants to groundwater. The cap also will decrease the gamma exposure rate to background levels and further decrease the likelihood of on-site workers and terrestrial animals coming into direct contact with the buried wastes.

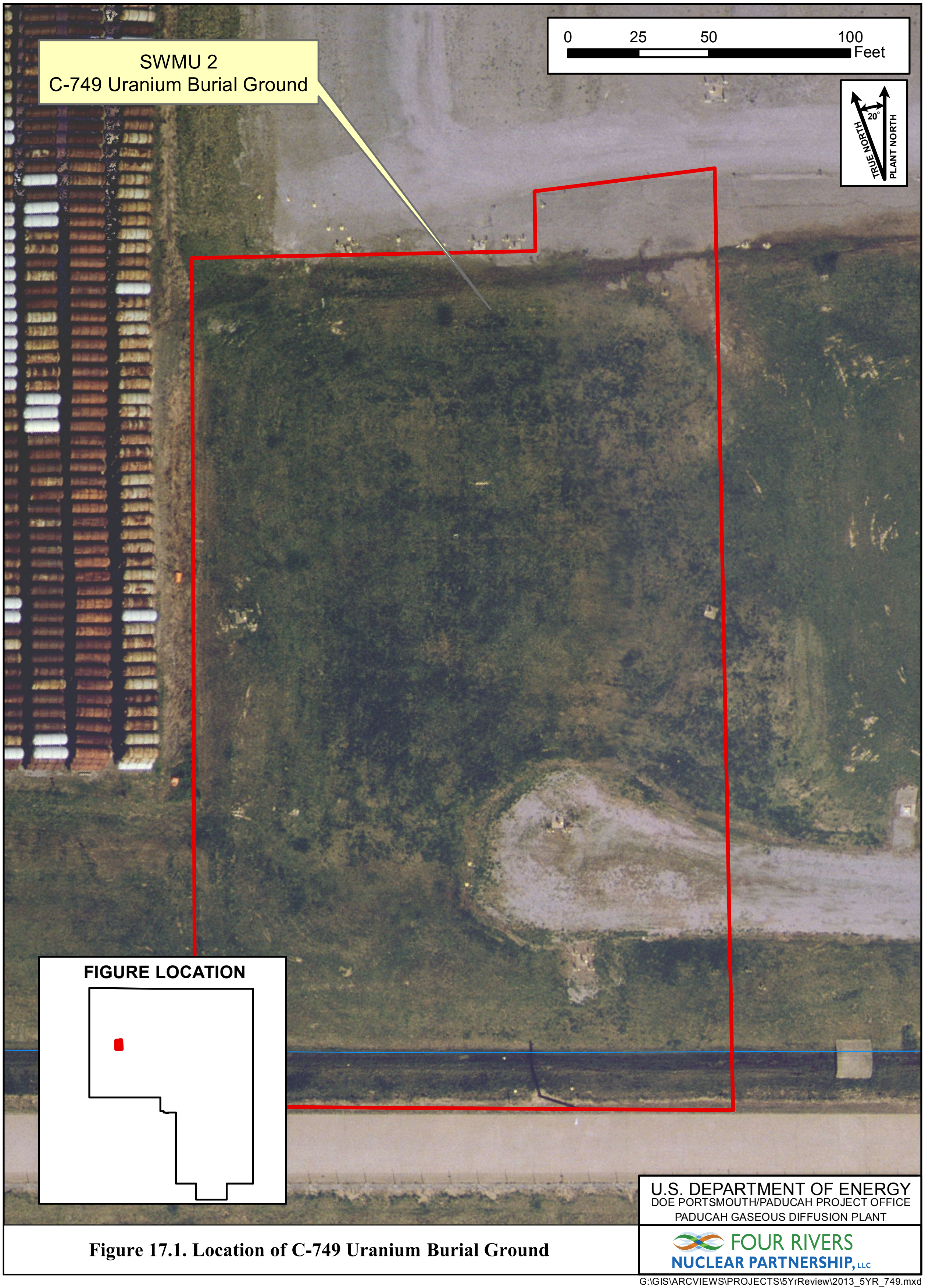

Figure 17.1. Location of C-749 Uranium Burial Ground

Figure 17.2. C-749 Uranium Burial Ground

- A groundwater monitoring program will be implemented in the uppermost aquifer, the RGA, to detect any release of contaminants from the C-749 Uranium Burial Ground.

- Institutional controls will be implemented to prevent transferal of the C-749 Uranium Burial Ground property and prevent future intrusive activities at the unit (DOE 1995d).

In addition to the five-year review, the ROD states that the groundwater data will be evaluated annually. These evaluations are documented in the FFA semiannual reports. The October 2017 report contains a map depicting the C-749 Uranium Burial Ground groundwater MWs and a summary of the trends for TCE and Tc-99 for reporting dates 1996 through May 2017 (DOE 2017b).

17.2 REMEDY IMPLEMENTATION

Following the post-ROD investigation, it was determined that the multilayer low-permeability cap, which was meant to minimize vertical infiltration of rain water through unsaturated waste, would be ineffective because of the shallow groundwater found at the C-749 Uranium Burial Ground. This investigation fulfilled the IRA requirement to evaluate the cap's effect(s) on the shallow groundwater level in the UCRS and fill data gaps. As a result, the multilayer low-permeability cap installation was cancelled (Hodges 1996).

In 1996, three RGA MWs were constructed to detect potential releases from the C-749 Uranium Burial Ground. MW337 and MW338 were installed downgradient of the C-749 Uranium Burial Ground, and MW333 was installed upgradient of the burial ground. The wells currently are sampled as part of the Paducah Site Groundwater Monitoring Program, as specified in the EMP (FPDP 2018).

Because the ROD for this IRA was signed prior to the effective date of the Paducah Site MOA and LUCAP, a LUCIP does not exist for the institutional controls at the C-749 Uranium Burial Ground.

DOE remains in control of the property that the C-749 Uranium Burial Ground encompasses. No deed restriction has been filed as part of this IRA. Exposure pathways that could result in unacceptable risk are being controlled through DOE ownership and use of the property.

17.3 SYSTEMS OPERATIONS/OPERATIONS AND MAINTENANCE

There is no required O&M for this remedy.

17.4 PROGRESS SINCE LAST FIVE-YEAR REVIEW

The summation of the 2013 Five-Year Review protectiveness statement follows:

> The remedy for the C-749 Uranium Burial Ground is protective of human health and the environment in the short-term. Exposure pathways that could result in unacceptable risk are being controlled through DOE access controls. This earlier remedy is not a final RA and was not designed to fully address the risks to human health and the environment from the buried wastes nor return the area to unrestricted use and/or unlimited exposure. The selected remedy for the C-749 Uranium Burial Ground was an interim action, and a final CERCLA action currently is being evaluated under the BGOU to ensure long-term protectiveness.

There have been no previous issues or recommendations for the C-749 Uranium Burial Ground. The site remains unchanged as described in the 2013 Five-Year Review, and no new actions have occurred.

17.5 SITE INSPECTION

On December 14, 2017, a site inspection of the C-749 Uranium Burial Ground was performed by members of the Five-Year Review team and the facility manager. This area is located north and west of the C-600 Building and within the boundaries of the security-fenced area of the Paducah Site. There were no indications of erosion or standing water in the area. An access road is located on the south side of the burial ground. The road is maintained well and is in good condition. Access to the north side of the area is through the C-745-C Cylinder Storage yard. This area also is maintained well. The area is covered with grass, and it is mowed and well maintained. MWs in the area appear to be in good condition and are maintained well. The wells are secured with protective caps and casings with locks and are surrounded with guard posts.

17.6 TECHNICAL ASSESSMENT

The RAOs for the interim action were to mitigate migration of uranium and TCE from the C-749 Uranium Burial Ground to groundwater and to prevent disturbance or contact with the buried waste materials.

The C-749 Uranium Burial Ground low-permeability, multilayer cap was intended to mitigate migration of uranium and TCE from the area to groundwater; however, this action was cancelled after it was determined that it would be ineffective because of the shallow groundwater found at the burial ground.

Monitoring wells of the C-749 Uranium Burial Ground are sampled and analyzed for VOCs and Tc-99. The maximum detected concentrations of TCE, carbon tetrachloride, chloroform, and *cis*-1,2-dichloroethene in the one upgradient well and TCE, carbon tetrachloride, and *cis*-1,2-dichloroethene in two downgradient RGA wells located at the C-749 Uranium Burial Ground currently exceed the National Primary Drinking Water Standards and applicable state standards (Table 17.1). Tc-99 activity has remained below the MCL, but appears to be rising in the burial ground MWs.

The RAO to prevent disturbance or contact with buried waste material is being met, and the current action is protective of human health by preventing human exposure to buried wastes and groundwater through rigorous operational controls (i.e., radiological postings, radiological work permits, and excavation permits).

Tables 17.2 and 17.3 present downgradient vs. upgradient data showing a comparison of the initial (i.e., pre-1996) and current maximum concentrations of the principal contaminants detected in RGA wells at the C-749 Uranium Burial Ground, based on groundwater sampling conducted between 1996 and 2017. The maximum detected concentrations of TCE in the one upgradient well and the three downgradient RGA wells (MW337, MW338, and MW67), located at the burial ground, currently exceed the EPA Primary Drinking Water Standard MCL (5 µg/L) and comparable Kentucky MCL used for screening the results. Tc-99 activity has remained below the MCL of 4 mrem (interpreted by EPA to be equivalent to 900 pCi/L).

Concentrations of uranium currently are at nondetectable levels and have been previously, with the exception of two sampling events in downgradient well MW338. In one event, uranium was detected at a high level (350 µg/L on September 24, 2001), but subsequent sampling at the well and isotopic uranium analysis of the same sample show nondetectable levels;[10] therefore, the credibility of the high result is questionable. The second event shows that another detection (1.6 µg/L on December 3, 2002) was below the level established for RGA background (2 µg/L) and was followed by analyses that reported nondetectable concentrations.

Figure 17.3 illustrates TCE trends in upgradient MW333 and downgradient wells MW337, MW338, and MW67. These data show that TCE concentrations are higher in upgradient MW333 than in the downgradient wells. These data indicate that TCE contamination in the RGA at the C-749 Uranium Burial Ground is coming from an upgradient source and that the net groundwater flow direction is northward. See Figures 17.3 and 17.4 for RGA well locations.

[10] The laboratory reporting limit for uranium typically is 1 µg/L or less.

Table 17.1. Summary of C-749 Groundwater Monitoring Results (2013–2017)

Volatile Organic Compounds	MCL (µ/gL)	Max Level Detected (µg/L)		
		MW333	MW337	MW338
1,1,1-Trichloroethane	200			
1,1,2-Trichloroethane	5		2.73	1.36
1,1-Dichloroethane	N/A			
1,1-Dichloroethene	7		0.8	0.71
1,2-Dichloroethane	5			
Benzene	5			
Bromodichloromethane	N/A			
Carbon tetrachloride	5	166	24	30.4
Chloroform	80[1]	468	73	38
cis-1,2-Dichloroethene	70	808	140	82
Dimethylbenzene	N/A			
Ethylbenzene	700			
Tetrachloroethene	5		0.56	
Toluene	1,000			
trans-1,2-Dichloroethene	100		3.37	0.74
Trichloroethene	5	10,700	2,100	1,670
Vinyl chloride	2		0.69	
Radionuclides	**MCL (pCi/L)**	**Maximum Level Detected (pCi/L)**		
		MW333	MW337	MW338
Technetium-99	900	122	336	214

[1] MCL is for the sum of the concentrations for trihalomethanes.
*Shading indicates analysis available, but was not detected.

Table 17.2. Comparison of Initial and Current Contaminant Concentrations in RGA Groundwater, Downgradient of the C-749 Uranium Burial Ground

Analyte	Initial Conditions (Pre-1996)			Current Conditions (Post-ROD)			Screening Levels		Units
	Maximum Detected Results	Associated Well	Sampling Date	Maximum Detected Results	Associated Well	Sampling Date	RGA Background Values[a]	Maximum Contaminant Level	
TCE	0.003	MW50	11/10/1988 10/15/1991 1/29/1992 7/28/1992 10/7/1992	2.99	MW67	1/27/2015	No Value	0.005	mg/L
Uranium	0.001	MW51	5/1/1991	0.35[b]	MW338	9/24/2001	0.002	0.03	mg/L
cis-1,2-DCE	Not Analyzed	N/A	ALL	0.160	MW 67	2/3/2009	No Value	0.07	mg/L
Beryllium	0.0023	MW50	4/5/1990	0.0014	MW337	10/4/1996	0.004	0.004	mg/L
Calcium	16.8	MW50	10/20/1989	16	MW337	10/4/1996	40	No Value	mg/L
Chloride	13	MW67	2/18/1988	24.3	MW338	3/10/1998	89.2	250[c]	mg/L
Fluoride	0.89	MW51	5/1/1991	0.41	MW338 MW67	10/4/1996 10/8/1996	0.245	4	mg/L
Iron	82.8	MW50	10/20/1989	56	MW337	10/4/1996	3.72	0.3[c]	mg/L
Magnesium	6.43	MW67	2/24/1993	7.3	MW337	10/4/1996	15.7	No Value	mg/L
Manganese	1.8	MW51	1/13/1988	2.1	MW337	10/4/1996	0.082	0.05[c]	mg/L
Nitrate/Nitrite	0.07	MW50	4/5/1990	0.21	MW337	10/4/1996	13.5[d]	10[d]/1[d]	mg/L
Potassium	2.38	MW50	10/20/1989	3.9	MW337	10/4/1996	4.47	No Value	mg/L
Sodium	333	MW50	10/20/1989	14	MW338	10/4/1996	63.5	No Value	mg/L
Sulfate	12	MW67	2/24/1993	8.7	MW67	10/8/1996	19.1	No Value	mg/L

Table 17.2. Comparison of Initial and Current Contaminant Concentrations in RGA Groundwater, Downgradient of the C-749 Uranium Burial Ground (Continued)

Analyte	Initial Conditions (Pre-1996)			Current Conditions (Post-ROD)			Screening Levels		Units
	Maximum Detected Results	Associated Well	Sampling Date	Maximum Detected Results	Associated Well	Sampling Date	RGA Background Values[a]	Maximum Contaminant Level	
Vanadium	0.0568	MW50	10/20/1989	0.052	MW337	10/4/1996	0.139	No Value	mg/L
Gross Alpha	33.3[e]	MW67	11/17/1988	10.8	MW337	12/4/2003	2.36	15	pCi/L
Gross Beta	38 38[e]	MW50 MW51	10/20/1989 3/28/1991	196	MW337	9/25/2009	7.3	50[f]	pCi/L
Am-241	1.6	MW51	1/13/1988	0.35	MW67	10/8/1996	No Value	No Value	pCi/L
Pu-239	0.28	MW67	3/11/1991	0.13	MW338	10/4/1996	0.03	No Value	pCi/L
Tc-99	53.2	MW51	7/23/1992	347	MW337	8/10/2011	10.8	900	pCi/L
Th-230	ND	N/A	ALL	0.74	MW67	10/8/1996	0.54	No Value	pCi/L
U-234	2.5	MW67	3/11/1991	0.56	MW338	10/4/1996	0.7	10.24[g]	pCi/L
U-235/U-236	ND	N/A	ALL	0.11	MW337	10/4/1996	0.3[h]	0.466[g]	pCi/L
U-238	3.3	MW67	3/11/1991	0.67	MW338	10/4/1996	0.7	9.99[g]	pCi/L

ND = not detected.
N/A = not applicable
[a] Background values of RGA wells from Volume 5 of the GWOU FS, *Background Concentrations of Naturally Occurring Inorganic Chemicals and Selected Radionuclides in the Regional Gravel Aquifer and McNairy Formation at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (Volume 5 of the GWOU FS) (DOE 2001a).
[b] Isolated detection, isotopic analysis shows nondetects.
[c] Secondary MCL for reference only.
[d] Value is nitrate as nitrogen.
[e] Dissolved activity.
[f] 401 *KAR* 47:030 value.
[g] 2017 Update of the Human Health Risk Methods Document (DOE 2017h).
[h] Background value for U-235.

Table 17.3. Comparison of Initial and Current Contaminant Concentrations in RGA Groundwater, Upgradient of the C-749 Uranium Burial Ground

Analyte	Initial Conditions (Pre-1996)			Current Conditions (Post-ROD)			Screening Levels		Units
	Maximum Detected Results	Associated Well	Sampling Date	Maximum Detected Results	Associated Well	Sampling Date	RGA Background Values[a]	Maximum Contaminant Level	
TCE	ND	N/A	ALL	10.7	MW333	6/3/2015	No Value	0.005	mg/L
Uranium	0.019	MW48	8/1/1989	ND	N/A	ALL	0.002	0.03	mg/L
cis-1,2-DCE	Not Analyzed	N/A	ALL	0.808	MW333	6/3/2015	No Value	0.07	mg/L
Beryllium	0.01	MW48	8/1/1989	ND	N/A	ALL	0.004	0.004	mg/L
Calcium	17.2	MW48	4/3/1991	24.0	MW333	10/14/1996	40	No Value	mg/L
Chloride	12	MW48	3/9/1993	12.1	MW333	3/10/1998	89.2	250[b]	mg/L
Fluoride	0.18	MW48	5/24/1989	0.32	MW333	10/14/1996	0.245	4	mg/L
Iron	706	MW48	8/1/1989	6.2	MW333	10/14/1996	3.72	0.3[b]	mg/L
Magnesium	6.99	MW48	4/3/1991	9.2	MW333	10/14/1996	15.7	No Value	mg/L
Manganese	5.87	MW48	8/1/1989	2.6	MW333	10/14/1996	0.082	0.05[b]	mg/L
Nitrate/Nitrite	1.9[c]	MW48	12/11/1991	0.05	MW333	10/14/1996	13.5[c]	10[c]/1[d]	mg/L
Potassium	2.07	MW48	10/13/1989	1.2	MW333	10/14/1996	4.47	No Value	mg/L
Sodium	13.7	MW48	4/3/1991	16	MW333	10/14/1996	63.5	No Value	mg/L
Sulfate	12	MW48	3/9/1993 12/11/1992	16	MW333	10/14/1996	19.1	No Value	mg/L
Vanadium	0.0085	MW48	10/13/1989	0.0097	MW333	10/14/1996	0.139	No Value	mg/L
Gross Alpha	20.4[e]	MW48	1/13/1988	4.34	MW333	3/19/2007	2.36	15	pCi/L

Table 17.3. Comparison of Initial and Current Contaminant Concentrations in RGA Groundwater, Upgradient of the C-749 Uranium Burial Ground (Continued)

Analyte	Initial Conditions (Pre-1996)			Current Conditions (Post-ROD)			Screening Levels		Units
	Maximum Detected Results	Associated Well	Sampling Date	Maximum Detected Results	Associated Well	Sampling Date	RGA Background Values[a]	Maximum Contaminant Level	
Gross Beta	23[e]	MW48	1/13/1988	24.7	MW333	3/8/2010	7.3	50[f]	pCi/L
Am-241	3.7	MW48	3/27/1991	0.19	MW333	10/14/1996	No Value	No Value	pCi/L
Pu-239	ND	N/A	ALL	ND[g]	N/A	ALL	0.03	No Value	pCi/L
Tc-99	33	MW48	8/1/1989	122	MW333	7/17/2017	10.8	900	pCi/L
Th-230	ND	N/A	ALL	0.25	MW333	10/14/1996	0.54	No Value	pCi/L
U-234	ND	N/A	ALL	9.66	MW333	10/14/1996	0.7	10.24[h]	pCi/L
U-235/U-236	ND	N/A	ALL	0.35	MW333	10/14/1996	0.3[i]	0.466[h]	pCi/L
U-238	1.3	MW48	4/3/1991	0.14	MW333	10/14/1996	0.7	9.99[h]	pCi/L

ND = not detected.
N/A = not applicable
[a] Background values of RGA wells from Volume 5 of the GWOU FS, *Background Concentrations of Naturally Occurring Inorganic Chemicals and Selected Radionuclides in the Regional Gravel Aquifer and McNairy Formation at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (Volume 5 of GWOU FS) (DOE 2001a).
[b] Secondary MCL for reference only.
[c] Value is nitrate as nitrogen.
[d] Value is nitrite as nitrogen.
[e] Dissolved activity.
[f] 401 *KAR* 47:030 value.
[g] Value reported below laboratory detection limit, but was not laboratory qualified as a nondetect.
[h] 2017 Update of the Human Health Risk Methods Document (DOE 2017h).
[i] Background value for U-235.

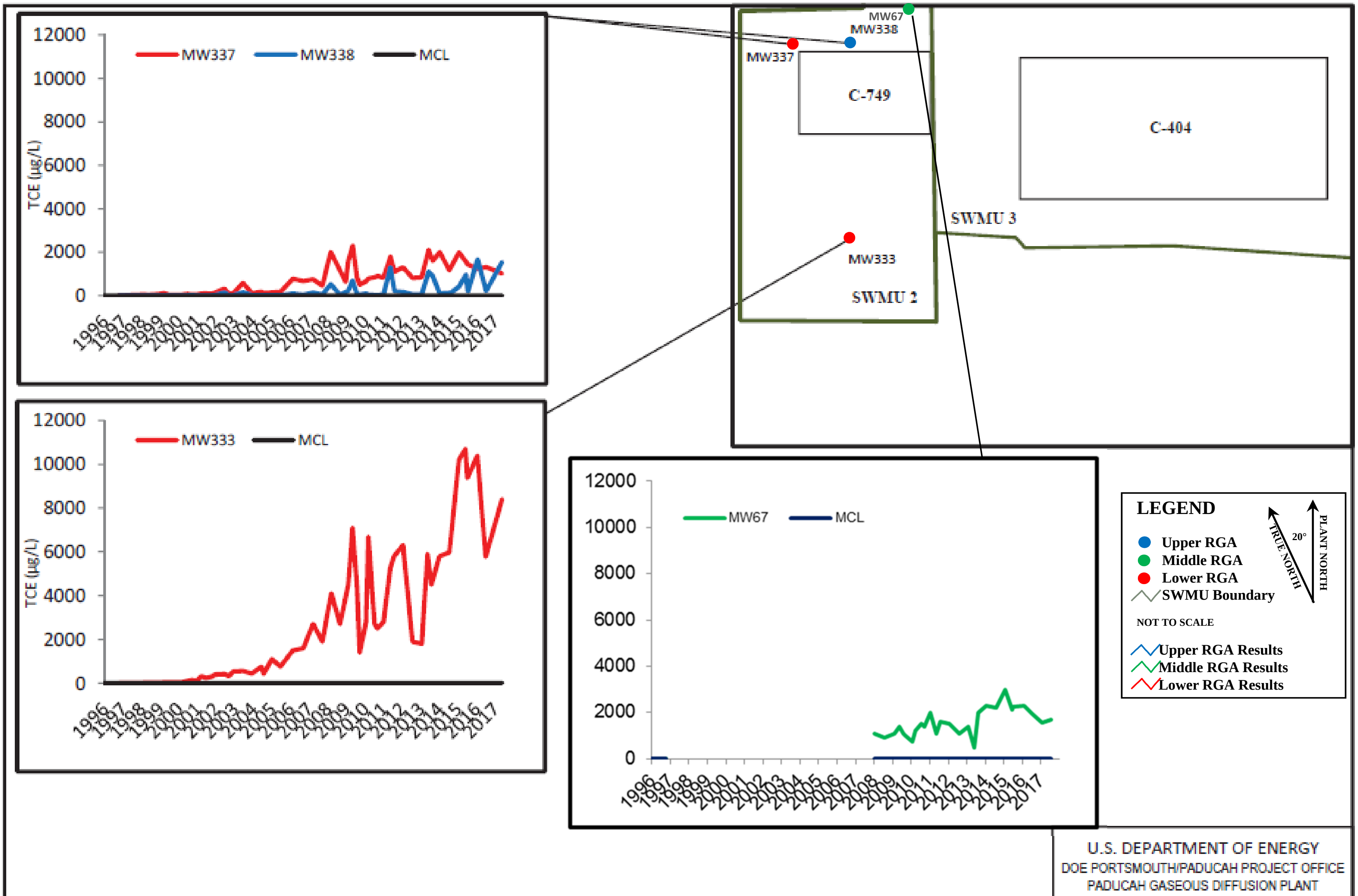

Figure 17.3. TCE Trends in MWs for the C-749 Uranium Burial Ground

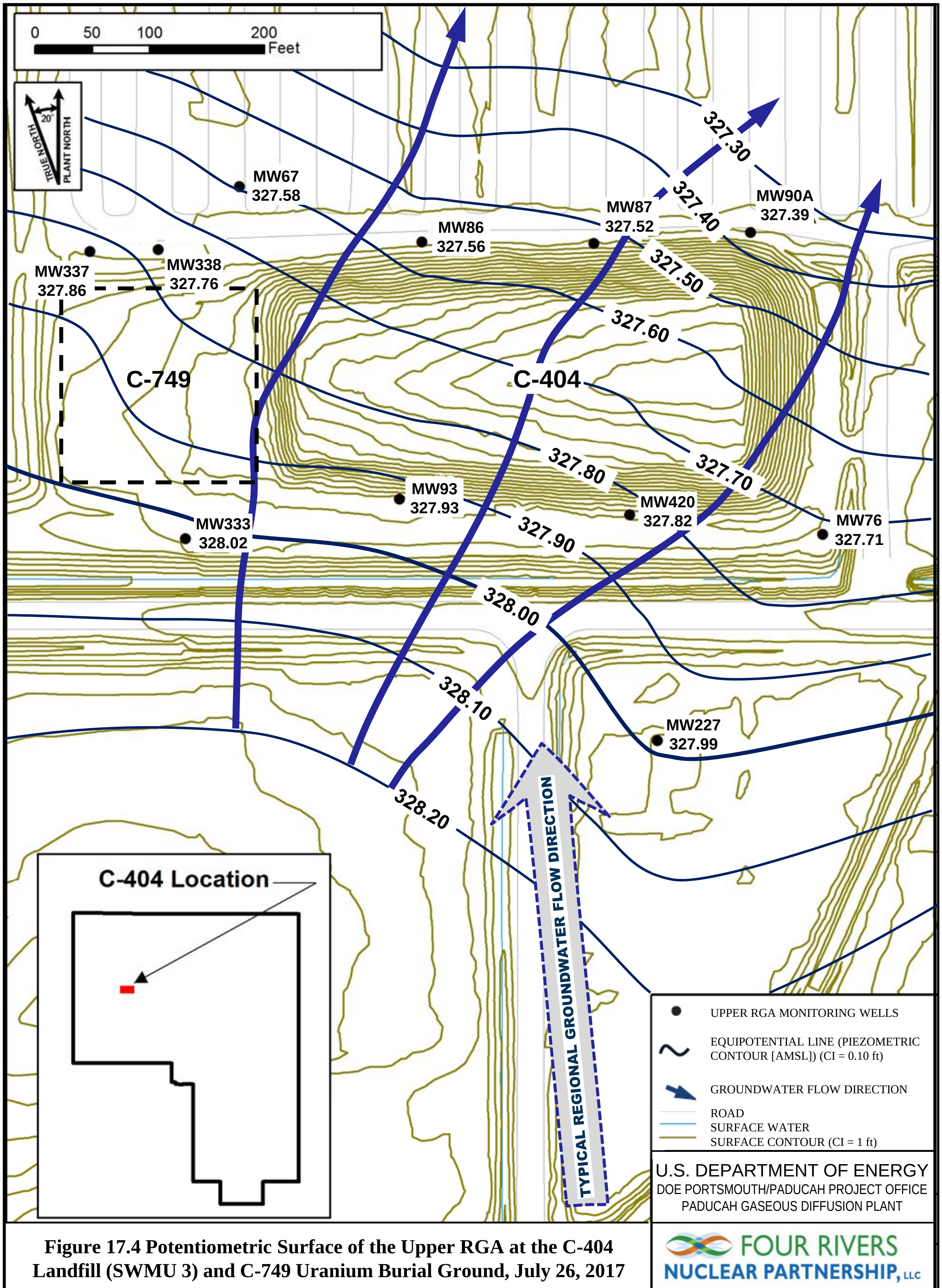

Figure 17.4 Potentiometric Surface of the Upper RGA at the C-404 Landfill (SWMU 3) and C-749 Uranium Burial Ground, July 26, 2017

A lower RGA well, MW548, was installed adjacent to MW333 in November 2015 as part of the RI of the C-747 Contaminated Burial Yard and C-748-B Burial Area (SWMU 4), which are located immediately south of the C-749 Uranium Burial Ground (DOE 2017i). Analyses currently are available for only three sampling dates. TCE levels in MW548 are similar to those of MW333, providing further evidence that the source of TCE is upgradient of (south of) the burial ground. [A C-749 Uranium Burial Ground source would be expected to result in higher TCE levels in the upper RGA (MW333).]

Figure 17.4 illustrates the potentiometric surface in the vicinity of the C-749 Uranium Burial Ground and the adjacent C-404 Landfill on July 26, 2017. There is a northerly gradient (compare 328.02-ft elevation at upgradient MW333 with 327.76 ft elevation downgradient MW338). The slight easterly vector of groundwater gradient likely is related to the fact that the C-404 Landfill has an impermeable, RCRA-design cap that limits infiltration in the vicinity of the unit. This will depress the water table in the vicinity of the C-404 Landfill slightly and induce some flow to the east, as shown on Figure 17.4, especially during periods of higher infiltration.

Because the C-749 Uranium Burial Ground is located inside the facility security-fenced area and under DOE ownership and control, deed restrictions have not been necessary. The burial ground is roped and posted along the perimeter of the unit to identify it as a radiological contamination zone requiring personal protective equipment, special training, and permits to gain access or to work within the area.

17.6.1 Question A: Is the Remedy Functioning as Intended by the Decision Documents?

Yes. The components of the remedy that were implemented are functioning as intended. Groundwater MWs constructed for the C-749 Uranium Burial Ground, consisting of two downgradient wells (MW337 and MW338) and one upgradient well (MW333), are located to monitor the facility. Furthermore, an existing RGA well (MW67) provides additional downgradient monitoring. Future Five-Year Reviews also will be able to include monitoring results from MW548.

17.6.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of the Remedy Selection Still Valid?

Yes. DOE remains in control of the property that the C-749 Uranium Burial Ground encompasses and the land use remains industrial; therefore, the exposure assumptions used in the ROD regarding disturbance or contact with the buried waste materials remains valid. There have been changes to the risk assessment methodology, but the protectiveness of the remedy was not affected. There have been no new contaminants identified.

The current groundwater data indicate that assumptions underlying the remedy selection in the ROD still are valid. The post-ROD monitoring program evaluated the proposed cap's effect on the shallow groundwater level and identified that the waste predominately was saturated, and the installation of the cap would not reduce potential groundwater contamination. Based on this conclusion by the parties, implementation of the cap's design and construction activities, as outlined in the current ROD, was canceled (Hodges 1996).

The exposure assumptions used to develop the Human Health Risk Assessment included both current exposures (industrial worker) and potential future exposures (future resident using groundwater and future industrial worker). The MCL for TCE remains 0.005 mg/L as it was during the original remedy selection; however, the parameters for risk evaluation of TCE have been revised. The original remedy was based on the assumption that institutional controls prevent access to the groundwater at the unit and eliminate any exposure pathway. Because the exposure assumption (no exposure) still is valid, the remedy remains protective. Also, the groundwater monitoring data for the C-749 Uranium Burial Ground indicate that the burial ground does not contribute significantly to the area-wide groundwater contamination that is being addressed through other actions.

No cleanup levels were established in the ROD because the selected remedy did not include excavation and removal of the waste and impacted soils.

There are no changes in standards identified as ARARs in the ROD that impact the protectiveness of the remedy. Additionally, there are no newly promulgated standards that might apply or be relevant and appropriate to the site that affect the protectiveness of the remedy. Finally, there are no changes in TBCs identified in the ROD that impact the protectiveness of the remedy. The following change was identified in the 2013 Five-Year Review, but it does not impact the protectiveness of the remedy.

- DOE O 5400.5 has been superseded by DOE O 458.1.

The RAOs used at the time of remedy selection still are valid.

17.6.3 Question C: Has Any Other Information Come to Light That Could Call into Question the Protectiveness of the Remedy?

For those remedy components that were implemented, no additional information has come to light since implementation of the remedy that could call into question their protectiveness.

17.7 ISSUES

None.

18. ISSUES, RECOMMENDATIONS, AND FOLLOW-UP ACTIONS

Operable Unit	Issue	Party Responsible	Oversight Agency	Recommendations and Follow-up Actions	Completion Date	Affects Protectiveness (Y/N)	
						Current	Future
Groundwater, Northwest Plume (SWMU 201)	The Northwest Plume (SWMU 201) IRA, designed to initiate hydraulic control of the high TCE concentration of the Northwest Plume, saw increases in TCE levels in a downgradient monitoring well. Increasing TCE levels in downgradient MW460 may be an indication of capture of downgradient groundwater impacted by site contaminants in response to drawdown of the aquifer or increasing TCE levels may indicate limited plume bypass of the optimization EW wellfield.	DOE	EPA and the Commonwealth of Kentucky	EW pump placement and pumping rates should be evaluated to optimize capture of the Northwest Plume.	12/30/2022 (End of Next Five-Year Review Period)	N*	N*

* Although the issue does not affect the current or future protectiveness, the issue and recommended actions are an optimization to the current remedy established and are included as recommended by guidance.

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19. PROGRESS SINCE THE LAST FIVE-YEAR REVIEW

2013 Issue	2013 Recommendations/ Follow-up Actions	Party Responsible	Milestone Date	Results	Date of Action
Northwest Plume (SWMU 201) (GWOU)					
The Northwest Plume is an IRA designed to initiate hydraulic control of the high TCE concentration area within the Northwest Plume and does not achieve final cleanup of the groundwater contamination. A follow-up evaluation is needed to ensure long-term protection.	Additional action, if necessary, for long-term protection should be evaluated and documented in the final decision document for the Dissolved-Phase Plumes OU and the CSOU.	DOE	4th Quarter FY 2045	In response to recommendations contained in the 2008 CERCLA Five-Year Review, construction activities for the Northwest Plume IRA Optimization commenced in March 2010. In August 2010, two new EWs (EW232 and EW233) became operational near the original south wellfield, adjacent to the north security fence of the Paducah Site. The location of the new EWs was optimized to capture the core and the lateral extent of the Northwest Plume. The north wellfield EWs (EW228 and EW229) were removed from service and the original south EWs (EW230 and EW231) were placed in standby mode, to be returned to service, if needed. The CSOU will begin upon completion of the last RA and closure of the potential on-site waste disposal facility. It will take approximately two years to complete. The CSOU is projected to begin around 2061.	N/A

2013 Issue	2013 Recommendations/ Follow-up Actions	Party Responsible	Milestone Date	Results	Date of Action
Northeast Plume (SWMU 202) (GWOU)					
The Northeast Plume RA is an IRA to initiate hydraulic control of the high TCE concentration area within the Northeast Plume that extends outside the security fence. Although the RAOs were met, additional mass removal can be achieved by an optimization.	The FFA parties recommended optimization of the Northeast Plume treatment system to increase TCE and 1,1-DCE mass removal and enhance the contaminant capture in the Northeast Plume in the vicinity of the eastern edge of the Paducah Site industrial facility. The recommendation for optimization is planned to occur in FY 2014. An evaluation of the results of the optimization of the Northeast Plume with field testing and use of the sitewide groundwater flow model is needed to understand the performance of the new EWs.	DOE	10/31/17	Construction of the optimized NEPCS was completed during the period of this fourth synchronized Five-Year Review and routine operation began on October 11, 2017. DOE, with a Groundwater Model Group representing the FFA parties and other technical input, completed an update of the sitewide groundwater flow model in July 2017. The O&M plan for the optimization project schedules the field testing of the EWs within 4 months of start-up of the EWs.	10/11/17
Water Policy (GWOU)					
All potentially affected residents within the water policy have been provided access to municipal water and have been provided an opportunity to sign license agreements to have their monthly water bills paid in return for commitments not to use their wells. Not all current landowners have signed license agreements for their properties; therefore, the potential exists that current, and possibly new, landowners could use their groundwater.	DOE will optimize the remedy to ensure that all landowners are educated about the potential contamination in their groundwater. An annual educational fact sheet will be sent to each address within the Water Policy Box. The fact sheet would outline the potential risk associated with the groundwater and inform residents within the Water Policy Box of the groundwater remediation. Land ownership also will be reviewed at the McCracken County Property Valuation Assessment office annually to search for new owners of land parcels within the Water Policy Box. The newly identified owners will be contacted and given information concerning the contaminated groundwater. Raising the education and awareness levels about the potential risk associated with the groundwater will reduce the likelihood that residents could use their groundwater.	DOE		Initial annual Water Policy Educational Mailer was mailed on January 27, 2016.	01/27/2016

2013 Issue	2013 Recommendations/ Follow-up Actions	Party Responsible	Milestone Date	Results	Date of Action
C-400 (GWOU)					
The ROD selected ERH to address the VOC source zone at C-400. The project is being implemented in phases. Once Phase I was completed, it was determined that ERH was effective in meeting RAOs in the UCRS and the upper RGA; however, target temperatures for ERH were not met in the lower RGA despite implementation of contingency measures intended to assist in attaining temperature goals. As a result, it was concluded that ERH would not be effective in remediation of VOC source zones in the lower RGA.	Evaluate alternative technologies to achieve the RAO for the lower RGA (reduce the extent and mass of the VOC source). The FFA parties have agreed to conduct a treatability study to support remedy selection for the lower RGA. Upon completion of the treatability study, the FFA parties will determine the path forward for treatment of the lower RGA, and the decision documents for implementation will be modified as appropriate.	DOE	4th Quarter FY 2022	The FFA parities agreed in the September 28, 2017, Memorandum of Agreement (MOA) (DOE 2017c) that, "Since the final remedy for the C-400 Complex OU will include the Phase IIb source area, …that the remediation work under the 2005 C-400 Cleaning Building Interim Action ROD is complete." Upon completion of the C-400 Complex OU ROD, the FFA parties will determine the path forward for treatment of the lower RGA, and the decision documents for implementation will be modified as appropriate.	N/A
The C-400 ERH project is an IRA under construction. A primary objective of the project is to reduce the extent and mass VOC sources and is not intended to achieve final cleanup of the groundwater contaminant source. VOC sources when combined with migration pathways can result in a potential exposure risk to VOC vapors when receptors are located nearby. This exposure pathway was not a primary objective of the project; therefore, it has not been fully evaluated as part of the C-400 ERH interim action. A follow-up evaluation is needed to ensure long-term protection.	To ensure that the remedy is protective for vapor intrusion, it is recommended that a vapor intrusion analysis be performed consistent with the Paducah Site Risk Methods Document as part of any subsequent follow-up C-400 actions (e.g., Groundwater Sources OU, Dissolved-Phase Plumes OU project).	DOE	3rd Quarter CY 2018	Vapor intrusion sampling was completed on February 12, 2018.	02/12/18

2013 Issue	2013 Recommendations/ Follow-up Actions	Party Responsible	Milestone Date	Results	Date of Action
Southwest Plume (GWOU)					
The Southwest Plume project is a RA under construction. The RA is designed to address VOC releases to groundwater. A follow-up evaluation is needed to ensure long-term protection.	Further evaluation is needed to ensure that the potential VOC sources not addressed by the remedy underlying the C-720 Building are addressed as part of any subsequent follow-up GWOU actions (e.g., Dissolved-Phase Plumes OU project).	DOE	2017	The implementation of the C-400 Complex as Paducah DOE's highest cleanup priority has resulted in resequencing of other cleanup work at the site to align with the new cleanup priorities and revised time frames projected for implementation. The FFA senior managers signed an MOA for the C-400 Complex under the FFA for the Paducah Site to document key aspects of the new strategy (DOE 2017c).	08/08/17
NSDD Sections 1 and 2 (SWMU 59) (SWOU)					
Based on the residual risk evaluation (Appendix B) that was performed as a result of the recommendation in the 2008 Five-Year Review, the remaining contamination poses minimal risk based on the current and reasonably anticipated future industrial exposure scenario.	Based on the residual risk evaluation concluding that the remaining contamination poses minimal risk based on the current and reasonably anticipated industrial exposure scenario, a request for modification of the NSDD LUCIP will be submitted for monitoring the LUCs to be reduced to once every five years in conjunction with the Five-Year Review. This includes reducing the annual verification of administrative controls and annual verification of access to once every five years for the NSDD Sections 1 and 2.	DOE		Upon evaluation of the recommendation from the 2013 Five-Year Review, it was determined by DOE that the cost savings associated with the recommendation compared to the cost of revision the document was negligible. Therefore, DOE has continued to comply with the NSDD LUCIP concerning the monitoring of the LUCs, annual verification of administrative controls, and annual verification of access.	N/A
C-746-K Sanitary Landfill (SWMU 8) (SWOU)					
The shaft of MW301 has buckled so that any repair/replacement of the pump would not be possible.	MW301 is installed in a position comparable to MW300, which typically has higher concentrations. Based on the location and sampling results of MW301, it is recommended that this well be abandoned.	DOE		The abandonment of MW301 was completed on August 5, 2014.	08/05/14

2013 Issue	2013 Recommendations/ Follow-up Actions	Party Responsible	Milestone Date	Results	Date of Action
Surface Water Interim Corrective Measures (SWOU)					
An evaluation of both sign programs (Surface Water ICM signs with EI signs) was conducted, and a decision was made to replace the Surface Water ICM signs with EI signs to reduce the possibility of confusing individuals entering the area because signs differ in content. The EI signs would meet the objectives of the ICM signs.	Specifically, where the signs are collocated, the Surface Water ICM sign will be removed leaving the EI sign. In those cases where no EI sign is located in close proximity to a Surface Water ICM sign, an EI sign will be erected to serve in place of the Surface Water ICM sign. Each sign will be assigned a unique number, thereby allowing the ICM locations to be identified separately for the next five-year review. The fencing located at areas A7 and A8 will be removed, and signs located at A1 will be removed.	DOE	2015	Completed and documented in the 2015 SWOU O&M Plan.	10/08/2015

Note: These schedules are estimates for planning. They are included only for informational purposes and are not intended to establish enforceable schedules or milestones. Enforceable milestones are contained in Appendix C of the FFA and Appendix 5 of the SMP.

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20. 2018 PROTECTIVENESS STATEMENTS

Overall, the selected remedies implemented thus far are protective, but the Paducah Site cleanup activities still are ongoing with additional future actions planned. The groundwater exposure pathways for the Paducah Site are being controlled by providing potentially affected residents access to municipal water under the Water Policy, combined with a series of source and plume control actions to reduce off-site contaminant migration. Other exposure pathways for other media (e.g., soil and sediment) are being controlled through individual OU actions, along with DOE ownership and use of the property.

20.1 GROUNDWATER OPERABLE UNIT

20.1.1 Northwest Plume

The remedy for the Northwest Plume (SWMU 201) is protective of human health and the environment in the short-term. Exposure pathways that could result in unacceptable risk are being controlled; however, additional actions, as part of the Dissolved-Phase Plume OU [see Appendix 3 of the FY 2018 and FY 2019 SMP for a discussion of the scope of the Dissolved-Phase Plumes OU (DOE 2019a)], need to be evaluated for long-term protection. A recommendation was made for an evaluation of EW pump placement and pumping rates to optimize capture of the Northwest Plume in response to increasing TCE levels in downgradient MW460.

The objective of this IRA is to initiate control of the source and mitigate the spread of contamination in the Northwest Plume. The optimization of the Northwest Plume IRA is intended to increase VOC mass removal and enhance the contaminant capture in the vicinity of the existing south wellfield located immediately north of the facility. In addition, successful control of the plume, in combination with existing controls (alternate water supply, monitoring, etc.), ensures protection during the period of the interim response.

20.1.2 Northeast Plume

The remedy for the Northeast Plume (SWMU 202) is protective of human health and the environment in the short-term. The Northeast Plume groundwater extraction system is being optimized to increase TCE mass removal, to enhance control of plume migration at the eastern edge of the PGDP industrial area. Exposure pathways that could result in unacceptable risk are being controlled; however, additional actions, as part of the Dissolved-Phase Plume OU [see Appendix 3 of the FY 2018 and FY 2019 SMP for a discussion of the scope of the Dissolved-Phase Plumes OU (DOE 2019a)], need to be evaluated for long-term protection.

The objective of this IRA is to initiate hydraulic control of the high concentration area within the Northeast Plume that extends outside the facility security fence. Optimization of the Northeast Plume is ongoing to increase TCE and 1,1-DCE mass removal and to enhance the contaminant capture in the Northeast Plume in the vicinity of the eastern edge of the Paducah Site. In addition, successful control of the plume, in combination with existing controls (alternate water supply, monitoring, etc.), ensures protection during the period of the interim response.

20.1.3 Cylinder Drop Test Area

The remedy for the Cylinder Drop Test Area (SWMU 91) is protective of human health and the environment in the short-term. Exposure pathways that could result in unacceptable risk are being controlled through DOE access controls. This project is not a final action and was not designed to return the areas to unrestricted use and unlimited exposure. A final TCE cleanup level providing long-term protection of groundwater has not yet been established. In order to establish long-term protectiveness, per Section III of the FFA, "…any necessary RA shall be selected and implemented…." as part of the CSOU (EPA 1998).

The RAO for this remedy is intended to prevent rural residents from exposure to the only COC, TCE. This RAO has been met through treatment of soils to a concentration below cleanup goals, thereby reducing the amount of TCE available to leach to groundwater.

20.1.4 Water Policy

The remedy for the Water Policy currently protects human health and the environment by institutional controls, including administrative controls, in the short-term. Exposure pathways that could result in unacceptable risk are being controlled; however, additional actions, as part of the Dissolved-Phase Plume OU, need to be evaluated for long-term protection.

The objective of this RA is to prohibit the use of contaminated groundwater and provide a safe, alternate water supply to the residents in the affected area. This objective has been met by providing potentially affected residents access to municipal water in accordance with the Water Policy and corresponding license agreements, thereby reducing opportunities for exposure to contaminated groundwater.

20.1.5 C-400 Electrical Resistance Heating

The IRA for the VOC contamination at C-400 Building is protective of human health and the environment upon completion in the short-term. In the interim, LUCs for this action include property record notices and deed restrictions, administrative controls, and access controls. This action, in combination with other CERCLA response actions and existing controls (alternate water supply, monitoring, etc.), has adequately addressed known exposure pathways that could result in unacceptable risks originating from C-400. In order to establish long-term protectiveness, additional RAs will be evaluated and selected, as necessary, under the GWOU.

20.1.6 Southwest Plume

Oil Landfarm

The remedial action for VOC sources at the Oil Landfarm is expected to be protective of human health and the environment upon completion; however, a period of time is expected before attainment of the third RAO is confirmed. Interim LUCs consisting of placement of warning signs and DOE's excavation/penetration permit program are in place to prevent exposure to site contaminants. This action, in combination with other CERCLA response actions and existing controls (alternate water supply, monitoring, etc.), has addressed adequately known exposure pathways that could result in unacceptable risks originating from the Southwest Plume (SWMU 210). Interim LUCs consisting of placement of warning signs and DOE's excavation/penetration permit program are in place to prevent exposure to site contaminants.

C-720 Building Northeast and Southeast Spill Sites

Implementation of the selected remedial action at the C-720 Building Northeast and Southeast Spill Sites (SWMUs 211-A and 211-B) is pending confirmation by the FFA parties. Common elements of both possible remedial actions, the interim LUCs, have been implemented; however, the combination of other

CERCLA response actions and existing controls (alternate water supply, monitoring, etc.), has addressed known exposure pathways that could result in unacceptable risks originating from the Southwest Plume C-720 Building Northeast and Southeast Spill Sites. Interim LUCs consisting of placement of warning signs and DOE's excavation/penetration permit program are in place to prevent exposure to site contaminants.

20.2 SURFACE WATER OPERABLE UNIT

20.2.1 NSDD Source Control

The remedy for the NSDD Source Control is protective of human health and the environment. Exposure pathways that could result in unacceptable risk are being controlled. This project is not a final action and was not designed to return the areas to unrestricted use.

The objective of this IRA is to initiate control of the source of continued contaminant releases into the NSDD and mitigate the spread of contamination from the NSDD. This objective was achieved by mitigating the discharge of contaminants into NSDD, institutional controls to limit the potential for direct exposure, and engineering controls to mitigate the infiltration and migration of contaminants from the NSDD to the subsurface environment and off-site (i.e., outside the existing security fence).

20.2.2 NSDD Sections 1 and 2

The remedy for the NSDD Sections 1 and 2 (SWMU 59) is protective of human health and the environment in the short-term. Exposure pathways that could result in unacceptable risk currently are being controlled. This project is not a comprehensive final action for NSDD Sections 1 and 2. In order to establish long-term protectiveness, additional action will be evaluated and selected, as necessary, under the SWOU.

The ROD established the following RAOs: prevention of future discharge of process water to the NSDD; reduction of the risk to industrial workers and ecological receptors from exposure to contaminated surface soil, sediment, and surface water; and prevention of future on-site runoff from being transported off-site (i.e., outside the existing security fence) via the NSDD. The RAOs have been achieved effectively through excavation of contaminated sediment and placement of clean soil to meet the cleanup goal and implementation of LUCs assuring protectiveness.

20.2.3 C-746-K Sanitary Landfill

The remedy for the C-746-K Landfill (SWMU 8) is protective of human health and the environment. Exposure pathways that could result in unacceptable risk are being controlled. This project is not a final action and was not designed to return the areas to unrestricted use.

The RAOs for this unit are to control the release of COCs from the unit, limit direct contact by humans, and reduce overall risks to ecological receptors. The RAOs have been met through reduction of human risks by posting warning signs and other institutional controls, through reduction of ecological risks by installing riprap over exposed acidic leachate seeps, and by mitigating current direct contact with the buried waste through DOE ownership and use of the property.

20.2.4 Fire Training Area

The remedy for the Fire Training Area (SWMU 100) is protective of human health and the environment in the short-term. Exposure pathways that could result in unacceptable risk are being controlled. This project is not a final action and was not designed to return the areas to unrestricted use and unlimited exposure. In order to establish long-term protectiveness, per Section III of the FFA, "…any necessary RA shall be selected and implemented…." as part of the CSOU (EPA 1998).

The selected remedy for the Fire Training Area, which rested upon the surrounding area remaining industrialized, is NFA (outside of maintaining institutional controls). The same land use that was in place and relied upon to support NFA still is in place and remains effective. This also is consistent with the expected future use of the area, as described in the SMP.

20.2.5 Surface Water Interim Corrective Measures

The remedy for the surface water ICMs currently protects human health and the environment by institutional controls; however, additional actions under the SWOU need to be evaluated for long-term protectiveness.

The objective of the surface water ICMs work plan is to design a system of institutional controls that will identify the areas of contamination through posting warning signs and restrict casual public access to the creeks. This objective has been met through posting warning signs and constructing fences near bridges crossing affected streams. These institutional controls serve to inform the public about the areas of contamination, resulting in a reduction of casual public access to the streams.

20.2.6 Surface Water On-site Sediment Removal

The remedy for the Surface Water On-site Sediment Removal is protective of human health and the environment in the short-term due to excavation of contaminated sediment/soil and placement of clean soil to meet the cleanup goal. In order to establish long-term protectiveness, additional RAs will be evaluated and selected, as necessary, under the SWOU.

The RAOs for this unit were to ensure that direct contact risk at the on-site ditches for the current industrial worker falls within the EPA risk range and to ensure that direct contact risk at the NSDD for both the current industrial worker and recreational user falls within the EPA risk range. These RAOs were met by excavation of contaminated sediment/soil and placement clean soil to meet the cleanup goal.

20.3 BURIAL GROUNDS OPERABLE UNIT

20.3.1 C-749 Uranium Burial Ground

The remedy for the C-749 Uranium Burial Ground (SWMU 2) is protective of human health and the environment in the short-term. Exposure pathways that could result in unacceptable risk are being controlled through DOE access controls. This earlier remedy is not a final RA and was not designed to address fully the risks to human health and the environment from the buried wastes nor return the areas to unrestricted use and/or unlimited exposure. The selected remedy for the C-749 Uranium Burial Ground was an interim action, and a final CERCLA action will be evaluated under the BGOU to ensure long-term protectiveness.

The RAOs for the interim action were to mitigate migration of uranium and TCE from the C-749 Uranium Burial Ground to groundwater and to prevent disturbance or contact with the buried waste materials. The interim ROD selected an impermeable cap, groundwater monitoring, and institutional controls. Based on a conclusion by the parties that the waste within the burial ground was saturated, implementation of the cap's design and construction activities as outlined in the current ROD was canceled (Hodges 1996). The interim action, as implemented, provides protection by mitigating direct contact with the buried waste through DOE ownership and use of the property. This action, in combination with other CERCLA response actions and existing controls (alternate water supply, monitoring, etc.), has addressed adequately current known exposure pathways that could result in unacceptable risks originating from the C-749 Uranium Burial Ground.

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21. NEXT REVIEW

DOE expects that the next Five-Year Review for the Paducah Site will be issued by the end of July 2023. Note: These schedules are estimates for planning and are included for informational purposes only; they are not intended to establish enforceable schedules or milestones. Enforceable milestones are contained in Appendix C of the FFA and Appendix 5 of the SMP. All RAs discussed within this text, in addition to any new actions initiated or completed within the next five years, will be included in that review.

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22. FIVE-YEAR REVIEW PROCESS

22.1 ADMINISTRATIVE COMPONENTS

DOE’s D&R contractor performed this fourth synchronized Five-Year Review. The reviews were conducted during December 2017 through February 2018. The following are the components of this review.

- Document review
- Data review
- Site inspection
- Interviews of personnel responsible for specific aspects of some of the response actions
- Five-Year Review report development and review

22.2 COMMUNITY NOTIFICATION AND INVOLVEMENT

Community involvement at the Paducah Site is handled primarily in conjunction with the CAB. The CAB meets monthly to discuss many aspects of environmental restoration efforts at the Paducah Site. Copies of Administrative Record decision documents are kept at the Environmental Information Center. The Environmental Information Center is open to the public during regular business hours. DOE published a public notice in the local newspaper on December 17, 2018, announcing the Five-Year Review had been initiated and requested that any suggestions, issues, questions, or concerns regarding this review be provided from December 18 through December 31, 2018. No comments were received.

22.3 DOCUMENT REVIEW

This activity consisted of a review of relevant documents to the RA of each of the units and the previous five-year reviews. This was conducted during December 2017 through February 2018. These documents are included as references in Chapter 23.

22.4 DATA REVIEW

Groundwater, surface water, and sediment samples are collected routinely at the Paducah Site to assess environmental conditions. These data are stored in Paducah’s Oak Ridge Environmental Information System. Data were downloaded for review from Paducah’s Oak Ridge Environmental Information System throughout the review process.

22.5 SITE INSPECTIONS

Inspections were conducted at each of the response action sites during December 2017. The DOE D&R contractor conducted the inspections. Results of the inspections are discussed in each respective response action sections. The scope of the inspections was to verify that the selected remedy in the decision document remained protective.

22.6 INTERVIEWS

Interviews were conducted during December 2017 and January 2018 with various personnel connected to some of the response actions. Specifically, the project manager of the Northwest and Northeast Plumes treatment systems provided information on operation and maintenance of those systems, and the facility managers for various areas provided information on site conditions. Other interview specifics can be found in each selected remedy section. Also, interviews, found in Appendix A, were conducted with KDWM, Kentucky Department of Fish and Wildlife Resources, CAB, FRNP, and local residents concerning the overall DOE project.

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APPENDIX A

SITE INSPECTIONS

This appendix contains the site inspection checklists used by the lead inspectors. These checklists document the observations made by the lead inspectors at the time of the inspection. The observations were subsequently combined with other information to develop the main text of the document (Chapters 1–23). Because the lead inspectors were not aware of some project information at the time of the inspection, some statements found in the checklists vary from those in the main text. The main text presents the concluding information that is appropriate and pertinent for this fourth synchronized Five-Year Review.

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Five-Year Review Site Inspection Checklist
Northwest Plume

I. SITE INFORMATION	
Site name: NW Plume IRA	**Date of inspection:** 12/4/2017
Location and Region: Paducah, KY/Region 4	**EPA ID:** KY8890008982
Agency, office, or company leading the five-year review: DOE	**Weather/temperature:** Slightly cloudy transitioning to light rain, 55 - 65°F, Wind at 9 – 13 mph from S

Remedy Includes: (Check all that apply)

- □ Landfill cover/containment
- ☒ Access controls
- □ Institutional controls
- ☒ Groundwater pump and treatment
- □ Surface water collection and treatment
- □ Other____
- □ Monitored natural attenuation
- □ Groundwater containment
- □ Vertical barrier walls

Attachments: ☒ Inspection team roster attached ☒ Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** Brian Lowrance — Prog Integration Mgr — 12/4/2017
   Name — Title — Date
   Interviewed ☒ at site □ at office □ by phone Phone no. 270-559-6371
   Problems, suggestions; □ Report attached

   Remarks: No problems reported.

2. **O&M staff** Amy Rogers — P&T Proj Manager — 12/4/2017
   Name — Title — Date
   Interviewed ☒ at site □ at office □ by phone Phone no. 270-816-2361
   Problems, suggestions; □ Report attached :

   Remarks: No problems reported. Noted power disruptions due to storms are commonly resolved within an hour.

3.	**Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply. Agency ______________________________ Contact ______________________________ ____________________ _________ _____________ Name Title Date Phone no. Problems; suggestions; □ Report attached ____ ____ Agency ______________________________ Contact ______________________________ ____________________ _________ _____________ Name Title Date Phone no. Problems; suggestions; □ Report attached ____ ____ Agency ______________________________ Contact ______________________________ ____________________ _________ _____________ Name Title Date Phone no. Problems; suggestions; □ Report attached ____ ____ Agency ______________________________ Contact ______________________________ ____________________ _________ _____________ Name Title Date Phone no. Problems; suggestions; □ Report attached ____ ____
4.	**Other interviews** (optional) □ Report attached.

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)				
1. **O&M Documents**				
☒ O&M manual (SEP 2010)	☒ Readily available	☒Up to date	□ N/A	
☒ As-built drawings	☒ Readily available	☒ Up to date	□ N/A	
☒ Maintenance logs	☒ Readily available	☒ Up to date	□ N/A	
Remarks: Maintenance activities are scheduled and reported daily. Preventative maintenance is tracked in SOMAX. O&M Plan references need update. O&M manual is available electronically on the S: Drive				
2. **Site-Specific Health and Safety Plan**	☒ Readily available	☒ Up to date	□ N/A	
☒ Contingency plan/emergency response plan	☒ Readily available	☒ Up to date	□ N/A	
Remarks: JHA-10844 / H&S Plan: CP2-ER-0067/R1 / emergency response is addressed in the H&S Plan				
3. **O&M and OSHA Training Records**	☒ Readily available	☒ Up to date	□ N/A	
Remarks: Site training records are maintained electronically				
4. **Permits and Service Agreements**				
□ Air discharge permit	□ Readily available	□ Up to date	☒ N/A	
□ Effluent discharge	□ Readily available	□ Up to date	☒ N/A	
□ Waste disposal, POTW	□ Readily available	□ Up to date	☒ N/A	
□ Other permits______________________	□ Readily available	□ Up to date	☒ N/A	
Remarks: Effluent monitored by KPDES permit (Outfall 001). Site waste management program addresses waste. Carbon vessel change out every 6 months.				
5. **Gas Generation Records**	□ Readily available	□ Up to date	☒ N/A	
Remarks				
6. **Settlement Monument Records**	□ Readily available	□ Up to date	☒ N/A	
Remarks				
7. **Groundwater Monitoring Records**	☒ Readily available	☒ Up to date	□ N/A	
Remarks: Available to public through PEGASIS data retrieval system. Reported in semi-annual Federal Facility Agreement reports				
8. **Leachate Extraction Records**	□ Readily available	□ Up to date	☒ N/A	
Remarks				
9. **Discharge Compliance Records**				
□ Air	□ Readily available	□ Up to date	☒ N/A	
☒ Water (effluent)	☒ Readily available	☒ Up to date	□ N/A	
Remarks: Available to public through PEGASIS data retrieval system. Included in semi-annual Federal Facility Agreement reports				
10. **Daily Access/Security Logs**	□ Readily available	□ Up to date	☒ N/A	
Remarks				

IV. O&M COSTS

1. **O&M Organization**
□ State in-house □ Contractor for State
□ PRP in-house □ Contractor for PRP
□ Federal Facility in-house ☒ Contractor for Federal Facility
□ Other____

2. **O&M Cost Records** *Refer to Sect. 16.3 of the report.*
☒ Readily available □ Up to date: Revisited semi-annually (FFA semi-annual reports)
☒ Funding mechanism/agreement in place
Original O&M cost estimate: $240K/yr for NE Plume P&T □ Breakdown attached

Total annual cost by year for review period if available

From (Date)	To (Date)	Total cost	
4/1/13	9/30/13	$303K for NE & NW P&T Systems	□ Breakdown attached
10/1/13	9/30/14	$570 K for NE & NW P&T Systems	□ Breakdown attached
10/1/14	3/31/15	$250K for NE & NW P&T Systems	□ Breakdown attached
4/1/16	9/30/16	$378K for NE & NW P&T Systems	□ Breakdown attached
10/1/16	9/30/17	$756K for NE & NW P&T Systems	□ Breakdown attached

3. **Unanticipated or Unusually High O&M Costs During Review Period**
Describe costs and reasons: Combined cost of O&M of pump and treat systems remains less than forecasted.

V. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable □ N/A

A. Fencing

1. **Fencing damaged** □ Location shown on site map ☒ Gates secured □ N/A
Remarks: Treatment system is enclosed by security fence. The fencing is in good condition.

B. Other Access Restrictions

1. **Signs and other security measures** □ Location shown on site map □ N/A
Remarks: Monitoring wells and standby extraction wells are secured by locks.

C. Institutional Controls (ICs)
1. **Implementation and enforcement** Site conditions imply ICs not properly implemented ☐ Yes ☐ No ☒ N/A Site conditions imply ICs not being fully enforced ☐ Yes ☐ No ☒ N/A Type of monitoring (*e.g.*, self-reporting, drive by) ____ Frequency ____ Responsible party/agency ____ Contact ____ ____ ____ ____ Name Title Date Phone no. Reporting is up-to-date ☐ Yes ☐ No ☒ N/A Reports are verified by the lead agency ☐ Yes ☐ No ☒ N/A Specific requirements in deed or decision documents have been met ☐ Yes ☐ No ☒ N/A Violations have been reported ☐ Yes ☐ No ☒ N/A Other problems or suggestions: ☐ Report attached
2. **Adequacy** ☒ ICs are adequate ☐ ICs are inadequate ☐ N/A Remarks____
D. General
1. **Vandalism/trespassing** ☐ Location shown on site map ☒ No vandalism evident Remarks____
2. **Land use changes on site** ☒ N/A Remarks: Future transition of DOE-owned land to other agencies may limit access to monitoring wells.
3. **Land use changes off site** ☒ N/A Remarks____

VI. GENERAL SITE CONDITIONS
A. Roads ☒ Applicable □ N/A
1. **Roads damaged** □ Location shown on site map ☒ Roads adequate □ N/A Remarks: Roads are in good condition.
B. Other Site Conditions
Remarks : Treatment facility and extraction well vaults are well ordered and labeled. The grounds are well maintained.
VII. LANDFILL COVERS □ Applicable ☒ N/A
VIII. VERTICAL BARRIER WALLS □ Applicable ☒ N/A
IX. GROUNDWATER/SURFACE WATER REMEDIES ☒ Applicable □ N/A
A. Groundwater Extraction Wells, Pumps, and Pipelines ☒ Applicable □ N/A
1. **Pumps, Wellhead Plumbing, and Electrical** ☒ Good condition ☒ All required wells properly operating □ Needs Maintenance □ N/A Remarks: Two operating extraction wells
2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances** ☒ Good condition □ Needs Maintenance Remarks___
3. **Spare Parts and Equipment** ☒ Readily available ☒ Good condition □ Requires upgrade □ Needs to be provided Remarks___
B. Surface Water Collection Structures, Pumps, and Pipelines □ Applicable ☒ N/A

C. Treatment System ☒ Applicable ☐ N/A	
1.	**Treatment Train** (Check components that apply) ☐ Metals removal ☐ Oil/water separation ☐ Bioremediation ☒ Air stripping ☐ Carbon adsorbers ☒ Filters: (2) sand filters at beginning of treatment train ☐ Additive (*e.g.*, chelation agent, flocculent)____ ☒ Others: ion exchange – (4) tanks ☒ Good condition ☐ Needs Maintenance ☒ Sampling ports properly marked and functional ☒ Sampling/maintenance log displayed and up to date (available through SOMAX) ☒ Equipment properly identified ☒ Quantity of groundwater treated annually: 103,342,497 gallons (10/1/16 – 9/30/17) ☐ Quantity of surface water treated annually____ Remarks____
2.	**Electrical Enclosures and Panels** (properly rated and functional) ☐ N/A ☒ Good condition ☐ Needs Maintenance Remarks____
3.	**Tanks, Vaults, Storage Vessels** ☐ N/A ☒ Good condition ☒ Proper secondary containment ☐ Needs Maintenance Remarks____
4.	**Discharge Structure and Appurtenances** ☐ N/A ☒ Good condition ☐ Needs Maintenance Remarks: Beaver dams downstream of discharge are removed as necessary
5.	**Treatment Building(s)** ☐ N/A ☒ Good condition (esp. roof and doorways) ☐ Needs repair ☒ Chemicals and equipment properly stored Remarks____
6.	**Monitoring Wells** (pump and treatment remedy) ☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition ☒ All required wells located ☐ Needs Maintenance ☐ N/A Remarks____
D. Monitoring Data	
1.	Monitoring Data ☒ Is routinely submitted on time ☒ Is of acceptable quality
2.	Monitoring data suggests: ☐ Groundwater plume is effectively contained ☒ Contaminant concentrations are declining

D. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ All required wells located ☐ Needs Maintenance ☒ N/A
Remarks____
____

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

The NW Plume IRA is intended to initiate control of the high-concentration zones of TCE and Tc-99 in the NW Plume. Monitoring data indicate offsite contaminant levels and the extent of the main plume are declining.

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

O&M actions during the 2013-2017 period have prepared the treatment system to continue operating effectively. The IRA is expected to remain protective in concert with implementation of the site Water Policy.

C. Early Indicators of Potential Remedy Problems

Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future.

There are no indications of O&M problems that will impact the protectiveness of the IRA in the future.

D. Opportunities for Optimization

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

TCE and Tc-99 levels immediately downgradient of the extraction wells suggest the system may be optimized by repositioning the well pumps or adjusting the extraction rates.

ATTACHMENT
Inspection team roster (12/4/2017):

Kenneth Davis (FRNP)
Brian Lowrance (FRNP)
Amy Rogers (FRNP)
Jennifer Johnson (P2S)

Site map:

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2/14/2018

Five-Year Review Site Inspection Checklist
Northeast Plume

I. SITE INFORMATION	
Site name: NE Plume IRA	**Date of inspection:** 12/5/2017
Location and Region: Paducah, KY/Region 4	**EPA ID:** KY8890008982
Agency, office, or company leading the five-year review: DOE	**Weather/temperature:** Fair weather transitioning to cloudy skies, 40 - 43°F, wind 12 – 15 mph from NW

Remedy Includes: (Check all that apply)

□ Landfill cover/containment
☒ Access controls
□ Institutional controls
☒ Groundwater pump and treatment
□ Surface water collection and treatment
□ Other____
□ Monitored natural attenuation
□ Groundwater containment
□ Vertical barrier walls

Attachments: ☒ Inspection team roster attached ☒ Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** _Brian Lowrance_______________ _Prog Integration Mgr____ _ 12/5/2017______
Name Title Date
Interviewed ☒ at site □ at office □ by phone Phone no. 270-559-6371
Problems, suggestions; □ Report attached
Remarks: No problems reported.

2. **O&M staff** __Amy Rogers_______________ _P&T Proj Manager_____ __12/5/2017_______
Name Title Date
Interviewed ☒ at site □ at office □ by phone Phone no. _______________
Problems, suggestions; □ Report attached :
Remarks: No problems reported.____

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

Agency ______________________________
Contact ______________________________ ____________________ _________ _____________
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached ____
____

Agency ______________________________
Contact ______________________________ ____________________ _________ _____________
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached ____
____

Agency ______________________________
Contact ______________________________ ____________________ _________ _____________
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached ____
____

Agency ______________________________
Contact ______________________________ ____________________ _________ _____________
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached ____
____

4. **Other interviews** (optional) ☐ Report attached.

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)	
1.	**O&M Documents** ☒ O&M manual (SEP 2017) ☒ Readily available ☒Up to date ☐ N/A ☒ As-built drawings ☒ Readily available ☒ Up to date ☐ N/A ☒ Maintenance logs ☒ Readily available ☒ Up to date ☐ N/A Remarks: Maintenance activities are scheduled and reported daily. Preventative maintenance is tracked in SOMAX. O&M manual is available electronically on the S: Drive
2.	**Site-Specific Health and Safety Plan** ☒ Readily available ☒ Up to date ☐ N/A ☒ Contingency plan/emergency response plan ☒ Readily available ☒ Up to date ☐ N/A Remarks: JHA-10844 / H&S Plan: CP2-ER-0067/R1 / emergency response is addressed in the H&S Plan
3.	**O&M and OSHA Training Records** ☒ Readily available ☒ Up to date ☐ N/A Remarks: Site training records are maintained electronically
4.	**Permits and Service Agreements** ☐ Air discharge permit ☐ Readily available ☐ Up to date ☒ N/A ☐ Effluent discharge ☐ Readily available ☐ Up to date ☒ N/A ☐ Waste disposal, POTW ☐ Readily available ☐ Up to date ☒ N/A ☐ Other permits______________________ ☐ Readily available ☐ Up to date ☒ N/A Remarks: Water effluent monitored at C-001 outfall. Site waste management program addresses waste
5.	**Gas Generation Records** ☐ Readily available ☐ Up to date ☒ N/A Remarks____
6.	**Settlement Monument Records** ☐ Readily available ☐ Up to date ☒ N/A Remarks____
7.	**Groundwater Monitoring Records** ☒ Readily available ☒ Up to date ☐ N/A Remarks: Available to public through PEGASIS data retrieval system. Reported in semi-annual Federal Facility Agreement reports
8.	**Leachate Extraction Records** ☐ Readily available ☐ Up to date ☒ N/A Remarks____
9.	**Discharge Compliance Records** ☐ Air ☐ Readily available ☐ Up to date ☒ N/A ☒ Water (effluent) ☒ Readily available ☒ Up to date ☐ N/A Remarks: Available to public through PEGASIS data retrieval system. Included in semi-annual Federal Facility Agreement reports
10.	**Daily Access/Security Logs** ☐ Readily available ☐ Up to date ☒ N/A Remarks____

IV. O&M COSTS	
1.	**O&M Organization** □ State in-house □ Contractor for State □ PRP in-house □ Contractor for PRP □ Federal Facility in-house ☒ Contractor for Federal Facility □ Other____
2.	**O&M Cost Records** *Refer to Sect. 16.3 of the report.* ☒ Readily available □ Up to date: Revisited semi-annually (FFA semi-annual reports) ☒ Funding mechanism/agreement in place Original O&M cost estimate: $240K/yr for NE Plume P&T □ Breakdown attached Total annual cost by year for review period if available From: 4/1/13 (Date) To: 9/30/13 (Date) $303K for NE & NW P&T Systems (Total cost) □ Breakdown attached From: 10/1/13 (Date) To: 9/30/14 (Date) $570 K for NE & NW P&T Systems (Total cost) □ Breakdown attached From: 10/1/14 (Date) To: 3/31/15 (Date) $250K for NE & NW P&T Systems (Total cost) □ Breakdown attached From: 4/1/16 (Date) To: 9/30/16 (Date) $378K for NE & NW P&T Systems (Total cost) □ Breakdown attached From: 10/1/16 (Date) To: 9/30/17 (Date) $756K for NE & NW P&T Systems (Total cost) □ Breakdown attached
3.	**Unanticipated or Unusually High O&M Costs During Review Period** Describe costs and reasons: Combined cost of O&M of pump and treat systems remains less than forecasted.

V. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable □ N/A	
A. Fencing	
1.	**Fencing damaged** □ Location shown on site map ☒ Gates secured □ N/A Remarks: Both treatment systems are enclosed in security fencing. The fences are in good condition.
B. Other Access Restrictions	
1.	**Signs and other security measures** □ Location shown on site map □ N/A Remarks: Standby extraction wells are secured by fencing. Monitoring wells are locked.

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

Site conditions imply ICs not properly implemented ☐ Yes ☐ No ☒ N/A
Site conditions imply ICs not being fully enforced ☐ Yes ☐ No ☒ N/A

Type of monitoring (*e.g.*, self-reporting, drive by) ______
Frequency ______
Responsible party/agency ______
Contact ______ ______ ______ ______
Name Title Date Phone no.

Reporting is up-to-date ☐ Yes ☐ No ☒ N/A
Reports are verified by the lead agency ☐ Yes ☐ No ☒ N/A

Specific requirements in deed or decision documents have been met ☐ Yes ☐ No ☒ N/A
Violations have been reported ☐ Yes ☐ No ☒ N/A
Other problems or suggestions: ☐ Report attached

2. **Adequacy** ☒ ICs are adequate ☐ ICs are inadequate ☐ N/A
Remarks______

D. General

1. **Vandalism/trespassing** ☐ Location shown on site map ☒ No vandalism evident
Remarks______

2. **Land use changes on site** ☒ N/A
Remarks______

3. **Land use changes off site** ☒ N/A
Remarks______

VI. GENERAL SITE CONDITIONS

A. Roads ☒ Applicable ☐ N/A

1. **Roads damaged** ☐ Location shown on site map ☒ Roads adequate ☐ N/A
Remarks______

B. Other Site Conditions
Remarks : Treatment systems and extraction wells are well labeled and ordered. The grounds are well maintained.
VII. LANDFILL COVERS ☐ Applicable ☒ N/A
VIII. VERTICAL BARRIER WALLS ☐ Applicable ☒ N/A
IX. GROUNDWATER/SURFACE WATER REMEDIES ☒ Applicable ☐ N/A
A. Groundwater Extraction Wells, Pumps, and Pipelines ☒ Applicable ☐ N/A
1. **Pumps, Wellhead Plumbing, and Electrical** ☒ Good condition ☒ All required wells properly operating ☐ Needs Maintenance ☐ N/A Remarks: Two operating extraction wells
2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances** ☒ Good condition ☐ Needs Maintenance Remarks
3. **Spare Parts and Equipment** ☒ Readily available ☒ Good condition ☐ Requires upgrade ☐ Needs to be provided Remarks
B. Surface Water Collection Structures, Pumps, and Pipelines ☐ Applicable ☒ N/A
C. Treatment System ☒ Applicable ☐ N/A
1. **Treatment Train** (Check components that apply) ☐ Metals removal ☐ Oil/water separation ☐ Bioremediation ☒ Air stripping ☐ Carbon adsorbers ☒ Filters: (4) bag filters at beginning of treatment systems ☐ Additive (*e.g.*, chelation agent, flocculent) ☐ Others ☒ Good condition ☐ Needs Maintenance ☒ Sampling ports properly marked and functional ☒ Sampling/maintenance log displayed and up to date (available through SOMAX) ☒ Equipment properly identified ☒ Quantity of groundwater treated annually: new systems – project 134 million gallons ☐ Quantity of surface water treated annually Remarks
2. **Electrical Enclosures and Panels** (properly rated and functional) ☐ N/A ☒ Good condition ☐ Needs Maintenance Remarks
3. **Tanks, Vaults, Storage Vessels** ☐ N/A ☒ Good condition ☒ Proper secondary containment ☐ Needs Maintenance Remarks
4. **Discharge Structure and Appurtenances** ☐ N/A ☒ Good condition ☐ Needs Maintenance Remarks: Outfall C-001

5.	**Treatment Building(s)** □ N/A ☒ Good condition (esp. roof and doorways) □ Needs repair ☒ Chemicals and equipment properly stored Remarks____
6.	**Monitoring Wells** (pump and treatment remedy) ☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition □ All required wells located □ Needs Maintenance □ N/A Remarks____
D. Monitoring Data	
1.	Monitoring Data ☒ Is routinely submitted on time ☒ Is of acceptable quality
2.	Monitoring data suggests: □ Groundwater plume is effectively contained ☒ Contaminant concentrations are declining
D. Monitored Natural Attenuation	
1.	**Monitoring Wells** (natural attenuation remedy) □ Properly secured/locked □ Functioning □ Routinely sampled □ Good condition □ All required wells located □ Needs Maintenance ☒ N/A Remarks____
X. OTHER REMEDIES	
	If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.
XI. OVERALL OBSERVATIONS	
A.	**Implementation of the Remedy**
	Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.). The NE Plume IRA is intended to control the high concentration area of the NE Plume that extends outside the plant security area and to track contaminant migration. Monitoring data clearly show that the IRA has achieved its goal of controlling the offsite plume. An optimization of the extraction well system is intended to increase TCE mass removal. The optimization became operational in October 2017. The effectiveness of the optimization will require future monitoring results to assess.

B.	**Adequacy of O&M**
	Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy. O&M activities completed during the 2013-2017 period should significantly enhance the current protectiveness of the remedy and should contribute to the goal of long-term protectiveness.
C.	**Early Indicators of Potential Remedy Problems**
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future. The optimization of the EW system should ensure continuing operations. Maintenance of the shutdown EW system appears adequate to support re-start of the original EW system, if needed.
D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. An optimization of the IRA was completed in October 2017. Opportunities for additional optimization are not yet evident.

ATTACHMENT

Inspection team roster (12/5/2017):

Kenneth Davis (FRNP) Brian Lowrance (FRNP) Jennifer Johnson (P2S)

Site map:

Five-Year Review Site Inspection Checklist
Cylinder Drop Test Area or LASAGNA™ Technology Demonstration

I. SITE INFORMATION	
Site name: Lasagna Treatment Area/Cylinder Drop Test Area, SWMU 91	**Date of inspection:** 12/6/2017
Location and Region: Paducah, KY/Region 4	**EPA ID:** KY8890008982
Agency, office, or company leading the five-year review: DOE	**Weather/temperature:** Clear, 41°F, 5-10 mph winds
Remedy Includes: (Check all that apply) □ Landfill cover/containment □ Monitored natural attenuation □ Access controls □ Groundwater containment □ Institutional controls □ Vertical barrier walls □ Groundwater pump and treatment □ Surface water collection and treatment x Other_- Lasagna Technology Demonstration	
Attachments: ☒ Inspection team roster attached ☒ Site map attached	
II. INTERVIEWS (Check all that apply)	
1. **O&M site manager** Brian Lowrance (Name) Facility Manager (Title) 12/6/2017 (Date) Interviewed ☒ at site □ at office □ by phone Phone no. ______ Problems, suggestions; □ Report attached No problems or suggestions identified.	
2. **O&M staff** N/A (Name) ______ (Title) ______ (Date) Interviewed □ at site □ at office □ by phone Phone no. ______ Problems, suggestions; □ Report attached ______	

3.	**Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply. Agency ______________________________ Contact ______________________________ ___________________ ________ ____________ Name Title Date Phone no. Problems; suggestions; □ Report attached ____ Agency ______________________________ Contact ______________________________ ___________________ ________ ____________ Name Title Date Phone no. Problems; suggestions; □ Report attached ____ Agency ______________________________ Contact ______________________________ ___________________ ________ ____________ Name Title Date Phone no. Problems; suggestions; □ Report attached ____ Agency ______________________________ Contact ______________________________ ___________________ ________ ____________ Name Title Date Phone no. Problems; suggestions; □ Report attached ____
4.	**Other interviews** (optional) □ Report attached.

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)				
1.	**O&M Documents**			
	□ O&M manual	□ Readily available	□ Up to date	☒ N/A
	□ As-built drawings	□ Readily available	□ Up to date	☒ N/A
	□ Maintenance logs	□ Readily available	□ Up to date	☒ N/A
	Remarks______			
2.	**Site-Specific Health and Safety Plan**	□ Readily available	□ Up to date	☒ N/A
	□ Contingency plan/emergency response plan	□ Readily available	□ Up to date	☒ N/A
	Remarks______			
3.	**O&M and OSHA Training Records**	□ Readily available	□ Up to date	☒ N/A
	Remarks______			
4.	**Permits and Service Agreements**			
	□ Air discharge permit	□ Readily available	□ Up to date	☒ N/A
	□ Effluent discharge	□ Readily available	□ Up to date	☒ N/A
	□ Waste disposal, POTW	□ Readily available	□ Up to date	☒ N/A
	□ Other permits______	□ Readily available	□ Up to date	☒ N/A
	Remarks______			
5.	**Gas Generation Records**	□ Readily available	□ Up to date	☒ N/A
	Remarks______			
6.	**Settlement Monument Records**	□ Readily available	□ Up to date	☒ N/A
	Remarks______			
7.	**Groundwater Monitoring Records**	□ Readily available	□ Up to date	☒ N/A
	Remarks______			
8.	**Leachate Extraction Records**	□ Readily available	□ Up to date	☒ N/A
	Remarks______			
9.	**Discharge Compliance Records**			
	□ Air	□ Readily available	□ Up to date	☒ N/A
	□ Water (effluent)	□ Readily available	□ Up to date	☒ N/A
	Remarks______			
10.	**Daily Access/Security Logs**	□ Readily available	□ Up to date	☒ N/A
	Remarks______			

IV. O&M COSTS

1. **O&M Organization**

□ State in-house □ Contractor for State
□ PRP in-house □ Contractor for PRP
□ Federal Facility in-house ☒ Contractor for Federal Facility
x Other No operation and maintenance specifically required for SWMU 91.

2. **O&M Cost Records** *Refer to Sect. 14.3 of the report.*

□ Readily available □ Up to date
□ Funding mechanism/agreement in place
Original O&M cost estimate____________________ □ Breakdown attached

Total annual cost by year for review period if available

From (Date)	To (Date)	Total cost	
From__________	To__________	__________________	□ Breakdown attached
From__________	To__________	__________________	□ Breakdown attached
From__________	To__________	__________________	□ Breakdown attached
From__________	To__________	__________________	□ Breakdown attached
From__________	To__________	__________________	□ Breakdown attached

3. **Unanticipated or Unusually High O&M Costs During Review Period**

Describe costs and reasons: ____

V. ACCESS AND INSTITUTIONAL CONTROLS □ Applicable x N/A

VI. GENERAL SITE CONDITIONS

A. Roads □ Applicable ☒ N/A

B. Other Site Conditions

Remarks: Treatment area is not distinguishable from surrounding area by observation. The northern portion of the surface is gravel covered similar to the C-745-B Cylinder yard; while the southern portion of the treatment area is bare soil with limited grass and some gravel present.

VII. LANDFILL COVERS □ Applicable ☒ N/A

VIII. VERTICAL BARRIER WALLS □ Applicable ☒ N/A

IX. GROUNDWATER/SURFACE WATER REMEDIES □ Applicable ☒ N/A

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction. See Attachment

XI. OVERALL OBSERVATIONS

A.	**Implementation of the Remedy**
	Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.). The Lasagna remedy implementation at the Cylinder Drop Test Area was completed in December, 2001.
B.	**Adequacy of O&M**
	Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy. The Lasagna remedy does not have ongoing operation and maintenance activities.
C.	**Early Indicators of Potential Remedy Problems**
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future. Review. No indicators of potential remedy problems were identified during this Five Year
D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. Review. No optimization opportunities were identified during this Five Year

ATTACHMENT

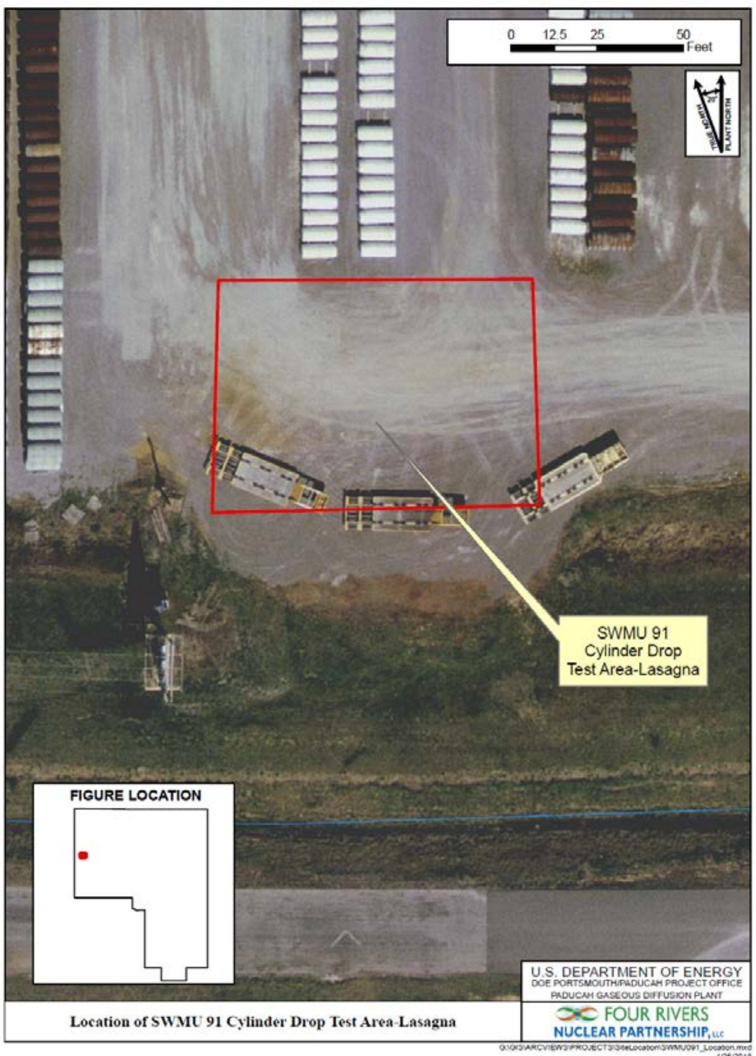
Section X - Other Remedies:

SWMU 91 Remedy – Lasagna (Electro-Osmosis contaminant migration): The SWMU 91 treatment area at the time of inspection (12/6/2017) was gravel covered with a bare soil, grass, and gravel mix covering the southern portion of the area. The area appeared well kept with no tall grass, water holes, or erosion visible. The treatment area lies within several radiologically controlled areas which are not associated with the treatment area. The treatment area also shares area with the C-745-B Cylinder Yard. All treatment was performed on subsurface soils and visual inspection from the surface is not feasible.

Inspection team roster (12/6/2017):

Jennifer Blewett (FRNP)
LeAnne Garner (FRNP)
Jennifer Johnson (Pro2Serv)
Brian Lowrance (FRNP)
Teresa Overby (FRNP)
Justin Riley (FRNP)
Bryan Clayton (FRNP)

Site map:



Location of SWMU 91 Cylinder Drop Test Area-Lasagna

Five-Year Review Site Inspection Checklist
Water Policy

I. SITE INFORMATION	
Site name: PGDP Water Policy	**Date of inspection:** 12/12/2017
Location and Region: Paducah, KY/Region 4	**EPA ID:** KY8890008982
Agency, office, or company leading the five-year review: DOE	**Weather/temperature:** 43 F and overcast

Remedy Includes: (Check all that apply)

- □ Landfill cover/containment
- □ Access controls
- □ Institutional controls
- □ Groundwater pump and treatment
- □ Surface water collection and treatment
- ☒ Other_ removal action
- □ Monitored natural attenuation
- □ Groundwater containment
- □ Vertical barrier walls

Attachments: ☒ Inspection team roster attached ☒ Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** _Teresa Overby_ _Program Manager_ _12/6/2017_
   Name Title Date
   Interviewed ☒ at site □ at office □ by phone Phone no. ______________
   Problems, suggestions; □ Report attached __None____________________

2. **O&M staff** __N/A__ ______________ ________
   Name Title Date
   Interviewed □ at site □ at office □ by phone Phone no. ______________
   Problems, suggestions; □ *Report attached* ______________________

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

Agency ______________________________
Contact ______________________________ ____________________ _________ _____________
Name Title Date Phone no.
Problems; suggestions; □ Report attached ____
____

Agency ______________________________
Contact ______________________________ ____________________ _________ _____________
Name Title Date Phone no.
Problems; suggestions; □ Report attached ____
____

Agency ______________________________
Contact ______________________________ ____________________ _________ _____________
Name Title Date Phone no.
Problems; suggestions; □ Report attached ____
____

Agency ______________________________
Contact ______________________________ ____________________ _________ _____________
Name Title Date Phone no.
Problems; suggestions; □ Report attached ____
____

4. **Other interviews** (optional) □ *Report attached.*

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)				
1.	**O&M Documents**			
	□ O&M manual	□ Readily available	□ Up to date	☒ N/A
	□ As-built drawings	□ Readily available	□ Up to date	☒ N/A
	□ Maintenance logs	□ Readily available	□ Up to date	☒ N/A
	Remarks______			
2.	**Site-Specific Health and Safety Plan**	□ Readily available	□ Up to date	☒ N/A
	□ Contingency plan/emergency response plan	□ Readily available	□ Up to date	☒ N/A
	Remarks______			
3.	**O&M and OSHA Training Records**	□ Readily available	□ Up to date	☒ N/A
	Remarks______			
4.	**Permits and Service Agreements**			
	□ Air discharge permit	□ Readily available	□ Up to date	☒ N/A
	□ Effluent discharge	□ Readily available	□ Up to date	☒ N/A
	□ Waste disposal, POTW	□ Readily available	□ Up to date	☒ N/A
	□ Other permits______	□ Readily available	□ Up to date	☒ N/A
	Remarks______			
5.	**Gas Generation Records**	□ Readily available	□ Up to date	☒ N/A
	Remarks______			
6.	**Settlement Monument Records**	□ Readily available	□ Up to date	☒ N/A
	Remarks______			
7.	**Groundwater Monitoring Records**	□ Readily available	□ Up to date	☒ N/A
	Remarks______			
8.	**Leachate Extraction Records**	□ Readily available	□ Up to date	☒ N/A
	Remarks______			
9.	**Discharge Compliance Records**			
	□ Air	□ Readily available	□ Up to date	☒ N/A
	□ Water (effluent)	□ Readily available	□ Up to date	☒ N/A
	Remarks______			
10.	**Daily Access/Security Logs**	□ Readily available	□ Up to date	☒ N/A
	Remarks______			

IV. O&M COSTS

1. **O&M Organization**
☐ State in-house ☐ Contractor for State
☐ PRP in-house ☐ Contractor for PRP
☐ Federal Facility in-house ☒ Contractor for Federal Facility
☐ Other______________________________

2. **O&M Cost Records** Refer to Sect. 8.3 of the report.
☐ Readily available ☐ Up to date
☐ Funding mechanism/agreement in place
Original O&M cost estimate____________________ ☐ Breakdown attached

Total annual cost by year for review period if available

From__________ (Date)	To__________ (Date)	__________ (Total cost)	☐ Breakdown attached
From__________ (Date)	To__________ (Date)	__________ (Total cost)	☐ Breakdown attached
From__________ (Date)	To__________ (Date)	__________ (Total cost)	☐ Breakdown attached
From__________ (Date)	To__________ (Date)	__________ (Total cost)	☐ Breakdown attached
From__________ (Date)	To__________ (Date)	__________ (Total cost)	☐ Breakdown attached

3. **Unanticipated or Unusually High O&M Costs During Review Period**
Describe costs and reasons: *Costs are discussed in Sect. 8.3 of the report.*

V. ACCESS AND INSTITUTIONAL CONTROLS ☐ Applicable ☒ N/A

VI. GENERAL SITE CONDITIONS

A. Roads ☐ Applicable ☒ N/A

B. Other Site Conditions

Remarks ______________________________

VII. LANDFILL COVERS ☐ Applicable ☒ N/A

VIII. VERTICAL BARRIER WALLS ☐ Applicable ☒ N/A

IX. GROUNDWATER/SURFACE WATER REMEDIES ☐ Applicable ☒ N/A

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS	
A.	**Implementation of the Remedy**
	Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.). The primary objective of the Water Policy Removal Action is to prevent local residents from using contaminated groundwater by providing municipal water to residences and businesses and eliminating the use of private water wells. The action continues to eliminate the exposure pathway to the groundwater, which is supported by monthly water usage data provided by the West McCracken County Water District, indicating that residents are utilizing the municipal water. For the site inspection, a drive-by of all the properties was conducted. No sign of groundwater use was observed (e.g., new groundwater well).
B.	**Adequacy of O&M**
	Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy. See Section 8.3 in main text.
C.	**Early Indicators of Potential Remedy Problems**
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future. None.
D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. None.

ATTACHMENT

Inspection team roster (12/12/2017):
Jennifer Johnson (Pro2Serve)
Teresa Overby (FRNP)

Site map:

Five-Year Review Site Inspection Checklist
C-400 Electrical Resistance Heating

I. SITE INFORMATION	
Site name: C-400 IRA	**Date of inspection:** 12/20/17
Location and Region: Paducah, Kentucky	**EPA ID:** KY8890008982
Agency, office, or company leading the five-year review: DOE	**Weather/temperature:** Overcast with intermittent drizzle / 45° F
Remedy Includes: (Check all that apply) □ Landfill cover/containment □ Access controls **X** Institutional controls □ Groundwater pump and treatment □ Surface water collection and treatment **X** Other __Soil Vapor Groundwater Treatment System (SVGTS)	□ Monitored natural attenuation □ Groundwater containment □ Vertical barrier walls
Attachments: **X** Inspection team roster attached	**X** Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** Clint Dietsch ______ Facility Manager ______ 12/4/2017
Name Title Date
Interviewed **X** at site □ at office □ by phone Phone no. _____________
Problems, suggestions; □ Report attached __

Remarks: SVGTS facility currently non-operational, IRA completed, D&D planned for SVGTS system.

2. **O&M staff** _N/A*________________ ______________________________ _____________
Name Title Date
Interviewed □ at site □ at office □ by phone Phone no. ____________
Problems, suggestions; □ Report attached
Remarks: * SVGTS facility currently non-operational, IRA completed, D&D planned for SVGTS system.

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

Agency Kentucky Department of Environmental Protection
Contact _Gaye Brewer_____________________ Environmental Scientist __12/20/2017_______________
Name Title Date Phone no.
Problems; suggestions; ◻ Report attached ______________________________

Agency _ ______________________
Contact ______________________ ______________ ________ __________
Name Title Date Phone no.
Problems; suggestions; ◻ Report attached ______________________________

Agency ______________________
Contact ______________________ ______________ ________ __________
Name Title Date Phone no.
Problems; suggestions; ◻ Report attached ______________________________

Agency ______________________
Contact ______________________ ______________ ________ __________
Name Title Date Phone no.
Problems; suggestions; ◻ Report attached ______________________________

4. **Other interviews** (optional) ◻ Report attached.

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)				
1.	**O&M Documents**			
	X O&M manual	**X** Readily available	□ Up to date	□ N/A
	X As-built drawings	**X** Readily available	□ Up to date	□ N/A
	□ Maintenance logs	□ Readily available	□ Up to date	X N/A
	Remarks SVGTS facility currently non-operational, IRA completed, D&D planned for SVGTS. DOE preparing C-400 IRA RACR.			
2.	**Site-Specific Health and Safety Plan**	**X** Readily available	□ Up to date	□ N/A
	X Contingency plan/emergency response plan	**X** Readily available	□ Up to date	□ N/A
	Remarks __CP2-ER-1125 contingency Plan for Temporary Staging Areas ______________________			
3.	**O&M and OSHA Training Records**	**X** Readily available	□ Up to date	□ N/A
	Remarks__ SVGTS facility currently non-operational, IRA completed, D&D planned for SVGTS. DOE currently preparing C-400 IRA RACR.			
4.	**Permits and Service Agreements**			
	□ Air discharge permit	□ Readily available	□ Up to date	**X** N/A
	X Effluent discharge	**X** Readily available	□ Up to date	□ N/A
	X Waste disposal, POTW	**X** Readily available	□ Up to date	□ N/A
	X Other permits _CERCLA______	**X** Readily available	□ Up to date	□ N/A
	Remarks:_SVGTS facility currently non-operational, IRA completed, D&D planned for SVGTS.____ DOE currently preparing C-400 IRA RACR.____			
5.	**Gas Generation Records**	□ Readily available	□ Up to date	**X** N/A
	Remarks____			
6.	**Settlement Monument Records**	□ Readily available	□ Up to date	**X** N/A
	Remarks____			
7.	**Groundwater Monitoring Records**	**X** Readily available	**X** Up to date	□ N/A
	Remarks _Groundwater monitoring records for the site are readily available through PEGASIS._______			
8.	**Leachate Extraction Records**	□ Readily available	□ Up to date	**X** N/A
	Remarks____			
9.	**Discharge Compliance Records**			
	X Air	**X** Readily available	**X** Up to date	□ N/A
	X Water (effluent)	**X** Readily available	**X** Up to date	□ N/A
	Remarks_ Records required by the O&M plan have been submitted as part of the RACR.			
10.	**Daily Access/Security Logs**	**X** Readily available	**X** Up to date	□ N/A
	Remarks:_Access / Security logs maintained at site operations trailer._________________________			

IV. O&M COSTS

1. **O&M Organization**
□ State in-house □ Contractor for State
□ PRP in-house □ Contractor for PRP
□ Federal Facility in-house **X** Contractor for Federal Facility
□ Other____

2. **Total Project Cost Records**
X Readily available **X** Up to date
□ Funding mechanism/agreement in place
Original O&M cost estimate_$_2.25M * □ Breakdown attached

Total annual cost by Fiscal Year (Oct.1 – Sept. 30)

FY 2013U $ 2,415,385 □ Breakdown attached

FY 2014 $ 5,760,567 □ Breakdown attached

FY 2015 $ 532,678 □ Breakdown attached

FY 2016 $ 10,222 □ Breakdown attached

FY 2017 $ 0 □ Breakdown attached

* Source - C-400 Phase IIa O&M Plan (DOE/LX/07-1285&D2).

3. **Unanticipated or Unusually High O&M Costs During Review Period**
Describe costs and reasons:
- August 2013, Encountered issues during commissioning of steam regenerated carbon adsorption skid unit resulting in time delays.
- November 2013, Unseasonably cold weather results in significant freeze damage to groundwater treat system components causing extensive time delays
- February 2014, While bringing the carbon regen system back online, encountered higher than anticipated VOC levels from ERH wellfield (ERH electrodes remained on at reduced power while groundwater treatment system was repaired, approximately 60 days) resulting in extensive troubleshooting of carbon regen system to process VOCs.
- February 2014, Power loss to heater units in groundwater treatment system tent results in additional freeze damage to treatment systems and significant time delays.

V. ACCESS AND INSTITUTIONAL CONTROLS **X** Applicable □ N/A

A. Fencing

1. **Fencing damaged** □ Location shown on site map □ Gates secured **X** N/A
Remarks:

B. Other Access Restrictions

1. **Signs and other security measures** **X** Location shown on site map □ N/A
Remarks______A LUC boundary map for the C-400 area is attached____________________________

C. Institutional Controls (ICs)

1.	**Implementation and enforcement** Site conditions imply ICs not properly implemented □ Yes **X** No □ N/A Site conditions imply ICs not being fully enforced □ Yes **X** No □ N/A Type of monitoring (*e.g.*, self-reporting, drive by) _Self Reporting_ Frequency _Annual_ Responsible party/agency _DOE_ Contact _Dave Dollins_ PPPO Site Project Manager (270) 441-6819 Name Title Date Phone no. Reporting is up-to-date **X** Yes □ No □ N/A Reports are verified by the lead agency **X** Yes □ No □ N/A Specific requirements in deed or decision documents have been met □ Yes **X** No □ N/A Violations have been reported □ Yes □ No **X** N/A Other problems or suggestions: □ Report attached SVGTS facility currently non-operational, IRA completed, D&D planned for SVGTS. DOE currently preparing C-400 IRA RACR.
2.	**Adequacy** **X** ICs are adequate □ ICs are inadequate □ N/A Remarks_ LUCIP for C-400 is in place and controls site land use.
D. General	
1.	**Vandalism/trespassing** □ Location shown on site map **X** No vandalism evident Remarks
2.	**Land use changes on site** **X** N/A Remarks
3.	**Land use changes off site** **X** N/A Remarks
VI. GENERAL SITE CONDITIONS	
A. Roads **X** Applicable □ N/A	
1.	**Roads damaged** **X** Location shown on site map **x** Roads adequate □ N/A Remarks: No issues observed. A location map is attached showing surrounding roads.

B. Other Site Conditions

Remarks SVGTS facility currently non-operational, IRA completed, D&D planned for SVGTS. DOE currently preparing C-400 IRA RACR.

VII. LANDFILL COVERS □ Applicable **X** N/A

VIII. VERTICAL BARRIER WALLS □ Applicable **X** N/A

IX. GROUNDWATER/SURFACE WATER REMEDIES **X** Applicable □ N/A

A. Groundwater Extraction Wells, Pumps, and Pipelines □ Applicable **X** N/A

B. Surface Water Collection Structures, Pumps, and Pipelines □ Applicable **X** N/A

C. Treatment System **X** Applicable □ N/A

1. **Treatment Train** (Check components that apply)
□ Metals removal □ Oil/water separation □ Bioremediation
X Air stripping **X** Carbon adsorbers
□ Filters
□ Additive (*e.g.*, chelation agent, flocculent)
X Others Ion Exchange, Carbon Regeneration
□ Good condition □ Needs Maintenance
X Sampling ports properly marked and functional
□ Sampling/maintenance log displayed and up to date
X Equipment properly identified
□ Quantity of groundwater treated annually
□ Quantity of surface water treated annually
Remarks SVGTS facility currently non-operational, IRA completed, D&D planned for SVGTS. DOE currently preparing C-400 IRA RACR. Completed quantities will be reported in the RACR.

2. **Electrical Enclosures and Panels** (properly rated and functional)
□ N/A **X** Good condition □ Needs Maintenance
Remarks

3. **Tanks, Vaults, Storage Vessels**
□ N/A **X** Good condition **X** Proper secondary containment □ Needs Maintenance
Remarks

4. **Discharge Structure and Appurtenances**
□ N/A **X** Good condition □ Needs Maintenance
Remarks

5. **Treatment Building(s)**
□ N/A **X** Good condition (esp. roof and doorways) □ Needs repair
□ Chemicals and equipment properly stored
Remarks SVGTS facility currently non-operational, IRA completed, D&D planned for SVGTS. DOE currently preparing C-400 IRA RACR.

6. **Monitoring Wells** (pump and treatment remedy)
X Properly secured/locked X Functioning **X** Routinely sampled **X** Good condition
X All required wells located □ Needs Maintenance □ N/A
Remarks

D. Monitoring Data	
1.	Monitoring Data **X** Is routinely submitted on time **X** Is of acceptable quality
2.	Monitoring data suggests: □ Groundwater plume is effectively contained **X** Contaminant concentrations are declining
D. Monitored Natural Attenuation	
1.	**Monitoring Wells** (natural attenuation remedy) □ Properly secured/locked □ Functioning □ Routinely sampled □ Good condition □ All required wells located □ Needs Maintenance **X** N/A Remarks____
X. OTHER REMEDIES	
	If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction. **N/A**
XI. OVERALL OBSERVATIONS	
A.	**Implementation of the Remedy**
	Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.). Remedy has been completed. Please reference the RACR for details on the effectiveness of the remedy. SVGTS facility currently non-operational, IRA completed, and deactivation and demolition is planned for the SVGTS system
B.	**Adequacy of O&M**
	Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy. Remedy is complete. Please see RACR for issues that are remaining for long-term protectiveness of the remedy.

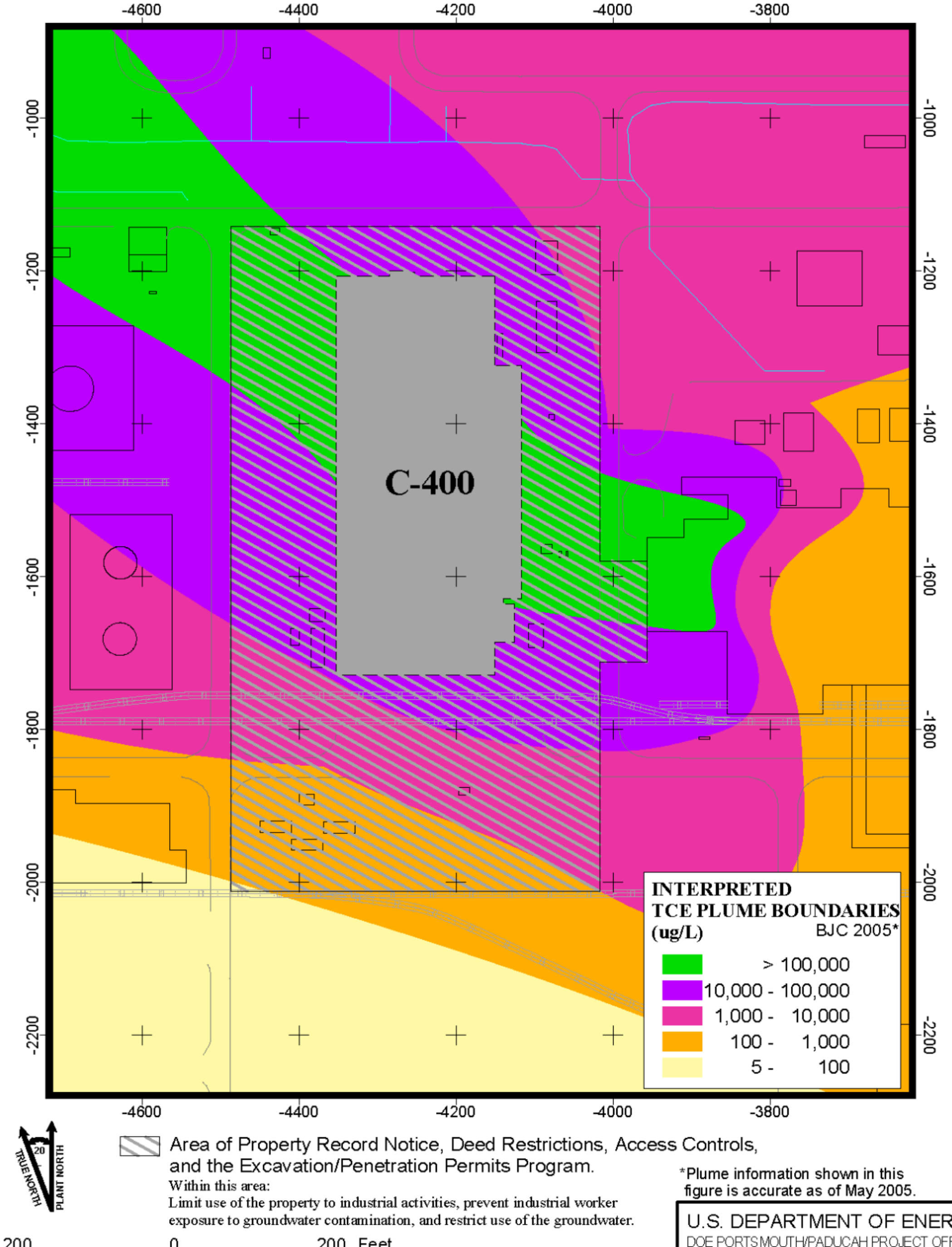
C.	Early Indicators of Potential Remedy Problems
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future. Remedy problems are detailed in the C-400 RACR
D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. Opportunities for Optimization will be discussed in new C-400 Complex OU Remedial Action Scoping Documents

Attachment:

Inspection Team Roster (12/20/2017):

Name	**Title**	**Organization**
Teresa Overby	Project Manager	FRNP
Clint Dietsch	Facility Manager	FRNP
Robert Flynn	Lead Inspector	FRNP
Gaye Brewer	Environmental Scientist	Kentucky Department of Environmental Protection
Jennifer Johnson	Environmental Specialist	Pro2Serve

DOCUMENT No. DOE/OR/07-2151&D2



Area of Property Record Notice, Deed Restrictions, Access Controls, and the Excavation/Penetration Permits Program.

Within this area:
Limit use of the property to industrial activities, prevent industrial worker exposure to groundwater contamination, and restrict use of the groundwater.

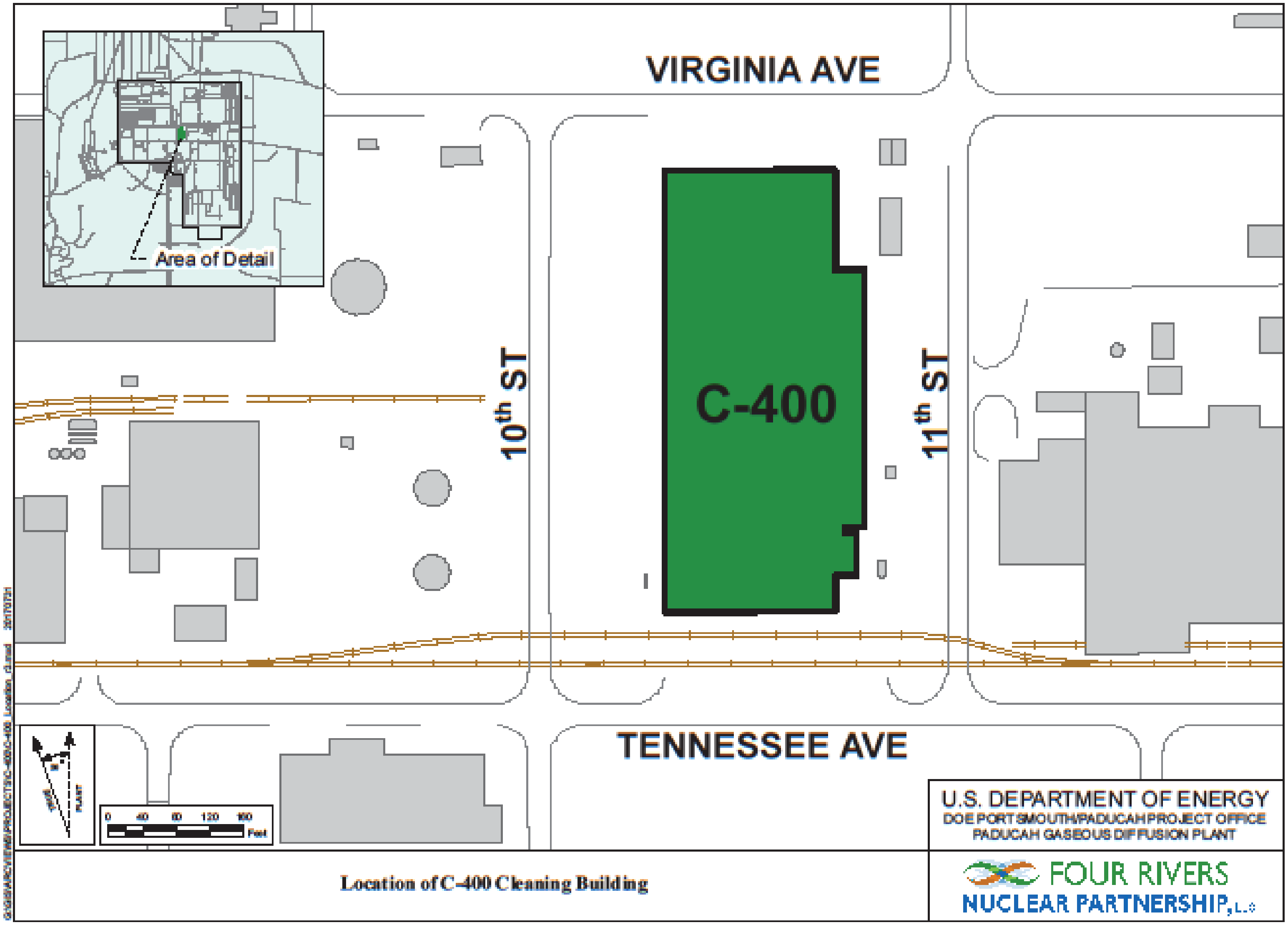
*Plume information shown in this figure is accurate as of May 2005.

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

LUC Boundary for the C-400 Area

PADUCAH Remediation Services
A Portage Shaw Joint Venture Company

Figure No. C5AC90005SK009r2.apr
DATE 03-30-07



Location of C-400 Cleaning Building

Five-Year Review Site Inspection Checklist
Southwest Plume—Oil Landfarm

I. SITE INFORMATION	
Site name: Southwest Plume, SWMU 1 – Oil Landfarm, Soil Mixing	**Date of inspection:** 12/20/2017
Location and Region: Paducah, KY/Region 4	**EPA ID:** KY8890008982
Agency, office, or company leading the five-year review: DOE	**Weather/temperature:** Overcast, 50°F, 5-10 mph winds, Intermittent Drizzle

Remedy Includes: (Check all that apply)

□ Landfill cover/containment □ Monitored natural attenuation
□ Access controls □ Groundwater containment
□ Institutional controls □ Vertical barrier walls
□ Groundwater pump and treatment
□ Surface water collection and treatment
x Other_- Soil Mixing with Zero-Valent Iron Remedial Action Area – Remedial Action completed in 2016

Attachments: ☒ Inspection team roster attached ☒ Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** _Clinton Dietsch_ _Facility Manager_ _12/20/2017_
   Name Title Date
   Interviewed ☒ at site □ at office □ by phone Phone no. ______
   Problems, suggestions; □ Report attached __No problems or suggestions identified.

2. **O&M staff** __N/A__ ______ ______
   Name Title Date
   Interviewed □ at site □ at office □ by phone Phone no. ______
   Problems, suggestions; □ Report attached ______

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

Agency ______________________________
Contact ______________________________ ____________________ _________ _____________
Name Title Date Phone no.
Problems; suggestions; □ Report attached ____
____

Agency ______________________________
Contact ______________________________ ____________________ _________ _____________
Name Title Date Phone no.
Problems; suggestions; □ Report attached ____
____

Agency ______________________________
Contact ______________________________ ____________________ _________ _____________
Name Title Date Phone no.
Problems; suggestions; □ Report attached ____
____

Agency ______________________________
Contact ______________________________ ____________________ _________ _____________
Name Title Date Phone no.
Problems; suggestions; □ Report attached ____
____

4. **Other interviews** (optional) □ Report attached.

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1. **O&M Documents**
   - □ O&M manual — □ Readily available — □ Up to date — ☒ N/A
   - □ As-built drawings — □ Readily available — □ Up to date — ☒ N/A
   - □ Maintenance logs — □ Readily available — □ Up to date — ☒ N/A

   Remarks____

2. **Site-Specific Health and Safety Plan** — □ Readily available — □ Up to date — ☒ N/A
   - □ Contingency plan/emergency response plan — □ Readily available — □ Up to date — ☒ N/A

   Remarks____

3. **O&M and OSHA Training Records** — □ Readily available — □ Up to date — ☒ N/A

   Remarks____

4. **Permits and Service Agreements**
   - □ Air discharge permit — □ Readily available — □ Up to date — ☒ N/A
   - □ Effluent discharge — □ Readily available — □ Up to date — ☒ N/A
   - □ Waste disposal, POTW — □ Readily available — □ Up to date — ☒ N/A
   - □ Other permits_____________________ — □ Readily available — □ Up to date — ☒ N/A

   Remarks____

5. **Gas Generation Records** — □ Readily available — □ Up to date — ☒ N/A

   Remarks____

6. **Settlement Monument Records** — □ Readily available — □ Up to date — ☒ N/A

   Remarks____

7. **Groundwater Monitoring Records** — ☒ Readily available — □ Up to date — □ N/A

   Remarks: Groundwater monitoring results available electronically in PGDP Environmental Information System____

8. **Leachate Extraction Records** — □ Readily available — □ Up to date — ☒ N/A

   Remarks____

9. **Discharge Compliance Records**
   - □ Air — □ Readily available — □ Up to date — ☒ N/A
   - □ Water (effluent) — □ Readily available — □ Up to date — ☒ N/A

   Remarks____

10. **Daily Access/Security Logs** — □ Readily available — □ Up to date — ☒ N/A

    Remarks____

IV. O&M COSTS

1. **O&M Organization**
☐ State in-house ☐ Contractor for State
☐ PRP in-house ☐ Contractor for PRP
☐ Federal Facility in-house ☒ Contractor for Federal Facility
x Other No operation and maintenance specifically required for SWMU 1.

2. **O&M Cost Records** *Refer to Sect. 14.3 of the report.*
☐ Readily available ☐ Up to date
☐ Funding mechanism/agreement in place
Original O&M cost estimate____________________ ☐ Breakdown attached

Total annual cost by year for review period if available

From__________ To__________ __________________ ☐ Breakdown attached
Date Date Total cost
From__________ To__________ __________________ ☐ Breakdown attached
Date Date Total cost
From__________ To__________ __________________ ☐ Breakdown attached
Date Date Total cost
From__________ To__________ __________________ ☐ Breakdown attached
Date Date Total cost
From__________ To__________ __________________ ☐ Breakdown attached
Date Date Total cost

3. **Unanticipated or Unusually High O&M Costs During Review Period**
Describe costs and reasons: ____________________

V. ACCESS AND INSTITUTIONAL CONTROLS ☐ Applicable x N/A

A. Fencing

1. **Fencing damaged** ☐ Location shown on site map ☐ Gates secured ☒ N/A

B. Other Access Restrictions

1. **Signs and other security measures** ☒ Location shown on site map ☐ N/A
Remarks: Warning signs were present at the entrance to the SWMU.

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

Site conditions imply ICs not properly implemented ☐ Yes ☒ No ☐ N/A
Site conditions imply ICs not being fully enforced ☐ Yes ☒ No ☐ N/A

Type of monitoring (*e.g.*, self-reporting, drive by) ____________
Frequency ____________
Responsible party/agency ____________
Contact ____________ ____________ ____________ ____________
Name Title Date Phone no.

Reporting is up-to-date ☐ Yes ☐ No ☒ N/A
Reports are verified by the lead agency ☐ Yes ☐ No ☒ N/A

Specific requirements in deed or decision documents have been met ☐ Yes ☐ No ☒ N/A
Violations have been reported ☐ Yes ☐ No ☒ N/A
Other problems or suggestions: ☐ Report attached

2. **Adequacy** ☒ ICs are adequate ☐ ICs are inadequate ☐ N/A
Remarks: Land use controls required by the ROD include warning signs and implementation of DOE's Excavation/Penetration Permit Program

D. General

1. **Vandalism/trespassing** ☐ Location shown on site map ☒ No vandalism evident
Remarks____________

2. **Land use changes on site** ☐ N/A
Remarks: SWMU 1 is located adjacent to the C-745-A Cylinder Storage Yard on the north. SWMU is bound on the south by active railroad tracks. No land use changes identified.

3. **Land use changes off site** ☒ N/A
Remarks____________

VI. GENERAL SITE CONDITIONS

A. Roads ☒ Applicable ☐ N/A

1. **Roads damaged** ☒ Location shown on site map ☒ Roads adequate ☐ N/A
Remarks: Roads are present and adequate to allow sampling vehicles to approach monitoring wells as needed.

B. Other Site Conditions

Remarks: Soil Mixing treatment area is not distinguishable from remaining area of SWMU 1 by observation. The SWMU is grass covered with a gravel road passing through it. To the north is the C-745-A Cylinder yard. To the south is active railroads and grass covered areas.

VII. LANDFILL COVERS ☐ Applicable ☒ N/A

VIII. VERTICAL BARRIER WALLS ☐ Applicable ☒ N/A

IX. GROUNDWATER/SURFACE WATER REMEDIES ☐ Applicable ☒ N/A

X. OTHER REMEDIES	
	If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction. See Attachment
XI. OVERALL OBSERVATIONS	
A.	**Implementation of the Remedy**
	Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.). SWMU 1 remedial action was the implementation of soil mixing technology followed by placement of zero-valent iron in mixed soil. All remedial activities were performed in the subsurface. Therefore, no visible observations are possible. Monitoring wells drilled following the remedial action are present and show no maintenance issues.
B.	**Adequacy of O&M**
	Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy. SWMU 1 Soil Mixing and Zero-Valent Iron does not have ongoing operation and maintenance activities.
C.	**Early Indicators of Potential Remedy Problems**
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future. No indicators of potential remedy problems were identified during this Five Year Review inspection.
D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. No optimization opportunities were identified during this Five Year Review inspection.

ATTACHMENT

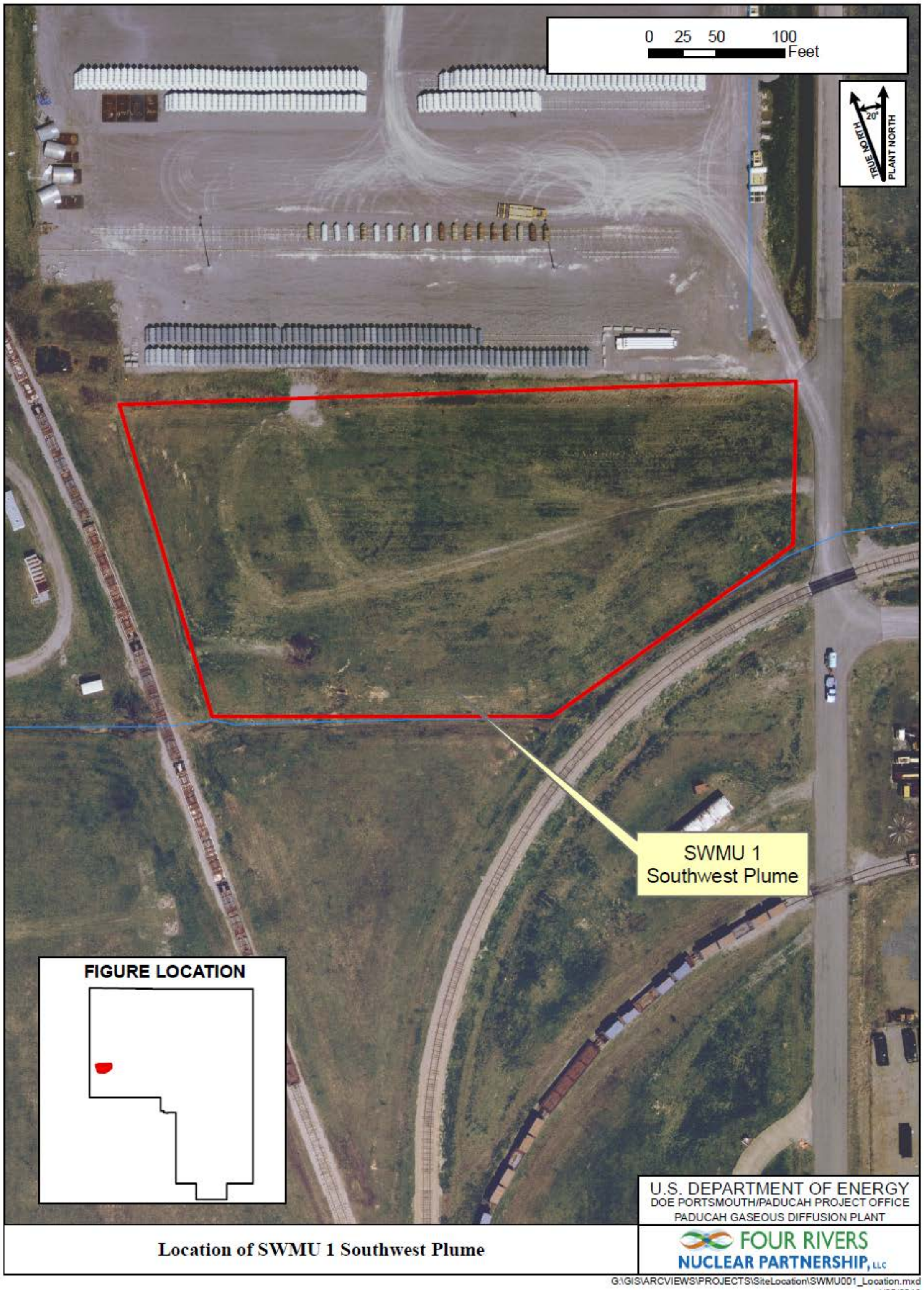
Section X - Other Remedies:

SWMU 1 – Oil Landfarm Remedy – Soil Mixing with Zero-Valent Iron Placement with Interim LUCs: The SWMU 1 treatment area at the time of inspection (12/20/2017) was grass covered with a gravel road passing through the SWMU. The actual area that was soil mixed was visibly present at the time of the inspection. Field implementation was completed in 2016. The SWMU 1area appeared well kept with no tall grass, water holes, or untreated erosion visible. All treatment was performed on subsurface soils and visual inspection from the surface is not feasible. The interim LUCs for SWMU 1 consist of the PGDP site's excavation-penetration permit program and placement of warning signs. Interim LUCs were active during the five-year inspection.

Inspection team roster (12/6/2017):

Gay Brewer, (KDEP)	Jennifer Johnson (Pro2Serv)	Bryan Clayton (FRNP)
Clinton Dietsch (FRNP)	Teresa Overby (FRNP)	
Rob Flynn (FRNP)		

Site map:



0 25 50 100
Feet
TRUE NORTH
PLANT NORTH
20°
SWMU 1
Southwest Plume
FIGURE LOCATION
U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT
FOUR RIVERS
NUCLEAR PARTNERSHIP, LLC
Location of SWMU 1 Southwest Plume
G:\GIS\ARCVIEWS\PROJECTS\SiteLocation\SWMU001_Location.mxd
1/25/2018

Five-Year Review Site Inspection Checklist
Southwest Plume—C-720 Building TCE
Northeast and Southeast Spill Sites

I. SITE INFORMATION	
Site name: Southwest Plume, SWMU 211-A and SWMU 211-B, C-720 Building	**Date of inspection:** 12/20/2017
Location and Region: Paducah, KY/Region 4	**EPA ID:** KY8890008982
Agency, office, or company leading the five-year review: DOE	**Weather/temperature:** Overcast, 50°F, 5-10 mph winds, Intermittent Drizzle
Remedy Includes: (Check all that apply) □ Landfill cover/containment □ Monitored natural attenuation □ Access controls □ Groundwater containment □ Institutional controls □ Vertical barrier walls □ Groundwater pump and treatment □ Surface water collection and treatment x Other_- Remedy selected by the signed ROD included either Enhanced In Situ Bioremediation with Interim LUCs or Long-Term Monitoring with Interim LUCS with final implementation to identified by the FFA parties after remedial design support investigation was completed. FFA parties are currently evaluating collected data before selecting remedial alternative.	
Attachments: ☒ Inspection team roster attached ☒ Site map attached	
II. INTERVIEWS (Check all that apply)	
1. **O&M site manager** _Clinton Dietsch_ (Name) _Facility Manager_ (Title) _12/20/2017_ (Date) Interviewed ☒ at site □ at office □ by phone Phone no. ______ Problems, suggestions; □ Report attached __No problems or suggestions identified.__	
2. **O&M staff** __N/A__ (Name) ______ (Title) ______ (Date) Interviewed □ at site □ at office □ by phone Phone no. ______ Problems, suggestions; □ Report attached ______	

3.	**Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply. Agency ______________________________ Contact ______________________________ ____________________ _________ _____________ Name Title Date Phone no. Problems; suggestions; □ Report attached ____ ____ Agency ______________________________ Contact ______________________________ ____________________ _________ _____________ Name Title Date Phone no. Problems; suggestions; □ Report attached ____ ____ Agency ______________________________ Contact ______________________________ ____________________ _________ _____________ Name Title Date Phone no. Problems; suggestions; □ Report attached ____ ____ Agency ______________________________ Contact ______________________________ ____________________ _________ _____________ Name Title Date Phone no. Problems; suggestions; □ Report attached ____ ____
4.	**Other interviews** (optional) □ Report attached.

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)				
1.	**O&M Documents**			
	☐ O&M manual	☐ Readily available	☐ Up to date	☒ N/A
	☐ As-built drawings	☐ Readily available	☐ Up to date	☒ N/A
	☐ Maintenance logs	☐ Readily available	☐ Up to date	☒ N/A
	Remarks____			
2.	**Site-Specific Health and Safety Plan**	☐ Readily available	☐ Up to date	☒ N/A
	☐ Contingency plan/emergency response plan	☐ Readily available	☐ Up to date	☒ N/A
	Remarks____			
3.	**O&M and OSHA Training Records**	☐ Readily available	☐ Up to date	☒ N/A
	Remarks____			
4.	**Permits and Service Agreements**			
	☐ Air discharge permit	☐ Readily available	☐ Up to date	☒ N/A
	☐ Effluent discharge	☐ Readily available	☐ Up to date	☒ N/A
	☐ Waste disposal, POTW	☐ Readily available	☐ Up to date	☒ N/A
	☐ Other permits______________________	☐ Readily available	☐ Up to date	☒ N/A
	Remarks____			
5.	**Gas Generation Records**	☐ Readily available	☐ Up to date	☒ N/A
	Remarks____			
6.	**Settlement Monument Records**	☐ Readily available	☐ Up to date	☒ N/A
	Remarks____			
7.	**Groundwater Monitoring Records**	☐ Readily available	☐ Up to date	☒ N/A
	Remarks:			
8.	**Leachate Extraction Records**	☐ Readily available	☐ Up to date	☒ N/A
	Remarks____			
9.	**Discharge Compliance Records**			
	☐ Air	☐ Readily available	☐ Up to date	☒ N/A
	☐ Water (effluent)	☐ Readily available	☐ Up to date	☒ N/A
	Remarks____			
10.	**Daily Access/Security Logs**	☐ Readily available	☐ Up to date	☒ N/A
	Remarks____			

IV. O&M COSTS

1. **O&M Organization**
☐ State in-house ☐ Contractor for State
☐ PRP in-house ☐ Contractor for PRP
☐ Federal Facility in-house ☒ Contractor for Federal Facility
x Other No operation and maintenance specifically required for SWMUs 211-A and 211-B as implementation of remedial actions is pending FFA approval.

2. **O&M Cost Records** *Refer to Sect. 14.3 of the report.*
☐ Readily available ☐ Up to date
☐ Funding mechanism/agreement in place
Original O&M cost estimate____________________ ☐ Breakdown attached

Total annual cost by year for review period if available

From__________ To__________ __________________ ☐ Breakdown attached
Date Date Total cost
From__________ To__________ __________________ ☐ Breakdown attached
Date Date Total cost
From__________ To__________ __________________ ☐ Breakdown attached
Date Date Total cost
From__________ To__________ __________________ ☐ Breakdown attached
Date Date Total cost
From__________ To__________ __________________ ☐ Breakdown attached
Date Date Total cost

3. **Unanticipated or Unusually High O&M Costs During Review Period**
Describe costs and reasons: ____

V. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable ☐ N/A

A. Fencing

1. **Fencing damaged** ☐ Location shown on site map ☐ Gates secured ☒ N/A

B. Other Access Restrictions

1. **Signs and other security measures** ☒ Location shown on site map ☐ N/A
Remarks: Warning signs were present at each SWMU.

C. Institutional Controls (ICs)
1. **Implementation and enforcement** Site conditions imply ICs not properly implemented ☐ Yes ☒ No ☐ N/A Site conditions imply ICs not being fully enforced ☐ Yes ☒ No ☐ N/A Type of monitoring (*e.g.*, self-reporting, drive by) ______ Frequency ______ Responsible party/agency ______ Contact ______ ______ ______ ______ Name Title Date Phone no. Reporting is up-to-date ☐ Yes ☐ No ☒ N/A Reports are verified by the lead agency ☐ Yes ☐ No ☒ N/A Specific requirements in deed or decision documents have been met ☒ Yes ☐ No ☐ N/A Violations have been reported ☐ Yes ☐ No ☒ N/A Other problems or suggestions: ☐ Report attached ______ ______
2. **Adequacy** ☒ ICs are adequate ☐ ICs are inadequate ☐ N/A Remarks: Land use controls required by the ROD include warning signs and implementation of DOE's Excavation/Penetration Permit Program ______ ______
D. General
1. **Vandalism/trespassing** ☐ Location shown on site map ☒ No vandalism evident Remarks______ ______
2. **Land use changes on site** ☐ N/A Remarks: SWMU 211-A is located northeast of the northeast corner of the C-720 Building and SWMU 211-B is located southeast of the southeast corner of the C-720 Building. No land use changes identified. Both areas are used for performing equipment maintenance, storing/staging of equipment, and parking vehicles.______
3. **Land use changes off site** ☒ N/A Remarks______ ______
VI. GENERAL SITE CONDITIONS
A. Roads ☒ Applicable ☐ N/A
1. **Roads damaged** ☒ Location shown on site map ☒ Roads adequate ☐ N/A Remarks: Roads are present and adequate to allow equipment access to SWMU areas.______ ______

B. Other Site Conditions
Remarks: ____
VII. LANDFILL COVERS □ Applicable ☒ N/A
VIII. VERTICAL BARRIER WALLS □ Applicable ☒ N/A
IX. GROUNDWATER/SURFACE WATER REMEDIES □ Applicable ☒ N/A
A. Groundwater Extraction Wells, Pumps, and Pipelines □ Applicable ☒ N/A
X. OTHER REMEDIES
If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction. See Attachment
XI. OVERALL OBSERVATIONS
A. Implementation of the Remedy
Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.). The remedy action has not been implemented at either SWMU. Remedy selected by the signed ROD included either Enhanced In Situ Bioremediation with Interim LUCs or Long-Term Monitoring with Interim LUCS with final implementation to be identified by the FFA parties after remedial design support investigation was completed. FFA parties are currently evaluating collected data before selecting remedial for implementation.
B. Adequacy of O&M
Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy. No operation and maintenance activities are being performed at either SWMU. The remedial action implementation is pending FFA party final selection.
C. Early Indicators of Potential Remedy Problems
Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future. No indicators of potential remedy problems were identified during this Five Year Review inspection.
D. Opportunities for Optimization
Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. No optimization opportunities were identified during this Five Year Review inspection.

ATTACHMENT

Section X - Other Remedies:

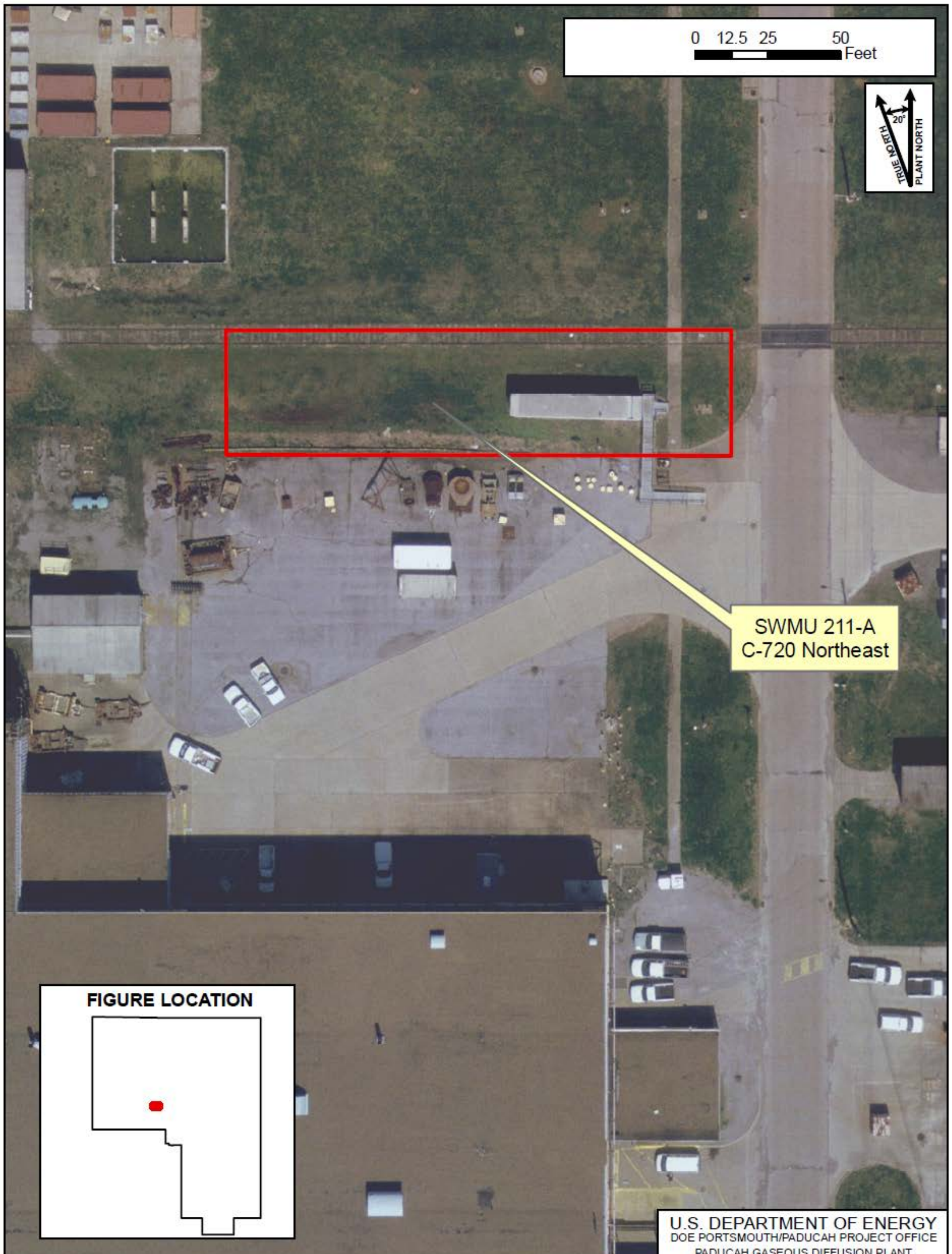
Remedy selected by the signed ROD included either Enhanced In Situ Bioremediation with Interim LUCs or Long-Term Monitoring with Interim LUCS with final implementation to be identified by the FFA parties after remedial design support investigation was completed. FFA parties are currently evaluating collected data before selecting final remedial alternative. These interim LUCs for SWMUs 211-A and 211-B consist of the PGDP site's excavation-penetration permit program and placement of warning signs. Interim LUCs were active during the five-year inspection.

Inspection team roster (12/6/2017):

Gay Brewer, (KDEP)
Clinton Dietsch (FRNP)
Rob Flynn (FRNP)
Jennifer Johnson (Pro2Serv)
Teresa Overby (FRNP)
Bryan Clayton (FRNP)

Site map:

C-720 Building TCE Northeast Spill Site

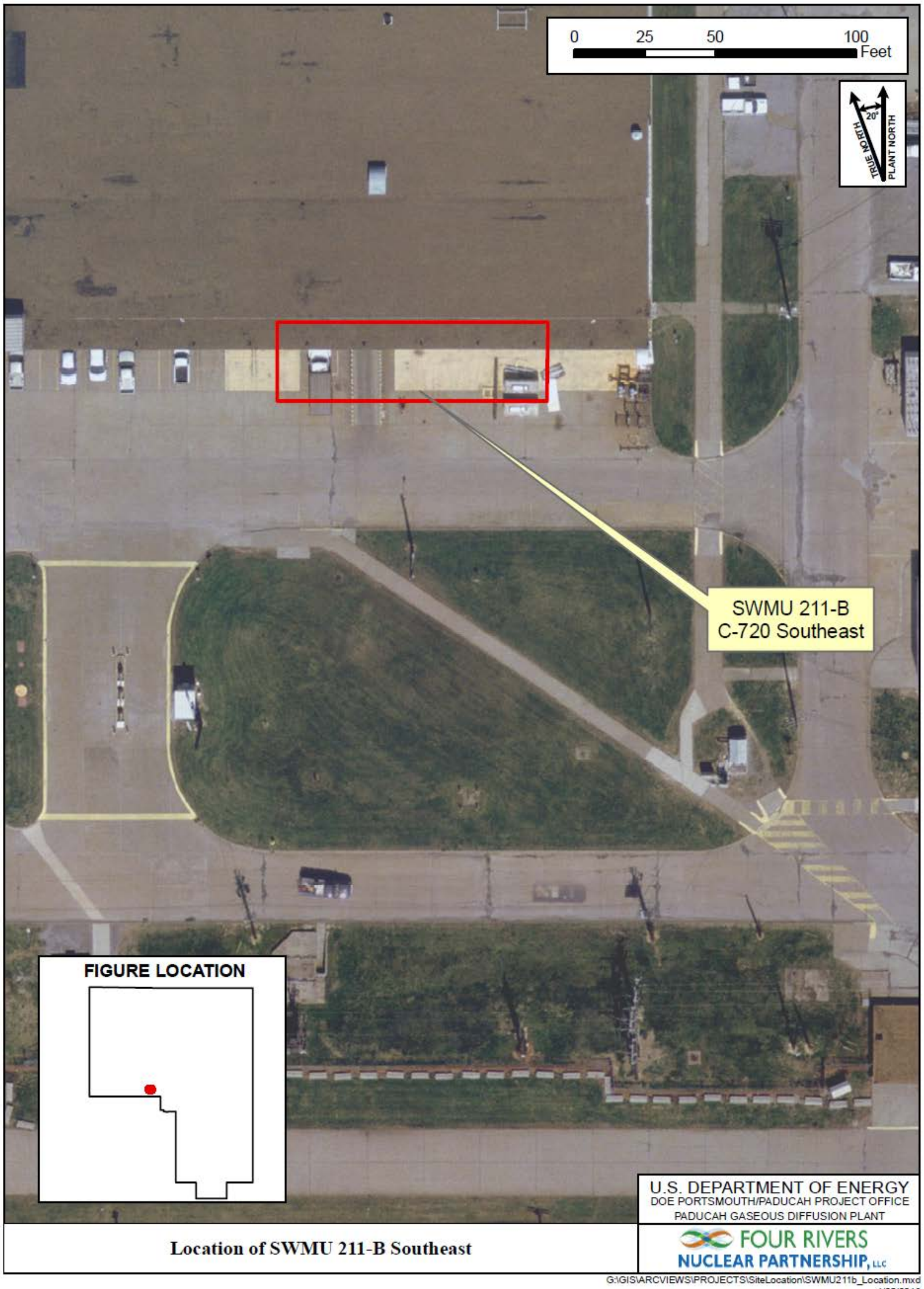


Location of SWMU 211-A Northeast

G:\GIS\ARCVIEWS\PROJECTS\SiteLocation\SWMU211a_Location.mxd
1/25/2018

Site map:

C-720 Building TCE Southeast Spill Site



Five-Year Review Site Inspection Checklist
NSDD Source Control

I. SITE INFORMATION	
Site name: NSDD Source Control	**Date of inspection:** 12/14/2017
Location and Region: Paducah, KY/Region 4	**EPA ID:** KY8890008982
Agency, office, or company leading the five-year review: DOE	**Weather/temperature:** 39 F and overcast

Remedy Includes: (Check all that apply)

- ☐ Landfill cover/containment
- ☐ Access controls
- ☐ Institutional controls
- ☐ Groundwater pump and treatment
- ☒ Surface water collection and treatment
- ☐ Other____
- ☐ Monitored natural attenuation
- ☐ Groundwater containment
- ☐ Vertical barrier walls

Attachments: ☒ Inspection team roster attached ☒ Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** _Justin Riley_ _Facility Manager_ _12/14/2017_
   Name Title Date
   Interviewed ☒ at site ☐ at office ☐ by phone Phone no. ______________
   Problems, suggestions; ☐ Report attached __None__________________________

2. **O&M staff** __n/a__ ______________ ______________ ________
   Name Title Date
   Interviewed ☐ at site ☐ at office ☐ by phone Phone no. ______________
   Problems, suggestions; ☐ *Report attached* ______________________________

3.	**Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply. Agency ______________________________ Contact ______________________________ ____________________ _________ _____________ Name Title Date Phone no. Problems; suggestions; □ Report attached ____ ____ Agency ______________________________ Contact ______________________________ ____________________ _________ _____________ Name Title Date Phone no. Problems; suggestions; □ Report attached ____ ____ Agency ______________________________ Contact ______________________________ ____________________ _________ _____________ Name Title Date Phone no. Problems; suggestions; □ Report attached ____ ____ Agency ______________________________ Contact ______________________________ ____________________ _________ _____________ Name Title Date Phone no. Problems; suggestions; □ Report attached ____ ____
4.	**Other interviews** (optional) □ Report attached.

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)				
1.	**O&M Documents**			
	☒ O&M manual	☒ Readily available	☒ Up to date	☐ N/A
	☒ As-built drawings	☒ Readily available	☒ Up to date	☐ N/A
	☐ Maintenance logs	☐ Readily available	☐ Up to date	☒ N/A
	Remarks______			
2.	**Site-Specific Health and Safety Plan**	☐ Readily available	☐ Up to date	☒ N/A
	☐ Contingency plan/emergency response plan	☐ Readily available	☐ Up to date	☒ N/A
	Remarks______			
3.	**O&M and OSHA Training Records**	☐ Readily available	☐ Up to date	☒ N/A
	Remarks______			
4.	**Permits and Service Agreements**			
	☐ Air discharge permit	☐ Readily available	☐ Up to date	☒ N/A
	☐ Effluent discharge	☐ Readily available	☐ Up to date	☒ N/A
	☐ Waste disposal, POTW	☐ Readily available	☐ Up to date	☒ N/A
	☐ Other permits______	☐ Readily available	☐ Up to date	☒ N/A
	Remarks______			
5.	**Gas Generation Records**	☐ Readily available	☐ Up to date	☒ N/A
	Remarks______			
6.	**Settlement Monument Records**	☐ Readily available	☐ Up to date	☒ N/A
	Remarks______			
7.	**Groundwater Monitoring Records**	☐ Readily available	☐ Up to date	☒ N/A
	Remarks______			
8.	**Leachate Extraction Records**	☐ Readily available	☐ Up to date	☒ N/A
	Remarks______			
9.	**Discharge Compliance Records**			
	☐ Air	☐ Readily available	☐ Up to date	☒ N/A
	☐ Water (effluent)	☐ Readily available	☐ Up to date	☒ N/A
	Remarks______			
10.	**Daily Access/Security Logs**	☐ Readily available	☐ Up to date	☒ N/A
	Remarks______			

IV. O&M COSTS
1. **O&M Organization** □ State in-house □ Contractor for State □ PRP in-house □ Contractor for PRP □ Federal Facility in-house ☒ Contractor for Federal Facility □ Other____
2. **O&M Cost Records** *Refer to Sect. 11.3 of the report.* □ Readily available □ Up to date □ Funding mechanism/agreement in place Original O&M cost estimate____________________ □ Breakdown attached Total annual cost by year for review period if available From__________ To__________ __________________ □ Breakdown attached Date Date Total cost From__________ To__________ __________________ □ Breakdown attached Date Date Total cost From__________ To__________ __________________ □ Breakdown attached Date Date Total cost From__________ To__________ __________________ □ Breakdown attached Date Date Total cost From__________ To__________ __________________ □ Breakdown attached Date Date Total cost
3. **Unanticipated or Unusually High O&M Costs During Review Period** Describe costs and reasons: <u>Costs are discussed in Sect. 11.3 of the report.</u>____________________
V. ACCESS AND INSTITUTIONAL CONTROLS □ Applicable ☒ N/A
A. Fencing
1. **Fencing damaged** □ Location shown on site map □ Gates secured □ N/A Remarks____
B. Other Access Restrictions
1. **Signs and other security measures** □ Location shown on site map □ N/A Remarks____

C. Institutional Controls (ICs)				
1.	**Implementation and enforcement**			
	Site conditions imply ICs not properly implemented	□ Yes	☒ No	□ N/A
	Site conditions imply ICs not being fully enforced	□ Yes	☒ No	□ N/A
	Type of monitoring (*e.g.*, self-reporting, drive by) self-reporting			
	Frequency Semi-Annual inspections			
	Responsible party/agency Contractor to DOE			
	Contact ____ Name ____ Title ____ Date ____ Phone no.			
	Reporting is up-to-date	□ Yes	□ No	☒ N/A
	Reports are verified by the lead agency	□ Yes	□ No	☒ N/A
	Specific requirements in deed or decision documents have been met	☒ Yes	□ No	□ N/A
	Violations have been reported	□ Yes	□ No	☒ N/A
	Other problems or suggestions: □ Report attached			
	Deed restrictions are in place and are verified annually.			
2.	**Adequacy** ☒ ICs are adequate □ ICs are inadequate			□ N/A
	Remarks			
D. General				
1.	**Vandalism/trespassing** □ Location shown on site map ☒ No vandalism evident			
	Remarks			
2.	**Land use changes on site** □ N/A			
	Remarks No changes.			
3.	**Land use changes off site** □ N/A			
	Remarks No changes.			
VI. GENERAL SITE CONDITIONS				
A. Roads □ Applicable ☒ N/A				
VII. LANDFILL COVERS □ Applicable ☒ N/A				
VIII. VERTICAL BARRIER WALLS □ Applicable ☒ N/A				

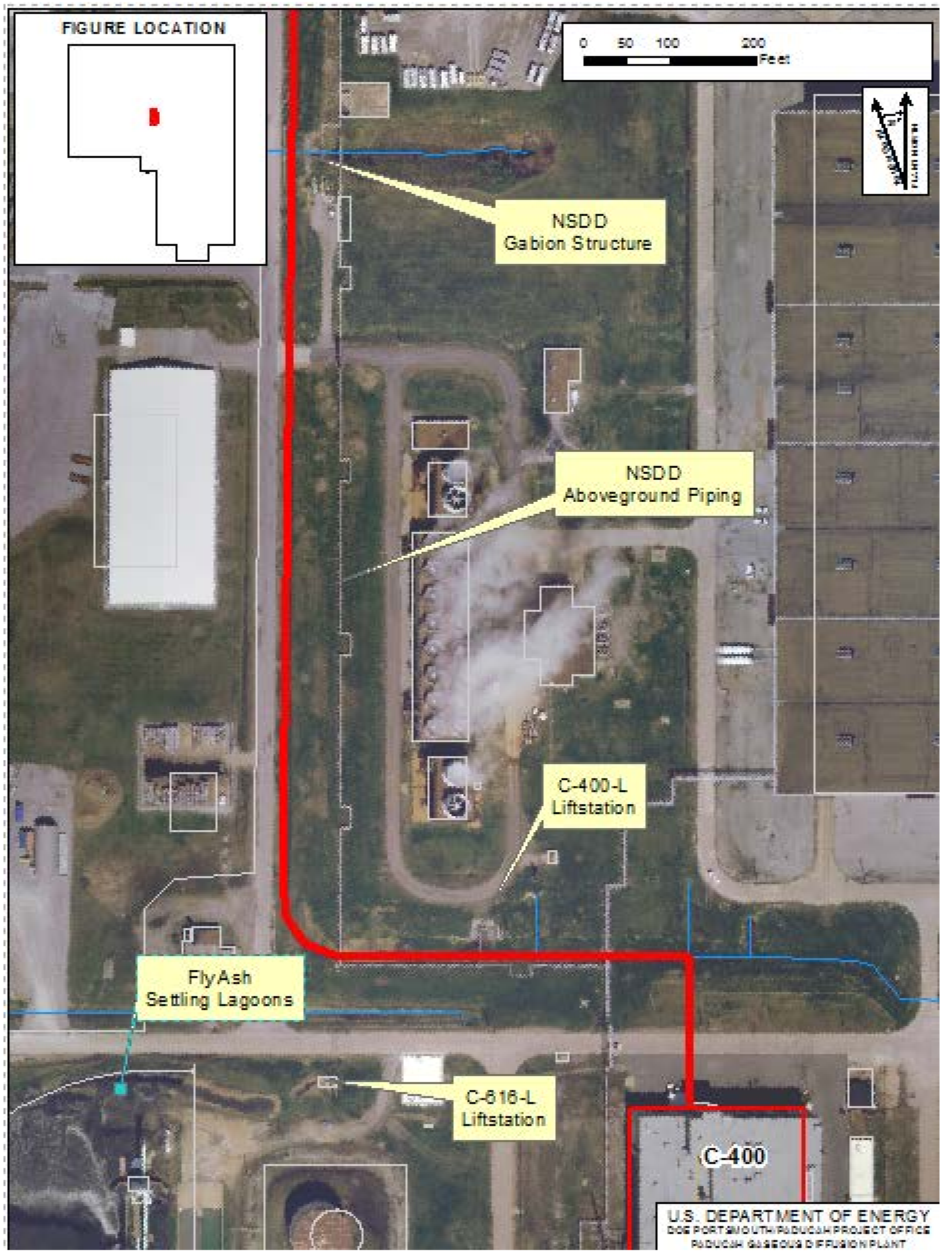
IX. GROUNDWATER/SURFACE WATER REMEDIES ☒ Applicable ☐ N/A
A. Groundwater Extraction Wells, Pumps, and Pipelines ☐ Applicable ☒ N/A
B. Surface Water Collection Structures, Pumps, and Pipelines ☒ Applicable ☐ N/A
1. **Collection Structures, Pumps, and Electrical** ☒ Good condition ☐ Needs Maintenance Remarks____
2. **Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances** ☒ Good condition ☐ Needs Maintenance Remarks____
3. **Spare Parts and Equipment** ☐ Readily available ☒ Good condition ☐ Requires upgrade ☐ Needs to be provided Remarks____
C. Treatment System ☐ Applicable ☒ N/A
D. Monitoring Data
1. Monitoring Data NA ☐ Is routinely submitted on time ☐ Is of acceptable quality
2. Monitoring data suggests: ☐ Groundwater plume is effectively contained ☐ Contaminant concentrations are declining
D. Monitored Natural Attenuation
1. **Monitoring Wells** (natural attenuation remedy) ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ All required wells located ☐ Needs Maintenance ☒ N/A Remarks____
X. OTHER REMEDIES
If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS	
A.	**Implementation of the Remedy**
	Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.). The principal goals of the interim action were to: mitigate the introductive of contaminants into the NSDD; decrease the migration of contaminants already present in the NSDD; and decrease the potential for direct contact with the contaminated material. This was accomplished by installing an ion exchange system in C-400 Building, rerouting effluent from C-400 to Outfall 008, constructing aboveground piping and lift stations to an existing lift station, installing settling lagoons for the fly ash, installing a gabion sediment trap, and installing warning signs.
B.	**Adequacy of O&M**
	Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy. There was no excessive debris over the gabion screens. The aboveground piping was in good condition, the insulation was intact, and the metal jacket covering was not rusted or deteriorated. The lift stations appear to be functioning properly. See Section 11.3.
C.	**Early Indicators of Potential Remedy Problems**
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future. None.
D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. None.

ATTACHMENT

Inspection team roster (12/14/2017):
Jennifer Johnson (Pro2Serve)
Teresa Overby (FRNP)
Justin Riley (FRNP)
LeAnne Garner (FRNP)

Site map:



Five-Year Review Site Inspection Checklist
NSDD Sections 1 and 2

I. SITE INFORMATION	
Site name: NSDD Sections 1 and 2	**Date of inspection:** 12/14/2017
Location and Region: Paducah, KY/Region 4	**EPA ID:** KY8890008982
Agency, office, or company leading the five-year review: DOE	**Weather/temperature:** 39 F and overcast

Remedy Includes: (Check all that apply)

- □ Landfill cover/containment
- □ Access controls
- ☒ Institutional controls
- □ Groundwater pump and treatment
- ☒ Surface water collection and treatment
- □ Other____
- □ Monitored natural attenuation
- □ Groundwater containment
- □ Vertical barrier walls

Attachments: ☒ Inspection team roster attached ☒ Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** _Justin Riley______________ _Facility Manager_____ _12/14/2017________
   Name Title Date
   Interviewed ☒ at site □ at office □ by phone Phone no. ______________
   Problems, suggestions; □ Report attached __None____

2. **O&M staff** __n/a________________ _____________________ ________
   Name Title Date
   Interviewed □ at site □ at office □ by phone Phone no. ______________
   Problems, suggestions; □ *Report attached* ____

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

Agency ______________________________
Contact ______________________________ ___________________ ________ ____________
Name Title Date Phone no.
Problems; suggestions; □ Report attached ____
____

Agency ______________________________
Contact ______________________________ ___________________ ________ ____________
Name Title Date Phone no.
Problems; suggestions; □ Report attached ____
____

Agency ______________________________
Contact ______________________________ ___________________ ________ ____________
Name Title Date Phone no.
Problems; suggestions; □ Report attached ____
____

Agency ______________________________
Contact ______________________________ ___________________ ________ ____________
Name Title Date Phone no.
Problems; suggestions; □ Report attached ____
____

4. **Other interviews** (optional) □ *Report attached.*

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1. **O&M Documents**

☒ O&M manual	☒ Readily available	☒ Up to date	□ N/A
□ As-built drawings	□ Readily available	□ Up to date	☒ N/A
□ Maintenance logs	□ Readily available	□ Up to date	☒ N/A

Remarks____

2. **Site-Specific Health and Safety Plan** □ Readily available □ Up to date ☒ N/A

□ Contingency plan/emergency response plan □ Readily available □ Up to date ☒ N/A

Remarks____

3. **O&M and OSHA Training Records** □ Readily available □ Up to date ☒ N/A

Remarks____

4. **Permits and Service Agreements**

□ Air discharge permit	□ Readily available	□ Up to date	☒ N/A
□ Effluent discharge	□ Readily available	□ Up to date	☒ N/A
□ Waste disposal, POTW	□ Readily available	□ Up to date	☒ N/A
□ Other permits______________	□ Readily available	□ Up to date	☒ N/A

Remarks____

5. **Gas Generation Records** □ Readily available □ Up to date ☒ N/A

Remarks____

6. **Settlement Monument Records** □ Readily available □ Up to date ☒ N/A

Remarks____

7. **Groundwater Monitoring Records** □ Readily available □ Up to date ☒ N/A

Remarks____

8. **Leachate Extraction Records** □ Readily available □ Up to date ☒ N/A

Remarks____

9. **Discharge Compliance Records**

□ Air	□ Readily available	□ Up to date	☒ N/A
□ Water (effluent)	□ Readily available	□ Up to date	☒ N/A

Remarks____

10. **Daily Access/Security Logs** □ Readily available □ Up to date ☒ N/A

Remarks____

IV. O&M COSTS

1. **O&M Organization**
☐ State in-house ☐ Contractor for State
☐ PRP in-house ☐ Contractor for PRP
☐ Federal Facility in-house ☒ Contractor for Federal Facility
☐ Other______________________________

2. **O&M Cost Records** *Refer to Sect. 12.3 of the report.*
☐ Readily available ☐ Up to date
☐ Funding mechanism/agreement in place
Original O&M cost estimate____________________ ☐ Breakdown attached

Total annual cost by year for review period if available

From__________ (Date)	To__________ (Date)	__________ (Total cost)	☐ Breakdown attached
From__________ (Date)	To__________ (Date)	__________ (Total cost)	☐ Breakdown attached
From__________ (Date)	To__________ (Date)	__________ (Total cost)	☐ Breakdown attached
From__________ (Date)	To__________ (Date)	__________ (Total cost)	☐ Breakdown attached
From__________ (Date)	To__________ (Date)	__________ (Total cost)	☐ Breakdown attached

3. **Unanticipated or Unusually High O&M Costs During Review Period**
Describe costs and reasons: Costs are discussed in Sect. 12.3 of the report.

V. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable ☐ N/A

A. Fencing

1. **Fencing damaged** ☐ Location shown on site map ☒ Gates secured ☐ N/A
Remarks______________________________

B. Other Access Restrictions

1. **Signs and other security measures** ☐ Location shown on site map ☒ N/A
Remarks______________________________

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

Site conditions imply ICs not properly implemented ☐ Yes ☒ No ☐ N/A
Site conditions imply ICs not being fully enforced ☐ Yes ☒ No ☐ N/A

Type of monitoring (*e.g.*, self-reporting, drive by) self-reporting ____________________
Frequency Semi-Annual inspections ____________________
Responsible party/agency Contractor to DOE ____________________
Contact ____________ ____________ ____________ ____________
Name Title Date Phone no.

Reporting is up-to-date ☐ Yes ☐ No ☒ N/A
Reports are verified by the lead agency ☐ Yes ☐ No ☒ N/A

Specific requirements in deed or decision documents have been met ☒ Yes ☐ No ☐ N/A
Violations have been reported ☐ Yes ☐ No ☒ N/A
Other problems or suggestions: ☐ Report attached
Deed restrictions are in place and are verified annually.

2. **Adequacy** ☒ ICs are adequate ☐ ICs are inadequate ☐ N/A
Remarks____________________

D. General

1. **Vandalism/trespassing** ☐ Location shown on site map ☒ No vandalism evident
Remarks____________________

2. **Land use changes on site** ☐ N/A
Remarks No changes.

3. **Land use changes off site** ☐ N/A
Remarks No changes.

VI. GENERAL SITE CONDITIONS

A. Roads ☐ Applicable ☒ N/A

B. Other Site Conditions

Remarks ____________________

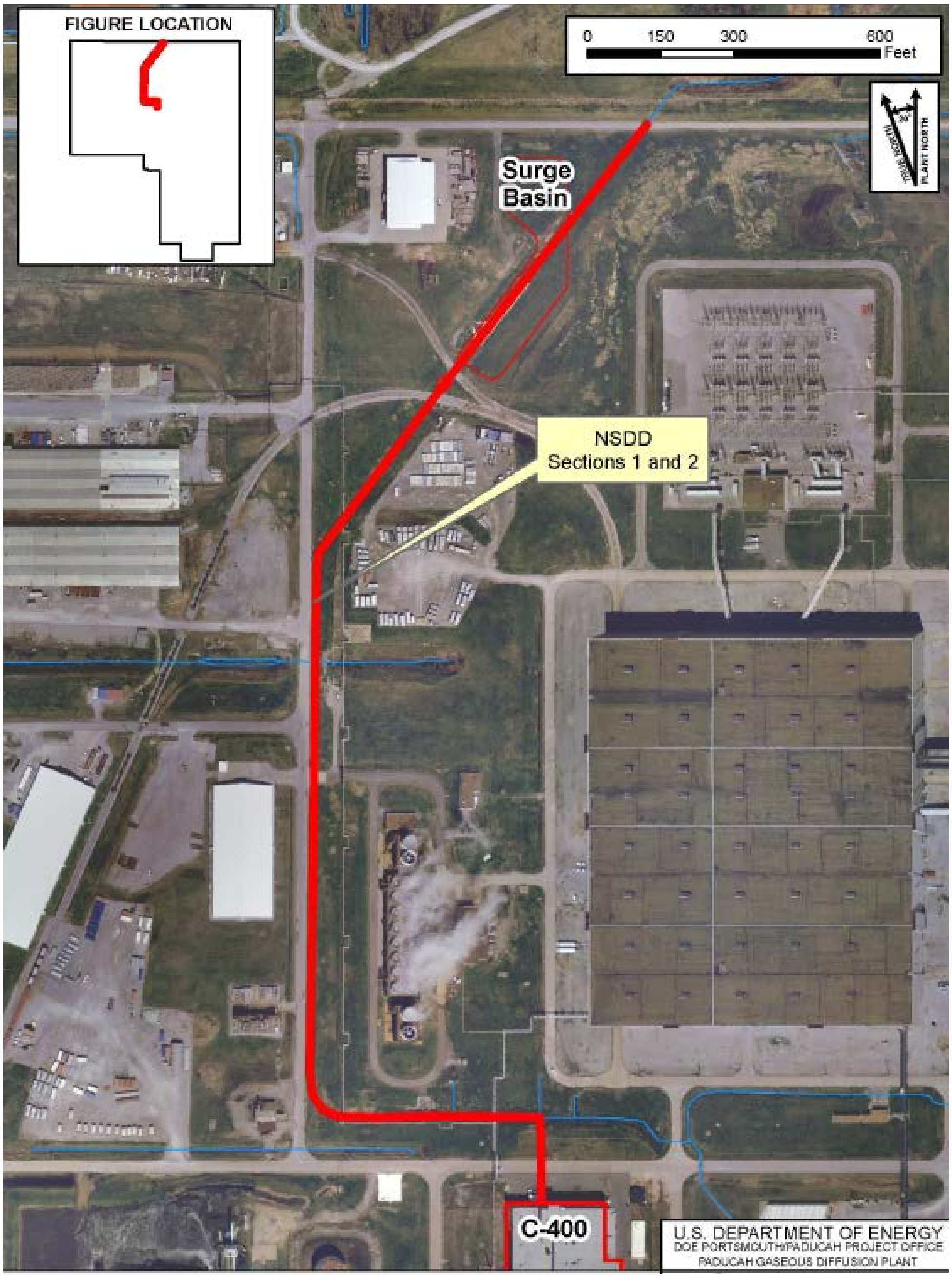
VII. LANDFILL COVERS □ Applicable ☒ N/A
VIII. VERTICAL BARRIER WALLS □ Applicable ☒ N/A
IX. GROUNDWATER/SURFACE WATER REMEDIES □ Applicable ☒ N/A
A. Groundwater Extraction Wells, Pumps, and Pipelines □ Applicable ☒ N/A
B. Surface Water Collection Structures, Pumps, and Pipelines ☒ Applicable □ N/A
1. **Collection Structures, Pumps, and Electrical** ☒ Good condition □ Needs Maintenance Remarks______________________________
2. **Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances** ☒ Good condition □ Needs Maintenance Remarks______________________________
3. **Spare Parts and Equipment** □ Readily available ☒ Good condition □ Requires upgrade □ Needs to be provided Remarks______________________________
C. Treatment System □ Applicable ☒ N/A
D. Monitoring Data
1. Monitoring Data □ Is routinely submitted on time □ Is of acceptable quality
2. Monitoring data suggests: □ Groundwater plume is effectively contained □ Contaminant concentrations are declining
D. Monitored Natural Attenuation
1. **Monitoring Wells** (natural attenuation remedy) □ Properly secured/locked □ Functioning □ Routinely sampled □ Good condition □ All required wells located □ Needs Maintenance ☒ N/A Remarks______________________________
X. OTHER REMEDIES
If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS	
A.	**Implementation of the Remedy**
	Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.). The goals of the remedy were implemented by excavating contaminated soil and sediment from the channel of the NSDD. Upon excavation, a 2-ft clay layer was placed in the NSDD channel to add an extra layer of protection for maintenance workers.
B.	**Adequacy of O&M**
	Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy. The ditch has been well-maintained; grass was established in the channel, but was not impeding flow. The flow into the surge basin was unimpeded. The grass cover is well established and was mowed. There were no visible signs of erosion along the banks of the surge basin. See Section 12.3.
C.	**Early Indicators of Potential Remedy Problems**
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future. None.
D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. None.

ATTACHMENT

Inspection team roster (12/14/2017):
Jennifer Johnson (Pro2Serve)
Teresa Overby (FRNP)
Justin Riley (FRNP)
LeAnne Garner (FRNP)

Site map:



Five-Year Review Site Inspection Checklist
C-746-K Landfill

I. SITE INFORMATION	
Site name: C-746-K Landfill	**Date of inspection:** 12/20/2017
Location and Region: Paducah, KY/Region 4	**EPA ID:** KY8890008982
Agency, office, or company leading the five-year review: DOE	**Weather/temperature:** 57 F

Remedy Includes: (Check all that apply)

☒ Landfill cover/containment
□ Access controls
□ Institutional controls
□ Groundwater pump and treatment
□ Surface water collection and treatment
□ Other____________________
□ Monitored natural attenuation
□ Groundwater containment
□ Vertical barrier walls

Attachments: ☒ Inspection team roster attached ☒ Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** _Clint Dietsch_ (Name) _Facility Manager_ (Title) _12/20/2017_ (Date)
   Interviewed ☒ at site □ at office □ by phone Phone no. ______________
   Problems, suggestions; □ Report attached __None____________________

2. **O&M staff** __n/a__ (Name) ______ (Title) ______ (Date)
   Interviewed □ at site □ at office □ by phone Phone no. ______________
   Problems, suggestions; □ *Report attached* ____________________

3.	**Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply. Agency ______________________________ Contact ______________________________ ___________________ ________ ____________ Name Title Date Phone no. Problems; suggestions; □ Report attached ____ ____ Agency ______________________________ Contact ______________________________ ___________________ ________ ____________ Name Title Date Phone no. Problems; suggestions; □ Report attached ____ ____ Agency ______________________________ Contact ______________________________ ___________________ ________ ____________ Name Title Date Phone no. Problems; suggestions; □ Report attached ____ ____ Agency ______________________________ Contact ______________________________ ___________________ ________ ____________ Name Title Date Phone no. Problems; suggestions; □ Report attached ____ ____
4.	**Other interviews** (optional) □ *Report attached.*

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)				
1.	**O&M Documents**			
	☒ O&M manual	☒ Readily available	☒ Up to date	□ N/A
	☒ As-built drawings	☒ Readily available	□ Up to date	□ N/A
	□ Maintenance logs	□ Readily available	□ Up to date	☒ N/A
	Remarks A drainage pipe was noted during the inspection and appeared to go from the eastern side of the landfill, under a monitoring well pad and existing to the east of the pad. This was not confirmed from the drawings.			
2.	**Site-Specific Health and Safety Plan**	□ Readily available	□ Up to date	☒ N/A
	□ Contingency plan/emergency response plan	□ Readily available	□ Up to date	☒ N/A
	Remarks			
3.	**O&M and OSHA Training Records**	□ Readily available	□ Up to date	☒ N/A
	Remarks			
4.	**Permits and Service Agreements**			
	□ Air discharge permit	□ Readily available	□ Up to date	☒ N/A
	□ Effluent discharge	□ Readily available	□ Up to date	☒ N/A
	□ Waste disposal, POTW	□ Readily available	□ Up to date	☒ N/A
	☒ Other permits KPDES	☒ Readily available	☒ Up to date	□ N/A
	Remarks			
5.	**Gas Generation Records**	□ Readily available	□ Up to date	☒ N/A
	Remarks			
6.	**Settlement Monument Records**	□ Readily available	□ Up to date	☒ N/A
	Remarks			
7.	**Groundwater Monitoring Records**	☒ Readily available	☒ Up to date	□ N/A
	Remarks			
8.	**Leachate Extraction Records**	□ Readily available	□ Up to date	☒ N/A
	Remarks			
9.	**Discharge Compliance Records**			
	□ Air	□ Readily available	□ Up to date	☒ N/A
	□ Water (effluent)	□ Readily available	□ Up to date	☒ N/A
	Remarks			
10.	**Daily Access/Security Logs**	□ Readily available	□ Up to date	☒ N/A
	Remarks			

IV. O&M COSTS

1. **O&M Organization**
☐ State in-house ☐ Contractor for State
☐ PRP in-house ☐ Contractor for PRP
☐ Federal Facility in-house ☒ Contractor for Federal Facility
☐ Other____

2. **O&M Cost Records** *Refer to Sect. 13.3 of the report.*
☐ Readily available ☐ Up to date
☐ Funding mechanism/agreement in place
Original O&M cost estimate____________________ ☐ Breakdown attached

Total annual cost by year for review period if available

From (Date)	To (Date)	Total cost	
From__________	To__________	__________________	☐ Breakdown attached
From__________	To__________	__________________	☐ Breakdown attached
From__________	To__________	__________________	☐ Breakdown attached
From__________	To__________	__________________	☐ Breakdown attached
From__________	To__________	__________________	☐ Breakdown attached

3. **Unanticipated or Unusually High O&M Costs During Review Period**
Describe costs and reasons: Costs are discussed in Sect. 13.3 of the report.

V. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable ☐ N/A

A. Fencing

1. **Fencing damaged** ☐ Location shown on site map ☐ Gates secured ☒ N/A
Remarks____

B. Other Access Restrictions

1. **Signs and other security measures** ☒ Location shown on site map ☐ N/A
Remarks____

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

Site conditions imply ICs not properly implemented □ Yes ☒ No □ N/A
Site conditions imply ICs not being fully enforced □ Yes ☒ No □ N/A

Type of monitoring (*e.g.*, self-reporting, drive by) ______________________
Frequency ______________________
Responsible party/agency ______________________
Contact ______________ ______________ ________ ________
Name Title Date Phone no.

Reporting is up-to-date □ Yes □ No ☒ N/A
Reports are verified by the lead agency □ Yes □ No ☒N/A

Specific requirements in deed or decision documents have been met ☒ Yes □ No □ N/A
Violations have been reported □ Yes □ No ☒ N/A
Other problems or suggestions: □ Report attached

2. **Adequacy** ☒ ICs are adequate □ ICs are inadequate □ N/A
Remarks______________________

D. General

1. **Vandalism/trespassing** □ Location shown on site map ☒ No vandalism evident
Remarks______________________

2. **Land use changes on site** □ N/A
Remarks___None.______________________

3. **Land use changes off site** □ N/A
Remarks__None.______________________

VI. GENERAL SITE CONDITIONS
A. Roads ☒Applicable □ N/A
1. **Roads damaged** ☒ Location shown on site map ☒ Roads adequate □ N/A Remarks____
B. Other Site Conditions
Remarks ____
VII. LANDFILL COVERS ☒ Applicable □ N/A
A. Landfill Surface
1. **Settlement** (Low spots) □ Location shown on site map ☒ Settlement not evident Areal extent______________ Depth____________ Remarks____
2. **Cracks** □ Location shown on site map ☒ Cracking not evident Lengths____________ Widths___________ Depths__________ Remarks____
3. **Erosion** □ Location shown on site map ☒ Erosion not evident Areal extent______________ Depth____________ Remarks____
4. **Holes** □ Location shown on site map ☒ Holes not evident Areal extent______________ Depth____________ Remarks____
5. **Vegetative Cover** □ Grass □ Cover properly established ☒ No signs of stress □ Trees/Shrubs (indicate size and locations on a diagram) Remarks____
6. **Alternative Cover (armored rock, concrete, etc.)** □ N/A Remarks____
7. **Bulges** □ Location shown on site map ☒ Bulges not evident Areal extent______________ Height____________ Remarks____
8. **Wet Areas/Water Damage** ☒ Wet areas/water damage not evident □ Wet areas □ Location shown on site map Areal extent______________ □ Ponding □ Location shown on site map Areal extent______________ □ Seeps □ Location shown on site map Areal extent______________ □ Soft subgrade □ Location shown on site map Areal extent______________ Remarks____

9.	**Slope Instability** ☐ Slides ☐ Location shown on site map ☒ No evidence of slope instability Areal extent______________ Remarks____ ____
B. Benches ☐ Applicable ☒ N/A (Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)	
C. Letdown Channels ☐ Applicable ☒ N/A (Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)	
D. Cover Penetrations ☒ Applicable ☐ N/A	
1.	**Gas Vents** ☐ Active ☒ Passive ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☒ Good condition ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A Remarks____ ____
2.	**Gas Monitoring Probes** ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☒ N/A Remarks____ ____
3.	**Monitoring Wells** (within surface area of landfill) ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☒ N/A Remarks____ ____
4.	**Leachate Extraction Wells** ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☒ N/A Remarks____ ____
5.	**Settlement Monuments** ☐ Located ☐ Routinely surveyed ☒ N/A Remarks____ ____

E. Gas Collection and Treatment ☐ Applicable ☒ N/A

F. Cover Drainage Layer ☐ Applicable ☒ N/A

G. Detention/Sedimentation Ponds ☐ Applicable ☒ N/A

H. Retaining Walls ☐ Applicable ☒ N/A

I. Perimeter Ditches/Off-Site Discharge ☒ Applicable ☐ N/A

1. **Siltation** ☐ Location shown on site map ☒ Siltation not evident
   Areal extent_______________ Depth_____________
   Remarks____
   ____

2. **Vegetative Growth** ☐ Location shown on site map ☒ N/A
   ☐ Vegetation does not impede flow
   Areal extent_______________ Type_____________
   Remarks____
   ____

3. **Erosion** ☐ Location shown on site map ☒ Erosion not evident
   Areal extent_______________ Depth_____________
   Remarks____
   ____

4. **Discharge Structure** ☒Functioning ☐ N/A
   Remarks____
   ____

VIII. VERTICAL BARRIER WALLS ☐ Applicable ☒ N/A

IX. GROUNDWATER/SURFACE WATER REMEDIES ☒ Applicable ☐ N/A

A. Groundwater Extraction Wells, Pumps, and Pipelines ☐ Applicable ☒ N/A

B. Surface Water Collection Structures, Pumps, and Pipelines ☐ Applicable ☒ N/A

C. Treatment System ☐ Applicable ☒ N/A

D. Monitoring Data

1. Monitoring Data
   ☒ Is routinely submitted on time ☒ Is of acceptable quality

2. Monitoring data suggests:
   ☐ Groundwater plume is effectively contained ☐ Contaminant concentrations are declining

D. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)
   ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
   ☐ All required wells located ☐ Needs Maintenance ☒ N/A
   Remarks____
   ____

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

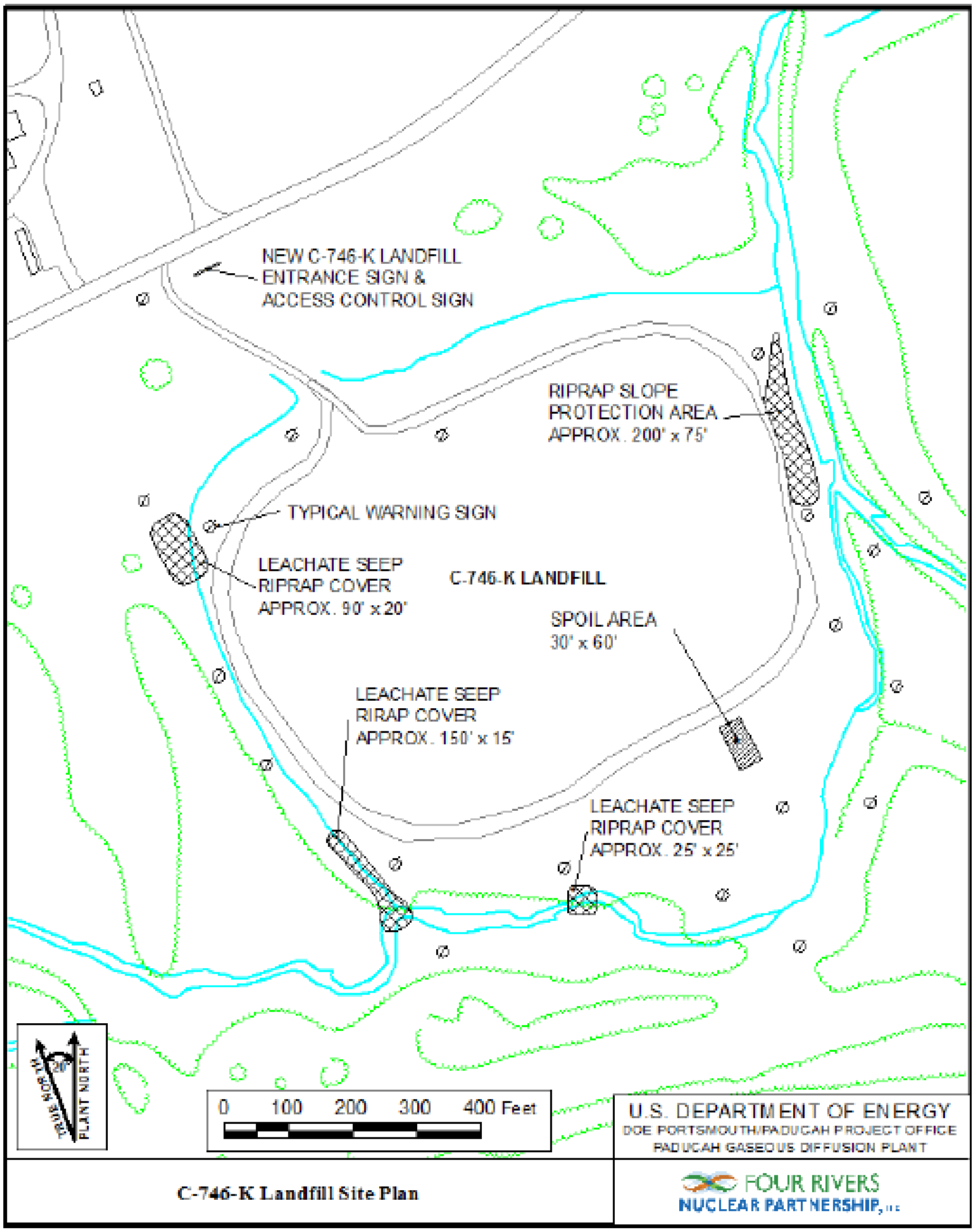
XI. OVERALL OBSERVATIONS	
A.	**Implementation of the Remedy**
	Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.). The riprap, landfill cap, and signs are in place and in good condition. No problems were noted with the systems operation or maintenance.
B.	**Adequacy of O&M**
	Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy. See Section 13.3 in main text.
C.	**Early Indicators of Potential Remedy Problems**
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future. None.
D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. None.

ATTACHMENT

Inspection team roster (12/20/2017):

Jennifer Johnson (Pro2Serve)	Clint Dietsch (FRNP)	Gaye Brewer (KDEP)
Teresa Overby (FRNP)	Brian Begley (KDEP)	Christopher Jung (KDEP)

Site map:



Five-Year Review Site Inspection Checklist
Fire Training Area

I. SITE INFORMATION	
Site name: Fire Training Area, SWMU 100	**Date of inspection:** 12/6/2017
Location and Region: Paducah, KY/Region 4	**EPA ID:** KY8890008982
Agency, office, or company leading the five-year review: DOE	**Weather/temperature:**

Remedy Includes: (Check all that apply)

- ☐ Landfill cover/containment
- ☒ Access controls
- ☐ Institutional controls
- ☐ Groundwater pump and treatment
- ☐ Surface water collection and treatment
- ☐ Other____
- ☐ Monitored natural attenuation
- ☐ Groundwater containment
- ☐ Vertical barrier walls

Attachments: ☒ Inspection team roster attached ☒ Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** _Brian Lowrance_____________ _Facility Manager_____ _12/6/2017_______
   Name Title Date
   Interviewed ☒ at site ☐ at office ☐ by phone Phone no. ______________
   Problems, suggestions; ☐ Report attached ____

2. **O&M staff** __N/A________________________ ______________________ ____________
   Name Title Date
   Interviewed ☐ at site ☐ at office ☐ by phone Phone no. ______________
   Problems, suggestions; ☐ Report attached ____

3.	**Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply. Agency ______________________________ Contact ______________________________ ____________________ _________ _____________ Name Title Date Phone no. Problems; suggestions; ☐ Report attached ____ ____ Agency ______________________________ Contact ______________________________ ____________________ _________ _____________ Name Title Date Phone no. Problems; suggestions; ☐ Report attached ____ ____ Agency ______________________________ Contact ______________________________ ____________________ _________ _____________ Name Title Date Phone no. Problems; suggestions; ☐ Report attached ____ ____ Agency ______________________________ Contact ______________________________ ____________________ _________ _____________ Name Title Date Phone no. Problems; suggestions; ☐ Report attached ____ ____
4.	**Other interviews** (optional) ☐ Report attached.

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)				
1.	**O&M Documents**			
	□ O&M manual	□ Readily available	□ Up to date	☒ N/A
	□ As-built drawings	□ Readily available	□ Up to date	☒ N/A
	□ Maintenance logs	□ Readily available	□ Up to date	☒ N/A
	Remarks______________________________			
2.	**Site-Specific Health and Safety Plan**	□ Readily available	□ Up to date	☒ N/A
	□ Contingency plan/emergency response plan	□ Readily available	□ Up to date	☒ N/A
	Remarks______________________________			
3.	**O&M and OSHA Training Records**	□ Readily available	□ Up to date	☒ N/A
	Remarks______________________________			
4.	**Permits and Service Agreements**			
	□ Air discharge permit	□ Readily available	□ Up to date	☒ N/A
	□ Effluent discharge	□ Readily available	□ Up to date	☒ N/A
	□ Waste disposal, POTW	□ Readily available	□ Up to date	☒ N/A
	□ Other permits______________________	□ Readily available	□ Up to date	☒ N/A
	Remarks______________________________			
5.	**Gas Generation Records**	□ Readily available	□ Up to date	☒ N/A
	Remarks______________________________			
6.	**Settlement Monument Records**	□ Readily available	□ Up to date	☒ N/A
	Remarks______________________________			
7.	**Groundwater Monitoring Records**	□ Readily available	□ Up to date	☒ N/A
	Remarks______________________________			
8.	**Leachate Extraction Records**	□ Readily available	□ Up to date	☒ N/A
	Remarks______________________________			
9.	**Discharge Compliance Records**			
	□ Air	□ Readily available	□ Up to date	☒ N/A
	□ Water (effluent)	□ Readily available	□ Up to date	☒ N/A
	Remarks______________________________			
10.	**Daily Access/Security Logs**	□ Readily available	□ Up to date	☒ N/A
	Remarks______________________________			

IV. O&M COSTS

1. **O&M Organization**
☐ State in-house ☐ Contractor for State
☐ PRP in-house ☐ Contractor for PRP
☐ Federal Facility in-house ☒ Contractor for Federal Facility
☐ Other____

2. **O&M Cost Records** *Refer to Sect. 14.3 of the report.*
☐ Readily available ☐ Up to date
☐ Funding mechanism/agreement in place
Original O&M cost estimate____________________ ☐ Breakdown attached

Total annual cost by year for review period if available

From (Date)	To (Date)	Total cost	
___________	___________	___________________	☐ Breakdown attached
___________	___________	___________________	☐ Breakdown attached
___________	___________	___________________	☐ Breakdown attached
___________	___________	___________________	☐ Breakdown attached
___________	___________	___________________	☐ Breakdown attached

3. **Unanticipated or Unusually High O&M Costs During Review Period**
Describe costs and reasons: Costs are discussed in Sect. 14.3 of the report.

V. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable ☐ N/A

A. Fencing

1. **Fencing damaged** ☐ Location shown on site map ☐ Gates secured ☐ N/A
Remarks Plant fence

B. Other Access Restrictions

1. **Signs and other security measures** ☐ Location shown on site map ☒ N/A
Remarks____

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

Site conditions imply ICs not properly implemented ☐ Yes ☒ No ☐ N/A
Site conditions imply ICs not being fully enforced ☐ Yes ☒ No ☐ N/A

Type of monitoring (*e.g.*, self-reporting, drive by) none, SWMU 100 is NFA
Frequency ______
Responsible party/agency ______
Contact ______ ______ ______ ______
Name Title Date Phone no.

Reporting is up-to-date ☐ Yes ☐ No ☒ N/A
Reports are verified by the lead agency ☐ Yes ☐ No ☒ N/A

Specific requirements in deed or decision documents have been met ☐ Yes ☐ No ☒ N/A
Violations have been reported ☐ Yes ☐ No ☒ N/A
Other problems or suggestions: ☐ Report attached

2. **Adequacy** ☒ ICs are adequate ☐ ICs are inadequate ☐ N/A
Remarks______

D. General

1. **Vandalism/trespassing** ☐ Location shown on site map ☒ No vandalism evident
Remarks______

2. **Land use changes on site** ☒ N/A
Remarks______

3. **Land use changes off site** ☒ N/A
Remarks______

VI. GENERAL SITE CONDITIONS

A. Roads ☐ Applicable ☒ N/A

1. **Roads damaged** ☐ Location shown on site map ☐ Roads adequate ☐ N/A
Remarks______

B. Other Site Conditions

Remarks Annual fire training still is held at the facility.
MW 315 and MW330 are on site. Both wells are locked.
Equipment present include ladder/stand, pipes, sewer, plastic.

VII. LANDFILL COVERS ☐ Applicable ☒ N/A

VIII. VERTICAL BARRIER WALLS ☐ Applicable ☒ N/A

IX. GROUNDWATER/SURFACE WATER REMEDIES ☐ Applicable ☒ N/A

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

C. Early Indicators of Potential Remedy Problems

Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future.

D. Opportunities for Optimization

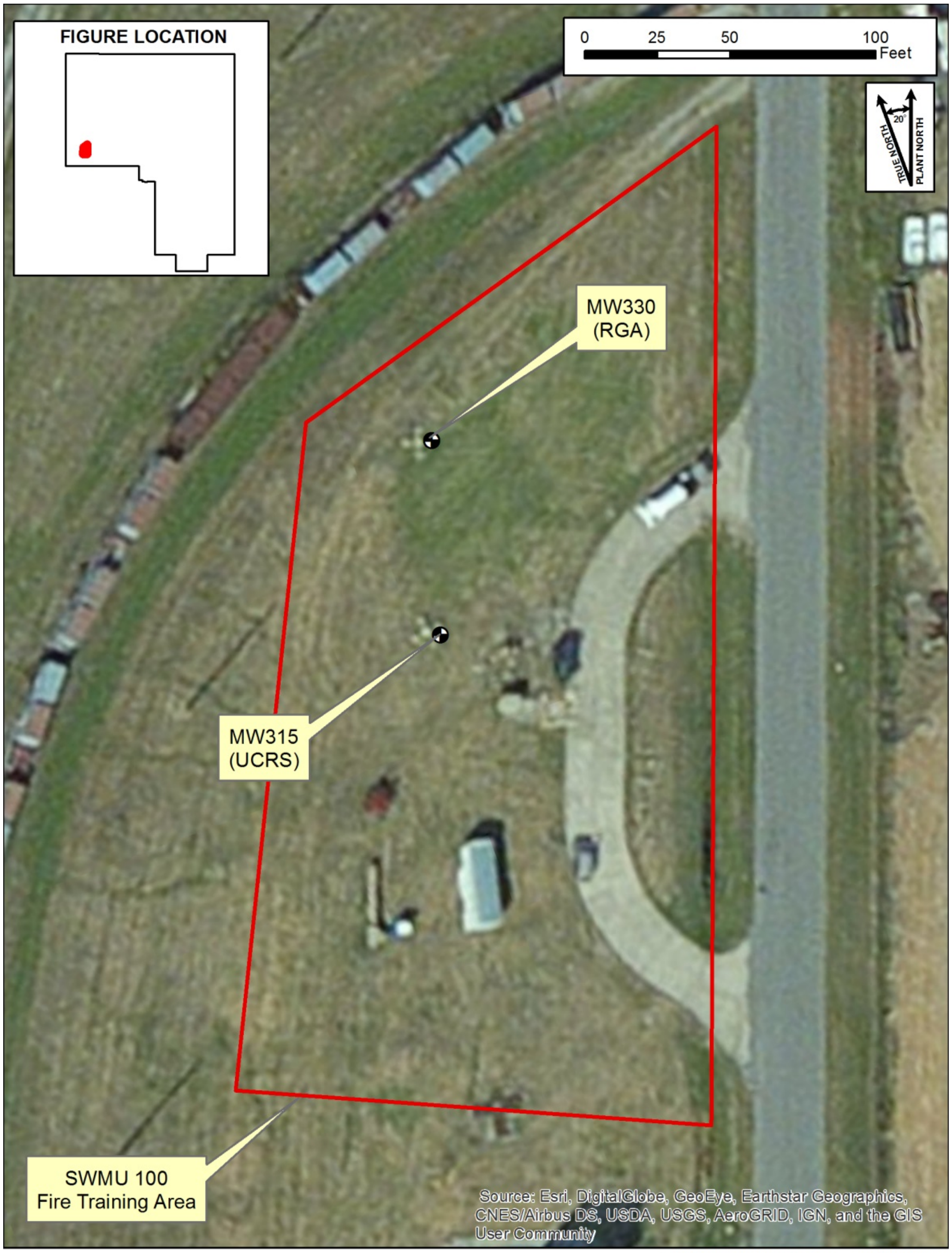
Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

ATTACHMENT

Inspection team roster (12/6/2017):

Jennifer Blewett (FRNP)	Jennifer Johnson (FRNP)	Teresa Overby (FRNP)
LeAnne Garner (FRNP)	Brian Lowrance (FRNP)	Justin Riley (FRNP)

Site map:



G:\GIS\ARCVIEWS\PROJECTS\5YrReview\2018_SWMU100.mxd
2/1/2017

Five-Year Review Site Inspection Checklist
Surface Water Interim Corrective Measures

I. SITE INFORMATION	
Site name: Surface Water ICM	**Date of inspection:** 12/13/2017
Location and Region: Paducah, KY/Region 4	**EPA ID:** KY8890008982
Agency, office, or company leading the five-year review: DOE	**Weather/temperature:** 50F and clear
Remedy Includes: (Check all that apply) □ Landfill cover/containment ☒ Access controls □ Institutional controls □ Groundwater pump and treatment □ Surface water collection and treatment □ Other________________	□ Monitored natural attenuation □ Groundwater containment □ Vertical barrier walls
Attachments: ☒ Inspection team roster attached	☒ Site map attached
II. INTERVIEWS (Check all that apply)	
1. **O&M site manager** _Justin Riley_ (Name) _Facility Manager_ (Title) _12/13/2017_ (Date) Interviewed ☒ at site □ at office □ by phone Phone no. ________ Problems, suggestions; □ Report attached __None________	
2. **O&M staff** __n/a__ (Name) ________ (Title) ________ (Date) Interviewed □ at site □ at office □ by phone Phone no. ________ Problems, suggestions; □ *Report attached* ________	

3.	**Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply. Agency ______________________________ Contact ______________________________ ____________________ _________ _____________ Name Title Date Phone no. Problems; suggestions; □ Report attached ______________________________ ______________________________ Agency ______________________________ Contact ______________________________ ____________________ _________ _____________ Name Title Date Phone no. Problems; suggestions; □ Report attached ______________________________ ______________________________ Agency ______________________________ Contact ______________________________ ____________________ _________ _____________ Name Title Date Phone no. Problems; suggestions; □ Report attached ______________________________ ______________________________ Agency ______________________________ Contact ______________________________ ____________________ _________ _____________ Name Title Date Phone no. Problems; suggestions; □ Report attached ______________________________ ______________________________
4.	**Other interviews** (optional) □ *Report attached.*

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)				
1.	**O&M Documents**			
	☒ O&M manual	☒ Readily available	☒ Up to date	☐ N/A
	☐ As-built drawings	☐ Readily available	☐ Up to date	☒ N/A
	☐ Maintenance logs	☐ Readily available	☐ Up to date	☒ N/A
	Remarks			
2.	**Site-Specific Health and Safety Plan**	☐ Readily available	☐ Up to date	☒ N/A
	☐ Contingency plan/emergency response plan	☐ Readily available	☐ Up to date	☒ N/A
	Remarks			
3.	**O&M and OSHA Training Records**	☐ Readily available	☐ Up to date	☒ N/A
	Remarks			
4.	**Permits and Service Agreements**			
	☐ Air discharge permit	☐ Readily available	☐ Up to date	☒ N/A
	☐ Effluent discharge	☐ Readily available	☐ Up to date	☒ N/A
	☐ Waste disposal, POTW	☐ Readily available	☐ Up to date	☒ N/A
	☐ Other permits	☐ Readily available	☐ Up to date	☒ N/A
	Remarks			
5.	**Gas Generation Records**	☐ Readily available	☐ Up to date	☒ N/A
	Remarks			
6.	**Settlement Monument Records**	☐ Readily available	☐ Up to date	☒ N/A
	Remarks			
7.	**Groundwater Monitoring Records**	☐ Readily available	☐ Up to date	☒ N/A
	Remarks			
8.	**Leachate Extraction Records**	☐ Readily available	☐ Up to date	☒ N/A
	Remarks			
9.	**Discharge Compliance Records**			
	☐ Air	☐ Readily available	☐ Up to date	☒ N/A
	☐ Water (effluent)	☐ Readily available	☐ Up to date	☒ N/A
	Remarks			
10.	**Daily Access/Security Logs**	☐ Readily available	☐ Up to date	☒ N/A
	Remarks			

IV. O&M COSTS
1. **O&M Organization** □ State in-house □ Contractor for State □ PRP in-house □ Contractor for PRP □ Federal Facility in-house ☒ Contractor for Federal Facility □ Other
2. **O&M Cost Records** *Refer to Sect. 15.3 of the report.* □ Readily available □ Up to date □ Funding mechanism/agreement in place Original O&M cost estimate______ □ Breakdown attached Total annual cost by year for review period if available From______ To______ ______ □ Breakdown attached Date Date Total cost From______ To______ ______ □ Breakdown attached Date Date Total cost From______ To______ ______ □ Breakdown attached Date Date Total cost From______ To______ ______ □ Breakdown attached Date Date Total cost From______ To______ ______ □ Breakdown attached Date Date Total cost
3. **Unanticipated or Unusually High O&M Costs During Review Period** Describe costs and reasons: *Costs are discussed in Sect. 15.3 of the report.*
V. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable □ N/A
A. Fencing
1. **Fencing damaged** ☒ Location shown on site map □ Gates secured □ N/A Remarks Fences were in good shape.
B. Other Access Restrictions
1. **Signs and other security measures** ☒ Location shown on site map □ N/A Remarks Signs were present and were legible.

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

Site conditions imply ICs not properly implemented	□ Yes	□ No	☒ N/A
Site conditions imply ICs not being fully enforced	□ Yes	□ No	□ N/A

Type of monitoring (e.g., self-reporting, drive by) ________________________________
Frequency ____
Responsible party/agency ____
Contact ____________________________ ________________ ________ __________
Name Title Date Phone no.

Reporting is up-to-date	□ Yes	□ No	☒ N/A
Reports are verified by the lead agency	□ Yes	□ No	☒ N/A
Specific requirements in deed or decision documents have been met	□ Yes	□ No	☒ N/A
Violations have been reported	□ Yes	□ No	☒ N/A

Other problems or suggestions: □ Report attached
____
____
____
____

2. **Adequacy** □ ICs are adequate □ ICs are inadequate ☒ N/A
Remarks__ ________________________________
____
____

D. General

1. **Vandalism/trespassing** □ Location shown on site map ☒ No vandalism evident
Remarks____
____

2. **Land use changes on site** □ N/A
Remarks_No changes.____
____

3. **Land use changes off site** □ N/A
Remarks__No changes.____
____

VI. GENERAL SITE CONDITIONS

A. Roads □ Applicable ☒ N/A

B. Other Site Conditions

Remarks ____
____

VII. LANDFILL COVERS □ Applicable ☒ N/A

VIII. VERTICAL BARRIER WALLS □ Applicable ☒ N/A

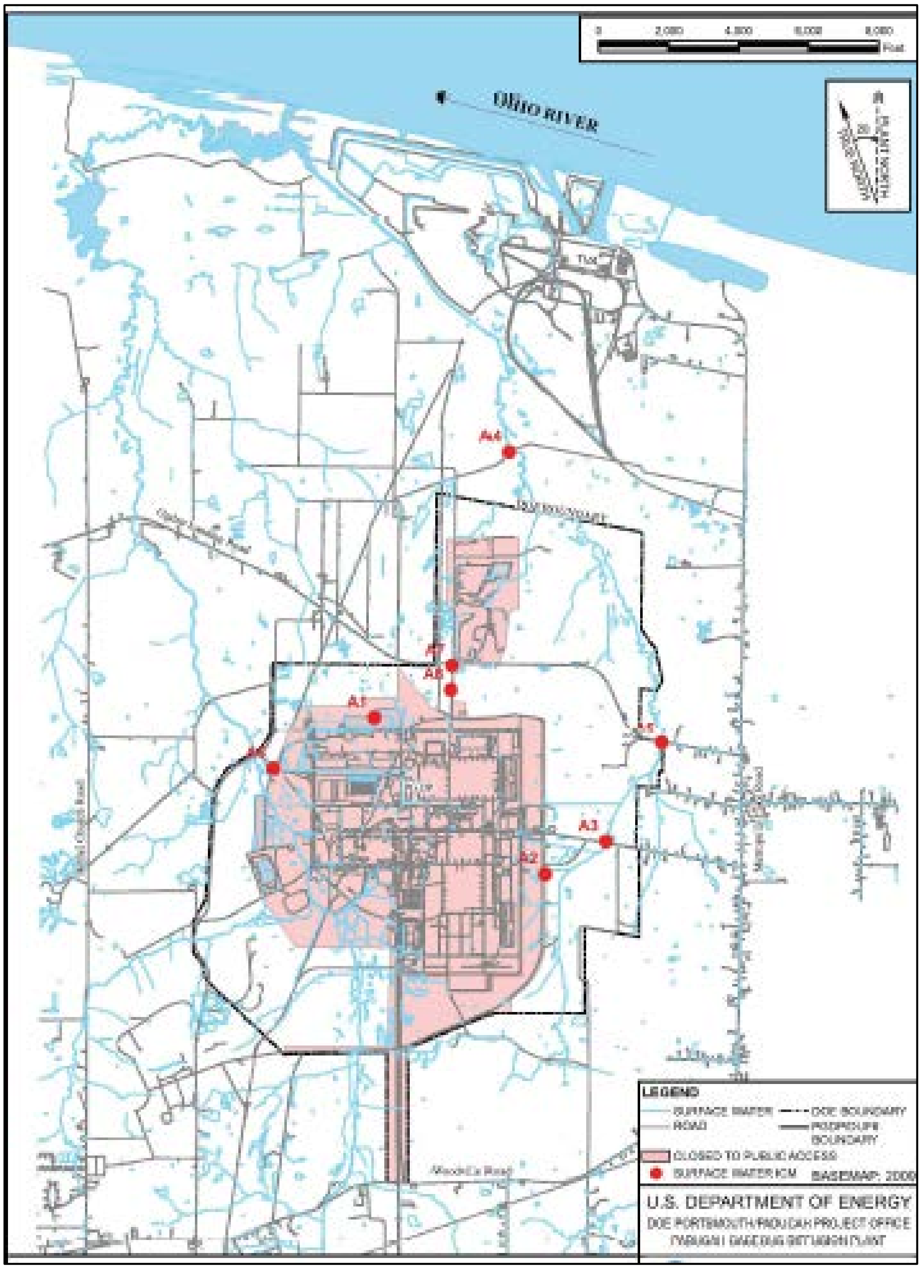
IX. GROUNDWATER/SURFACE WATER REMEDIES □ Applicable ☒ N/A

X. OTHER REMEDIES	
	If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.
XI. OVERALL OBSERVATIONS	
A.	**Implementation of the Remedy**
	Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.). The actions chosen were to install fencing and posting signs to warn people in the area of the dangers posed by direct contact with the water and/or sediments. The remedy is functioning as designed.
B.	**Adequacy of O&M**
	Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy. See Section 15.3.Regular inspections and sign replace is ongoing and continue to keep the remedy functioning as designed.
C.	**Early Indicators of Potential Remedy Problems**
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future. None.
D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. None.

ATTACHMENT

Inspection team roster (12/14/2017):
Jennifer Johnson (Pro2Serve)
Teresa Overby (FRNP)
Justin Riley (FRNP)

Site map:



Five-Year Review Site Inspection Checklist
Surface Water On-Site Sediment Removal

I. SITE INFORMATION	
Site name: Surface Water On-Site Sediment Removal	**Date of inspection:** 12/6/2017
Location and Region: Paducah, KY/Region 4	**EPA ID:** KY8890008982
Agency, office, or company leading the five-year review: DOE	**Weather/temperature:**

Remedy Includes: (Check all that apply)

- □ Landfill cover/containment
- □ Access controls
- □ Institutional controls
- □ Groundwater pump and treatment
- □ Surface water collection and treatment
- ☒ Other_ non-time-critical removal action
- □ Monitored natural attenuation
- □ Groundwater containment
- □ Vertical barrier walls

Attachments: ☒ Inspection team roster attached ☒ Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** _Brian Lowrance_ _Facility Manager_ _12/6/2017_
   Name Title Date
   Interviewed ☒ at site □ at office □ by phone Phone no. ________
   Problems, suggestions; □ Report attached ________

2. **O&M staff** __Justin Riley__ _Facility Manager_ _12/6/2017_
   Name Title Date
   Interviewed ☒ at site □ at office □ by phone Phone no. ________
   Problems, suggestions; □ Report attached ________

3.	**Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply. Agency ______________________________ Contact ______________________________ ___________________ ________ ____________ Name Title Date Phone no. Problems; suggestions; □ Report attached ______________________________ ______________________________ Agency ______________________________ Contact ______________________________ ___________________ ________ ____________ Name Title Date Phone no. Problems; suggestions; □ Report attached ______________________________ ______________________________ Agency ______________________________ Contact ______________________________ ___________________ ________ ____________ Name Title Date Phone no. Problems; suggestions; □ Report attached ______________________________ ______________________________ Agency ______________________________ Contact ______________________________ ___________________ ________ ____________ Name Title Date Phone no. Problems; suggestions; □ Report attached ______________________________ ______________________________
4.	**Other interviews** (optional) □ Report attached.

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)				
1.	**O&M Documents**			
	□ O&M manual	□ Readily available	□ Up to date	☒ N/A
	□ As-built drawings	□ Readily available	□ Up to date	☒ N/A
	□ Maintenance logs	□ Readily available	□ Up to date	☒ N/A
	Remarks______________________________			
2.	**Site-Specific Health and Safety Plan**	□ Readily available	□ Up to date	☒ N/A
	□ Contingency plan/emergency response plan	□ Readily available	□ Up to date	☒ N/A
	Remarks______________________________			
3.	**O&M and OSHA Training Records**	□ Readily available	□ Up to date	☒ N/A
	Remarks______________________________			
4.	**Permits and Service Agreements**			
	□ Air discharge permit	□ Readily available	□ Up to date	☒ N/A
	□ Effluent discharge	□ Readily available	□ Up to date	☒ N/A
	□ Waste disposal, POTW	□ Readily available	□ Up to date	☒ N/A
	□ Other permits______________________	□ Readily available	□ Up to date	☒ N/A
	Remarks______________________________			
5.	**Gas Generation Records**	□ Readily available	□ Up to date	☒ N/A
	Remarks______________________________			
6.	**Settlement Monument Records**	□ Readily available	□ Up to date	☒ N/A
	Remarks______________________________			
7.	**Groundwater Monitoring Records**	□ Readily available	□ Up to date	☒ N/A
	Remarks______________________________			
8.	**Leachate Extraction Records**	□ Readily available	□ Up to date	☒ N/A
	Remarks______________________________			
9.	**Discharge Compliance Records**			
	□ Air	□ Readily available	□ Up to date	☒ N/A
	□ Water (effluent)	□ Readily available	□ Up to date	☒ N/A
	Remarks______________________________			
10.	**Daily Access/Security Logs**	□ Readily available	□ Up to date	☒ N/A
	Remarks______________________________			

IV. O&M COSTS

1. **O&M Organization**
   ☐ State in-house ☐ Contractor for State
   ☐ PRP in-house ☐ Contractor for PRP
   ☐ Federal Facility in-house ☒ Contractor for Federal Facility
   ☐ Other____
   ____

2. **O&M Cost Records** *Refer to Sect. 16.3 of the report.*
   ☐ Readily available ☐ Up to date
   ☐ Funding mechanism/agreement in place
   Original O&M cost estimate____________________ ☐ Breakdown attached

   Total annual cost by year for review period if available

From (Date)	To (Date)	Total cost	
From__________	To__________	__________________	☐ Breakdown attached
From__________	To__________	__________________	☐ Breakdown attached
From__________	To__________	__________________	☐ Breakdown attached
From__________	To__________	__________________	☐ Breakdown attached
From__________	To__________	__________________	☐ Breakdown attached

3. **Unanticipated or Unusually High O&M Costs During Review Period**
   Describe costs and reasons: Costs are discussed in Sect. 16.3 of the report.______________________
   ____

V. ACCESS AND INSTITUTIONAL CONTROLS ☐ Applicable ☒ N/A

VI. GENERAL SITE CONDITIONS

A. Roads ☐ Applicable ☒ N/A

B. Other Site Conditions

Remarks See map in attachment for notes on general site conditions.________________________
____

VII. LANDFILL COVERS ☐ Applicable ☒ N/A

VIII. VERTICAL BARRIER WALLS ☐ Applicable ☒ N/A

IX. GROUNDWATER/SURFACE WATER REMEDIES ☐ Applicable ☒ N/A

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

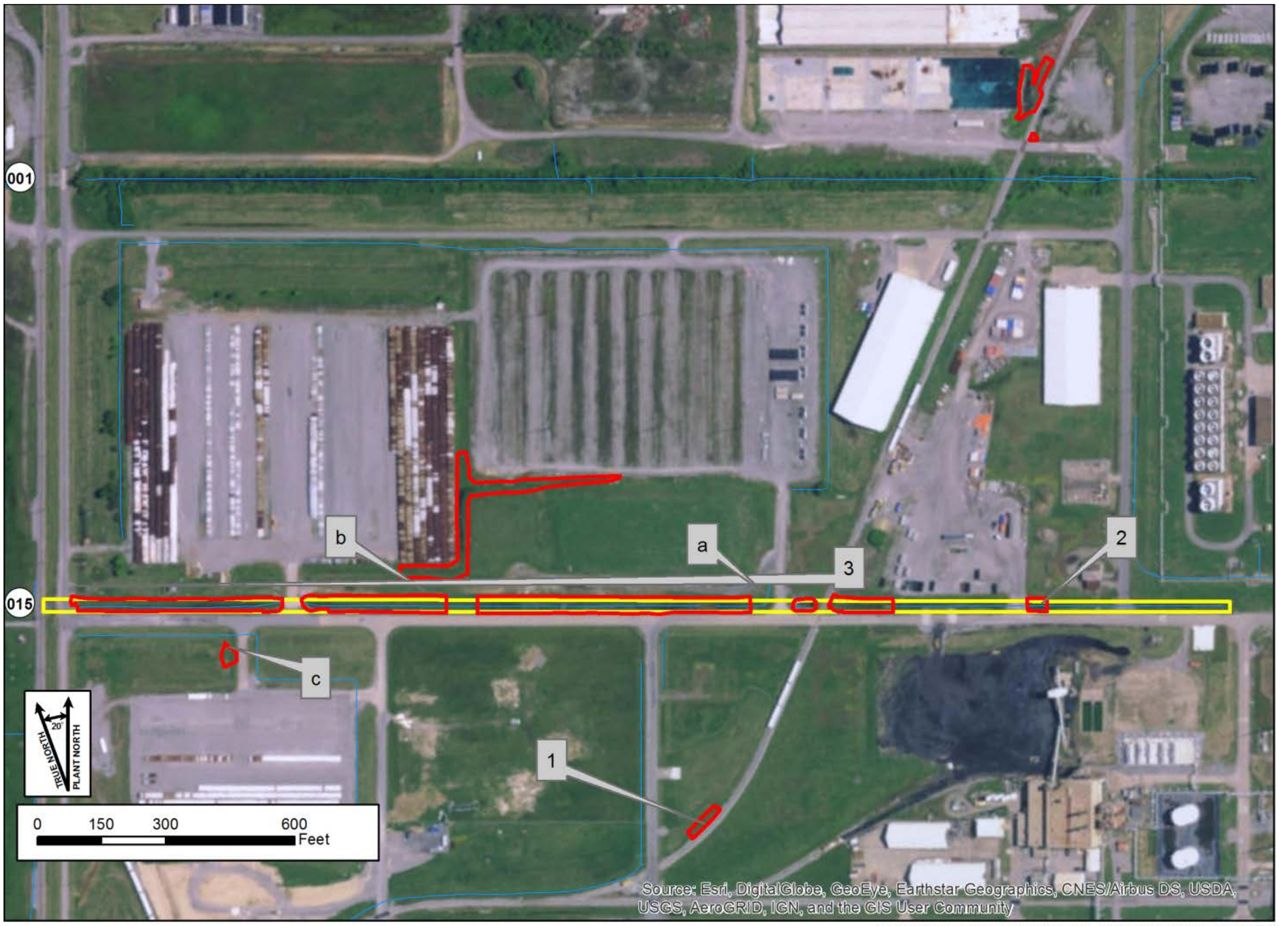
XI. OVERALL OBSERVATIONS	
A.	**Implementation of the Remedy**
	Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.). Areas determined to be "hot spots" during the SWOU On-site Site Investigation were determined to require removal. This removal was performed as a non-time-critical removal action. Objectives of this action were to (1) ensure direct contact risk at the on-site ditches for the current industrial worker fall within the EPA risk range and (2) ensure direct contact risk at the NSDD for both the current industrial worker and recreational user fall within the EPA risk range.
B.	**Adequacy of O&M**
	Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy. There is no O&M for this remedy.
C.	**Early Indicators of Potential Remedy Problems**
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future. None.
D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

ATTACHMENT

Inspection team roster (12/6/2017):

Jennifer Blewett (FRNP)	Jennifer Johnson (FRNP)	Teresa Overby (FRNP)
LeAnne Garner (FRNP)	Brian Lowrance (FRNP)	Justin Riley (FRNP)

Site map:



S:\Env Services\Environmental Stewardship\ERP - Risk\GIS\SWOUOnsite_Inspection1.mxd
12/13/2017

Area 1: grass-covered ditch—no erosion issues, some standing water in ditch.
Area 2: grass-covered ditch—standing water, no significant erosion within ditch, but some on roadside leading to ditch.
Area 3: drive-by inspection—ditches generally in good condition, either grass-covered or rip rap. Specific notations are made below.

(a) rip rap, significant standing water
(b) some standing water
(c) some standing water

Inspection team roster (12/12/2017):

LeAnne Garner (FRNP) | Jennifer Johnson (FRNP) | Teresa Overby (FRNP)

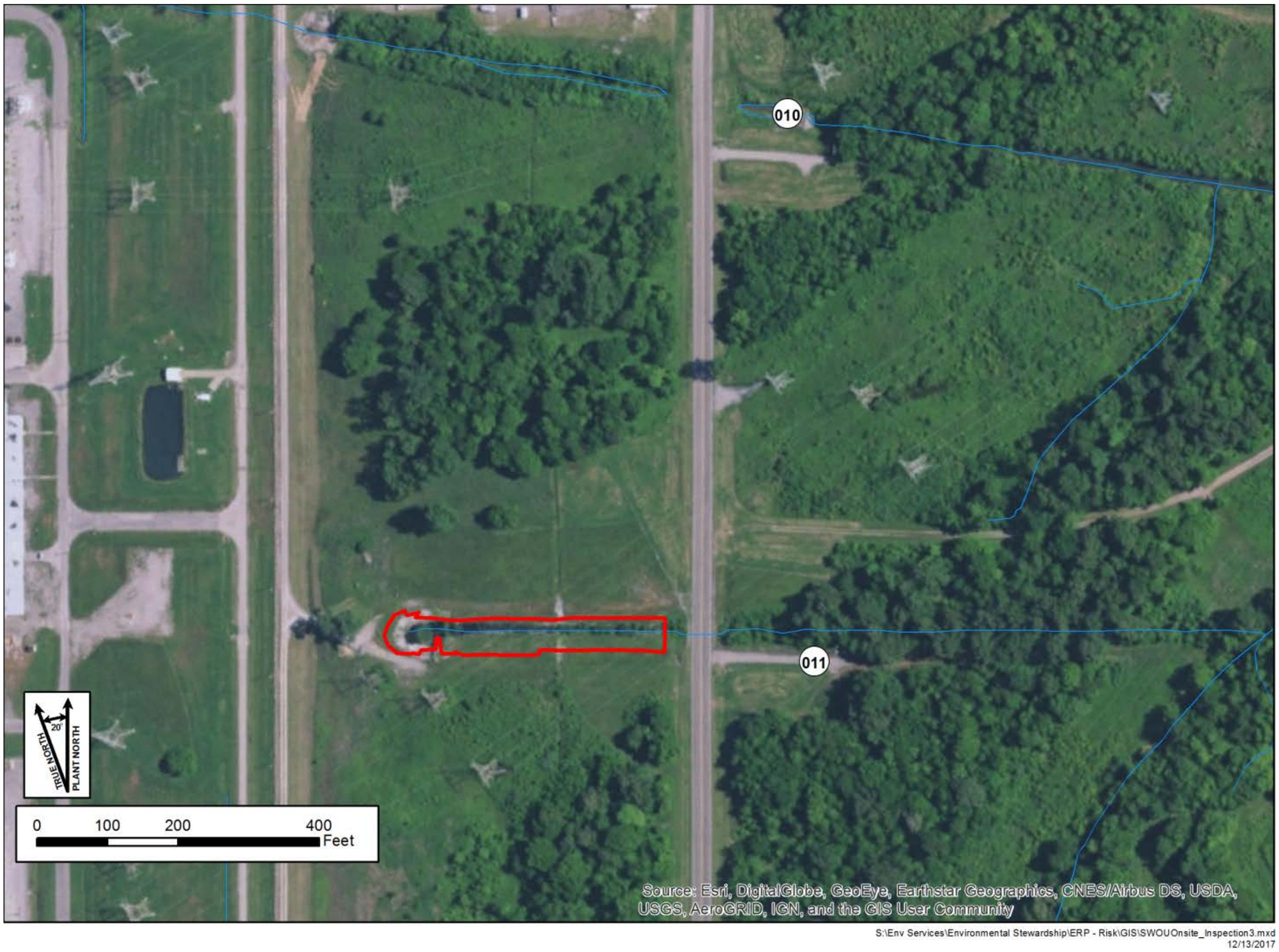
Site Map:

S:\Env Services\Environmental Stewardship\ERP - Risk\GIS\SWOUOnsite_Inspection2.mxd
12/13/2017

Area 1: drive-by inspection—rip rap appears to be holding well, some standing water
Area 2: rip rap in place, no standing water, rad signs clearly visible
Area 3: drive-by inspection—ditches generally in good condition, primarily covered by rip rap. Specific notation is made below.

(a) Maintenance (brush cutting) recently has been performed.

Site map:

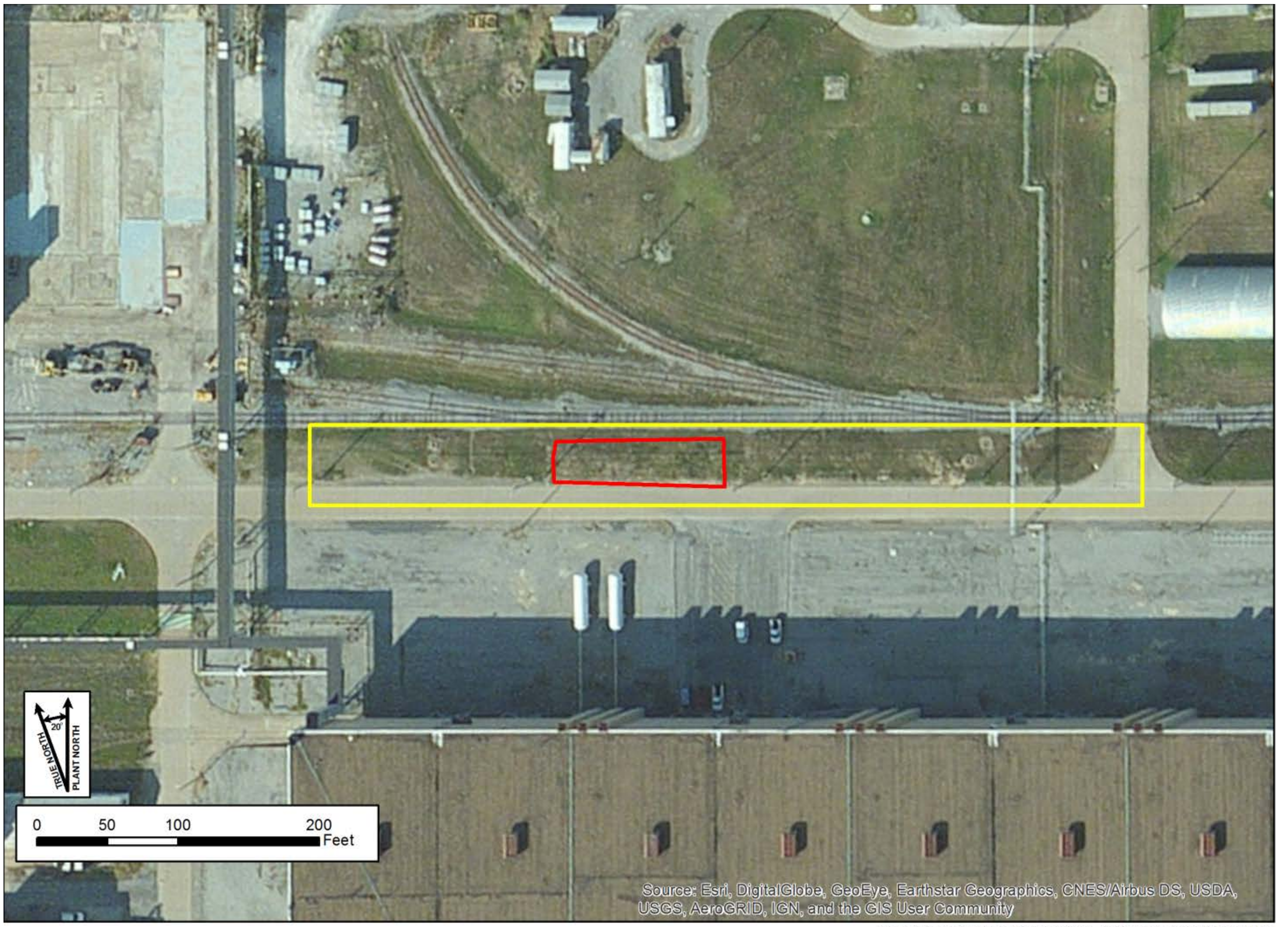


Outfall 011 Area: drive-by inspection—rip rap appears to be in good shape, slope is grass-covered, rad signs are visible, standing water is present.

Inspection team roster (12/14/2017):

Clint Dietsch (FRNP)	Jennifer Johnson (FRNP)	Justin Riley (FRNP)
LeAnne Garner (FRNP)	Teresa Overby (FRNP)	

Site map:



S:\Env Services\Environmental Stewardship\ERP - Risk\GIS\SWOUOnsite_Inspection4.mxd
12/13/2017

SWMU 92 Area: grass-covered

Five-Year Review Site Inspection Checklist
C-749 Uranium Burial Ground

I. SITE INFORMATION	
Site name: C-749 Uranium Burial Ground	**Date of inspection:** 12/14/2017
Location and Region: Paducah, KY/Region 4	**EPA ID:** KY8890008982
Agency, office, or company leading the five-year review: DOE	**Weather/temperature:** 39 F and clear

Remedy Includes: (Check all that apply)

☒ Landfill cover/containment
□ Access controls
□ Institutional controls
□ Groundwater pump and treatment
□ Surface water collection and treatment
□ Other____
□ Monitored natural attenuation
□ Groundwater containment
□ Vertical barrier walls

Attachments: ☒ Inspection team roster attached ☒ Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** Clint Dietsch — Facility Manager — 12/20/2017
   Name Title Date
   Interviewed ☒ at site □ at office □ by phone Phone no. ______________
   Problems, suggestions; □ Report attached __None______________________________________

2. **O&M staff** n/a ______________ ____________________ ________
   Name Title Date
   Interviewed □ at site □ at office □ by phone Phone no. ______________
   Problems, suggestions; □ Report attached ____

3.	**Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply. Agency ______________________________ Contact ______________________________ ___________________ ________ ____________ Name Title Date Phone no. Problems; suggestions; □ Report attached ____ ____ Agency ______________________________ Contact ______________________________ ___________________ ________ ____________ Name Title Date Phone no. Problems; suggestions; □ Report attached ____ ____ Agency ______________________________ Contact ______________________________ ___________________ ________ ____________ Name Title Date Phone no. Problems; suggestions; □ Report attached ____ ____ Agency ______________________________ Contact ______________________________ ___________________ ________ ____________ Name Title Date Phone no. Problems; suggestions; □ Report attached ____ ____
4.	**Other interviews** (optional) □ Report attached.

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)				
1.	O&M Documents			
	□ O&M manual	□ Readily available	□ Up to date	☒ N/A
	□ As-built drawings	□ Readily available	□ Up to date	☒N/A
	□ Maintenance logs	□ Readily available	□ Up to date	☒ N/A
	Remarks_ ___			
2.	**Site-Specific Health and Safety Plan**	□ Readily available	□ Up to date	☒ N/A
	□ Contingency plan/emergency response plan	□ Readily available	□ Up to date	☒ N/A
	Remarks___			
3.	**O&M and OSHA Training Records**	□ Readily available	□ Up to date	☒ N/A
	Remarks___			
4.	**Permits and Service Agreements**			
	□ Air discharge permit	□ Readily available	□ Up to date	☒ N/A
	□ Effluent discharge	□ Readily available	□ Up to date	☒ N/A
	□ Waste disposal, POTW	□ Readily available	□ Up to date	☒ N/A
	□ Other permits___	□ Readily available	□ Up to date	☒ N/A
	Remarks___			
5.	**Gas Generation Records**	□ Readily available	□ Up to date	☒ N/A
	Remarks___			
6.	**Settlement Monument Records**	□ Readily available	□ Up to date	☒ N/A
	Remarks___			
7.	**Groundwater Monitoring Records**	☒ Readily available	☒ Up to date	□ N/A
	Remarks___			
8.	**Leachate Extraction Records**	□ Readily available	□ Up to date	☒ N/A
	Remarks___			
9.	**Discharge Compliance Records**			
	□ Air	□ Readily available	□ Up to date	☒ N/A
	□ Water (effluent)	□ Readily available	□ Up to date	☒ N/A
	Remarks___			
10.	**Daily Access/Security Logs**	□ Readily available	□ Up to date	☒ N/A
	Remarks___			

IV. O&M COSTS
1. **O&M Organization** □ State in-house □ Contractor for State □ PRP in-house □ Contractor for PRP □ Federal Facility in-house ☒ Contractor for Federal Facility □ Other____
2. **O&M Cost Records** Refer to Sect. 17.3 of the report. □ Readily available □ Up to date □ Funding mechanism/agreement in place Original O&M cost estimate____________________ □ Breakdown attached Total annual cost by year for review period if available From__________ To__________ __________________ □ Breakdown attached Date Date Total cost From__________ To__________ __________________ □ Breakdown attached Date Date Total cost From__________ To__________ __________________ □ Breakdown attached Date Date Total cost From__________ To__________ __________________ □ Breakdown attached Date Date Total cost From__________ To__________ __________________ □ Breakdown attached Date Date Total cost
3. **Unanticipated or Unusually High O&M Costs During Review Period** Describe costs and reasons: Costs are discussed in Sect. 17.3 of the report.______________
V. ACCESS AND INSTITUTIONAL CONTROLS □ Applicable ☒ N/A
A. Fencing
1. **Fencing damaged** □ Location shown on site map □ Gates secured ☒ N/A Remarks____
B. Other Access Restrictions
1. **Signs and other security measures** □ Location shown on site map □ N/A Remarks____

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

Site conditions imply ICs not properly implemented ☐ Yes ☒ No ☐ N/A
Site conditions imply ICs not being fully enforced ☐ Yes ☒ No ☐ N/A

Type of monitoring (e.g., self-reporting, drive by) ____________________
Frequency ____________________
Responsible party/agency ____________________
Contact ____________________ ____________________ __________ __________
Name Title Date Phone no.

Reporting is up-to-date ☐ Yes ☐ No ☒ N/A
Reports are verified by the lead agency ☐ Yes ☐ No ☒ N/A

Specific requirements in deed or decision documents have been met ☐ Yes ☐ No ☒ N/A
Violations have been reported ☐ Yes ☐ No ☒ N/A
Other problems or suggestions: ☐ Report attached

2. **Adequacy** ☒ ICs are adequate ☐ ICs are inadequate ☐ N/A
Remarks____________________

D. General

1. **Vandalism/trespassing** ☐ Location shown on site map ☒ No vandalism evident
Remarks____________________

2. **Land use changes on site** ☒ N/A
Remarks____________________

3. **Land use changes off site** ☒ N/A
Remarks____________________

VI. GENERAL SITE CONDITIONS

A. Roads ☒Applicable ☐ N/A

1. **Roads damaged** ☒ Location shown on site map ☒ Roads adequate ☐ N/A
Remarks____________________

B. Other Site Conditions

Remarks ______ No issues were noted on the site inspection.______________________________

VII. LANDFILL COVERS ☒ Applicable ☐ N/A

A. Landfill Surface

1. **Settlement** (Low spots) ☐ Location shown on site map ☒ Settlement not evident
Areal extent______________ Depth____________
Remarks____

2. **Cracks** ☐ Location shown on site map ☒ Cracking not evident
Lengths____________ Widths___________ Depths__________
Remarks____

3. **Erosion** ☐ Location shown on site map ☒ Erosion not evident
Areal extent______________ Depth____________
Remarks____

4. **Holes** ☐ Location shown on site map ☒ Holes not evident
Areal extent______________ Depth____________
Remarks____

5. **Vegetative Cover** ☐ Grass ☐ Cover properly established ☒ No signs of stress
☐ Trees/Shrubs (indicate size and locations on a diagram)
Remarks____

6. **Alternative Cover (armored rock, concrete, etc.)** ☒ N/A
Remarks____

7. **Bulges** ☐ Location shown on site map ☒ Bulges not evident
Areal extent______________ Height____________
Remarks____

8. **Wet Areas/Water Damage** ☒ Wet areas/water damage not evident
☐ Wet areas ☐ Location shown on site map Areal extent______________
☐ Ponding ☐ Location shown on site map Areal extent______________
☐ Seeps ☐ Location shown on site map Areal extent______________
☐ Soft subgrade ☐ Location shown on site map Areal extent______________
Remarks____

9. **Slope Instability** ☐ Slides ☐ Location shown on site map ☒ No evidence of slope instability
Areal extent______________
Remarks____

B. Benches ☐ Applicable ☒ N/A (Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)	
C. Letdown Channels ☐ Applicable ☒ N/A (Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)	
D. Cover Penetrations ☐ Applicable ☒ N/A	
E. Gas Collection and Treatment ☐ Applicable ☒ N/A	
F. Cover Drainage Layer ☐ Applicable ☒ N/A	
G. Detention/Sedimentation Ponds ☐ Applicable ☒ N/A	
H. Retaining Walls ☐ Applicable ☒ N/A	
I. Perimeter Ditches/Off-Site Discharge ☒ Applicable ☐ N/A	
1.	**Siltation** ☐ Location shown on site map ☒ Siltation not evident Areal extent_______________ Depth_____________ Remarks____ ____
2.	**Vegetative Growth** ☐ Location shown on site map ☒ N/A ☐ Vegetation does not impede flow Areal extent_______________ Type_____________ Remarks____ ____
3.	**Erosion** ☐ Location shown on site map ☒ Erosion not evident Areal extent_______________ Depth_____________ Remarks____ ____
4.	**Discharge Structure** ☒Functioning ☐ N/A Remarks____ ____
VIII. VERTICAL BARRIER WALLS ☐ Applicable ☒ N/A	
IX. GROUNDWATER/SURFACE WATER REMEDIES ☐ Applicable ☒ N/A	
X. OTHER REMEDIES	
If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.	

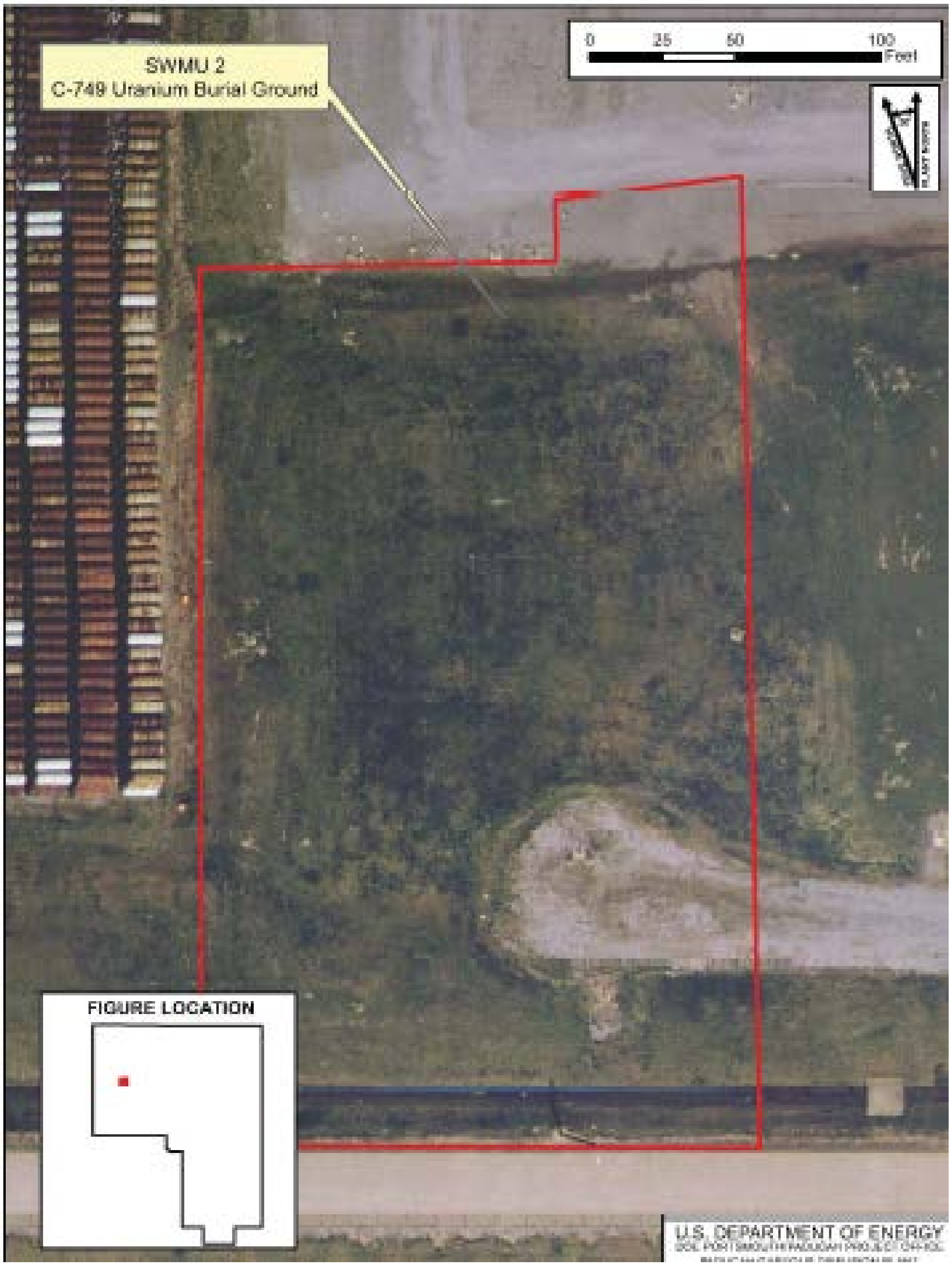
XI. OVERALL OBSERVATIONS	
A.	**Implementation of the Remedy**
	Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.). The landfill and signs are in place and in good condition. No problems were noted with the maintenance. Monitoring wells are in place and are inspected yearly.
B.	**Adequacy of O&M**
	Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy. See Section 17.3 in main text.
C.	**Early Indicators of Potential Remedy Problems**
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future. None.
D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. None.

ATTACHMENT

Inspection team roster (12/20/2017):

Jennifer Johnson (Pro2Serve)	Clint Dietsch (FRNP)	Justin Riley (FRNP)
Teresa Overby (FRNP)	LeAnne Garner (FRNP)	

Site map:



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APPENDIX B

INTERVIEWS

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Interviews Conducted for the 2018 Five-Year Review

Groups From Guidance	Recommended for 2018	Rationale	Interviewed in 2013
Background Information			
Lead Agency Staff/Management*	Yes	Information sought also is available from the Administrative Record.	Yes
Nearest Neighbors	Yes	Information sought cannot be obtained elsewhere.	Yes
Community Representatives	Yes	Information sought cannot be obtained elsewhere.	Yes
State and Local Considerations			
State Contacts	Yes	Information sought cannot be obtained elsewhere.	Yes
Local Authorities	Yes	Information sought cannot be obtained elsewhere.	Yes
Construction Considerations**			
Construction Contractor	N/A	Information sought is available from the Administrative Record.	N/A
Construction Manager	N/A	Information sought is available from the O&M and Facility Managers.	N/A
Local Emergency Response Officials	N/A	These officials participate in regular drills at the site and their insight is addressed as part of those actions.	N/A
Performance, Operation and Maintenance Problems			
O&M Manager (Facility Manager)	Yes	Information sought cannot be obtained elsewhere.	Yes
O&M Staff	Yes	Information sought cannot be obtained elsewhere.	Yes
Remedial Design/Remedial Action Consultant***	N/A	Information sought also is available from the Administrative Record.	N/A

*Lead Agency Staff/Management is listed instead of Previous EPA Staff/Management from the EPA Guidance since it is written for EPA project managers on EPA-lead sites.

**This group is inherent in this review process.

***This category is inherent in this review process.

NOTE: All comments received from the interviews have been forwarded to the appropriate Paducah Site manager to be addressed.

INTERVIEW RECORD

Site Name: Paducah Site		
Subject: Background Information Group	**Time:1100**	**Date:01312018**

Type: ×Telephone Visit Other **Location of Visit:**

Contact Made By:

Name: Teresa Overby	**Title: Project Lead**	**Organization: FRNP**
Jennifer Johnson	**Pro2Serve Field Lead**	**Pro2Serve**

Individual Contacted:

Name: Water Policy Resident	**Title: n/a**	**Organization: n/a**

Telephone No: **E-Mail Address:**

Summary Of Conversation

1. What is your overall impression of the project? (general sentiment)

Doing a good job getting the site cleaned up.

2. What effects have site operations had on the surrounding community?

No opinion—community is appreciative of the effort to clean up.

3. Are you aware of any community concerns regarding the site or its operation and administration? If so, please give details.

No

4. Are you aware of any events, incidents, or activities at the site such as vandalism, trespassing, or emergency responses from local authorities? If so, please give details.

No

5. Do you feel well informed about the site's activities and progress?

Yes, I receive mailers. The mailers could use more detail.

6. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?

It would help the community understand if more detail was included in the mailers like XX amount of hazardous waste was shipped off.

INTERVIEW RECORD

Site Name: Paducah Site		
Subject: Background Information Group	**Time:0930**	**Date:01252018**
Type: ☐☐Telephone ×☐Visit ☐☐Other **Location of Visit: C-103**		

Contact Made By:		
Name: Teresa Overby	**Title: Project Lead**	**Organization: FRNP**
Jennifer Johnson	**Pro2Serve Field Lead**	**Pro2Serve**

Individual Contacted:		
Name: David Dollins	**Title: Groundwater Project Manager**	**Organization: DOE**
Telephone No:	**E-Mail Address:**	

Summary Of Conversation

1. What is your overall impression of the project? (general sentiment)

There is a lot being accomplished. There has been a lot of remediation completed at the site.

2. What effects have site operations had on the surrounding community?

The site has made for a better quality of life with more openness about the site which relieves fears in the public.

3. Are you aware of any community concerns regarding the site or its operation and administration? If so, please give details.

No.

4. Are you aware of any events, incidents, or activities at the site such as vandalism, trespassing, or emergency responses from local authorities? If so, please give details.

There has been a recent mineral oil spill at the site.

5. Do you feel well informed about the site's activities and progress?

Yes.

6. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?

DOE management is doing an excellent job in guiding the cleanup.

INTERVIEW RECORD

Site Name: Paducah Site			
Subject: State and Local Considerations		**Time:1030**	**Date:01222018**
Type: ×□Telephone □□Visit □□Other **Location of Visit:**			
Contact Made By:			
Name: Teresa Overby	**Title: Project Lead**	**Organization: FRNP**	
Jennifer Johnson	**Pro2Serve Field Lead**	**Pro2Serve**	
Individual Contacted:			
Name: Timothy Kreher	**Title: WKWMA Manager**	**Organization: KDFW**	
Telephone No: 270-488-3233	**E-Mail Address:timothy.kreher@ky.gov**		

Summary Of Conversation

1. What is your overall impression of the project? (general sentiment)

Things move slow. There is vagueness about the direction. The projects that are ongoing are good.

2. Have there been routine communications or activities (site visits, inspections, reporting activities, etc.) conducted by your office regarding the site? If so, please give purpose and results.

I am onsite most every day to fix problems, not usually problems with DOE. The house that I live in is in the Water Policy area. There are quarterly meetings with DOE for interaction and DOE has been responsive. Only time issues are seen is when there is a change over.

3. Have there been any complaints, violations, or other incidents related to the site requiring a response by your office? If so, please give details of the events and results of the responses.

Issues noted recently have been trash and loitering at sirens of Kelley Road. DOE has already addressed that issue.

4. Do you feel well informed about the site's activities and progress?

For the most part I feel well informed. The changing of the power lines was not well communicated or coordinated.

5. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?

When conducting operations outside the LA in sight of the public, more oversight may help activities move along quicker and give a better impression.

INTERVIEW RECORD

Site Name: Paducah Site

Subject: State and Local Considerations	**Time:0900**	**Date:01162018**
Type: ×Telephone Visit Other **Location of Visit:**		
Contact Made By:		
Name: Teresa Overby	**Title: Project Lead**	**Organization: FRNP**
Jennifer Johnson	**Pro2Serve Field Lead**	**Pro2Serve**
Individual Contacted:		
Name: Gaye Brewer	**Title: Environmental Scientist**	**Organization: KDEP**
Telephone No: 270-898-8468	**E-Mail Address:gaye.brewer@ky.gov**	
Summary Of Conversation		

1. What is your overall impression of the project? (general sentiment)

Progress is too slow.

2. Have there been routine communications or activities (site visits, inspections, reporting activities, etc.) conducted by your office regarding the site? If so, please give purpose and results.

Yes, I was onsite inspecting C-404 landfill the day of the mineral oil spill. I also participate in the monthly FFA Manager's meetings.

3. Have there been any complaints, violations, or other incidents related to the site requiring a response by your office? If so, please give details of the events and results of the responses.

Initial response to the mineral oil spill at outfall 012 was acceptable and there is still ongoing cleanup. The state Emergency Response Team was called out to the spill.

4. Do you feel well informed about the site's activities and progress?

The CAB gets better overall description of site activities than at the FFA Managers meetings.

5. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?

Better communication, more timely and more forthright, between the FFA parties would be beneficial. Keeping discussions limited to the "hands on" manager and not elevating all actions would help to stream line the agreement process.

INTERVIEW RECORD

Site Name: Paducah Site			
Subject: Performance, Operation, and Maintenance Problems Group		**Time:1330**	**Date:011132018**
Type: ☐Telephone ×Visit ☐Other **Location of Visit: C-764-T3**			
Contact Made By:			
Name: Teresa Overby	**Title: Project Lead**	**Organization: FRNP**	
Jennifer Johnson	**Pro2Serve Field Lead**	**Pro2Serve**	
Individual Contacted:			
Name: Denver Parman	**Title: Pump and Treat Staff**	**Organization: FRNP**	
Telephone No: 270-441-5210	**E-Mail Address:Denver.parman@pad.pppo.gov**		

Summary Of Conversation

1. What is your overall impression of the project? (general sentiment)

Good. System functions efficiently.

2. Is the remedy functioning as expected? How well is the remedy performing?

Yes, it is functioning as expected.

3. What does the monitoring data show? Are there any trends that show contaminant levels are decreasing?

The data show that levels are decreasing.

4. Is there a continuous on-site O&M presence? If so, please describe staff and activities. If there is not a continuous on-site presence, describe staff and frequency of site inspections and activities.

O&M personnel are on call 24/7 and are present 40 hours per week. The system has a system to perform callouts if something is not right.

5. Have there been any significant changes in the O&M requirements, maintenance schedules, or sampling routines since start-up or in the last five years? If so, do they affect the protectiveness or effectiveness of the remedy? Please describe changes and impacts.

For the NW facility O&M remains the same. The NE was optimized and there is an updated O&M plan.

6. Have there been unexpected O&M difficulties or costs at the site since start-up or in the last five years? If so, please give details.

No.

7. Have there been opportunities to optimize O&M, or sampling efforts? Please describe changes and resultant or desired cost savings or improved efficiency.

In 2015, the NW, updated electronics and changed out the carbon vessel system this saved man hours. Previously it took a full day and 10 people, now the carbon change out takes 2 people and 1 hour. In 2017, the NE, updated so that all electronics are controlled from one point out of the weather, so the man hours for maintenance has been reduced.

8. Do you have any comments, suggestions, or recommendations regarding the project?

Internal expertise and equipment for the computer system at the pump and treat systems would help with troubleshooting and possibly quicker resolution of any issue that arises.

INTERVIEW RECORD

Site Name: Paducah Site		
Subject: Performance, Operation, and Maintenance Problems Group	**Time:** 1330	**Date:** 01102018
Type: Telephone × Visit Other **Location of Visit:** C-764-T3		

Contact Made By:

Name: Teresa Overby	**Title: Project Lead**	**Organization: FRNP**
Jennifer Johnson	**Pro2Serve Field Lead**	**Pro2Serve**

Individual Contacted:

Name: Clint Dietsch	**Title: Engineer (FM for C-400, SWMU8, and SWMU 1**	**Organization: FRNP**
Telephone No: 270-441-5254	**E-Mail Address:Clinton.dietsch@pad.pppo.gov**	

Summary Of Conversation

1. What is your overall impression of the project? (general sentiment)

Each remedy is performing to treatment goals as established and have met several remedial action objectives.

2. Is the remedy functioning as expected? How well is the remedy performing?

Remedies are functioning as expected. Where remedial objectives are not fully obtained, additional remedial actions to address are in future actions.

3. What does the monitoring data show? Are there any trends that show contaminant levels are decreasing?

Contamination levels have been decreasing in SWMU 1 and C-400.

4. Is there a continuous on-site O&M presence? If so, please describe staff and activities. If there is not a continuous on-site presence, describe staff and frequency of site inspections and activities.

O&M presence at this time is onsite during normal working hours, however, during operations both SWMU 1 and C-400 had continuous presense.

5. Have there been any significant changes in the O&M requirements, maintenance schedules, or sampling routines since start-up or in the last five years? If so, do they affect the protectiveness or effectiveness of the remedy? Please describe changes and impacts.

Both remedies have been complete and are shut down and on standby at this time. There were no significant O&M changes during operations.

6. Have there been unexpected O&M difficulties or costs at the site since start-up or in the last five years? If so, please give details.

C-400 had difficulty treating the RGA material and this remedial action objective has been moved to future remedial actions.

7. Have there been opportunities to optimize O&M, or sampling efforts? Please describe changes and resultant or desired cost savings or improved efficiency.

C-400 has pursued steam treatability design to optimize RGA treatment. This will hopefully complete all RAOs.

8. Do you have any comments, suggestions, or recommendations regarding the project?

No recommendations for continued O&M pending future remedial actions.

INTERVIEW RECORD

Site Name: Paducah Site			
Subject: Performance, Operation, and Maintenance Problems Group		**Time:1330**	**Date: 01102018**
Type: ☐☐Telephone ×☐Visit ☐☐Other **Location of Visit: C-764-T3**			

Contact Made By:

Name: Teresa Overby	**Title: Project Lead**	**Organization: FRNP**
Jennifer Johnson	**Pro2Serve Field Lead**	**Pro2Serve**

Individual Contacted:

Name: Brian Lowrance	**Title: Operations Manager/FM**	**Organization: FRNP**
Telephone No: 270-441-5896	**E-Mail Address:brian.lowrance@pad.pppo.gov**	

Summary Of Conversation

1. What is your overall impression of the project? (general sentiment)

Effective, the active part of the project continues to have a positive affect on reducing NW plume TCE concentrations. Less active projects continue to maintain condition in an effective manner.

2. Is the remedy functioning as expected? How well is the remedy performing?

Yes, the more active NE/NW pump and treat is functioning as expected and performing its intended function in a satisfactory manner. Lesser active (e.g. Cylinder Drop Test Area, Fire Training Area) remedies are monitored and controlled to ensure the associated remedies are maintained.

3. What does the monitoring data show? Are there any trends that show contaminant levels are decreasing?

For NW and NE pump and treat the monitoring data illustrates TCE concentrations have decreases when compared to plume maps from the past. Less active are typically not directly monitored. General environmental sampling has not identified any negative trends associated with any of these remedies.

4. Is there a continuous on-site O&M presence? If so, please describe staff and activities. If there is not a continuous on-site presence, describe staff and frequency of site inspections and activities.

O&M personnel are present during normal scheduled project business hours. NE/NW pump and treat PLC system monitors operational parameters and will call-out personnel if conditions are outside these parameters.

5. Have there been any significant changes in the O&M requirements, maintenance schedules, or sampling routines since start-up or in the last five years? If so, do they affect the protectiveness or effectiveness of the remedy? Please describe changes and impacts.

No significant changes in O&M requirements. Requirements have increased some as a new treatment trailer has been added to the NE plume.

6. Have there been unexpected O&M difficulties or costs at the site since start-up or in the last five years? If so, please give details.

No.

7. Have there been opportunities to optimize O&M, or sampling efforts? Please describe changes and resultant or desired cost savings or improved efficiency.

Yes and implemented. A new treatment trailer has been added at the NE plume which has optimized the positive affect on reducing TCE concentrations, which increases reliability.

8. Do you have any comments, suggestions, or recommendations regarding the project?

Not at this time.